CHINA AND GLOBAL CLIMATE CHANGE

Proceedings of the conference held at
Lingnan University, Hong Kong, 18-19 June 2009

Organised by the Centre for Asian Pacific Studies
and the Environmental Studies Programme,
Lingnan University

Paul G. Harris, Director

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Published in 2009 by the Centre for Asian Pacific Studies and the Environmental Studies Programme, Lingnan University, Hong Kong

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Preface

The conference on China and Global Climate Change was held at Lingnan University, Hong Kong, from 18-19 June 2009. About 100 scholars from around the world participated in the conference. They served in various capacities, including as presenters, researchers, paper writers and/or discussants. The conference was jointly organized and sponsored by Lingnan University's Centre for Asian Pacific Studies (CAPS) and its Environmental Studies Programme (ESP). The objective of the conference was to examine the problem of how to reconcile China's growing greenhouse gas emissions with the Chinese government's unwillingness (so far) to join binding international commitments to reduce those emissions.

Since the start of international negotiations on climate change in the 1980s, the Chinese government has refused to be bound by commitments to limit its pollution of the atmosphere. This refusal is based on the historical responsibility of the world's wealthy countries for past emissions and China's status as a developing country. President Hu Jintao recently reaffirmed that China will not commit to mandatory emissions-reduction targets before the world's wealthy countries take the lead in addressing global climate change. He has also called on affluent countries to pay for emissions limitations in China and other developing countries.

Alongside these Chinese concerns about justice and historical responsibility is the new reality that China has become the largest national source of pollution causing climate change. Without China's involvement, notably limitations in its future greenhouse gas emissions, international efforts to mitigate global warming substantially are unlikely to succeed. This comes against the backdrop of increasing concerns among atmospheric scientists that global warming is happening more quickly than predicted, that climate change will be more severe than anticipated, and that the poorest countries and people of the world will experience monumental suffering in coming decades as a consequence.

Thus the conference aimed to assess how China's longstanding concerns about international fairness and justice can be squared against the pressing need for an effective international regime that limits greenhouse gas emissions – including those from China.

Conference Themes and Questions

Major themes underlying the conference included (1) practical considerations, including the latest findings on greenhouse gas emissions and climate change impacts, including in China; (2) ethical considerations, including questions of fairness, justice and human rights related to climate change and China's role; and (3) political considerations, including issues related to the domestic and international politics of climate change, the international climate change negotiations, and the political significance in other countries of China's climate change diplomacy and policies. The conference participants aimed to address these and other questions related to China and global climate change:

> Is there any common ground between China's concern with development and international justice, on one hand, and growing greenhouse gas emissions and the worsening problem of climate change, on the other?
>
> What must the developed countries do to persuade the Chinese government to commit to greenhouse gas limitations, and eventually reductions, in the future? How can they facilitate those limitations?

Does China's newfound wealth undermine the argument that it should not be required to limit its greenhouse gas emissions? What ethical arguments bolster or bring into question China's reluctance to restrain emissions?

How do the adverse impacts of climate change for China's poorest people, and indeed for poor people throughout the developing world, affect China's obligations? Does China have obligations to poorer countries just as wealthier countries have obligations to China?

How significant is it, practically, ethically and politically, that China is going down the same fossil-fuel development path as the West just as scientists are warning of the severe consequences of doing so? Does it matter that China's economic emergence has occurred against the backdrop of improving climate science, whereas the West was historically unaware that its development path was unsustainable?

Should China's new wealthy classes be allowed to hide behind China's developing-country status to avoid lifestyle changes increasingly demanded of most people, including poor ones, in the world's developed countries?

How is the failure of Western governments to implement major cuts in greenhouse gases a political issue in China? Do China's positions on climate change make it more difficult for developed-country governments to persuade their constituents to accept the major cuts in greenhouse gas emissions that will be required to address climate change?

Are workable and affordable technical solutions available to allow China to take a different development path so that its people can enjoy the fruits of modernity without causing monumental harm to the global environment? How can the West encourage and support those solutions?

Given that China and the United States are the largest national sources of greenhouse gas pollution, albeit with very different capabilities and historical responsibilities, how might they work together to protect the atmospheric commons?

Participants in the conference approached these and related questions from a variety of epistemological, empirical and ontological perspectives. While their conclusions varied, there was a strong consensus among delegates in attendance that it is vitally important to understand China's role in efforts to address climate change. The papers that comprise these proceedings make a major contribution to developing and advancing that understanding at a crucial stage in international efforts to curb and respond to atmospheric pollution.[1]

Acknowledgements
The conference would not have been possible without the work of more people than I can count. I am grateful firstly to the participants, especially the dozens of scholars who attending the meeting in Hong Kong and spent two days intensively sharing ideas about China's role in the climate change problem and related debates. A number of people at Lingnan University

[1] In addition to presentations related to the papers here, the conference included presentations only by Kevin DeLuca and Ye Sun, who spoke on "Framing China: US Media, Global Warming, and the Chinese 'Threat,' " and Sondra Venable, who talked about "Russian Resources, Chinese Emissions: The Greenhouse-Gas Footprint of Sino-Russian Trade."

have my gratitude for helping to organize and run the conference: Professor Brian Bridges, for acting as an experienced sounding board throughout the preparations; Dr. Jonathan Symons for helping to organize and plan the panels, and for serving as discussant; and Cyrus Lee, Yuen Chong Wai, and Tommy Wong from the Department of Political Science, and Dorothy Kok and Felix Tsang from the Institute of Humanities and Social Sciences, for helping on the day of the conference.

All of us are especially indebted to Roger Lee Huang, Research Development Officer in CAPS and ESP, for his monumental efforts in helping me with every aspect of the conference, including making the complicated arrangements for both bringing delegates to Hong Kong and getting their papers on the table at the conference; for taking care of a variety of unexpected problems before, during and after the conference; for making sure all of the delegates (especially those from overseas) were happily housed and fed; and – last but not least – devoting many hours indeed to collecting all of the papers together and formatting them for these proceedings.

Indeed, it is these proceedings that will outlast the conference. They will serve as the foundation for full-fledged publications to come, thereby building on the conference itself and adding to debates about how to solve the puzzle of China's growing affluence and its growing contribution to climate change.

Paul G. Harris
Hong Kong
June 2009

Introduction

Paul G. Harris[1]

In December 2009, diplomats will meet in Copenhagen to finalize what many hope will be a strong agreement to fight global warming and climate change. They will grapple with how to address these problems in light of new scientific findings showing that the adverse effects of global warming are happening sooner and are more severe than scientists predicted only a year or two ago. Some countries, notably in Europe, have started to take serious steps to limit and in several cases reduce their emissions of carbon dioxide and other greenhouse gases. However, those efforts have been very slow in coming, and any politically realistic scenarios for action by industrialized countries in the next decade or two will be swamped by increasing emissions from the developing world.

One reason for the world's slow and weak response to climate change is a game of "you go first" being played between rich and poor countries, particularly between China and the United States. Both of these latter countries now agree that much more needs to be done. The United States no longer denies the problem, and China has come to acknowledge its major role. At the same time, China rightly expects the United States and other wealthy countries to do much more to reduce their pollution and provide aid to help developing countries grow more sustainably and cope with the effects of climate change. After all, China's average per capita emissions of greenhouse gases remain well below those in the developed world.

However, owing to its large population and rapid economic growth, China's emissions are ballooning. It has overtaken the United States to become the most polluting country in the world, and within the next twenty years or so its emissions of carbon dioxide will account for nearly one-third of the global total.

Three Dilemmas

How can the world reconcile China's new status as the largest polluter of the atmosphere with its justifiable expectations for continued economic development? In answering this question, we might start by thinking about three dilemmas presented by a rising China:

A Practical Dilemma

China's efforts to limit its carbon dioxide emissions, while commendable, are nowhere near enough to actually start reducing national emissions. Pollution will increase, albeit at a somewhat slower rate, as China's economy grows. Without much more robust action by China in the near future, efforts in the West to prevent the worst effects of climate change will fail. Industrialized countries are understandably not enthusiastic about doing what is necessary, including implementing economically and politically disruptive policies at home, if their efforts will be in vain. Thus, avoiding concrete and measurable action is no longer a practical option for China – at least not if the world is to make substantial progress in fighting climate change this century.

An Ethical Dilemma

China has argued for decades that developing countries should not be required to limit their development to fix a problem caused by the industrialized world. Its argument that rich

[1] Outgoing Professor of International and Environmental Studies, Director of the Centre for Asian Pacific Studies, and Director of the Environmental Studies at Lingnan University, Hong Kong; incoming Chair Professor of Global and Environmental Studies, and Head of the Department of Social Sciences, at the Hong Kong Institute of Education (pharris @ ied.edu.hk).

countries should substantially reduce their greenhouse pollution and provide developing countries with aid to address climate change seems unassailable. The rich countries caused the problem and they ought to fix it before requiring developing countries to act. But this argument applies only if we think narrowly in terms of governments and states. If we think in terms of *people*, China's argument is much weaker. After all, many millions of Chinese are now living affluent lifestyles akin to those of people in the West. If it is wrong for Londoners and New Yorkers to pollute the atmosphere, it must be wrong for affluent people in Hong Kong and Shanghai to do so, too.[2]

A Political Dilemma

While industrialized countries are indeed responsible for most of the climate change problem today, millions of affluent Chinese are responsible for much of the problem in the future. It may be politically impossible for Western governments to ask their citizens to change their lifestyles substantially, and to pay more for energy, when those people are bombarded with television images of Chinese joining the global consumer class – something for which the Chinese government is rightly proud, but which has profoundly negative consequences for the global environment.

Beijing's Leadership?

How can we escape these dilemmas? The solution to the "you go first" mentality of climate change diplomacy may be found in an acknowledgment by Beijing that not all Chinese are the same. Some of them have a responsibility to act now to fight climate change even if China as a state continues to reject such a responsibility. Put another way, all of China need not wait until Americans and Australians go first. Affluent people in China can act alongside the majority of Americans and Australians. Most Chinese people will continue to use more energy, as is their right, but the most affluent among them will have to cut back alongside most Westerners.

China can be a leader on climate change without limiting its development. By formally agreeing to have some of its most well off people act in the fight against climate change, China can break the diplomatic deadlock and remove the last excuse that Western governments have used to avoid fulfilling their responsibilities. By doing so, Beijing would send a powerful message around the world

Thus Beijing may hold the key to a future in which the Earth's climate is more benign than many scientists fear – but only if affluent people in China accept that they are part of the problem.

[2] For extensive elaboration on this point, see Paul G. Harris, *World Ethics and Climate Change: From International to Global Justice* (Edinburgh: Edinburgh University Press, in press).

Global Sustainability, Climate Change and China:
The Need for a New Paradigm for International Cooperation

Mukul Sanwal[1]

Abstract

The basic assumptions of global environmental sustainability around international cooperation that were laid out fifty years ago no longer hold. This common understanding was based on the fact of the historical responsibility of developed countries for causing the pollution – developed countries would do whatever has to be done and support developing countries through provision of financial resources and technology. Therefore, to ensure global sustainability, we have to seriously consider whether adopting a defensive posture in the ongoing climate negotiations is the best policy or, with the balance of economic power shifting out of the United States and Europe to Asia, the time has come for countries like China to design a different paradigm for sustainable development.

Achieving a global consensus to meet the challenge of climate change is an issue that is currently being debated. The lack of progress relates to the design and implementation of the rules that have been established to reflect the historical responsibility of industrialised countries for global pollution. The gap between concern for the environment and the nature and scope of the design and implementation of the actions – the way the problem has been defined, arrangements for multilateral cooperation designed and implementation sought through the market – has led to a situation where international cooperation is seen in terms of burden sharing. Consequently, the basic assumptions of global environmental sustainability that developed countries will do whatever has to be done and international cooperation will support actions in developing countries, laid out fifty years ago, no longer hold. In fact, by framing the issue in terms of responses to international commitments, such negotiations not only lead to inconclusive debate but also serve to stifle innovative solutions based on national circumstances.

This paper analyses the implications of the historical responsibility of developed countries in causing the global problem of climate change and its adverse effects in the context of the current impasse in finding a global consensus to deal with the challenge of climate change. The paper is in three parts. Part I highlights the gap between the rhetoric of developed countries in their concern for the global environment and the reality of their actions in designing the rules, establishing institutions and implementing actions. Part II of the paper suggests policy drivers for global sustainability, based on current emission trends that focus on modifying consumption patterns and recognising ecological services as key elements of global sustainability. In this framework international cooperation would be based on designing new institutions to support technology development and transfer to respond to the scale and speed required to meet the challenge, instead of the current focus on international trade. In the last part of the paper a new paradigm is proposed for a global consensus where patterns of resource use will have to be common for all countries.

I.
Climate Change in The Context of Sustainable Development

A better understanding is emerging of what sustainable development means, driven largely by the intensive academic research, business concern and policy experience around climate change. Current research trends on how to meet global challenges focus on societal dynamics as both the root of environmental problems and the potential solution to them (IHDP, 2007).

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[1] Mukul Sanwal has held senior policy positions in the Government of India, United Nations Environment Programme and in the United Nations Climate Change Secretariat. Currently he is Adviser to the South Centre, Geneva. These are his personal views. (sanwals@gmail.com)

Environmental problems are no longer defined as discrete problems, but are increasingly being understood as symptoms of a particular development path.

Seen from this perspective, from an effectiveness point of view, the choice is not between preservation and exploitation of nature, and there is widespread disappointment with the conventional approach to conservation and pollution based on command-and-control promoted during the 1980s and 1990s. From an equity point of view, the current concern is not so much over the sovereign right to exploit natural resources but rather on the consequences of institutional patterns of resource use that would have to be common for all countries. Clearly, the way the issue continues to be framed only around the environment is a major reason why effective solutions have not emerged.

According to recently released UN data for the European Commission, emissions from the energy sector, accounting for 80 per cent of total GHG emissions, increased by 2.2 per cent in the period 1990 and 2006 – transportation emissions increased 25.8 per cent and emissions from energy industries by 3.7 per cent (UNFCCC, 2009), despite its emissions trading scheme, and emissions in Japan and the United States have should double digit growth. On the other hand, the approach adopted by China focuses on activities that generate the pollution. Placing resource conservation, environmental protection and economic development on equal footing is showing good progress. The 11th Five year Plan of China (2006-2010) has set a target to reduce energy use per unit of GDP by 20 per cent by 2010 compared to 2005, China has more efficient coal fired plants than the United States and is becoming the major world market for such plants, and also for renewable energy (IEA, 2009). On World Environment Day China issued a nationwide call for a “low carbon lifestyle”. Against these achievements, the continuing in-action, even in those developed countries who are championing global sustainability, means that we need to question the assumption in the international relations literature that countries are seeking a fair outcome in the on-going negotiations.

Actions by all countries are to be taken within the framework of the rights and obligations established by the Climate Change Convention, negotiated in 1992, which requires developed countries to take the lead and to provide technology and financial resources to enable measures to be taken by developing countries. Previous negotiations on climate change have picked the low-hanging fruit available to developed countries, and as considerations of historical responsibility and global social justice for sustainable development are brought to the fore by developing countries, we may well have reached the end of the line for arriving at a global consensus under the current framework. We need to identify why the current regime has not worked, and what might be done about it.

The time has come to rethink the current model for international cooperation that focuses solely on national emissions rather than on the activities that generate those emissions. Current approaches to climate change do not address the essential drivers of the emissions - the individual citizen. The missing element can be provided by a shared vision where patterns of resource use have to be common for all countries.

The Missing Element of Equity

A global response to meet the challenge of climate change raises questions as to how the burden of reducing the threat should be shared among nations throughout the world, given that they have different responsibilities for causing the problem and different vulnerabilities to harm caused by climate change.

The tension between industrialized and developing countries over global, as distinct from local, environmental concerns goes back to the Stockholm Conference on the Human Environment in 1972. At that time the argument was made that population growth in developing countries would lead to environmental catastrophe. At the Rio Conference on

Environment and Development in 1992, when the Convention on Climate Change was negotiated, the issue was defined as one of production patterns, with rising industrial emissions of greenhouse gases in developing countries leading to global warming, and catastrophe. Industrial emissions in industrialized countries have remained steady since 1990, since they had completed development of their infrastructure and had begun shifting to services as the engine of economic growth. Since industrialization was just getting way in developing countries, the finger continued to point at them.

Viewing climate change and its adverse effects through the prism of justice and human rights, rather than only through the lens of science and economics, reveals a very different picture to the popular version of polar bears on ice floes in danger of extinction and smokestacks clouding the sky. The dominant view in developing countries is of one billion citizens lacking access to modern electricity, and an equal number suffering from increasingly more prolonged drought. For example, Darfur is already experiencing the catastrophic adverse effects of climate change.

A shared global vision of countries at different levels of development – per capita GDP as well as emissions – must have environmentally sustainable global growth as the central objective, with carbon management as a result and not the other way round. On a per-capita basis, developed countries emit almost three times as much carbon dioxide as the world average and about six times more than in developing countries. The global goal should target consumption and not production patterns, with the per capita emissions of developed countries coming below the world average within the next twenty years, as a first step.

Yet, pressure continues to mount on developing countries to take on commitments to reduce emissions of carbon dioxide because of their strong economic growth. These initiatives ignore the provisions of the Climate Convention, in particular, Article 4.7, which states that "the extent to which developing country Parties will effectively implement their commitments under the convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will fully take into account that economic and social development and eradication of poverty are the first and overriding priorities of the developing country parties". That "the Parties have a right to, and should promote, sustainable development" (Article 3.4) is one of the principles of the Convention.

While considerable progress has been made at the global level in identifying issues that are of common concern, even after forty years of discourse, debate and discussion, considerably less progress has been made in developing a shared conceptualisation of how to deal with these issues in the North-South context. This topic arises in every serious international discussion in the context of implementing multilateral environmental agreements, and is a source of significant tension.

The Political Bias in The Way Sustainability has Been Framed

The nature and scope of the problem of global sustainability has long been recognized, but not acted upon because of political considerations. The report 'US Priority Interests in the Environmental Activities of International Organizations', prepared by the Committee on International Environmental Affairs of the State Department, in the run-up to the first United Conference on the Environment in 1970, noted that

"Long range policy planning to cope with global environmental problems must take account of the total ecological burden. This burden tends to increase with population growth and with the level of economic activity, whereas the capacity of the environment to provide essential inputs to production and to absorb unwanted outputs from consumption is fundamentally limited. The problem with managing total ecological burden will remain even after world population is stabilized. *Controlling that burden by systematic reduction in per capita production of goods and services would be politically unacceptable.* A concerted effort is needed to orient technology towards making human demands upon the environment less severe" (italics added) (State Department, 2005 - 1).

As the annual publication of The World Watch Institute observes, changing lifestyles will also be necessary, "as the world's climate cannot be saved by technology alone. The way we live will have to change as well…..the things we may need to learn to live without – oversized cars and houses, status based consumption, easy and cheap world travel, meat with every meal, disposable everything – are not necessities or in most cases what makes people happy" (State of the World, 2009) .

Despite the scientific evidence that climate change is really a problem of the ecological burden of developed country per capita consumption and production patterns, the issue has been framed in terms of assessments of damage and the attendant emissions targets and timetables that pits old against new emitters. Global attention is sought to be focused on the increasing emissions from China (and India), where three quarters of the electricity generated goes for industrial production and any reduction in emissions will have a direct impact on economic growth, unlike in developed countries where consumption by households accounts for two-thirds of the electricity generated, and reductions will impact only on (wasteful) lifestyles.

The absence of a shared global vision has hindered a global consensus. As early as 1970, the State Department noted that

"….some African representatives may strongly *challenge developed countries "doctrine" on environmental matters at the upcoming Stockholm Conference*….their views linking environment and development will be with us for years to come…. that the documents prepared for the Conference give *far more weight to the preoccupations of industrialized countries than to the far more serious ones of the developing countries……….* the problems to be discussed at the conference are of a *political nature* (italics added) (State department, 2005 - 2).

Even though three-quarters of Africa still has no access to electricity, the aspirations of developing countries for economic growth continue to be highlighted as the problem in dealing with climate change, while the impact of developed countries economies on the environment is ignored. For example, the Energy Information Administration has predicted that coal would provide 57 per cent of US electrical power production in 2030, up from 51 per cent today (EIA, 2008), but the focus in the media and in the negotiations is on the continued reliance of China and India on their coal reserves. The additional cost of building integrated gasification combined cycle (IGCC) coal fired plants in China instead of more conventional plants has been estimated by the US National Academy of Sciences to be $190 billion (National Academy of Sciences, 2008), however, there is limited discussion of technology transfer at the global level. According to recent estimates by the International Energy Agency carbon capture and storage, a technology that is not yet commercial, would double the cost of a coal fired plant (IEA, 2009), and raises the question regarding the provision of financial resources on a grant or concessional basis. It is also not generally pointed out that China has only 13 per cent of the number of cars in the US, with a population that is four times larger. A shared global vision of environmentally sustainable global growth, supported by technology transfer, will be essential for any meaningful deal on climate change.

The methods adopted for arriving at a consensus also continue to have a familiar ring to them. In the run-up to the Stockholm Conference on the Human Environment, the Scientific Attaché in Brazil suggested to the State Department that

" ….as you know one of the standard department procedures, especially where international organizations or activities such as the upcoming Stockholm Conference are concerned, when they run into trouble is to attempt to *mount a demarche by all of the ' friendlies' on the poor little fellow who happens to be 'unenlightened' to appreciate fully the merits of our position*….. I think we can anticipate without much difficulty that there is going to be a continuation of the feeling among many of the underdeveloped countries *that being concerned about the environment is, in the final analysis, a rich man's game.* This feeling may well, in fact be present at a low level even with countries which may be pragmatically willing to go along "*for what's in it for them*". While we know this not just a rich man's game, *we also know that it is sometimes very difficult to persuade otherwise someone whose major goal must be development*. Accordingly, my suggestion would be that you …….set in motion now…with specific 'friendlies' ….. .a well thought programme of gradually informing and hopefully converting the key policymakers wherever that seems necessary. …..to *establish long term persuasive relationships with the policymakers of specific underdeveloped countries where they may have influence by virtue of past association or a special relationship*…." (italics added) (State Department, 2005 – 3).

A shared global vision with respect to patterns of resource use would not need tactics that knowingly lead to outcomes detrimental to the interests of one partner in the negotiations. The context in which sustainability has been discussed at the multilateral level has changed, since the issue first came onto the global agenda in 1972, stressing single global solutions and financial inducements. The challenge now is to increase resource productivity – using fuel, water and raw materials more productively. In this framework of global sustainability stressing demand side management, patterns of resource use will have to be common for all countries, and primarily require national action in developed countries.

Questions Around The Legitimacy of Multilateral Environmental Agreements

The recently published 'The Oxford Handbook of International Environmental Law' raises the important issue of legitimacy, that "international environmental law continues to struggle with the complaint that it reflects the concerns of developed countries more than those of developing countries…..in the ongoing debates over whether developing countries, for example, should preserve biological resources of global concern or should reduce their greenhouse gas emissions and, if so, how much financial support developed countries should provide for such efforts" (Bodansky, 2007). Maurice Strong, writing in 'Foreign Affairs' in 1973 immediately after the Stockholm Conference, also advocated a management approach to global environmental problems, and did not advocate multilateral environmental treaties as an organising theme (Strong, 1973).

The current global framework was established to respond to concerns with growing industrial pollution in the mid-twentieth century. The Stockholm Conference on the Human Environment, in 1972, made a distinction between global and local environmental problems, and recognised the socio-economic factors behind many global environmental problems, but both developed and developing countries were uneasy with the resulting compromise because it implied a trade-off between environment and development. The Rio Conference on Environment and Development (UNCED), in 1992, continued to treat environment as a separate policy issue, and focussed on the promotion of multilateral environmental instruments as a way to make environment and development compatible.

International environmental law was adopted as the framework for governance in order to reconcile the differing and competing concerns of developed and developing countries. This framework was conceptualised in terms of mutual rights and responsibilities of polluting and victim states. It was argued that interdependence in terms of contributions and solutions required cooperation, and the response was to build multilateral treaty-based regimes. The use of law to produce global collective benefits raised the important question of burden sharing. However, the principle of common but differentiated responsibilities that emerged at the Rio Conference, in 1992, did not specify what is to be done and paid for and by whom and for what purpose.

Principles included in treaties, for example equity, not only raise difficult questions and leave them unanswered, but reservations have also been recorded to these Principles in areas that deal with issues in the North-South context. The most important Principles, Principle 7, of the Rio Declaration, referring to common but differentiated responsibilities, and benefit sharing in the Convention on Biological Diversity have not been accepted by the United States (UN, 1992) and the European Union (UN, 1993), respectively. At the World Summit on Sustainable Development, 2002, the United States recorded an interpretative statement, repeating its position that Principle 7 of the Rio Declaration highlights the "special leadership role of developed countries……and the United States does not accept any international obligations or liabilities, or any diminution of the responsibilities of developing countries under international law". The United States goes on to add that in its view "….negotiation of an international regime to promote and safeguard the fair and equitable sharing of benefits arising out of the utilization of genetic resources….would not entail the development of a legally binding instrument" (UN, 2002). Consequently, these principles have yet to gain legal status, and this factor accounts for the limited progress in achieving a consensus on actions for implementation of the related agreements.

The problems with the current framework are not limited to the 'Rio Conventions'. The development of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes provides another example. In the 1980's following increasingly stringent environmental standards and rising disposal costs in industrialised countries, attempts to ship toxic wastes to developing countries led countries in the African region to call for an outright ban on the export of hazardous wastes. A multilateral agreement was achieved only on regulation rather than on a ban of such exports. Experience with implementation of these treaties shows that a very different framework than the current paradigm based on international environmental law is needed (Sanwal, 2007).

The continued stress on achieving a negotiated and legally binding agreement as the outcome of inter-governmental meetings has resulted in the Commission on Sustainable Development concluding its session in May 2007 without any agreed outcome. The unresolved issue centred around an international treaty on time bound targets for energy efficiency (pushed by the European Union) and the provision of financial and technical assistance (pushed by the developing countries) (ENB, 2007). In a related development, at the Solar World Congress, in September 2007, China proposed a multilateral science and technology co-operation agreement to establish international laboratories and research and development centres on renewable energy to act as a platform for transfer of technology (SciDev Net, 2007).

In fact the 2002 World Summit on Sustainable Development (WSSD) had adopted a very different approach, and considered consumption and production patterns as an essential element in understanding how global environmental problems can be solved locally. The Johannesburg Plan of Implementation requires placing "more emphasis on actions that enable implementation at all levels, including promoting and facilitating partnerships involving Governments, international organizations and relevant stakeholders for the implementation of

Agenda 21"(para 146, Johannesburg Programme of Implementation). The emphasis is on three *new* areas. First, to "focus on the cross-sectoral aspects of specific sectoral issues and provide a forum for better integration of policies, including through interaction among Ministers dealing with the various dimensions and sectors of sustainable development through the high level segments" (para 147). Second, "identify constraints on implementation and make recommendations to overcome those constraints" (para 148). Third, "promote best practices and lessons learned in sustainable development" (para 150).

New processes for enhanced global cooperation, directed equally towards national governments, business and local communities, will require arrangements to rebalance the relationship between formal and informal institutions. The focus is shifting from policy guidance to countries, developed through an agreed document, to sharing experiences of best practices. The new institutional framework requires coherence with new actors at multiple levels, with human well-being as the overriding objective. Though fresh thinking has taken place in the periodic international conferences distinguishing between global environmental and sustainable development governance, the outcomes have yet to be developed into a new framework.

Despite the emergence of new perspectives, developed countries continue in their efforts to alter the agreed balance of rights and obligations in the climate treaty in order to shift the burden onto developing countries. For example, they are not willing to accept a climate agreement based on equal per capita emissions allocations or historical cumulative emissions, because of the implications for them. Moreover, even those that acknowledge that over the long term there is no real alternative to convergence on roughly equal per emissions at very low levels (about 2 tons per capita), suggest a graduated approach that eliminates the "simplistic" division between developed and developing countries as well as a shift to the principle of capacity in place of responsibility. Such a view goes back to 1992, when the US insisted on introducing capacity into the principles of the climate treaty. Differentiation was also proposed by developed countries during the Montreal Protocol negotiation in the 1990's, arguing that wealthy developing countries should not get any assistance (and a formula based on per capita emissions was agreed). These elements are currently again being raised in the climate negotiations to divert attention from the real issue of the ecological burden of developed country lifestyles.

A recent study of international support for adaptation to climate change concluded that the various funds are not technically adequate for responding to developing countries' needs, both because of the complex design of the funds and the poor implementation of the guidance provided by the Conference of the Parties (Mohner and Klien, 2007). It is now being recognized that "the times when it was possible to sweeten a deal for developing countries with placebo funds and voluntary declarations have irrevocably past" (Muller, 2008). A recent publication co-authored by the OECD - Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A study Drawing on Patent Data – concludes that "there is no visible effect of the Kyoto Protocol on technology transfer" (Dechezlepretre, 2008). The European Policy Institute assessing the extent to which the EU has lived up to existing financial commitments made for supporting implementation of the Kyoto Protocol has concluded that there is lack of clarity in defining what is new and additional, the information communicated to the UNFCCC is unreliable or not provided, and the annual amount provided to multilateral funds "falls well short" of the commitment. (Pallermaerts, 2009)

While globalization increases the rewards in coordinating policies, the interests of major economies need to converge and domestic costs should not be high for a multilateral agreement.

Using Market Based Arrangements to Shift the Burden

Under the current framework developed countries consider international trade as the most powerful form of international cooperation. Multilateral negotiations, therefore, seek solutions through cost-benefit analysis, global market mechanisms to secure efficiency gains, and a global price for carbon - which essentially mean reducing costs in industrialised countries. Consequently, the focus of international negotiations is to seek outcomes that create, national, regional and global markets, as in the case of the "flexibility mechanisms" of the Kyoto Protocol, companies profiting through new markets for cleaner technologies, or even shifting polluting industries overseas. This framework completely avoids the ethical question of industrialised countries emitting greenhouse gases above their fair share of safe global emissions, and has an immediate duty to reduce their national emissions without regard to global cost-benefit analyses and global agreements.

For example, the leader of the US delegation to the Stockholm Conference, held in 1972, obtained the approval of the President on the environmental goals, stating that

"The overall U.S. objective to the conference is to raise the level of national and international awareness and understanding of environmental problems and to increase national, regional and global capabilities to recognize and solve those problems which have serious adverse impact on the human environment. *By doing so we will maintain and improve our international economic, competitive position as other countries adopt control measures comparable to our domestic measures*" (italics added) (State Department, 2005 – 3).

Actions by developing countries interlinked with commercial interests of developed countries were also a decisive factor in the United States agreeing to the Montreal Protocol. Richard Benedick, who led the United States delegation, documents the pressure "American corporate chiefs" put on the Bush Administration.

In the current negotiations on climate change the stress on global emissions standards in electricity generation, cement and steel sectors will impact only on developing countries, and have the objective of opening the way for export of equipment. This is because in the developed countries emissions from industrial emissions have been steady since 1992, and any global standard would be based on levels they have already achieved. Calls in the WTO for developing countries reducing tariffs on environmental goods and services, and simultaneous demands for raising tariffs in developed countries on imports manufactured in countries that do not have emission reduction commitments, should be seen in this context.

Just as financial wizards did not understand that their increasingly complex models were getting further away from the real world, climate policymakers are also being lulled into complacency by new financial products like Emissions Trading with opt outs, as well as the project based Clean Development Mechanism (CDM) and Reducing Emissions from Forests and Forest Degradation (REDD) that essentially offset emissions. Offsets allow companies and governments in developed countries to pay developing countries to make their carbon reductions for them. It has been pointed that so many permits may be bought that industries will have emitted 1 per cent more in 2008 than they did in 1990 (Michael Wara, Stanford University, USA, in 'International Herald Tribune' 8 May 2009).

The Stern Report is an illustration of the continuing problems with formulations based on cost-benefit analysis for burden sharing to produce collective benefits (Stern, 2007). The weight given to future generations has been criticised as too high (by William Nordhouse, of Yale University) and the weight given to the consumption of the poor relative to that of the rich has been criticised as too low (by Partha Dasgupta, of Cambridge University). Both agree that the choices made in the report are inconsistent with each other: egalitarianism between the future and the past also requires egalitarianism between the rich and the poor. The conclusions of the report lead to a redistribution from poorer to richer countries, and raises questions regarding mitigation of climate change that are political, rather than legal or technical in nature (Economist, 2007).

As the Nobel Prize winner, Joseph Stiglitz, recently pointed out in his address to the International Economics Association, held in Istanbul in June 2008, the key problem is how to allocate emission rights, currently valued at about $2 trillion annually, that is 5% of global GDP, and the "only serious defensible principle is equal emission rights per capita, adjusted for past emissions…. as a process of slowly easing in emission rights would increase inequities associated with past emissions". Even if this entails large redistribution, it is not clear why this should be treated differently than other property rights. Stiglitz goes on to argue that climate change will require a new economic model – changed patterns of consumption and innovation, as "only through changes in patterns of demand will adverse effects on developing countries be mitigated".

For international comparison of the effects of the measures adopted by all countries it is important to agree on, and understand, the driving forces. Such indicators are best based on per-capita consumption and not on GDP. Market exchange rates fluctuate widely and differences in consumption of different baskets of goods and energy prices makes determination of purchasing power parity problematic as a tool to compare countries with one another. The two also give different results even for countries at similar levels of economic development. In what can be considered as a response to these methodological problems, the Chancellor of Germany has suggested adoption of a global standard of 2 tonnes of carbon dioxide per capita as the basis for international cooperation on climate change.

II.
The Emerging Focus on Consumption Patterns

As the International Energy Agency points out, in developed countries on the consumer side of the economy technological and lifestyle changes combined with higher incomes have significantly altered energy use patterns since the Climate Convention was negotiated in 1992, with over two-thirds of carbon dioxide emissions now coming from the services, households and travel sectors. In those countries over forty per cent of the electricity generated is used in buildings – as a result of urbanization - in cooling and heating, lighting and appliances, and end-use energy demand continues to increase.

A recent study also highlights a shortcoming of the current international approach of setting emissions targets on a nation-by-nation basis, and at the point of production rather than consumption, amidst increasing globalisation of the world economy. As manufacturing industries and their jobs shift from high-wage developed economies to low-wage developing economies, and more and more goods and services flow the other way, national emissions targets have less meaning. Economic researchers at Carnegie Mellon University in Pennsylvania have come up with a fully quantified measure of China's export-related emissions using standard money flow models and official China emissions data. The team, led by Christopher Weber, found that in 2005, China emitted 1.7 billion tonnes of greenhouse gases from its export-related sectors, 33 per cent of the national total, up from an estimated 12 per cent of total emissions in 1987. It has, thus, become easier for developed countries' to slow the growth in their emissions and meet their targets at the expense of developing countries - in effect, exporting their emissions. These findings bring a new perspective to the international debate over emission targets and burden sharing as the UN struggles to strike a new global accord to succeed the Kyoto Protocol on global warming.

The Human Development Report, 2007/8, 'Fighting Climate Change: Human Solidarity in a Divided World', produced by the United Nations Development Programme, concluded that “carbon intensive growth is symptomatic of a deeper problem…that the economic model which drives growth, and the profligate consumption in rich countries that goes with it, is unsustainable”. Such a debate has not taken place, because it would focus attention on the consumption patterns of the rich countries. The consumer is the ultimate driver of emissions of greenhouse gases, and lifestyles need to change to meet the threat of climate change.

So far efforts of industrialised countries to reduce carbon dioxide emissions have mainly focussed on “production”, with higher prices of fuels and electricity as the key to ‘energy efficiency’ and reduced emissions in more energy intensive industry. However, progressive reductions in primary energy needed to produce one unit of GDP have not reduced emissions.

This trend is borne out by the recent analysis of consumption trends in industrialised countries conducted by the International Energy Agency for the period 1990 - 2004:

- Despite an improvement of 25 per cent in the energy intensity of GDP in both Europe and the US, total emissions of carbon dioxide have decreased by only 1.5 per cent in Europe (EU-15), and have risen by 16.3 per cent in the United States, because of its higher growth rate fuelled by consumer demand.
- Energy use in manufacturing has remained unchanged, while final energy use, and emissions of carbon dioxide, have each increased by 14% - even though half of the increased demand has been met through energy efficiency.
- Energy use in passenger transport increased 25%, and in freight transport 24%. There has been a 31% increase in passenger travel. Buses and trains account for only 5% of total passenger travel, slightly lower than in 1990, while air travel has increased 61% in this period. Cars used 88% of energy in the transport sector, with a minimum ownership level of 0.35 cars per capita - car ownership has doubled in Greece and Ireland.
- Appliances account for more than half of the electricity used in households, with a 48% growth - half of which is in the newer small appliances, like computers.
- Electricity consumption in the services sector increased 50%, and in households by 35%. Oil with a share of 47% and electricity (22%) dominate total final energy consumption.

The patterns of energy use provide important insights into the role of governments in influencing the demand for electricity and oil, and consequent emissions of carbon dioxide. Buildings, including households and services, at present account for 40% of energy use in industrialised countries, driven by growth of the services sector and higher incomes - more households, bigger apartments and more appliances. Two-thirds of the increase in electricity demand in the EU between 1978 and 2003 was accounted for by appliances. Small appliances are becoming the largest source of emissions from households - personal computers, mobile phones, personal audio equipment. Also, improvements in vehicle and engine technology have been offset by consumer preferences for larger and heavier vehicles. Developing countries can be expected to follow a similar path.

Measures to improve energy efficiency, without affecting the service, stand out as the cheapest way to curb energy demand and carbon dioxide emissions growth in all countries in the near term, and do not need any international agreement. Building standards for new construction should include insulation of walls and windows. The use of compact florescent lamps and light emitting diodes alone would cut down the electricity used for lighting by more than half. High speed passenger trains and metros will also serve to reduce emissions of carbon dioxide by shifting the balance to mass transportation. With retail distribution networks just being established in developing countries, this is the appropriate time to craft policy interventions by working together with business to shape retail distribution models, structure of supply chains, physical infrastructure and consumer behaviour to prioritise areas where energy use can be avoided. Expanding forest cover provides a range of ecosystem services – water, soil conservation, food and fodder – including sequestration of carbon dioxide. End-use energy efficiency and conservation has benefits for economic growth and for the environment - reducing demand for electricity generation and oil as well as emissions of carbon dioxide.

The global dialogue provides an opportunity to identify sectors and activities where energy efficiency can support both the environment and economic growth. For example, it has been estimated, by the International Energy Agency, the United Nations Environment Programme and by the Intergovernmental Panel on Climate Change, that 30% of the projected increase in greenhouse gas emissions in the building sector can be avoided at no cost. Business has also noted that technology available today can make dramatic improvements in building energy efficiency (WBCSD 2007, UNEP 2007, IEA 2007).

Clearly, a different metric, than the current approach of focussing on global industrial emissions, is needed in setting public policy priorities worldwide for dealing with climate change and its adverse effects.

The Underestimated Concern of Adaptation and Ecological Services

Every published literature and assessment has concluded that developing countries, rather than developed countries, will bear the adverse impacts of climate change with huge economic costs. Agriculture is the sector that will be adversely impacted the most, and a majority of the population in developing countries derives their livelihood from agriculture. The IPCC has concluded agricultural output in developing countries is expected to decline by 10-20 per cent by 2080 (IPCC, 2007).

The International Food Policy Research Institute and the UN Food and Agriculture Organisation point out that while early impacts can be reduced by adaptation, options for developing countries diminish and associated costs increase with increasing climate change impacts (Cohen, 2008). A recent paper for the Brookings Institution points out that Darfur is an example of how climate change could leave global development in the balance, and the question is now being raised whether because of the impacts of climate change many developing countries will be able to grow at all! (Mendelsohn, 2008).

The Food and Agriculture Organization, the World Food Programme and the International Fund for Agricultural Development have expressed their "deepest concern" that climate change is a major challenge to world food security, and will increase hunger and malnutrition amongst the poorest. They have argued that it is paramount that we address food security concerns when discussing the challenges of climate change.

The World Health Organization, in a recent study, points out that developing countries could spend between US$6 to $18 billion a year by 2030 to manage additional costs to health services as a result of climate change. The WHO has found that modest global warming since 1970 was already causing in excess of 150,000 deaths every year. Infectious diseases are appearing in new locations where people do not have immunity and health services do not have the experience in treating infections, hence the need for rich countries responsible for global warming to help pay towards these additional health costs.

As the main determinant of a countries adaptive capacity is economic wealth, such unprecedented adverse impacts of climate change will severely constrain development and lock the poor in long term poverty traps. Meeting this challenge will require major new investments, for example in agricultural research to develop new drought resistant crop varieties and insurance schemes. UNDP has estimated the <u>annual</u> costs of adapting to climate change to be $86 billion in 2015, while the amount pledged to date (cumulatively, not per year) is $300million. It is now recognised that fighting climate change and fighting poverty have to be addressed together (CCCD, 2009).

The livelihoods of the rural poor and the conservation and sustainable use of natural resources are also so intimately intertwined that they are best addressed through an integrated approach, irrespective whether the primary motivation is development or environmental conservation. It is estimated that environmental wealth accounts for 26 per cent of the total wealth of low-income countries, versus 13 per cent of wealth in middle-income countries and only 2 per cent of wealth in developed countries (Hamilton, 2005).

A shift is taking place from the widely held perspective that policy interventions cannot lead to alleviation of poverty and to the conservation of natural resources – which are two sides of the same coin. The adoption of the Millennium Development Goals by the United Nations underlines the reality that after over 50 years of public programmes the world still has nearly $4billion poor, who subsist on less than $2 a day and environmental degradation continues. The 'Bottom of the Pyramid' provides new growth opportunities for innovation and entrepreneurship, with new products, services and payment models to make finance and technology affordable and accessible to the poor. The recent independent evaluation of the International Finance Corporation also concludes that economic growth, poverty reduction and environmentally and socially sustainable development can have mutually reinforcing development and financial benefits (IFC, 2008). However, new conceptual frameworks and strategies tailored to social value creation, where the objective is for the maximum number to benefit from the effort, are yet to be developed.

The global goal to deal with climate change should be determined in terms of sustainable development. International cooperation would then be framed in terms of emission reduction in industrialized countries, joint programmes to support adaptation to the adverse impacts of climate change and transfer of technology to developing countries to enable them to modify their trajectory of growth.

International Cooperation, Technology and Global Sustainability

At the climate change negotiations in Bali, in December 2007, developing countries agreed to take mitigation actions in the context of sustainable development. This distinction suggests that the focus of such actions should shift from considering the environmental impact of carbon dioxide to analysing its linkages with the provision of energy services for human well being.

Energy services are directly related to human well being. Development of infrastructure, urbanization, manufacturing and services are all essential for economic growth, and for alleviation of poverty. For example, the per capita generation of electricity in India is one-fifteenth that of the United States. Estimates suggest that currently, worldwide 1.6 billion people lack access to electricity. As developing countries still need to build their infrastructure, the objective of international negotiations on climate change should be to determine how their economic growth can take place in an environmentally sustainable manner.

Sustainability, as defined in the Objective and the Principles of the Climate Change Convention, is not limited to "industrial emissions" (that is how we currently measure emissions), but rather requires a focus on all sectors and activities where carbon is embedded, used and its concentration impacts adversely, for example food security. The global focus on moving to a low carbon society is an acknowledgement that the citizen is not only the driver of emissions but also the victim of the adverse impacts of climate change.

Growth in carbon dioxide emissions is linked to the use of fossil fuels to meet the increasing demands for energy services. At around $3000 per capita GDP in PPP terms, energy demand explodes as industrialization and personal mobility take off, and beyond $ 30,000 per capita GDP economic growth can continue without significant energy increases, with the absolute level varying depending on national circumstances. According to the government of the UK over 40% of emissions of carbon dioxide arise directly from the decisions of citizens, for example, heating and using electricity in homes and driving vehicles. The government funded Carbon Trust in the UK reports that leisure and recreation accounts for most of the current emissions for the average British citizen, of which half is from transportation (Carbon Trust, 2006). Only one country - Norway, with the highest Human Development Index in the world, and a GDP of $46,000 per capita in PPP terms - has pledged that it will become carbon neutral from 2050. Clearly, high levels of national wealth are a precondition for effective carbon management; however, in the interim a lot can be achieved.

Researchers at the Chinese Academy of Social Sciences have proposed a Carbon Budget, defined as per capita cumulative emissions during a given period of time, to establish a threshold level for national emissions, to reflect differential conditions between countries and meet an agreed long term global goal through emissions trading. Since developed countries have used up their budget, they would be able to obtain surpluses from developing countries by providing financial support for low carbon development. This approach, based on transfers of financial resources and technology, has been suggested as a win-win solution to meet the challenge of climate change through international cooperation (Pan, 2008).

In a sustainable development framework, international cooperation will be based around development and transfer of technology. In this paradigm, global sustainability will not depend on negotiated global environmental goals and emission reduction commitments by developing countries, but rather on mechanisms for transfer of technology to reconcile the competing concerns. The European Parliament, in its resolution of 15 November 2007 on climate change, recognised that Intellectual Property Rights (IPR) licensing fees in the area of clean technologies constitute a barrier to the transfer of such technology to developing countries, and stressed the provision of alternate means of compensation for IPR holders to facilitate technology flows.

There is a global consensus that a technological shift, unprecedented in the scale and speed of deployment, will be critical in determining environmentally sustainable patterns of resource use to meet the challenge of climate change. Global policy needs to focus directly on developing new energy technologies, rather than leave it to the market. For example, the market failure that results from anti-competitive measures of pharmaceutical companies to delay research, development and commercialization of drugs by firms in developing countries is now well documented, and is also under inquiry by the European Commission.

According to the World Intellectual Property Organization (WIPO, 2009) effective transfer of technology requires public institutions to maintain an interest and a degree of leverage over technology developed through public investment, the creation of new enterprises as tailor-made vehicles for development of a new technology, a broad-based open licensing structure to promote dissemination of a platform or enabling technology, cross-licensing structures or pool arrangements that allow diverse technology players to build on the benefits of each others' technologies, and packaging the patented technology with other non-patented material, such as manufacturing knowhow, other commercial information, or regulatory approval dossiers.

Placing relevant technologies in the public domain has been discussed at the multilateral level since 1992. Such a provision is included in Agenda 21 as well as in the Kyoto Protocol. These elements provide a good starting point for further discussion, because global policy needs to focus directly on the effective development and transfer of new energy technologies (to *enable* developing countries to take actions, as the Bali Action Plan requires), otherwise emissions cannot be reduced within the timeframe required without affecting economic growth.

Currently a multilateral technology fund is under discussion in the climate negotiations. Such a fund should cover incremental capital and operational costs so long as the cost of electricity from clean coal and renewable energy technologies exceeds those determined by current energy strategies. Only with a global approach that recognises the central importance of energy services in human well-being can there be broad public support in developing countries for dealing with climate change.

III

The New Paradigm

The response at the multilateral level to the seismic shift in economic power and demand from Asia, particularly from China, has largely been of a scarcity mentality seen as a zero-sum game, rather than develop a shared vision where everyone can become better off.

The on-going negotiations for moving to a low carbon future will now focus on the gaps between the positions of developed and developing countries, and identify options. The three key gaps relate to global equity, meeting the costs of adaptation and technology transfer. The shared vision should modify consumption patterns in developed countries leading to real cuts in global emissions without adding any burden on developing countries, provide adequate and predictable resources to enable adaptation to the adverse impacts of climate change that are already upon us, and establish mechanisms for effective development and transfer of technology to enable global reduction of emissions. We need to move away from ever changing assessments to a fundamental transformation of the global economy and human activity in ways that ensures patterns of resource use are common for all countries.

By making human well-being as the central objective, a new sustainable development paradigm is emerging that focuses on reacting to change rather than focus only on preventing it. This approach has three key elements. First, with the growing importance of the service sector and consumer demand in economic growth, it points to the need for developed countries to adopt consumption rather than a production-based approach to address the driving forces of environmental change. Second, it focuses on avoidance, rather than on reduction, of adverse impacts on the environment through a different growth path for developing countries that also distinguishes between management of the environment and sustainable development. Third, to meet the concerns of the large majority of the global population in developing a vision of environmentally sustainable global growth, it suggests that the bio-physical limits to growth require deeper action in the industrialised countries, including technology transfer to those who bear little responsibility for causing this problem. While there is an increasing recognition of the consumer as the driver of global environmental change, there is continuing divergence of opinion and experience about how to address those concerns at the societal level.

The North-South divide can be overcome by recognizing poverty alleviation as the key strategy for dealing with the interrelated challenges of climate change, energy security, food security and equity. Since raising standards of living, per capita emissions and international equity are related issues, patterns of natural resource use will have to common for all countries. It is in this framework that mitigation measures should be identified, to determine where modification of longer term trends is needed. Considering the full range of natural resources, ecosystem services and activities impacted by the concentration of greenhouse gases will also bring adaptation to the fore as a global concern. A broader perspective is the only way to ensure that conflict over natural resources – food, water and energy – is avoided in the coming decade.

The increasing share of consumer demand in the GDP of major economies, sustained economic growth of Asia and financial and technological globalization are leading to a re-balancing of the current framework of global environmental governance. The new sustainable development paradigm should focus on alleviation of poverty, the welfare needs of citizens and the decisions of consumers. This framework of international cooperation re-balances the roles of the state, markets and citizens. The consumer, not the state, is the driver of environmental change, and new knowledge needs to be developed to support the modification of consumption patterns and develop a vision of environmentally sustainable global growth.

The challenge of sustainable development - striking a balance between environmental imperatives, social justice and economic growth – is to create affluence that is independent of energy intensive consumption. As developing countries still need to build their infrastructure, the objective of international negotiations on climate change should be to determine how their economic growth can take place in an environmentally sustainable manner. The time has come for developing countries to design a new paradigm for sustainable development.

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Climate Change, Water, and China's Security:
Implications for Global Cooperation on Climate Change

Scott Moore[1]

Abstract

This paper links the issues of climate change, water, and China's security, arguing that the water-related impacts of climate change post significant strategic challenges for China and Asia, with consequent implications for China's participation and engagement in global climate change cooperation efforts. Specifically, water-related climate impacts will strain the capacity of many key public institutions, and imperil the government's strategic development objectives. Recognizing these imperatives points the way toward a strategic dialogue with China on climate change. This paper first discusses scientific assessments of predicted hydrological changes in China and neighboring countries under climate change, progressing to a security analysis of the challenges these changes pose, and finally discusses how Chinese policymakers and commentators view climate change and water as geopolitical issues. This paper concludes by examining implications for global climate cooperation.

Introduction: Linking Climate Change, Water, and China's Security

As the world approaches the international climate negotiations at Copenhagen in December 2009, the two imperatives of promoting economic development and protecting the global atmospheric commons seem increasingly to stand at odds. Even as scientific assessments of the impacts of climate change grow more urgent, large developing nations like China and India continue to prioritize their own economic goals. Given the difficulties in resolving this impasse, it is helpful to think broadly about all dimensions of the climate change problem, social, political, economic and ecological.

This paper seeks a role in this debate by examining the strategic-security implications for China of a changing climate, with specific reference to water issues. It does so chiefly with an eye towards evaluating the contribution that such a perspective can make to shaping China's participation in global cooperation on climate change. Most commentators agree that China will play a crucial role in finalizing a post-2012 climate agreement; from this perspective, there is clear value to seeking a security imperative in its approach to international cooperation on climate change. As international relations scholar Katherine Morton has pointed out, the value in "securitizing" the climate issue is that "In situations where there is a growing international consensus that a problem exists, but limited consensus on the most effective and fair method of dealing with it, a preventive security approach encourages action on the basis of a pragmatic calculation that prevention is better than cure" (Morton, 2008, p. 54).[2]

The argument presented here is that water-related impacts of climate change imperil many of China's strategic development objectives, presenting an opportunity for foreign countries to engage the country in a strategic dialogue on climate cooperation. This paper first presents a scientific assessment of water-related climate change impacts, both in China and its neighboring countries. Next, it discusses strategic and security implications for China's foreign relations, domestic issues like food security, and also internal stability. The final section of the paper discusses discourse on climate change, water, and security topics within China, pursuing an understanding of how such discourse could help frame the

[1] Fulbright Fellow, Peking University (scott.michel.moore@gmail.com)

[2] Morton also appropriately notes the objections of some who argue that securitizing environmental issues distracts from ecological, moral, and other imperatives to protect the environment. This paper does not specifically consider such objections here, instead choosing to qualify its conclusions and recommendations with these objections in mind.

country's participation in an international, strategic dialogue on climate change issues. This multifaceted approach, spanning the physical and social sciences, frames the Conclusions section, which identifies cross-cutting issues related to water, climate change, and China's security and also discusses implications for global climate cooperation.

This integration of climate change, water, and Chinese security issues is timely for several reasons. First, many of the most severe likely impacts of climate change in China and Asia generally are water-related, such as a predicted long-term decline in water runoff from the Himalayan region (Intergovernmental Panel on Climate Change, 1997, p. 15). Second, there is growing recognition of the linkages between water availability, conflict, and security issues in Asia. As a recent Asia Society report notes, "more than one billion people in Asia alone are projected to experience negative impacts on water resources as a result of climate change…Over time, these effects will have a profound impact on security throughout the region" (Asia Society, 2009, p. 7). Finally, climate change is becoming an important issue in China's relations with the rest of the world, as indicated by the recent visit of US Secretary of State Hillary Clinton to Beijing (Landler, 2009). Despite this confluence of factors, few commentators have focused specifically on the implications for China's security of water-related climate impacts. It is thus high time to do so.

Before delving into this discussion, the linkages between climate change, water, and security require further articulation. Recent decades have witnessed the gradual broadening of the concept of security from its traditional political and military foundations. In an influential 1989 article, former US government official Jessica Mathews called for a redefinition of national security to "include resource, environmental and demographic issues" (Mathews, 1989, p. 162). Subsequent research and scholarship has given prominence to the field of environmental security, which in one articulation "is central to national security, comprising the dynamics and interconnections among the natural resource base, the social fabric of the state, and the economic engine for local and regional stability" (Institute for Environmental Security, 2004).

Several strands of environmental security and related discourse are of relevance to this paper. First is a growing body of scholarship that has identified clear, though context-specific linkages between resources scarcity, environmental change, and conflict, particularly at the sub-national level (Homer-Dixon, Environmental Scarcities and Violent Conflict: Evidence from cases, 1994). As a recent United Nations report concluded, "Environmental factors are rarely if ever the sole cause of conflict, but exploitation of resources is present in each stage of the conflict cycle" (United Nations Environment Program, 2009, p. 5). Second is the increasing focus of many institutions with a traditional security focus on climate change and instability. In 2007 the United Nations Security Council held its first-ever debate on climate change, and a major US Centre for Naval Analyses report found that "Climate change acts as a threat multiplier for instability in some of the most volatile regions of the world" (Center for Naval Analyses, 2007, p. 6).

In addition, the concept of human security is relevant to discussions of some of the water-related impacts China is likely to face as a result of climate change. According to one widely accepted definition, "The objective of human security is to safeguard the vital core of all human lives from critical pervasive threats, in a way that is consistent with long-term human fulfilment" (Alkire, 2002). Human security thus entails issues, such as an equitable distribution of resources, that do not fall within more traditional or restrictive conceptions of security (Morton, 2008, p. 54). Here, however, the value of a human security perspective is that it facilitates the analysis of water-related climate impacts within the context of China's pervasive regional, ethnic, and economic disparities.

Applying these broadened conceptions of security to water-related climate impacts focuses this paper on the social and political consequences of shifting water resource distributions within China. from this perspective, it is possible to understand more concretely the security consequences of a changing climate in china, and to discuss how these consequences can and should guide both Chinese and international approaches to global climate cooperation. To begin this discussion, this paper turns now to a scientific assessment of water-related climate impacts for China and its Asian neighbours.

Water-Related Climate Change Impacts in China and Asia: the Scientific Basis

The eastern portion of the Asian landmass, of which China is a part, faces particularly acute changes in water availability and distribution as a result of climate change. While climate modeling is subject to significant uncertainties, this section identifies two such changes which are of particular relevance to non-traditional security issues (discussed in the subsequent section). First, the incidence of extreme water-related phenomena, such as prolonged drought and severe flooding, is likely to increase. Second, some regions, many of them already under water stress, are likely to be heavily, and perhaps catastrophically, impacted by changes in water availability. This section indicates that, based on existing scientific research, whatever the precise nature and distribution of water-related climate change impacts in China and its neighboring countries, they will be acute and pervasive.

Many Asian nations are already under water stress, and the Asian continent has the lowest per-capita water allocation of any continent save Antarctica (Asia Society, 2009, p. 9); (See Table 1 below).

Table 1: Water Resources and Dependency (From Asia Society, Asia's Next Challenge: Securing the Region's Water Future, p. 44)

Country	*Total Internal Renewable Water Resources (km3)*	*Total External Renewable Water Resources (km3)*	*Dependency Ratio (%)*
Afghanistan	55	10	15
Australia	492	0	0
Bangladesh	105	1,106	91
Cambodia	121	356	75
China	2,812	17	1
India	1,261	636	34
Indonesia	2,838	0	0
Iran	128	9	7
Japan	430	0	0
Kazakhstan	75	34	31
Kyrgyzstan	46	-26	0
Laos	190	143	43
Malaysia	580	0	0
Mongolia	45	0	0
Myanmar	881	165	16
Nepal	198	12	6
Pakistan	55	170	77
Philippines	479	0	0
South Korea	65	5	7
Sri Lanka	50	0	0
Thailand	210	200	49
United States	2,800	51	8
Uzbekistan	16	34	77
Vietnam	366	525	59

Moreover, as a recent Intergovernmental Panel on Climate Change (IPCC) report has concluded, “Asia has a very high population that is growing at a fast rate, low development levels and weak coping capacity. Climate change is expected to exacerbate the water scarcity situation in Asia, together with multiple socio-economic stresses” (Bates, Kundzewicz, Wu, & Palutikof, 2008, p. 85). In India, for example, over-exploitation of groundwater resources and population growth is expected to reduce per capita water availability by almost 50% by 2025 (China Daily, 2007, p. 6). In north China, the water use to availability ratio was three to four times the level in the south as of 2000 (Shalizi, 2006, p. 8). In China and its immediate neighbourhood, climate change threatens to exacerbate this already tenuous water situation in several ways.

The hydrology of Eastern Asia is dominated by two processes: atmospheric circulation, principally the Asiatic monsoon and El Nino-Southern Oscillation (ENSO), as well as a snow- and glacial-melt regime situated on the Himalayan region (Barnett, Adam, & Lettenmaier, 2005); (Xu, Takeuchi, & Ishidaira, 2004, p. 108). In China, for example, changes in aridity are determined primarily by summer precipitation, mostly the East Asian monsoon (Yang, Ding, Chen, & Liu, 2005, p. 177). Atmospheric circulation, though relatively poorly understood, appears to be set to increase the variability of precipitation and the risk of flooding as a result of climate change, while glacial melting will cause significant changes in the flow of Asia’s major rivers. Both have the potential to impose large economic costs and to disrupt agriculture.

China’s National Climate Change Program asserts that “climate change has already caused changes [in] water resources distribution over China,” focusing particularly on an increase in “hydrological extreme events” such as drought in the north and flooding in the south (National Development and Reform Commission, 2007, p. 22). This assessment draws largely from IPCC data indicating an observed increase in precipitation in north and northeastern China, and a marked increase in the west (Chang Jiang delta region) and southeast (Bates, Kundzewicz, Wu, & Palutikof, 2008, pp. 85-86). Yang, et al., for example, note that as a result of climate change precipitation is decreasing in eastern China agricultural areas, with drought-related agricultural losses increasing steadily since the mid-twentieth century (Yang, Ding, Chen, & Liu, 2005, p. 184). Tao, et al. similarly predicted that soil degradation under a changing climate would lead to higher probability of “disastrous drought and floods” in central, southwestern, and northeastern China (Tao, Yokozawa, Hayashi, & Lin, 2005, p. 169).

A tendency toward more extreme climate events is also predicted for other regions. A major study of the Indian Himalaya found that climate change will increase the variation of seasonal flows significantly (Singh, Arora, & Goel, 2006, p. 1991). In the Mekong, Southeast Asia’s most important river system, maximum monthly flows are expected to increase by 35-41% by mid-to late century over 20th century levels in the river basin, while the minimum monthly flows are expected to decline by 17-24% (Bates, Kundzewicz, Wu, & Palutikof, 2008, p. 87).

Such increased variation threatens to disrupt normal economic and agricultural activity in vulnerable regions, and as the IPCC has noted, “there could be increased flooding risks [in the Mekong region] during the wet season and an increased possibility of water shortages in the dry season” (Bates, Kundzewicz, Wu, & Palutikof, 2008, p. 87). In the case of the Mekong, this variability is enhanced by additional risks from sea level rise and resulting salt water intrusion poses a profound threat to agricultural production in the river’s delta region (Wassmann, Hien, Hoanh, & Tuong, 2004, p. 89).

Potentially even more serious, however, is a predicted long-term decline in water availability as Himalayan glaciers melt and snow packs are reduced in size. The IPCC estimates that a decrease in Himalayan glacier mass of about 25% is possible by 2050 as global temperatures rise (Intergovernmental Panel on Climate Change, 1997, p. 14). This is significant as glacial melt water accounts for some 70% of summer flow in the Ganges river system, and 50-60% of the flow in other major Asian river systems (Barnett, Adam, & Lettenmaier, 2005, p. 306). One major study predicted that Himalayan melt-fed water systems would peak at 150-170% of initial flow by 2050-2070, with annual mean flow declining thereafter by 33% and 4-18% less in the western and eastern Himalayan regions, respectively (Rees & Collins, 2006, pp. 2167-2168). As Barnett, et al. conclude, a significant portion of northwest China and northern India will be subject to declining water availability by the end of the century, as seasonal water shortages arrive abruptly, "going from plenty to want in perhaps a few decades" (Barnett, Adam, & Lettenmaier, 2005, pp. 304-306).

Nonetheless, there is likely to be substantial regional variability in these effects. Some river basins are likely to be particularly heavily impacted; the Tarim River for instance, Xinjiang's most important river system, depends on glacial melt water for 40% of its mean annual flow (Liu & Chen, 2006, p. 298). Other areas of north-western China are likely to be severely impacted by changes in water availability. As the IPCC has reported, "The duration of seasonal snow cover in [Chinese] alpine areas – namely the Tibet Plateau, Xinjiang and Inner Mongolia– is expected to shorten, leading to a decline in volume and resulting in severe spring droughts. Between 20% and 40% reductions in runoff per capita in Ningxia, Xinjiang and Qinghai Provinces are *likely* by the end of the 21st century" italics original (Bates, Kundzewicz, Wu, & Palutikof, 2008, p. 87).

Changes of similar magnitude are predicted for major river systems elsewhere in China and Asia. A major study by Manabe, et al., which attempted to model the effects of a quadrupling of atmospheric carbon dioxide concentrations above pre-industrial levels, concluded that most major Asian rivers, including the Chang Jiang (Yangtze) and Huang He (Yellow River) in China, and the Ganga/Brahmaputra in the Indian Subcontinent, were likely to experience large increases in flow on a one-hundred year timescale, but that the Mekong was expected to experience a 6% decrease (S. Manabe, Milly, Delworth, & Stouffer, 2004, p. 65); (see Table 2 below).

Table 2: Changes in flow of major East Asian rivers under climate change (Adapted from S. Manabe, Milly, Delworth, & Stouffer, 2004, p. 65)

River system	Chang Jiang	Huang He	Ganga/Brahmaputra	Mekong
% change in annual mean rates of simulated discharge (D, 103 m3 s−1)	+28	+18	+49	-6

Uncertainty and variability are also dominant themes in projections of changes regarding precipitation patterns. For instance, in a wide-ranging simulation of climactic and soil conditions, Tao et al. predicted that areas of central, western, and south-western China would face large soil-moisture deficits as a result of climate change, which in turn reduces precipitation (Tao, Yokozawa, Hayashi, & Lin, 2005, p. 193). The IPPC, however, notes that 2/3 of modelling studies on the same area predicts an increase in precipitation (Bates, Kundzewicz, Wu, & Palutikof, 2008, p. 88).

While some studies suggest that in north China only 70% of irrigation needs can be met under climate change scenarios, a major study of Chinese agricultural production under climate change indicates that the country will be able to meet its food requirements under any of the IPCC climate warming scenarios, assuming a carbon-dioxide fertilization effect

(Xiong, Lin, Ju, & Xu, 2007, p. 208).[3] Other research has broadly supported this conclusion, predicting increased production of staple food crops in China (Lobell, Burke, Tebaldi, Mastrandrea, Falcon, & Naylor, 2008, p. 609) and an increase in global food production generally under various climate change scenarios (Parry, Rosenzweig, Iglesias, Livermore, & Fischer, 2004, p. 63).

The best summary of these potential water-related climate impacts appears to be that water distribution patterns will become much more variable. Another characterization might be that many areas of China are likely to have too much water when they don't need it (i.e., flooding during the rainy season) and too little when they do (the dry summer months). Certain areas, such as northern and north-western China and the Mekong river system, will be more impacted, and by a greater combination of factors, than others. This conclusion has important implications for both China's national and regional security.

Strategic-Security Analysis of Water-Related Climate Impacts in China and Surrounding Countries

The scientific assessment presented above predicts that water-related climate impacts will be acute not only in China, but in surrounding nations as well. As a result, this strategic-security analysis first considers implications for China's regional security and foreign relations, before turning inward, to examine threats posed to food production, disaster management capacities, and internal stability within China. This section argues that water-related climate impacts will stress the disaster response and emergency management capacities of key institutions, such as the armed forces, and imperil many of the government's key strategic development objectives, such as the Western Development Strategy.

It is clear that water-related climate impacts spill over China's borders, which will increase the importance of water issues in China's foreign and regional security policies. Indeed, regional actors are already expressing growing concern over such water issues. At the 2008 World Economic Forum, 81% of business leaders ranked climate change and water issues as being those of greatest concern to Asia (Info-Prod Research, 2008). The Filipino Defense Secretary made a similar pronouncement with his recent statement that climate change is a greater long-term threat to his country's security than religious or social conflict, in large part due to water supply concerns (Antiporda, 2009).

This concern is reflected in the attitudes of China's neighbours. In Pakistan, for instance, officials have suggested that changes in Himalayan melt water could devastate agriculture in this already fragile country (Das, 2008). A recent study from the Earth Policy Institute makes clear the heavy dependence of vast numbers of people on glacial melt water-fed agriculture (Brown, 2008); (see Table 3 below). Given such dependence, transboundary water issues are certain to become an issue of growing importance for China. As the Asia Society's report on water and security has concluded, hydropolitics will be an increasingly potent force in Asian security (Asia Society, 2009, p. 13).

[3] A carbon-dioxide fertilization effect asserts that increased fixation of carbon dioxide, resulting in increased crop growth and yield. However, the extent of CO2 fertilization effects is contentious. See, for example, L. Hartwall Allen, Jeff Baker and Ken Boote, "The CO2 fertilization effect: higher carbohydrate production and retention as biomass and seed yield," Food and Agriculture Organization, http://www.fao.org/docrep/W5183E/w5183e06.htm, accessed May 26, 2009.

Table 3: Vulnerability of major Asian river systems to changes in glacial melt water (Adapted from Earth Policy Institute and U.N. Environment Programme, Global Outlook for Ice and Snow (Nairobi, Kenya: 2007), p. 131)

River system	*Population (million)*	*Basin area (thousand square kilometres)*	*Cropland (%)*	*Dependence on glacial melt water*
Tarim	8	1152	2	Very high
Indus	178	1082	30	Very high
Ganges	407	1016	72	High
Brahmaputra	118	651	29	High
Chang Jiang	368	1722	48	High
Yellow	147	945	30	High
Mekong	57	806	38	Moderate

In particular, certain Asian river systems seem to be more contentious than others. Based on their study of conflict and cooperation over water, Yoffee, et al. developed a “Basins at Risk” indicator, which ranks the Ganges, Indus, and Mekong as at risk for conflict (Yoffe, Wolf, & Giordano, 2003, p. 1123). Among these, the Mekong River System presents particular challenges for China’s security. Relations between China and its downstream neighbours in the Mekong basin have long been fragile (Morton, 2008, p. 8). This situation is likely to be exacerbated by the construction of several dams in Chinese territory, which restrict flow to downstream nations. If, as climate models suggest, water flow to the Mekong becomes more variable under climate change, China’s “asymmetric” control of the river’s headwaters will become an issue of even greater concern to Southeast Asian nations (Asia Society, 2009, p. 17).

This particular power asymmetry is of special significance, since Yoffee, et al.’s research suggests that a high density of dams is associated with conflictive behaviour, unless freshwater treaties are involved (Yoffe, Wolf, & Giordano, 2003, p. 1116). China has steadfastly refused to join such “hard law” regimes in the Mekong region (Nielsen, 2007, p. 217). Thus, it seems reasonable to assert that China will have to improve its cooperative frameworks if it is to avoid significant diplomatic tension with Mekong nations as the flow of the river changes along with the climate. Simply put, Beijing will almost certainly have to devote more diplomatic attention to the Mekong and other potential Asian “water hotspots” as climate change impacts accelerate.

In mainland China, specific regional impacts also appear to represent the most pressing security challenges. Several of China’s most strategically important regions are predicted to suffer significant water resource shortages as a result of climate change. As Barnett, et al. have observed, some 23% of China’s population lives in western regions where glacial melt water provides the principal dry season water source (Barnett, Adam, & Lettenmaier, 2005, p. 306), and as glaciers melt, water will become increasingly scarce during the dry season. One study, describing the disappearance of an oasis in north-western Gansu province, attributes climate change for causing a decrease in stream flow during the summer months. This decrease in water availability is inducing desertification, which exacerbated by population growth has imposed serious socioeconomic costs on an already poor area (Kang, Su, Tong, Zhang, Zhang, & Davies, 2008, p. 444). Such impacts are particularly significant since these western regions are not only impoverished, but also the most restive in China, being home to ethnic minorities who have long mounted challenges to Beijing’s rule (Davis, 2008).

These Changes in water availability in China’s restive northwest can pose security challenges in two primary ways. First, competition over scarce resources can exacerbate existing tensions between China’s majority Han ethnic group and minority groups such as the

Tibetans and Uyghur (Bhattacharji, 2008). As the Asia Society report has concluded, "One could certainly foresee the potential for conflict as urbanization and industry begin to deplete already scarce water supplies, particularly if certain Han-run businesses are perceived to be receiving favourable treatment in water resource allotment" (Asia Society, 2009, p. 19). One Chinese scholar has similarly noted the danger environmental change poses for the success of the country's much-touted Western Development Strategy (*Xibu da kaifa*), saying "The environment of the West itself is the foundation of the Western Development Strategy" (Lu, 2008).

Second, water scarcity could increase the numbers of "environmental refugees" from China's northwest, potentially inflaming ethnic tensions and increasing socioeconomic burdens (round out this sentence) as they seek opportunity elsewhere in China. A study by Kang, et al. found that increasing numbers of farmers in Gansu province are abandoning their lands as a result of "the rapid deterioration of [their] water environment" (Kang, Su, Tong, Zhang, Zhang, & Davies, 2008, p. 446). Similar phenomena have been described in Tibet, where a variety of challenges are inducing higher rates of out-migration of ethnic Tibetans (Morton, Climate Change on the Tibetan Pleateau: a new human security challenge, 2009). In the high Himalaya, minorities may be affected less by water shortages and more by increasing exposure to geologic hazards, such as the threat of flooding from glacial melt waters and landslides as permafrost melts (Hewitt, 2009). Nonetheless, the potential for environmental refugee outflows to increase exists in both regions.

The danger posed by such environmental refugees[4] is that they may be deprived of the means to sustain livelihoods in their new homes. Research has indicated that gradual environmental deterioration, as may be expected under climate change, affects the very poor disproportionately; already bereft of resources, they have little capacity to re-establish themselves elsewhere (Bates D. , 2002, p. 469). As Yan and Qian have described, arable land is scare in China, and environmental refugees, pulled away from their livelihoods and kinship networks, often have great difficulties in setting up livelihoods when forced to resettle (Yan & Qian, 2004, pp. 631-632). Research by environmental security scholars has further indicated that this dislocation can cause significant social stability issues. In particular, as a result of environmental scarcity "people migrate in large numbers to regions where resources seem more plentiful, only to fight with the people already there. Or they migrate to urban slums, where unemployed young men can be primed to join criminal gangs or radical political groups" (Homer-Dixon, Terror in the weather forecast, 2007).

Additionally, climate-related water shortages pose threats to China's food security. The north China winter drought of 2008-2009, which China's National Meteorology Centre classified as an "extreme weather event" (*Jiduan qihou shijian*) attributable to climate change (Liu Y. , 2009), illustrates these security implications. This drought, which occurred during the winter of 2008-2009, was the worst in 30 years, and affected China's principal wheat-growing areas, damaging 2.7 million *mu* of farmland[5] (Zhang & Wang, 2009). News reported indicated that about 40% of China's winter wheat crop would be affected (Li, 2009), and that the drought was expected to decrease the wheat harvest, one of China's most important, by 5% nationally, and by 20% in some areas, such as Henan province (Xinhua News Agency, 2009).

The scale of such effects has led many commentators to warn that climate-related drought in north China could threaten the country's food security (Liu S. , 2009). Political factors dictate that food security is an especially sensitive issue in China, as the government

[4] There is a technical though important distinction between "refugee" and "migrant." Refugees, according to the United Nations, are persons who are compelled to migrate by external factors, while migrants are those who choose to do so for other, typically economic reasons.
[5] This figure is equivalent to approximately 180,000 hectares (1 mu= 0.0667 hectares).

is anxious to insulate the large population of rural poor from food price shocks (Brown, 2008). While it is unclear whether, as Xiong, et al. have indicated, climate change will actually threaten China's total domestic food supply, it is clear that the government cannot afford to ignore extreme weather events, placing increasing pressure on the country's military and paramilitary institutions to develop disaster management and assistance capabilities.

Indeed, the drought provides an illustration of the increased need for such operations. The paramilitary People's Armed Police (*Renmin wuzhuang jingcha*) mobilized some 2400 troops over eight provinces, with commanders pledging to "make all-out efforts to fight the drought and prevent disaster," while also joining a "battle to snatch a bumper harvest." Additionally, assets from the People's Liberation Army, including seven Air Force aircraft and engineers from the country's strategic nuclear forces, were called into service. The Jinan Military District accompanied its mobilization with the exhortation to "call upon the [Sichuan] earthquake relief spirit" (*Fachang kangdi jiuzai jingshen*) (Wang, et al., 2009). With climate models predicting increasing incidence of extreme weather events, China's military will be compelled to incorporate these domestic disaster response and assistance capabilities more closely into its operational planning strategies.

In addition to posing challenges to the country's military, it is clear that adaptation to water-related climate impacts will impose serious economic costs upon China. Xinjiang Province, for example, is building 59 reservoirs to collect melt water from the Himalaya's shrinking glaciers in attempt to address concerns about long-term water availability. The ten-year project is expected to cost 200 million RMB per year for at least the next three years (Watts, 2009), a considerable sum for one of China's poorer areas. A large-scale study by Kirshen, et al. also sheds light on the costs of adaptation to water distribution changes in China. After compiling water storage costs and modelling changing flow under various climate change scenarios, the study indicated that water storage costs vary widely by region; the cost of capturing 120 billion cubic meters of water are USD$4.5 billion in the southern Xi Jiang river area, and less than USD$2 billion in the central Chang Jiang, for example. Most noticeably, it will become increasingly difficult and expensive to enhance water storage capacity (reservoirs, catchments, etc) in water-stressed areas like north China (Kirshen, McCluskey, Voegl, & Strzepek, 2005, p. 327).

The security implications of water-related climate impacts can be fundamentally characterized by the uncertainty they introduce with respect to overall water availability, food security, and social stability. As one commentator has noted, climate change is an "engine of destabilization" (Stuhltrager, 2008, p. 38). This characterization seems particularly appropriate with respect to China. Water-related climate impacts will be severe in several regions, both within China and in its border regions. In addition, these impacts have the potential to foster general instability. However, it is difficult to identify any of these security implications as direct. What appears more certain, however, is that China's military, governmental institutions, and national resources will be increasingly burdened by climate change and water issues. As a result, the government has been compelled to devote more attention to these issues, a trend which is only likely to accelerate. With this conclusion in mind, the next section investigates Chinese political and strategic discourse on climate change and water issues.

The Geopolitics of Water and Climate in China

It is clear that the distribution and availability of water resources in China and neighbouring countries will be severely impacted by climate change, a prospect which in turn entails significant security implications. What remains is to assess how China perceives this situation, and how it is responding. This final section thus discusses Chinese governmental? Too broad reactions and discourse on climate change, water, and security. It first describes changing Chinese perspectives on security, before more focusing more specifically on steps that China has taken to address water-related climate impacts, both within and outside the country's borders. This section argues that the Chinese government is particularly concerned about the consequences, both traditional security and otherwise, of water-related climate change impacts, presenting opportunities to open a strategic, security-focused international dialogue on climate change (addressed in the Conclusions section).

In recent years, Chinese analysts, have, mirroring their Western colleagues, have articulated a broader conception of security. China's "New Security Concept" (*Xin anquan guan*), promulgated since the late 1990s, addresses environmental and social issues, and also emphasizes cooperation and dialogue as a means of conducting foreign relations (Liu G. , 2006). As a subset of this trend, China's strategic studies and international relations community has also devoted increasing attention to the potentially destabilizing impacts of climate change. Citing the broadening definition of security in the West, Liu et al., for example, advocate creating a special policy research group that focuses on the political and security dimensions of environmental change (Liu, Ge, Fang, & Zhang, 2006, p. 350).

Chinese security commentators have been even more prolific in citing American analyses of the security threats posed by climate. A series of such reports, including a widely-read 2004 Department of Defense study, prompted commentary within China over the possibility that climate-related resource shortages could lead to conflict or even war (Lin, 2005). Some non-official commentators have gone so far as to extrapolate upon such analyses to suggest that the threat of water-related conflict may increase between China and neighbouring countries (Guoji Xuanqu Daobao, 2004). Several more official Chinese commentators have similarly but more soberly cited American national security analyses to focus on the potential for water-related conflict to increase in politically unstable regions of the world, such as the Middle East (Tong, 2007).

The Chinese government, in contrast, does not appear to view climate change, or any of its attendant impacts, as a security issue. For most officials, climate change simply does not rise to the level of national security (Zha, 2009). Moreover, Beijing has strongly opposed United Nations efforts to link climate change and security through debating climate change issues in the Security Council. *China Daily*, the country's official English-language newspaper, editorialized that "The call for the international community to address climate change is sensible, but sensationalizing it as an issue of security is conspiratorial" (China Daily Editorial Board, 2007). A separate *China Daily* report quoted China's deputy representative to the United Nations as saying, "Discussing climate change at the Security Council will not help countries in their efforts to mitigate its effects" (Le, 2007).

Moreover, the Chinese government has proven to be visibly reticent on some major transboundary water issues. It has consistently refused to participate in the Mekong Basin Commission (Morton, 2008, p. 58), despite the fact the Mekong system's headwaters are all in China, making it impossible to fashion a comprehensive water management system without Beijing. China has also been hesitant to support the creation of an International Biosphere Reserve in the Tumen River Delta area, since most of the environmental threats to the area come from China (Nam, 2005).

The picture becomes a bit more complicated when this analysis is expanded to non-governmental sources. Among Chinese security and international relations analysts, climate-related security issues are not taken very seriously (Zha, 2009). Nonetheless, several prominent Chinese analysts are increasingly outspoken in their advocacy for greater US-China climate cooperation. Zhang Haibin, a professor at Peking University, has written that "from a high-level strategic perspective actively promoting US-China climate cooperation will advance the mutual interests of all of humanity" (Zhang H. , 2009). Meanwhile, Chinese government media gave favourable coverage to the US Deputy National Security Adviser's

April 2009 message to China that the United States wished to enhance clean and renewable energy technology cooperation (Wang, 2009).

In addition, water issues have become more prominent in China's relations with some neighbouring countries. China has in recent years concluded a number of agreements with countries like Russia and Kazakhstan regarding the demarcation and protection of transboundary rivers (Ministry of Foreign Affairs, 2003). Furthermore, the Shanghai Cooperation Organization (SCO), which Beijing initially promoted largely as a body for expanding security cooperation and countering Western influence, has begun working on water issues. The SCO's 2004 meeting was devoted to water, and in 2005 the organization signed a compact with the Association of Southeast Asian nations to broaden cooperation on water resources (Asia Society, 2009, p. 38).

At the domestic level, Chinese officials appear to take very seriously the consequences of water-related climate change impacts. Premier Wen Jiabao, for instance, was quoted in 1998 as saying, “"The survival of the Chinese nation is threatened by the country's shortage of water” (Plafker, 2005). Lin Erda, a prominent member of China's Agricultural Sciences Institute, has similarly called attention to the threat posed by retreating glaciers, saying that these and other effects of climate change “directly threaten China's food security” (Lin, 2005). The recent winter drought of 2008-2009 also indicated the government's concern for water issues, with state media reporting in its wake that “Agriculture is a top government priority… [In early 2009 the] State Council and the Central Committee of the Communist Party issued their first joint document of the year, which reiterated that the development of agriculture and rural areas in 2009 was of special significance” (Xinhua News Agency, 2009).

Indeed, the government's response to the winter drought is indicative of the seriousness with which it takes water issues. Beijing declared a state of emergency as a result of the winter drought, and has earmarked some 400 million RMB for drought relief (Xinhua News Agency, 2009). State media coverage also highlighted government investment in water management, including an investment of some 62 billion RMB in rural water conservation from 2000-2008 (Xinhua News Agency, 2009). Government water officials further reiterated their intention to “strengthen control” of water resources, and to implement conservation practices (Xinhua News Agency, 2009).

Much of this effort seems to be specifically motivated by concerns for food and water security. In statements to the press, China's Minister for Water Resources stressed the need to redress inequities in the distribution of water resources to urban and rural residents (Beijing Qingnian Bao, 2009). Premier Wen Jiabao similarly emphasized the need to provide peasants with economic security and stability in a time of drought, saying "It's of vital significance to the overall economy to boost steady growth of grain production and farmers' income" (Xinhua News Agency, 2009). State media further repeated the theme of uneven access, including one report illustrating a peasant who pays five times the urban price of water just a few kilometres away (Hun, 2009).

Paralleling this focus on water security is an even more long-standing preoccupation with the fear that water shortages will impair food security. In mid-2008, state media reported that “With food and water security becoming great concerns around the world, China will take measures to ensure agricultural water use and promote its plan to increase food production,” including raising the price of water (Wang W. , 2008). China further appears to take the issue of water availability in the Himalaya seriously, flying several cloud-seeing sorties a month to increase rainfall and water availability on the Tibet-Qinghai Plateau (Zha, 2009). Perhaps the clearest statement of the government's linkage of water and security issues, however, is the National Framework for Medium to Long-Term Food

Security, released in 2008, which emphasizes water-saving agriculture and conversation (Xinhua News Agency, 2009).

Chinese discourse on climate, water, and security is clouded. As this section has indicated, there remains a high-level reticence to link climate change issues and security. However, some commentators have instead emphasized these linkages. Moreover, at the domestic level, official voices have expressed particular concern over inequities in water resource distribution, as well as potential implications for food security. The net result is that it is reasonable to assume China's foreign and security policy framework has not been broadened to include climate-related impacts. Given the manifold strategic challenges these impacts will pose for China, as outlined in the last section, this is of some concern. With this in mind, this paper turns to its conclusions, which include implications for global climate change cooperation and negotiations.

Conclusions: A Way Forward for Climate, Water, and Security in China and Asia

This paper has attempted to probe the intersection of climate, water, and security. In the process, it has examined the physical science basis of water-related climate change impacts, their security implications, and Chinese political and security discourse. In many ways, this is uncharted academic terrain. Scientific assessments of climate change and its impact on hydrological systems are subject to large uncertainties, while the security and political dimensions of the climate issue exist in a fluid context of popular and elite opinion. Nonetheless, this paper has advanced a consistent theme, namely that water-related climate change impacts will increasingly bear on China's security, foreign relations, and political discourse.

Beneath this over-arching conclusion, this analysis has uncovered several cross-cutting issues at the intersection of climate, water, and security. First among them is uncertainty. The climate system is incredibly complex, making precise scientific assessment of climate change impacts, particularly on water, extremely difficult. Indeed, one of the most confident predictions that can be made is that climate change will increase the variability in precipitation patterns. As a result of this fundamental uncertainty, the security implications of such change center on grave but general threats to stability, including large-scale migration, decreasing agricultural water availability, and increased risk of catastrophic flooding. Such uncertainty makes tinges climate security studies with a generic air. But this does not detract from their gravity: as security analyst James Stuhltrager has noted, climate change fundamentally represents uncertainty and risk, both of which are integral to security assessment and planning (Stuhltrager, 2008).

A second inter-related issue deals with acute regional impacts. It is clear that specific regions, such as the Mekong River, parts of the Indian Himalaya and northwest China, will be more severely impacted by changes in hydrology under climate change. In most such cases, these ecological impacts will be exacerbated by social, economic, and political factors; in the Mekong, water management is hampered by transboundary political disputes, while in northwest China ethnic tensions and poverty enhance the threat of climate-hydrological changes. Thus, the political-security implications of such changes are likely to be centered on several specific "hot spot" regions.

The third and final major cross-cutting issue identified in this analysis is that water-related climate change impacts will strain the capacity of Chinese institutions and policy frameworks. This is particularly evident with respect to the military's natural disaster response capabilities and transboundary water management policy, as well as with domestic agricultural, emergency management, and water management policies. The Chinese government, perhaps with the increased aid of international and civil society actors, will be pressed to improve its conceptual, planning and implementation capacities in each of these policy areas. While Chinese discourse provides evidence of a foundation for developing such capacities, they are unlikely to be sufficient to deal with the full scale of the climate change challenge. Finally, China will be forced to devote large economic resources to adaptation, including the construction of flood defenses, reservoirs, and water distribution systems, if it is to escape the worst water-related climate change impacts. At a time when China's development priorities demand investment in so many areas, this investment is almost certain to increase political tensions.

With these observations more fully articulated, this paper can at last approach the issue of implications for global cooperation on climate change. Before doing so, a caveat is appropriate. It is evident that, from the perspective of China and most other developing countries, the climate issue is defined primarily by political and economic issues. China's stated goals for the Copenhagen climate change conference, for example, emphasize adaptation and technology transfer, with funding responsibilities borne entirely by developed nations (National Development and Reform Commission, 2009).

These points of contention, rather than security or strategic dialogue, will define upcoming global climate negotiations. Indeed, Chinese leaders may continue to resist linking climate change and its national security, since as scholars have long noted there is little risk that climate change will foster interstate violence, the traditional focus of security (Deudney, 1990, p. 461). There is thus a limit to the benefit to be gained by "securitizing" the issue of climate change. However, this paper's conclusion that water-related security issues will be of increasing importance under climate change carries at least three significant implications for global climate cooperation.

First, water-related security issues present a particularly good opportunity to broaden and deepen bilateral and regional cooperation on climate change. Fundamentally, it presents an opportunity for strategic dialogue on the long-term impacts of climate change, rather than shorter-term disagreements over technology transfer or verifiable emissions reductions. Acute institutional vulnerabilities, such increased strain on emergency management and disaster response capabilities in China, present opportunities for international technical assistance and cooperation. A recent Council on Foreign Relations paper, for example, recommends that the US military integrate climate-related extreme weather response into its regional command structure (Busby, 2007, p. 21); building dialogue between such commands, their Chinese and other Asian counterparts could dramatically improve the efficacy of international disaster response efforts.

This kind of cooperation could be further strengthened by focusing developed-country climate adaptation funding to address acute strategic issues. For example, the US Agency for International Development has launched a program in cooperation with the Gates Foundation to develop new rice varieties capable of surviving various climate change-related stresses, thereby enhancing food security throughout South Asia. The USD$35 million project will focus on enabling farmers in the region to obtain higher rice yields even in the face of climate change, and with fewer inputs of fertilizer and irrigated water (US Federal News Service, 2009). Similar models could be explored, possibly with a greater degree of co-financing, in China.

Additionally, a recent cooperative venture between the Chinese Academy of Sciences and the US Department of Agriculture illustrates how bilateral technical assistance can focus on ameliorating water-related climate change impacts. The program, founded in 2005, is focused on preventing erosion in China's Loess Plateau, which is expected to experience severe flooding under climate change. Cooperative modeling between the two agencies identified no-till farming practices that can reduce soil loss by 85% under climate change, helping protect farmers from economic and ecological destruction (Zhang & Liu, 2008, p. 22A). Replicating similar programs can help target adaptation funding to averting the worst hydrological impacts of climate change (and attendant security effects), while also expanding bilateral climate cooperation.

The third and final implication of this analysis for global climate cooperation is to view such cooperation not only as an ecological imperative, but also as a strategic one. As a Council on Foreign Relations report has noted, international climate negotiations have a clear national security dimension, inasmuch as the international community has an interest in integrating nations like China and India into a “rules-based global order” through participation in climate negotiations (Busby, 2007, p. 19). This interest is heightened when the security ramifications of climate change, such as have been detailed in this paper, are considered. Fundamentally, these ramifications serve to highlight the fact that climate change impacts, both water and other, will reverberate across borders and traditional disciplinary distinctions between science, politics, and security. High-level security dialogue between China, the United States, and other countries can serve as a focal point for such discussions, and can be a component of existing initiatives, such as the US-sponsored Major Economies Process on Energy and Climate.

Climate change and its consequences will cast a growing shadow over international politics and relations in the coming years. Much about the issue is uncertain, but it seems safe to assert that policymakers and analysts in a wide variety of fields will be compelled to pay more attention to climate issues. This analysis is intended as a first step towards probing the issues involved for such actors at the intersection of climate change, water, and security, especially with respect to China and Asia. It will almost certainly, however, not be the last. Scientific assessments of climate change impacts are likely to improve in accuracy and detail, as is the analysis of the political, social, and strategic issues entailed in climate change. Such work is essential for sharpening the focus of this paper- to think broadly and critical about the manifold consequences of climate change, for China, Asia, and the world at large.

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Getting Hotter:
How Could China's Climate Change Policy Trajectory Impact a Post-Kyoto Accord?

Gloria Jean Gong[1]

Abstract

China's unprecedented economic growth has given rise to equally rapid increases in greenhouse gas emissions. China has already ratified the Kyoto and Montreal Protocols, yet as the international community looks beyond Kyoto, China's willingness to adhere to binding emissions standards remains a critical question. This study describes and analyzes the factors that influence China's possible participation in a binding greenhouse gas emissions treaty. Existing international treaty compliance models often overlook China's own official policies and stances toward such treaties. This study examines China's current climate change policy, historical adjustments of that policy, and potential future trajectory to determine the factors that would most impact China's willingness to sign a post-Kyoto climate change. This study utilizes both English and Chinese-language documents to analyze current Chinese climate change policies. It describes the historical trajectory of Chinese environmental policy since 1972, tracing the evolution of the "common but differentiated responsibilities" principle and of the demand for technology transfers and access to international funds. This study also examines reports from the World Bank, China Council for International Cooperation on Environment and Development (CCICED) and the Organisation for Economic Co-operation and Development (OECD), explicating how recommendations from influential organizations may impact China's future policy trajectory. Most surprisingly, the conclusion of this study is that China, while retaining much of its former stance on climate change, is also increasingly warming to taking bold actions to reduce greenhouse gas emissions.

I. Introduction

China's recent economic growth and industrial development have been breathtakingly rapid. These increases in manufacturing and industrial production coupled with growing consumption and an increased standard of living are inseparably connected to persistent environmental degradation and rising pollution.

The 2007 Synthesis Report of the Intergovernmental Panel on Climate Change warns that "warming of the climate system is unequivocal."[2] The report also estimates that global greenhouse gas emissions rose 70% since 1970, and that this steep increase in greenhouse gasses is very likely a major factor in global warming.[3] Climate change threatens to destabilize ecosystems, weaken food security and precipitate severe water shortages. International consensus on the threat climate change presents to the global community has solidified consistently since the early 1990s.

The international community responded with the United Nations Framework Convention on Climate Change and the Kyoto Protocol, an international treaty designed to combat global warming with a system of measuring, emissions caps, and credit trading. By 2008, of Kyoto Protocol signatories, only the United States of America had not and did not intend to ratify the treaty. Under the Kyoto system, China was classified as a non-Annex I developing nation and, like other non-Annex I nations, was not required to set emissions caps on any greenhouse gasses. Rather, developing nations agreed to conduct emissions

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[1] Chinese Flagship Fellow, Brigham Young University, email: gloriajean09@gmail.com

[2] Intergovernmental Panel on Climate Change (IPCC), *Fourth Assessment Report: Synthesis Report* (Geneva: United Nations, 2007), 2.

[3] *ibid*., 5.

measurements and submit regular reports to the United Nations Framework Convention on Climate Change while developed nations committed to reduce key greenhouse gas emissions and to provide technology and funding to lesser developed countries (LDCs).[4]

To China, the lack of binding emissions caps was a vital factor in ratifying the treaty. Since the 1970s, China has maintained that the right to industrial and economic development takes precedent over environmental protection, pointing out that developed countries only reached their current economic levels after passing through an industrial revolution. In addition, China and other LDCs argue that current levels of greenhouse gasses are overwhelmingly due to emissions by developed countries, and that forcing LDCs to truncate their growth to pay for the emissions of the first world is unfair. When criticized for its skyrocketing carbon emissions rates, China is quick to counter that in terms of emissions per capita, it still ranks far below the developed world. Table 1 shows China, the US, the largest emitter, smallest emitter, mean, and median countries on total carbon dioxide emission, per capita emission, and per US$ GDP emission.

Total CO_2	**kilotons**	**Per capita**	**tons**	**Per $GDP**	**kg/$ PPP**
~China†	6,251,235	Qatar	62.97	Uzbekistan	2.96
US	5,788,181	US	19.904	China	0.65
China	4,143,494	Mean*	5.7	US	0.56
Mean*	128,214	China	3.216	Mean*	0.5
Median**	7,971	Median**	2.7	Median**	0.33
Kiribati	29	Chad	0.013	Chad	0.01
US, 1st of 195 China, 2nd *Argentina, 31st **Mongolia, 97th		US, 7th of 191 China, 85th *Iran, 62nd **Syria, 96th		US, 38th of 170 China, 34th *Mauritania, 45th **Morocco, 85th	

Table 1: Comparison of Total, Per Capita, and Per $GDP CO_2 Emissions
† 2006 estimate from the Netherlands Environment Assessment Agency, 8% greater than US
Source: World Bank World Development Indicators 2004

Because of the large carbon intensity gap between developed and developing nations, China draws extensively on the principle of "common but differentiated responsibilities" to explain its reluctance to reduce emissions. The principle of "common but differentiated responsibility" outlined in the United Nations Framework Convention on Climate Change refers to assigning to developed countries the responsibility to "take the lead in combating climate change and the adverse effects thereof."[5]

Despite low per capita carbon emissions, China's burgeoning total emissions attract ever more international attention and concern. Studies made headlines when they reported that sometime in 2006, China surpassed the US as the largest emitter of carbon dioxide in the world, almost 15 years earlier than most research had predicted.[6] China's unfettered CO2

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[4] United Nations Framework Convention on Climate Change (UNFCCC), *Kyoto Protocol* (Kyoto, Japan: United Nations, 1998), 10.
[5] United Nations, *United Nations Framework Convention on Climate Change* (Rio de Janeiro: United Nations, 1992), 4.
[6] Maximilian Auffhammer and Richard T. Carson, "Forecasting the path of China's CO2 emissions using province-level information," *Journal of Environmental Economics and Management*, No. 55 (2008): 229–247.

emissions have political as well as environmental implications, and played a major factor in the US decision not to ratify the Kyoto Protocol. China defends some of its growth by pointing out that 26% of its carbon emissions are caused by manufacturing goods for the west, and argues that the west should take responsibility for these "exported emissions."[7]

As the effects of climate change grow ever clearer, China itself has begun to recognize the dire need to reduce greenhouse gas emissions. The National Eleventh Five-Year Plan for Environmental Protection released by the Ministry of Environmental Protection admits with disarming frankness that, "China is facing grim situation [*sic*] in addressing climate change with hard tasks."[8] Addressing climate change is an integral part of China's sustainable development goals, which are based largely on the United Nation's Agenda 21 framework. The international community has matched China's increased environmental activity with access to funding and technical support. This potential aid combined with China's ambition to lead the bloc of emerging economies makes China susceptible to pressure from the international community over issues of environmental protection.

Yet the debate about emissions cuts remains troubled. A lack of consensus on a post-Kyoto climate change protocol arises largely from uncertainty about China's willingness to participate in a treaty that includes binding emissions caps for LDCs. This study defines five major factors impacting China's potential compliance with a future climate change treaty: economic development, domestic goals, United Nations framework, allocation of responsibility and international cooperation. It examines these factors in light of China's current climate change policy, historical adjustments of that policy, and potential future trajectory.

II. Background and Literature Review

Deng Xiaoping's 1978 ascension to power after the death of Mao Zedong not only ended the Cultural Revolution but heralded renewed exchange between China and the world. In sharp contrast to Mao's strict isolation from the Western world, China participated more actively in international economic, cultural, and environmental systems. Under Deng's liberalizing influence, China broke from earlier policies of environmental exploitation and initiated its domestic environmental protection program. The year of Deng's rise to power saw a change in the constitution recognizing the importance of the environment. In the following year, the National People's Congress approved China's first draft law on environmental protection.[9]

In 1984 China held its second national conference on environmental protection, established an environmental protection commission and elevated the Environmental Protection Bureau to the National Environmental Protection Bureau (a status just below ministerial).[10] In the same year, Vaclav Smil's book *The Bad Earth* was published, giving the first comprehensive western overview of China's environmental condition.

When Lester Ross's *Environmental Policy in China* was published in 1988, Ross examined influences on China's interchange with the west over environmental policy questions, pointing out, among other factors, the continued influence of Soviet policy, guidance, and ideology. Yet China's approach to environmental protection began diverging

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Netherlands Environmental Assessment Agency (MNP), *China now no. 1 in CO2 emissions; USA in second position* (Bilthoven, Netherlands: MNP, 19 June 2007).

[7] China Council for International Cooperation on Environment and Development (CCICED), *Annual General Meeting: Summary Record* (Beijing: CCICED, 14 November 2008), 38.

[8] Chinese Ministry of Environmental Protection (MEP), *National Eleventh Five-year Plan for Environmental Protection* (Beijing: MEP, 26 November 2007), 2.

[9] Miranda Alice Schreurs and Elizabeth Economy, *The Internationalization of Environmental Protection* (Cambridge: Cambridge University Press, 1997), 22.

[10] Elizabeth Economy, *The River Runs Black: The Environmental Challenge of China's Future* (Ithaca, NY: Cornell University Press, 2005), 96.

from the Soviet model. In 1989 China formally promulgated its first Environmental Protection Law and granted the National Environmental Protection Bureau independent status from the Ministry of Urban and Rural Construction.

While rapid industrial growth gave rise to climbing pollution rates, China's participation in the 1992 UN Conference on Environment and Development (the Rio Convention) marked a new era of environmental participation from the central government. The inclusion of authors Dasheng Yang and Weiyu Yang in the 1993 international forum on global warming is representative of China's advance in environmental expertise.[11]

1993 also saw the publication of Vaclav Smil's *China's Environmental Crisis*, the follow-up to 1984's *The Bad Earth*. During the intervening nine years China had undergone a massive change. In *China's Environmental Crisis,* Smil noted the impact of rapid industrial development on China's environment and also wrote at length on the contemporary energy use trajectory and its implications. Interestingly, Smil presciently predicted China's impending challenges, writing that:

> The worst-case scenario would see an unmistakable onset of relatively rapid warming during the 1990s translating into substantial CO2 generation cuts in rich countries, with China becoming the leading producer of the gas before the year 2010, and finding itself under a mounting international pressure to start cutting its emissions.[12]

Smil criticized contemporary literature on the Chinese environment, writing that too much emphasis had been put on language ability resulting in "embarrassingly ignorant writings on the physical nature of China."[13]

The Rio Conference and the 1993 Climate Change Convention opened the door to a flood of publications addressing China's participation in international environmental treaties generally, and the global climate change regime specifically. Barbara Sinkule and Leonard Ortolano's book *Implementing Environmental Policy in China* presents an insightful analysis of the process of environmental policy formation within China. Using a wealth of Chinese sources, Sinkule and Ortolano address at length the "*san ge fabao*" ("three magic weapons") of environmental impact assessment, pollutant discharge fees, and the three synchronizations. Using the metaphor of "implementation games" as a framework for analysis, they also analyze individual industrial facilities and local environmental protection bureaus.[14] Sinkule and Ortolano's book is one of a handful that draw heavily on the language and logic of the Chinese environmental policy apparatus, and their attention yields profound insights into the process of policy making unique to China.

Council on Foreign Relations member Elizabeth Economy's *The River Runs Black: The Environmental Challenge of China's Future* (2004) also benefits from a deep familiarity with Chinese sources. Economy draws exhaustively on official documents, statistics and personal interviews to paint a compelling picture of the founding of the Ministry of Environmental Protection and China's environmental regime.

As the field of climate change and sustainable development studies explodes, more and more scholars with little specific knowledge of China apply their expertise to addressing China's environmental policy. In the late 1990's and early 2000's, the widespread popularity

[11] Richard A. Geyer, ed., *A Global Warming Forum: Scientific, Economic, and Legal Overview* (Boca Raton, FL: CRC Press, 1993), 3.
[12] Vaclav Smil, *China's Environmental Crisis: An Inquiry into the Limits of National Development* (New York: East Gate Book, 1993), 135.
[13] Vaclav Smil, *The Bad Earth: Environmental Degradation in China* (Armonk, NY: M.E. Sharpe, 1984), 6.
[14] Barbara Sinkule and Leonard Ortolano, *Implementing Environmental Policy in China*, (London: Praeger, 1995).

of sustainable development and environmental studies resulted in a plethora of comparative studies that included China.[15] Others examined the process of international environmental treaty-making from a political science standpoint.[16] Political science research in this area often uses game theory models to examine the incentive structures of international treaties or regimes and is largely based on realist theories of international relations.[17] Other studies use economic tools to assess the impact and efficacy of such incentive structures.[18] Scientific studies assess the environmental impact of existing treaties and policies and predict future impact.[19] As the complexity of the problem become apparent, many researchers moved toward an interdisciplinary approach, combining analytical tools from political science, economics and environmental sciences.[20]

The intricate models created and utilized by these scholars are valuable resources for understanding China's willingness to participate in international environmental treaties and for predicting its future compliance. While this method of broad comparison greatly increases our ability to compare China's actions in relation to other developing countries and in the context of international models, it invites further China-specific research.

The models are often applied to a wide range of countries and tend not to treat at any great length the impact of China's domestic policy on its compliance with international treaties. One potential reason for this lacuna is a linguistic and cultural barrier. A majority of the studies published in the West that include China, and even of studies focused primarily on China, are written by researchers with no apparent background in Chinese. While not an insurmountable handicap, the inability to directly access the wealth of environmental information available in Chinese or to understand the cultural context of public statements by Chinese officials might limit researchers to a superficial understanding of China's policy trajectory.

This study analyzes both English and Chinese-language documents in order to describe current Chinese climate change policies, including the Eleventh Five-Year Plan, the National Climate Change Plan, and the 2007 Report on the State of the Environment. It also

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[15] Carlo Carraro, ed., *International Environmental Agreements on Climate Change* (Dordrecht, Germany: Kluwer Academic Publishers, 1999).

Avijit Gupta and Mukul G. Asher, "Current Global Events and Projected Efforts" in *Environment and the Developing World* (Chichester, UK: John Wiley & Sons, 1998).

Joyeeta Gupta, *The Climate Change Convention and Developing Countries: From Conflict to Consensus* (Dordrecht, Germany: Kluwer Academic Publishers, 1997).

Anil Markandya and Kirsten Halsnaes, eds. *Climate Change and Sustainable Development: Prospects for Developing Countries* (London: Earthscan Publications Ltd., 2002).

Frank Wijen, Kees Zoeteman, and Jan Pieters, *A Handbook for Globalization and Environmental Policy: National Government Interventions in a Global Arena* (Cheltham, UK: Edward Elgar, 2005).

[16] Denise K. DeGarmo, *International Environmental Treaties and State Behavior: Factors Influencing Cooperation* (New York: Routledge, 2005).

Peter M. Haas, Robert O. Keohane, and Marc A. Levy, eds., *Institutions for the Earth: Sources for Effective International Environmental Protection* (Cambridge, MA: MIT Press, 1993).

Urs Luterbacher and Detlef F. Sprinz, *International Relations and Global Climate Change* (Cambridge, MA: MIT Press, 2001).

Farhana Yamin and Joanna Depledge, *The International Climate Change Regime: A Guide to Rules, Institutions and Procedures* (Cambridge: Cambridge University Press, 2004).

[17] Scott Barrett, *Environment and Statecraft*: *The Strategy of Environmental Treaty-making* (Oxford: Oxford University Press, 2003).

[18] Markandya and Halsnaes 2002.

[19] Geyer 1993.

[20] Edward Miles and others, *Environmental Regime Effectiveness: Confronting Theory with Evidence* (Cambridge, MA: MIT Press, 2002).

Lawrence Peretz, *Climate Change Research Progress* (New York: Nova Science Publishers, 2008).

Zhang Zhongxiang, *The Economics of Energy Policy in China: The Implications for Global Climate Change* (Cheltenham, UK: Edward Elgar, 1998).

describes the historical trajectory of Chinese environmental policy since 1972, tracing the evolution of the “common but differentiated responsibilities” principle and of the demand for technology transfers and access to international funds. Finally, by inspecting reports from the World Bank, China Council for International Cooperation on Environment and Development (CCICED), and Organisation for Economic Co-operation and Development (OECD), this study examines how recommendations from influential organizations could impact China’s future policy trajectory.

III. Analysis

This study identified the following five elements as currently impacting China’s policy on climate change: economic development, domestic goals, UN framework, allocation of responsibility, and international cooperation. The following section describes the current policy and official stance China takes on each element as well as the historical policy trajectory since 1972. After describing the historical trajectory and current status of China’s climate change policy, this study will examine possible future paths by exploring recommendations made to China by influential policy bodies.

A. Economic Development

Since its modern debut in international diplomacy, China has consistently insisted on a right to economic development that takes precedence over environmental protection. When China sent delegates to the 1972 UN Conference on the Human Environment, one of the central points upon which the delegates insisted was that the international community “assure the rights of developing countries to develop first and address their environmental challenges one by one."[21] China has reiterated this priority throughout its increased activity in international environmental exchanges. In a 2008 statement to the United Nations, Bai Yongjie, Counselor of the Chinese Mission to the UN, said that China would “strive for” a reduction in energy consumption and pollutant emissions, while maintaining that China’s primary goal was to double the per capita GDP of the year 2000 by 2010.[22]

Yet China has gradually shifted its position in regards to the constant primacy of economic development over environmental protection. In 1990, the chairman of the then State Environmental Protection Commission, Song Jian, suggested a balance between environmental protection and economic development, though it would take many years before Chinese policy gave more than cursory lip-service to the idea of an equal balance.[23] At the Rio Convention, China’s delegation officially stated that “environmental protection can only be effective when development has been attained.”[24]

In its section on “Philosophy, Basic Principles and Plan Objectives,” the Eleventh Five-year Plan for Environmental Protection reiterates the “three transformations” that have recently become the guiding principles of China’s environmental program. The three transformations most clearly encapsulate China’s growing commitment to balance environmental protection with economic growth. The first and second transformations emphasize a shift away from the current prioritization of economic growth over environmental protection toward a new standard of equal emphasis. The third transformation emphasizes a shift from government administration of environmental protection toward a

[21] Economy 2005, 94.
[22] Bai Yongjie, *Statement by Ms. BAI Yongjie, Counselor of the Chinese Mission to the UN at the Roundtable on “Environmental Sustainability” of the UN High-level Event on Millennium Development Goals* (New York: United Nations, 2008).
[23] Economy 2005, 187.
[24] *ibid.*, 98.

"comprehensive application of legal, economic, technical and necessary administrative methods to address environmental problems."[25]

While China is unlikely to relinquish its claims to a right to economic development at the cost of the environment, it seems increasingly open to recognizing environmental protection as a top priority. Though this new doctrine signals a substantive shift in philosophy, there remains a tendency toward internecine conflict between the ministries over development and environmental protection.

B. Domestic Climate Change Goals

China domestic climate change policy has evolved in response to international programs. Until the creation of the National Climate Change Program in 2007, China's domestic climate change policy was scattered between several policies. This section examines China's Local Agenda 21 (1993), National Eleventh Five-year Plan (2007), and National Climate Change Plan (2007) to illustrate the changes in approach to climate change mitigation and adaptation since the 1992 Rio Convention.

An aversion to binding carbon emissions caps consistently underlies China's approach to climate change policy. China's greenhouse gas emissions reduction goals are rarely stated in terms of reduction in total emissions. Rather, in keeping with the continued emphasis on environmental protection paired with economic growth, goals are most often framed in terms of China's carbon intensity (carbon emissions per unit GDP) or of carbon emissions per capita rather than gross emissions.

China has focused its domestic policy on two key instruments to combat climate change while promoting development:

1. Research and development that will strengthen basic measurement and analysis capabilities, developing renewable energy technologies, exploring carbon capture and sequestration and exploiting alternative energy sources.
2. Increasing efficiency of existing technologies, for example, upgrading current coal-burning power plants.

In the Initial National Communication on Climate Change to the UNFCCC, China pointed out that its observation infrastructure is underdeveloped, crippling its ability to accurately measure key emissions indicators.[26] China's insistence on increased efficiency as a way to reduce carbon emissions is in line with its determination to continue growth, but also accurately reflects the fact that upgrading outmoded technology is China's most accessible and efficient pathway to reducing greenhouse gas emissions. China's coal-fired plants often function with only a fraction of the efficiency of counterparts in the developed world. According to World Bank estimates, replacing obsolete technology with cleaner-burning, more efficient technology could reduce China's carbon dioxide emissions by as much as 40% by 2030.[27]

Local Agenda 21: China was the first country to formulate a Local Agenda 21 (LA21) in response to the United Nations' Agenda 21 (a framework for international sustainable development). One of the 19 areas of focus in China's Agenda 21 is "Protection of the Atmosphere," which includes prevention of stratospheric ozone depletion, controlling

[25] MEP 2007, 3.
[26] Government of China. *The People's Republic of China Initial National Communication on Climate Change* (Beijing: Government of China, 2004), 14.
[27] World Bank, WDI 2008.

greenhouse gas emissions, and construction of climate change monitoring, forecasting and service systems.[28]

LA21 states that “China wishes to bring the emission of greenhouse gases under control, reduce the growth rate of carbon dioxide emissions, study measures for reducing emissions of methane and nitrous oxide, maintain and strengthen greenhouse gas sinks.” The Agenda lays out a framework for combating climate change that includes research, strengthening the emissions measurement infrastructure and increasing efficiency in energy production and consumption. Its objectives for reduction of ozone depleting substances (ODS) focus on research and development activities that will improve the production of ODS substitutes. LA21 also prioritizes setting “targets for emission levels, in accordance with the international convention for the control of greenhouse gases” though the Agenda itself gives little indication of what those emissions levels would be.[29]

National Eleventh Five-Year Plan: Revealing vestiges of Soviet influence, China’s central government periodically publishes a five-year plan to outline policy direction. In 2007, in response to the central government’s Eleventh Five-Year Plan, the Ministry of Environmental Protection (MEP) published the Eleventh Five-Year Plan for Environmental Protection. The Plan lays out an ambitious list of policies intended to control the emissions of greenhouse gasses (GHGs), including accelerating development of energy saving technologies, developing renewable energy, controlling GHG emissions in industrial production processes and creating carbon sinks through reforestation projects.

In addition, MEP’s Five-Year Plan sets binding targets that are “fragmented [*sic*] to each province, autonomous region, and municipality directly under the State Council.”[30] Important to note, these binding targets are imposed on provincial governments by the central government and in no way indicate that China would agree to binding emissions reductions targets being placed on it by other, powers such as the United Nations, rather, these standards merely indicate that China is now prioritizing emissions reduction more so than in the past.

National Climate Change Plan: Signaling a growing commitment to address climate change, the central government called for the formation of a national climate change framework. Published in 2007, the 62-page document details China’s plan to mitigate and adapt to global warming. Key features of China’s National Climate Change Plan (CNCCP) include its admission of climate change as a “major global issue,” its placement of climate change within a sustainable development framework, its emphasis on equal treatment of adaptation and mitigation, and its lack of binding emissions standards.

The CNCCP reaffirms China’s commitment to achieving environmental protection within a larger framework of economic and social development. In the section on “China’s Efforts and Achievement in Mitigating Climate Change” the CNCCP outlines the direction of China’s Climate Change mitigation program including “restructuring the economy, promoting technology advancement and improving energy efficiency, optimizing energy mix by developing low-carbon and renewable energy, strengthening laws and regulations, and policies and measures relevant to addressing climate change.”[31] In addition to goals to raise conservation awareness, encourage climate change research and restructure legal and economic mechanisms and reduce emissions through technology upgrades, the CNCCP outlines specific standards on greenhouse gas emissions.

The key standards outlined in the CNCCP include:

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[28] Government of China, *Local Agenda 21 in China* (LA21) (Beijing: Government of China, 1993), 18.31.
[29] *ibid*., 18.32 b.
[30] *ibid*., 7.
[31] National Development and Reform Commission, *China’s National Climate Change Programme* (CNCCP) (Beijing: Government of China, 2007), 7.

- increase the proportion of renewable energy (including hydropower) to 10 percent of the primary energy supply by 2010;
- increase extraction of coal bed methane to 10 billion cubic meters;
- stabilize nitrous oxide emissions at 2005 levels by 2010;
- reduce CO2 emissions through a 20 percent reduction of energy consumption per unit GDP by 2010.[32]

Counselor of the Chinese Mission to the UN, Bai Yongjie, in her 2008 address to the Roundtable on "Environmental Sustainability" of the UN High-level Event on Millennium Development Goals, said that in addition to doubling the 2005 GDP by 2010, China would "strive for, as compared with the 2005 level, a 20% reduction in China's per unit GDP energy consumption, a 10% reduction in main pollutant discharge and a 20% increase in forest coverage."[33] Ms. Bai's statement not only clearly defines several of China's environmental goals, but also illustrates why China's domestic treatment of climate change has increasingly become the subject of international scrutiny.

C. United Nations Framework

China created its domestic climate change policy in response to and reflects the underlying structure of the UNFCCC. China has repeatedly criticized attempts to circumvent the UNFCCC, arguing that it should be the main vehicle for addressing climate change. China has also stressed the importance of delaying binding emissions caps on LDCs until developed countries have first reduced their carbon emissions.

Since 1992, the United Nations Framework Convention on Climate Change has remained the international community's key organ for mitigation of climate change. China's compliance with the Kyoto Protocol was greatly influenced by its inclusion as a non-Annex I country. Under the Kyoto Protocol, China was required to observe and report emissions data but was not required to reduce emissions of greenhouse gasses.

China has actively participated in UNFCCC activities and has resisted the creation of alternative treaties by nations dissatisfied with the Kyoto Protocol. At the release of the National Climate Change Plan, Ma Kai, minister of the Chinese National Development and Reform Commission, dismissed US President Bush's formation of the APEC Leader's Declaration on Climate Change, Energy Security and Clean Development (the Sydney Declaration), an alternative declaration to the Kyoto Protocol that contained no emissions reductions standards for developed countries and reiterated China's commitment to working within the UN Framework Convention on Climate Change.[34] After meeting with Australian Prime Minister John Howard to discuss the Sydney Declaration, Hu Jintao announced at a press conference that he hoped the Sydney Declaration would recognize the UN Framework Convention on Climate Change as the "main channel" through which the international community would address climate change.[35]

Ma Kai also pointed to China's low greenhouse gas emissions per capita and its status as a developing nation, arguing that it was "too early, too abrupt and too blunt" for the international community to impose emissions caps on China. China has also roundly rejected calls for emissions caps on high-emitting sectors, such as steel-making, labeling them as specifically antagonist to the interests of developing countries.[36]

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[32] CNCCP 2007, 26.
[33] Bai 2008.
[34] Wu Chong, "China rejects emissions caps in climate plan," *Science and Development Network*, 4 June 2007.
[35] Bill Tarrant, "China's Hu Wants UN Framework on Climate Change," *Reuters*, 7 September 2007.
[36] Chris Buckley and Emma Graham-Harrison, "China Grim on Prospects for Climate Path," *Reuters*, 7 October 2008.

D. Allocation of Responsibility

The principle of “common but differentiated responsibilities” laid out in the UNFCCC is now a ubiquitous tenet in Chinese environmental policy. The “common but differentiated responsibilities” principle holds that all members of the international community have a common responsibility to address the impact of climate change, but that developed nations are responsible for initiating cuts on GHG emissions. The questions of assignment of responsibility for environmental degradation arose in China’s interactions with the international community even under Mao.

Even before Mao's death, China sent delegates to the 1972 United Nations Conference on the Human Environment (UNCHE) in Stockholm, Sweden. At the UNCHE, Chinese delegates emphasized ten principles that would be echoed in subsequent documents. One of the principles was that the international community ought to "assign responsibility to the superpowers for the destruction of the human environment through their "imperialist" policies of plunder, aggression, and war” and to “sanction countries that plundered and destroyed the environment of developing countries."[37] Such openly antagonistic language was rapidly replaced by more diplomatic approaches, though China has not swayed from the central claim that responsibility for environmental degradation should primarily be assigned to developed countries. At the Rio Conference in 1992, China’s position stated that "the developed countries are responsible for global environmental degradation" and that “China should not talk about its responsibility for global environmental pollution and degradation."[38]

As the issue of global warming grew in importance, China applied the same policy stance toward differentiated responsibilities in mitigating climate change. But China, while remaining firm in the policy that the developed countries should bear the burden of responsibility for climate change and should be first to cut emissions, has softened its rhetoric and become more willing to engage. There are no further calls for sanctions on “imperialist” powers for their “acts of plunder.” Instead, the Eleventh Five-Year Plan assures that in addition to “adhering to the principle of ‘common but differentiated responsibilities’” China will:

> actively participate in international environmental conventions and WTO environment and trade negotiations, and safeguard environmental rights & interests of China as well as developing countries. China will perform its obligations, vigorously promote the domestic implementation work, accelerate the phasing out of substances that deplete ozone layer and try its best to control the emissions of greenhouse gases [*sic*].[39]

China’s willingness to engage in cooperative efforts to mitigate climate change does not mean it has relinquished its stance on assignment of responsibility. In 2008, China and India became ringleaders of a surprising upset at the G8+5 summit, refusing to support the G8’s goal to halve carbon emissions by 2050. Instead, the five leading emerging economies issued a joint statement calling on developed countries to “slash carbon emission levels by 80-95 per cent from 1990 levels.”[40]

When articulating China's demands of a post-Kyoto climate change treaty, China’s special representative to the climate change talks, Yu Qingtai said “any final deal must reflect rich countries' responsibility for gases emitted during production of the many Chinese-made

[37] Economy 2005, 94.
[38] *ibid*., 98.
[39] MEP 2007, 6.
[40] David Pilling, “China and India hold out on emissions targets,” *Financial Times*, 9 July 2008.

goods they consume."[41] The question of exported emissions rises to the front of the confrontation between China and other developed countries, with China pointing out that about 25% of its emissions are for the manufacture of goods exported to the west. China argues that forcing it to reduce its economic growth because the west has essentially exported the high-emissions industries to its nation is unfair and that developed nations must also shoulder responsibility for the emissions of the products they purchase from China.[42]

The National Climate Change Plan holds "common but differentiated responsibilities" as one of its guiding principles. In line with this principle, the CNCCP states that "the Parties included in Annex I to the Convention should take the lead in reducing greenhouse gas emissions." It also argues that the first priority for developing countries "with less historical emission and current low per capita emission [*sic*]…is to achieve sustainable development." The CNCCP firmly declares that "as a developing country, China will stick to its sustainable development strategy," essentially signaling an unwillingness to accept emissions caps unit it reaches its "first and overriding priorities of … sustainable development and poverty eradication." Though it makes no mention of a specific emissions reduction standard developed countries must meet before China will subject itself to emissions cuts, it echoes the UNFCCC in warning that " the extent to which developing countries will effectively implement their commitments under the Convention will depend on the effective implementation by developed [countries] of their basic commitments."[43]

E. International Cooperation

China's fervent participation in bilateral or multilateral cooperative climate change projects under the umbrella of UNFCCC structure highlights the powerful role *international funding* and *technology transfers* play in winning China's compliance. While demands for international funds and technology transfers to support the transition to environmental preservation were present since the 1970s, such whole-hearted enthusiasm illustrates China's gradual thaw towards submitting itself to external standards in exchange for international funds.

In 1988 Lester Ross noted the diminishing number of references to Soviet ideology in Chinese environmental policy and an increased willingness to participate in international environmental regimes. He wrote, "in contrast to the early 1970s when official spokesmen trumpeted China's inherent superiority, the tone nowadays is one of serious concern over the state of the environment, coupled with a search for effective policy."[44] In 1989, China signed and ratified the Montreal Protocol, an amendment to the Vienna Convention that set as its main goal the depletion of ozone depleting substances (ODS). China's active participation in reducing its ODS is an excellent example of effective binding emissions standards.[45]

In exchange for agreeing to phase out its production and consumption of designated ODSs, China gained access to the Multilateral Fund, a multi-billion dollar international fund established to assist developing countries in replacing outdated technologies, measuring and reporting ODS presence, and otherwise move toward the phase-out goal.

As of 2007, China had received the highest amount of funding of any country drawing on MLF resources. According to the Multilateral Fund's Country Programme and Compliance Summary Sheets, China has been approved to receive $779,788,815 in funds and

[41] Buckley and Graham-Harrison 2008.
[42] Buckley and Graham-Harrison 2008.
[43] CNCCP 2007, 24.
[44] Lester Ross, *Environmental Policy in China* (Bloomington, IN: Indiana University Press, 1988), 9.
[45] Chinese Ministry of Environmental Protection (MEP), *Report on the State of the Environment in China* (Beijing: Government of China, 2007).

has already received $614,032,859. This puts the price per ton at $3,593 approved funds or $2,829 disbursed funds.

ODP tonnes	ODP phased	US$ Approved	US$ disbursed	US$ approved ODP phased	US$ disbursed ODP phased
233,100	217,023.6	$779,788,815	$614,032,859	$3,593.11	$2,829.34

Table 2: Funding, Outcomes of China's Collaboration with the Multilateral Fund

With support from the MLF, China was very successful in reducing its consumption and production of almost every designated ODS. The goals for emissions reduction of CO2 and other greenhouse gas are noticeably vague in China's domestic policy documents, but there are specific goals detailing the goals to completely phase out the use and production of certain ODSs.[46]

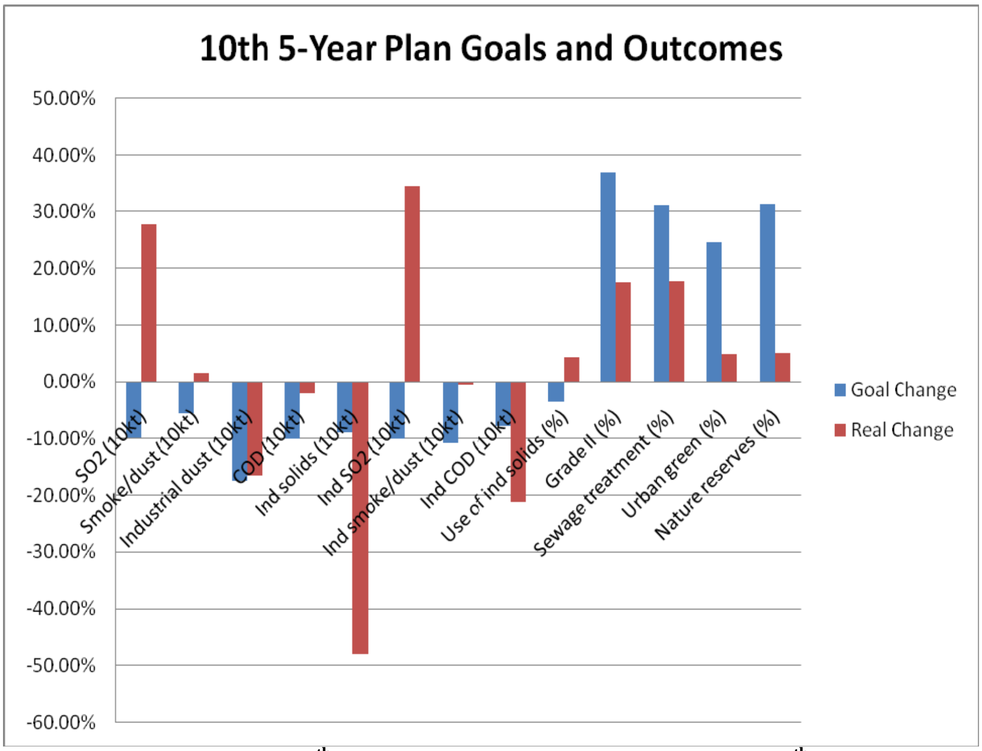

Figure 1: Comparison of 10th FYP goals with outcomes reported in 11th FYP

A comparison between the Tenth Five-Year Plan goals and achievements with those under the Montreal Protocol reveals a marked difference. Of the 13 goals listed in the Tenth Five-Year Plan, China reported meeting only two. Yet it has consistently met the standard and consumption reduction goals set under the Montreal Protocol (see graph below). Access to Multilateral Funds, expertise, and technology ensured China's willingness to comply with the binding reductions.

[46] "CFC Target Set by China for 2010," *China Daily*, 22 April 2003.

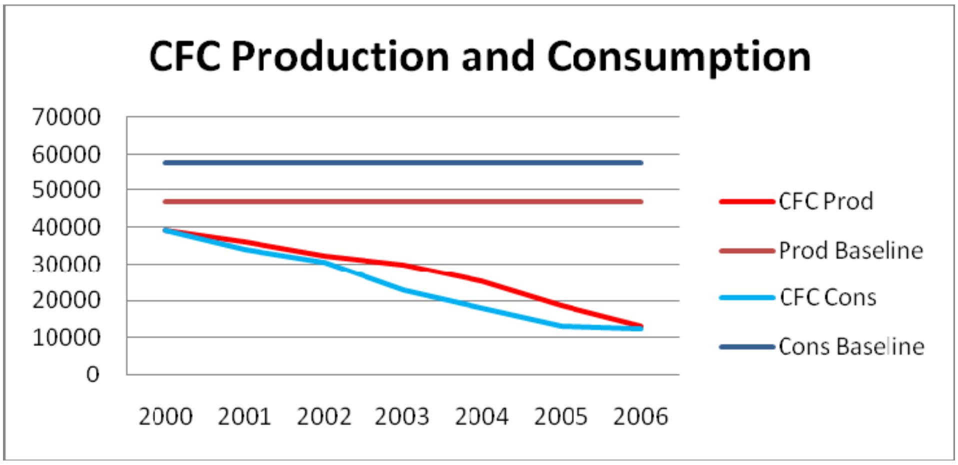

Figure 2: CFC Consumption and Production in tons

Thus two important aspects of international cooperation demanding consideration are *international funds* and *technology transfer*.

International funds: China claims that it is walking the path of development that other countries did during the Western Industrial Revolution. China insists that it is unfair for developed nations to expect it to curtail its economic and industrial development because of their emissions. In response, developed nations have pointed out that by leveraging existing technologies China can leapfrog the most harmful stages and avoid wreaking the same environmental havoc. The question of how to pay for the expensive leap in technology has plagued discussions of development since modern China's engagement with the west. The 1972 delegation to the UN Conference on the Human Environment put forward the principle that there be compensation for "any country polluted by another" and asked that the resolution include plans to "develop an international fund by the industrial countries to support environmental protection elsewhere."[47]

At the Rio Convention in 1992, the Chinese delegation stated more directly that "the developed countries should compensate developing countries for the efforts they undertake to meet international environmental agreements and should provide environmental technology and intellectual property at below-market prices."[48] In 1994, NEPA chairman Song Jian estimated that the international community would need to provide 30-40% of the $4 billion cost of China's Local Agenda 21 projects.[49]

China's Local Agenda 21 reflects the same sentiment, stating that China will "actively seek investment from the international community for projects which assist in the slowing of climate changes," including coal-fired power plants and other coal-gas projects, hydroelectric stations, coal methane utilization and reforestation projects.[50]

China not only exerted pressure on the international community to provide financial support to developing countries' environmental protection efforts; once funds were available to China, the positions switched and the donors were able to leverage their position to influence China's environmental protection policy. Ross observed the role economic considerations played in China's environmental decisions, noting in 1988 that donor organizations or governments "insisted on the incorporation of environmental assessments

[47] Economy 2005, 94.
[48] *ibid.*, 98.
[49] *ibid.*, 188.
[50] LA21 1993, 18.38.

into project evaluations, and, more importantly, included environmental improvement projects in their aid programs ... thus making such projects much more viable."[51] Even projects with primarily economic purpose incorporated requirements for certain environmental actions, using the hunger for development assistance to convince China to establish basic monitoring and conservation programs.

One clear example of the impact of funds lies in China's 2002 ratification of the Kyoto Protocol. As a non-Annex I signatory, China agreed to measure and submit regular communications on emissions in China. Under the Kyoto Protocol, China had access to the Clean Development Mechanism, which offered funds for new carbon reduction technology development. To date, China has received 52% of the funding from the MLF, more than any other developing nation.[52]

Under the umbrella of the UN programs or bilaterally, China has actively engaged with other nations or bodies on climate change collaborations. In 2008 China launched the UN-China Climate Change Partnership Framework, a partnership aimed at "supporting development of post-2012 strategies, strengthening global knowledge sharing and best practices … and designing adaptation policy frameworks to climate-proof future investments in less developed areas of China."[53] In 2008 Bai Yongjie also stated to the UN that China believes environmental difficulties facing the international community "need to be resolved through enhanced global, regional and bilateral cooperation."[54]

Technology transfer from developed nations: An issue closely related to access to international funds, technology transfer lies at the heart of environmental interactions between developed nations and China.

As early as 1972 China lobbied for international community to "support the free transfer of scientific and technical knowledge."[55] The Eleventh Five-Year Plan's "Priority Areas for Environmental Science & Technology Innovations "outlines China's plan to participate "extensively" in international cooperation. According to the Plan, China hopes to "consolidate and deepen its environmental cooperation" with key nations, the European Union and traditional allies, and to find opportunities for environmental collaboration with neighboring countries.[56] The Plan also states that "the introduction of foreign capitals, technologies and management experience will help China improve the environmental protection technology and management level...China will enhance its capacity in self innovation and actively promote international cooperation and technological transfer that reduce the emissions of greenhouse gases."[57] The "Science and Technology Innovations" section also outlines technology focus areas, including climate change adaptation and mitigation, population control, biodiversity conservation and biosafety.

China's special representative for climate change talks told a news agency he was "gloomy" about discussions on post-Kyoto treaties and cited the perceived failure of western governments to successfully fulfill their Kyoto obligations of technology transfers. Western governments point to their inability to mandate the transfer of patented technology, an excuse Yu and other Chinese officials dismiss.[58] Despite continued debate in the international

[51] Ross 1988, 203.
[52] Multilateral Fund for the Implementation of the Montreal Protocol, *Country Programme and Compliance Summary Sheets* (Montreal: United Nations, 2007), 54.
[53] Khalid Malik, *Speech at the Launching of Ceremony of the China Climate Change Partnership Framework* (Beijing: United Nation, 2008), 2.
[54] Bai 2008.
[55] Economy 2005, 94.
[56] MEP 2007, 6.
[57] *ibid.*
[58] Buckley and Graham-Harrison 2008.

political sphere, international cooperation between China and other nations blossomed after ratification of the Kyoto Protocol.

In 2005, the European Union and China announced a climate change partnership. The partnership pledged to work together on collective research projects on climate change adaptation technologies, agricultural substitutes, and other related topics. The EU- China Climate Change Partnership also established a new collaboration on clean coal technology. As part of the collaboration, the United Kingdom has pledged $6.1 million over three years towards clean coal technology research with China.[59] The research focuses on developing low-carbon emissions power stations and carbon capture and sequestration technologies. China and Australia have also signed a deal as part of a plan to cut power stations' CO2 emissions to test a post-combustion capture (PCC) pilot plant in Beijing.[60]

China has actively sought funding and technology transfers on a variety of projects, ranging from carbon trading to adaptation. Using United Nations funds provided under the Millennium Development Goals, China launched two carbon-trading programs in 2007, and a carbon trading exchange in Beijing, the first outside of Europe and the US.[61] A further $1.7 million of funding will go to 12 western Chinese regions to help facilitate carbon trading. Norway and the UN also provided $2.4 million of funds and technology for climate change adaptation and mitigation programs in some of China's most vulnerable ecosystems. The project will target both delicate and high-emissions areas, including Ningxia, Qinghai, Tibet, Hebei, Inner Mongolia, Liaoning and Shanxi.[62] Under the World Bank's Umbrella Carbon Facility and the Kyoto Protocol's Clean Development Mechanism, Asian and European companies are paying US$1 billion to help cut Chinese greenhouse gas emissions.[63]

Such collaborative projects lay the groundwork for China's future climate change policy trajectory.

IV. Future Trajectory

The previous section addressed the historical trajectory and current status of China's climate change policy. Together they give good indication of where China's policy stands and why. Another way of predicting possible future paths China may take is to look at the recommendations made by highly influential bodies. This section examines recommendations made to China's central government by the Organisation for Economic Co-operation and Development, the World Bank and the China Council for International Cooperation on Environment and Development. In general, the organizations promote increased participation in international environmental protection cooperation, especially encouraging access to international funding. They also emphasize the importance of technology innovation and modernization.

The Organisation for Economic Co-operation and Development (OECD) continued its decade-long work with SEPA with the first Environmental Performance Review of China in 2007. In the resulting report, the OECD outlined recommendations, including methods to address China's international cooperation. The recommendations all emphasize strengthening China's participation in international environmental co-operation, and include continuing China's "active engagement", strengthening infrastructure capabilities "in support of the

[59] Jia Heping, "China and UK sign clean coal research deal," *Science and Development Network*, 23 December 2005.

[60] Chen Weixiao, "China ventures into carbon capture," *Science and Development Network*, 7 August 2008.

[61] Jia Heping, "China launches carbon trading initiatives," *Science and Development Network*, 7 February 2007.

[62] Sun Xiaohua, "China adapts to climate change at the local level," *Science and Development Network*, 28 March 2007.

[63] Sophie Hebden, "US$1 billion to cut Chinese greenhouse gas emissions," *Science and Development Network*, 1 September 2006.

implementation of international commitments," developing partnerships with foreign enterprises and improving efficacy and use of "international support mechanisms" such as the Multilateral Fund, the World Bank's Clean Development Fund, and other similar funding mechanisms.

The core of the OECD's recommendation is active engagement in international environmental co-operation. As part of this engagement, the OECD has urged China to meet all the requirements of the Montreal Protocol for reduction of ODSs within the appointed timeframe. Although the OECD does not ultimately determine China's climate change policy, inasmuch as the OECD does wield influence, its recommendations can still indicate possible future climate change policy for China. If China engaged as fully as the OECD suggests, the international community's influence in China's domestic policy could be expected to grow significantly. Even the recommendation that China develop partnerships with foreign enterprises to receive "training, technical support and cleaner technology" implies a willingness to conform to the environmental requirements of foreign firms. If China implemented all the recommendations of the OECD, it would proactively adjust internal standards and processes to ensure international compatibility and would, in turn, benefit greatly from the resulting access to funds.

Recommendations from the World Bank follow a similar vein of thought, with a predictable emphasis on market forces. The World Bank Report *China: Air, Land, Water* points to structural changes and technology innovations emerging from "successful economic reforms" as the key to future reductions of greenhouse gasses.[64] China's accession to the World Trade Organization, the report posits, will speed these economic reforms. The report also calls for relying on pricing and regulatory measures to improve the quality of coal, countering greater demand for automobiles with increased fuel efficiency, and improving building energy efficiency. Additionally, the report recommends that China "explore new ways to tap into international capital, knowledge, and technology" to address environmental challenges. The report specifically urges that these gains in capital, knowledge and technology should be applied toward an aggressive alternative energy development program. Reducing China's coal dependence is so vital, the report claims, that China may not be able to rely solely on market forces, but may require additional government support.[65]

Established in 1992, the China Council for International Cooperation on Environment and Development (CCICED) is an advisory body made up of international experts and high-level Chinese officials, many of whom are ministers or vice-ministers of the main departments. The CCICED submits its reports directly to the highest levels of Chinese government. Current Premier Wen Jiabao was former chairperson of the CCICED; the current chairperson is the Vice Premier of the State Council, Li Keqiang. Among the CCICED's stated objectives are providing "advice, policy recommendations and early policy warnings to the Chinese Government" and acting in an advisory capacity to the Chinese Government on important environmental and developmental decisions.[66] Recommendations from the CCICED range from short-term pragmatic solutions to long-term policy principles.

The 2005 CCICED Annual General Meeting on "Sustainable Urbanization" suggested that climate change mitigation and adaptation be addressed at the planning stages of development in order to address predicted changes in rainfall, temperature and sea level. Suggestions also focused on the modernization of coal utilization as part of a national strategy to form a sustainable energy system. Interestingly, the report noted both the cost of

[64] World Bank, *China: Air, Land, Water* (Washington, DC: World Bank, 2001), 94.
[65] *ibid.*, 95.
[66] CCICED, "Basic Introduction" (accessed 13 February 2009); available from http://www.cciced.org/2008-02/26/content_10729561.htm; Internet.

delaying reduction of greenhouse gas emissions and the fact that planned investments into electricity would further solidify China's commitment to coal use.[67]

In 2003 the CCICED wrote, "China can build for its future, not simply retrofit the past—the very expensive route of already-industrialized countries."[68] This ambitious ideal is tempered by the acknowledgment that "the challenge of creating a sustainable national economy on the scale of China's is unprecedented. There is no existing model to draw upon…"[69] To face this challenge, the committee members wrote, "will require a singularly strong will, more financial resources, and great ingenuity."

The CCICED, like the World Bank and the OECD, envisions China expanding its role in the international community. This vision took more concrete form during the 2008 Annual General Meeting on "Innovation for a Harmonious Development" in which the members discussed the possibility for China to become a world leader in green technologies. Referencing the challenge of climate change, CCICED Chairperson Li Keqiang declared that "even with a slowing economy, no country can relent in the struggle."[70] To meet China's GHG emission reduction standards and long-term sustainable development goals, the committee recommended that future policy, including the Twelfth Five-Year Plan, focus in part on developing a Low Carbon Economy.[71] The Task Force on Energy Efficiency and Urban Development noted that "China is well positioned to play a lead role in the new clean technologies sector ... including clean transport, solar power, wind power, geothermal systems nuclear power systems, carbon capture and sequestration, clean coal etc." Though currently reflected only in a few levels of government, this viewpoint envisions shifting China's position from a recipient of technology transfers to a world leader in clean technology.[72] In order to realize this vision, the CCICED focuses heavily on the support of technology research and innovation, suggesting the creation of several national-level information networks and organizations to encourage innovation.

The Task Force on Innovation and Environmentally-Friendly Society linked China's ability to lead the world in clean technology with an ability to reduce emissions. The Task Force unexpectedly suggests that, while China's current goals of reduction in emissions intensity are worthwhile, "it is time to look at absolute pollution reduction, not just intensity reduction…"[73] During General Debate some members cited the Innovations Task Force in recommending the creation energy-intensity based mechanisms to complement the CDM and suggested that China "could play a role in championing this view as we move towards a new global climate."[74] While the recommendations put forward by the CCICED do not guarantee the direction of future policy, they do indicate broad topics in which the central government is most invested. According to the CCICED reports, China's policy future is one that supports a Low Carbon Economy, highly encourages innovation and leadership in clean technologies, and is open to considering absolute emissions cuts in addition to reductions in emissions intensity.

[67] CCICED, "CCICED Policy Recommendations" (accessed 13 February 2009); available from http://www.cciced.org/2008-02/28/content_10977838.htm; Internet.
[68] CCICED, "Recommendations to the Government of China from China Council for International Cooperation on Environment and Development Phase III" (accessed 13 February 2009); available from http://www.cciced.org/2008-03/08/content_11981414_4.htm; Internet.
[69] CCICED, "Recommendations of CCICED to the Government of China" (accessed 13 February 2009); available from http://www.cciced.org/2008-03/05/content_11655336.htm; Internet.
[70] CCICED 2008, 5.
[71] CCICED 2008, 51.
[72] *ibid*., 17.
[73] *ibid*., 16.
[74] *ibid*., 21.

V. Conclusion

In their monograph "Overcoming Obstacles to U.S.-China Cooperation on Climate Change," Kenneth Lieberthal and David Sandalow make nine recommendations to senior leadership on ways to facilitate post-Kyoto negotiations. The first recommendation is for both parties to acknowledge the legitimacy of each other's perspective. Lieberthal and Sandalow write that fundamental divisions between the US and China perspective remain significant, arguing that

> if the United States and China, as the world's major industrialized country and largest developing country, can start by recognizing and accepting different perspectives, and proceeding from there to constructive action, it could reduce obstacles to developing more widespread multilateral agreements. Including such an approach on U.S.-China bilateral agreements on climate change and clean energy could contribute to shaping post-Kyoto agreements to control greenhouse gas emissions globally.[75]

The importance of acknowledging the legitimacy of each party's viewpoint can be extended to the international community as well. This study, by describing the historical context and current status of China's climate change policy, facilitates understanding by framing China's perspective on climate change. As China jockeys into position to play a leading role in the international community throughout the next century, an understanding of the historical trajectory, current stance and possible future paths of China's climate change policy grants important insight into its approach to a post-Kyoto climate change protocol.

At an APEC meeting in 2007, Chinese President Hu Jintao succinctly summarized the following four principles of China's climate change stance: address climate change through cooperation, pursue sustainable development, uphold the UNFCCC as the main channel for addressing climate change, and "adhere to scientific and technological innovation."[76] The following points examine President Hu's statement in the light of the historical trajectory of China's climate change policy to predict what China is willing and is not willing to sign and enact in a post-Kyoto accord.

1. Address climate change through cooperation. This includes the responsibility of developed countries to "continue taking the lead in reducing emissions after 2012." Consistent since 1972, China has and does insist that developed countries reduce their emissions first. The National Climate Change Plan and other policies uphold China's commitment to the principle of "common but differentiated responsibilities."[77] A numerical standard of emissions reductions expected of developed countries is rarely named, though some statements have insisted that developed countries reduce emissions down to 40-95% of 1990 levels. As for addressing climate change through cooperation, China's commitment to working within the established international framework has strengthened considerably since the 1970s. This stronger commitment should play a factor in any post-Kyoto treaties, since China will be more eager than ever to take a major role as a leader in the developing world.

2. Pursue sustainable development. For a long time, China insisted on the right of LDCs to economic development at the cost of the environment. This stance has shifted dramatically, with China now giving equal weight to environmental protection, at least in theory. While actual practice appears to lag behind this ideal, China is clearly making sustainable development a priority. It is important to note, however, that while China may be willing to impose restrictive domestic standards if it sees fit, it will be less likely to accept external caps on emissions that would severely retard economic growth. Thus, a post-Kyoto

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[75] Kenneth Lieberthal and David Sandalow, "Overcoming Obstacles to U.S.-China Cooperation on Climate Change," *John L. Thornton China Center Monograph Series* (Washington, DC: Brookings Institute, 2009), 47.
[76] CCICED 2007.
[77] CNCCP 2007.

treaty that defines caps and cuts in terms of carbon intensity or per capita emissions for non-Annex I nations would be much more palatable to China than one that defined them in terms of total emissions. For example, a treaty that required a 4% annual decrease in energy intensity per GDP unit would be in line with China's current domestic goals.

3. Uphold the UNFCCC and the Kyoto Protocol as the "core mechanism and main channel for addressing climate change." Repeatedly rejecting treaties proposed outside of the UN framework, China has demonstrated its determination to work within the UNFCCC structure. The funding and technology transfer organs of the Kyoto Protocol have proved beneficial to China and lower the cost of making the transfer to more efficient technologies. The example of China's success in reducing ozone depleting substances under the Montreal Protocol raises an intriguing example of the efficacy of international funds in providing a powerful incentive to change production and consumption patterns. To merit China's support, a post-Kyoto protocol almost inevitably must be built upon the foundation of the UNFCCC and the Kyoto Protocol, including a continuation of existing international funds (e.g., the Clean Development Mechanism).

4. Science and technology innovation. China has turned to science and technology innovations as the key solution to reducing greenhouse gas emissions and increasing energy efficiency, continuing its request of technology transfers from the developed world. While the smooth transfer of technology has been interrupted by concerns over intellectual property rights, patent violation, potential military use and economic competition, China has already actively engaged in many bilateral and multilateral technology development projects. As such, China will likely require commitments by developed countries to provide services, funds and technology transfers to developed countries as a fundamental part of any post-Kyoto accord.

It is important to note that negotiation and ratification of any post-Kyoto treaty will be the beginning rather than the end of China's post-2012 climate change policy. Even after successful ratification, China will still face significant implementation challenges; lack of coordination between ministries, a growing sector of small to medium size enterprises and strong local protectionism present serious threats to China's ability to implement effective environmental policy. Jared Diamond and Jingguo Liu reported in their article "China's Environment in a Globalizing World" that township and village enterprises (TVEs) account for a third of Chinese production and half of its exports. TVEs, which average six workers, account for a disproportionate percentage of China's pollution. TVEs may often use high-polluting outdated technologies or unsafe chemical disposal practices, yet the small size of TVEs make them relatively difficult to regulate.[78] (1180)

Though policy-makers form increasingly sophisticated statutes, Chinese regulatory laws are famously vague in their stipulations. The Eleventh Five-Year Plan for Environmental Protection, for example, determines the direction of relevant policies and announces certain goals and central programs, yet leaves specific standards and implementation policies up to local governments. Unfortunately, the vagueness of the national laws leaves room for manipulation or even for contradictory local laws that create a legal space for industry to continue high-emitting practices.

Implementation at regional levels often runs headlong into local protectionism, one of the most daunting challenges facing environmental protection in China. Under pressure to grow their GDPs local governments often privilege industrial development over environmental protection, despite national or even local regulations. Government structure also inhibits effective environmental protection. Distribution of authority, incentive structures and the limits of the central government's power limit the power of the Ministry of Environmental Protection and of local environmental protection bureaus in pursuing effective

[78] Liu Jingguo and Jared Diamond, "China's Environment in a Globalizing World," *Nature*, 435 (2005):1180.

regulation. For example, Lieberthal notes that, “given the line of authority and incentives in China, the entrepreneurs (local territorial officials) typically control the regulators (local environmental officials).”[79] This study recommends further investigation of the impact of these challenges on China’s ability to implement a post-Kyoto climate change treaty.

China’s willingness to agree to mitigation and adaptation policy stipulations will most likely be affected by its ability to carry out the commitments it makes. China has ambitions to become the recognized leader of the developing world and to increase its influence in the international political sphere. One of the recurring phrases China uses to describe itself is a 负责任的发展中国家 (*fuzeren de fazhanzhong guojia*)—a responsible developing country, In negotiations on a climate change treaty, China will push for the inclusion of attainable standards that allow it to build its credibility as a responsible developing country. What standards are “attainable” for China? Answering that question is well beyond the scope of this study, but China’s determination to seek attainable standards explain in part its eagerness for technology transfers and funding. Funding and technology provided by the international community lowers the cost of implementation to China, making successful regulation more possible. Thus, the level of control to which China is willing to submit may be closely related to the amount of funding made available and the level of commitment from developed countries to transfer technology.

As the global community responds to increasingly urgent calls to action on climate change, mutual understanding will be critical in achieving consensus. China will play a key role in negotiating a successful post-Kyoto climate change accord, and a historically grounded description of China’s policy trajectory provides the perspective necessary to predict China’s stance on any number of post-Kyoto accord iterations.

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[79] Kenneth Lieberthal, “China’s Governing System and Its Impact on Environmental Policy Implementation,” *China Environment Series* (Philippines: Asian Development Bank, 1997), 4.

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Two Logics of Climate Change Games:
Environmental Governance and Know-How Competition

Hongyuan Yu[1]

Abstract

Global warming and the resulting climate change present the world with major and potentially devastating challenges. They lead to environmental degradation/scarcity and a radical reform of the energy mix among industrial countries, in addition to other non-traditional security concerns.[2] From the 1992 Rio Summit through the Kyoto Conference and the Bali Roadmap, a generation has passed since the world's governments began to seriously consider the problems of global warming and the resulting climate change. It is now patently clear that the world should get together to combat the climate disaster. However, we are always confused with two questions: why has global climate governance been so difficult, and what factors hamper the effectiveness of international cooperation. This article will give an explanation to two logics of climate change games by linking environmental governance and know-how competition.

For those concerned about climate change, collective actions and regimes designed to limit carbon emissions are at the core of global warming concerns. However, preventing catastrophic climate change is actually an energy challenge that leads to dramatic know-how competition in both new and alternative energy. In the international collective action against global warming, on the one hand, the pursuit of rational common goods leads to cooperation; on the other hand, the pursuit of rational self-interest or preference (in carbon emissions and energy know-how) among different states often frustrates international cooperation. Thus there are two logics of the climate change games: the logic of collective action in international environmental cooperation; and the logic of power competition in energy innovation, which is the foundation of power transition in this century. The energy revolution induced by global warming includes the discovery and exclusive possession of new energy sources, along with revolutionary progress in the promotion and application of new energy technology, improved social and economic efficiency, and government control over energy use. Not surprisingly, the transition of power and hegemony in the future will most likely be connected to energy.

In the fight against global warming, Western countries not only need to deal with the failure of collective action among Annex I countries (developed countries),[3] but also resolve interest conflicts between themselves. They also have to encourage developing countries to share concrete responsibilities in global governance on global climate change. Particularly, the rich countries—the European Union, Japan and the United States—have and will continue to achieve domination in the process of climate change politics, and they will

[1] Deputy Director of the Department of International Organizations and Laws, Shanghai Institute for International Studies, 845-1 Julu Road, Shanghai 200040, P.R., China, e-mail: hongyuanyu@126.com,yuhongyuan@hotmail.com

[2] Some of these ideas and a discussion of climate change can be found in: Yu Hongyuan, “Environmental Change and Asia-Pacific: China Responds to Global Warming," *Global Change, Peace, and Security*, vol. 17, issue 1, 2005; “Knowledge and Climate Change Policy Coordination in China,” *East Asia: An International Quarterly*. vol. 21, no. 3; “Global Environmental Regimes and Policy Coordination in China,” *Journal of Chinese Political Science,* vol. 9, no. 2, 2004; and *Global Warming and China's Environmental Diplomacy* in *Nova Science Publishers* (2008).

[3] The U.S. government argued that the Kyoto Protocol was unfair to the United States, and the U.S. Senate voted 95-0 to warn against the Kyoto treaty in 1997. The Bush administration withdrew from the Kyoto Protocol in 2001.

Statement by EPA Administrator Christine Whitman on Climate Change (March 6, 2001), available at www.yosemite.epa/gov/opa/admpress.

compete for leadership in new and alternative energy, which is at the core of a low-carbon economy.

China, which is the world's largest economic powerhouse and polluter, is central to both regional and global efforts against global warming, particularly in the post-Kyoto climate negotiations. The two-layer games in global climate change politics will pose double challenges on the country's domestic political economy and diplomacy. China's current development route is still a growth-oriented, unsustainable and resource-constrained economic model, and the country faces the crucial need to promote development while joining the global struggle against global warming and contributing to global economic growth. The government in Beijing seeks to act as a "responsible stakeholder in the international system," while pursuing a "scientific outlook on development" in its national economic development. On the one hand, given the growing absolute carbon emissions, China has turned into an "environmental superpower;"[4]on the other hand, its energy-intensive economy is not only pushing up growth rates in the United States, Japan, the EU and other economies, but also strengthening the capacity building for low-carbon and new energy. With these considerations in mind, in this paper, I look at some of the consequences and characteristics of the two-layer games in global climate change politics. Then I describe international and domestic implications for China.

1. Two Logics of Climate Change Games

In this analysis of the two logics of the international struggle against climate change, the first focus is on how to limit carbon emissions in different countries on the basis of the global collective action theory.[5] The other focus is on the competitive advantage of nations resulting from energy know-how.[6]

1.1. The Logic of Collective Action in International Environmental Cooperation

The future of the international struggle against global warming depends on collective action and shared responsibilities.[7] The international regime for averting climate change has sought to overcome this problem since the early 1990s. But the international effort against global warming has produced mixed results. The explanations of both liberals and constructivists look powerful in articulating an ideal condition or performance for collective action, but somewhat thin in explaining the effectiveness of the collective action which has been undertaken. The effectiveness of collective action involves two overlapping ideas: first, which members of the regime abide by its norms and rules, and second whether the regime achieves its objectives or fulfills certain purposes.[8] Apparently, the effectiveness of the UNFCCC and the Kyoto Protocol is very low. These divergences affect the effectiveness of the UNFCCC so much that a new theoretical analysis beyond constructivism or neoliberalism should be built.

Under Mancur Olson's collective action theory, three variables—selective inducement, optimal group structure or institution building, and major power—will determine the effectiveness of collective action. Major power interaction determines the rules and legitimacy of collective action. Selective inducements shape the pay-off structure of

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4 "Melting Asia: China, India, and Climate Change," *Economist* vol. 387 No. 8583(2008), pp.29-30.

5 See Mancur Olson, *The Logic of Collective Action* (Cambridge, MA: Harvard University Press, 1965), pp. 1-10.

6 See Michael E. Porter, *The Competitive Advantage of Nations* (Free Press, New York, 1990).

7 Thomas Risse-Kappen, *Bringing Transnational Relations Back In: Non-State Actors, Domestic Structures and International Institutions* (Cambridge: Cambridge University Press, 1995).

8 See Andreas Hasenclever, Peter Mayer, and Volker Rittberger, "Interest, Power, Knowledge: The Study of International Regimes," *Mershon International Studies Review* (1996) 40, pp. 177-228.

collective action. Institution building will help maintain structure stability in collective action. Among these three variables, major power plays a significant role. First, selective inducements depend on the preference structure and group scale. Second, the flexibility and payoff structure of the Kyoto Protocol affect the effectiveness of collective action against climate change. Third, when an established power abandons global collective action in some areas, some emerging powers will replace its role and push the collective action agenda forward.

A reduction of carbon emissions is at the core of collective action against climate change, and it has an impact on the material and physical foundations needed for the survival of a state. Since no country, by itself, would be able to substantially influence the climate system, according to the principle of summation,[9] all states in the world should make efforts to limit carbon emissions. The key concern is the payoff structure for carbon emission reductions among different signatory countries. Currently, most scholars have introduced market mechanisms to resolve the collective action problems. These models are designed and forwarded to the carbon credit market. Examples include CDM, IET and JI.

Homer-Dixon argued that climate change problems may soon increase the level of conflict between poor and rich countries.[10] Some Western scholars termed developing countries' climate policy the "maxi-mini principle"—one based on the maximization of rights and minimization of responsibilities. Under this view, some developing states are only interested in "free rides" and in gaining access to technical expertise, foreign aid, and information in order to further their goal of economic development.[11] Christopher D. Stone used the "free-rider" behaviors among poor countries in climate change as strong evidence to support carbon emission limitations in poor countries.[12]

1.2. International Competition for New Energy

Energy is fundamental to the prosperity and security of nations. The next-generation energy will determine not only the future of the international economic system but also the transition of power. Competition in the energy chain will determine the result of the power struggle based on innovation and influence power transition in the international system. The new energy is not only an important constituent of the next-generation energy system, but also will change the scenario of the future international power configuration. As Daniel Yergin[13] of the "American oil hegemony" and Paul Kennedy[14] of the "British coal hegemony" indicate, the prerequisite condition of significant structural changes in the international system is an energy power revolution based on the emergence of next-generation energy-led countries. Technological innovation is of key importance in the energy power structure. Modelski's long-cycle theory,[15] Kondratev's long-wave theory, and Schumpeter's economic-cycle theory[16] have all confirmed the historical contribution of the technological revolution and institutional innovation to the rise and fall of great powers. They all emphasized the effect of a "great technological breakthrough" on the world economic cycle, indicating that

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[9] Inge Kaul, Isabelle Grunberg, Marc A. Stern, *Global Public Goods: International Cooperation in the 21st Century,* New York, 1999, pp. 48-56.

[10] Thomas Homer-Dixon, *Environment, Scarcity, and Violence* (Princeton, NJ: Princeton University Press, 1999).

[11] Samuel S. Kim, "International Organizations in Chinese Foreign Policy," *Annals*, No. 519 (Jan. 1992) , p. 151.

[12] See Christopher D. Stone, *Defending the Global Commons*, Philippe Sands, ed., *Greening International Law*, Earthscan Publication Limited, 1993, p. 36.

[13] Daniel Yergin, "Ensuring Energy Security," *Foreign Affairs*, March 1, 2006, pp. 69-77.

[14] Paul Kennedy, *The Rise and Fall of the Great Powers,* Vintage, 1968.

[15] George Modelski, *Long Cycles in World Politics*, Seattle: University of Washington Press, 1987.

[16] Charles Kindleberger, *The World in Depression 1929-1939*, London: Allen Lane, The Penguin Press, 1973.

the cycle should owe its rise to the technological breakthrough, which mainly happened in energy areas such as the electricity steam engine and the internal-combustion engine. Michael E. Porter, in his book *The Competitive Advantage of Nations* explained why nations should make an innovation-based model of comparative advantages a priority in developing their competitive advantage.[17]

With the heated debate on collective action against climate change, Western countries have monopolized the future energy system based on new and alternative energy. Peter Evens once pointed out that every major power that dominated the international system had some know-how advantages.[18] For now, it seems that a low-carbon economy and clean energy will ultimately determine the future of energy power transition. Jonathan and other scholars recognized that the EU's environmental policy geared toward boosting the bloc's competitiveness and promoting climate negotiations could also boost its creativity and competitive advantage.[19] In 2007, the *Stern Review Report on the Economics of Climate Change*[20] and the *Low Carbon Economy Report* by the Royal Institute of International Affairs both confirmed that the EU promoted climate negotiations not just because it was a forerunner in a low-carbon economy, but also wanted to achieve dominance in global governance and lay foundations for the future economy. U.S. senior officers Paula Dobriansky, Richard Lee Armitage and Joseph Nye once proposed that U.S. involvement in climate negotiations could enhance the nation's "smart power" and the competitiveness of its industry.[21]

Western countries always use the fast growing carbon emissions in new emerging economies as a strong explanation for global warming. National competitive advantages are associated with carbon emission reductions. For those who advocate climate diplomacy, environmental capacity is one important part of a state's comprehensive national power. Thomas Homer-Dixon supports limitations in developing countries' environmental capacity and economic growth.[22] James N. Rosenau uses the concept of a "balance of payments" instead of a "balance of power" in global environmental governance, and argues that developing countries should share the costs and responsibilities for global environmental protection.[23]

2. The Logic of Collective Action in Climate Change

2.1. The Different Responses of the EU and the U.S.

The EU's climate diplomacy aims to serve the bloc's leadership in global governance. The EU has been closely involved in the international debate on global warming and climate change. EU countries have always been "at the forefront of efforts to strengthen the international commitments on climate change."[24] The bloc plays the role of a leader and

[17] See Michael E. Porter, *The Competitive Advantage of Nations*, Free Press, New York, 1990.
[18] Peter Evens, "Transnational Linkages and the Economic Role of the State," *Bringing the State Back In*, T. Skocpol and Peter Evans, et al. New York: Cambridge University Press.
[19] Jonathan Golub ed., *Global Competition and EU Environmental Policy*, New York: Routledge, 1998.
[20] Nicholas Stern, "Stern Review on the Economics of Climate Change," http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm.
[21] Foreign Relations Council, "National Security Consequences of U.S. Oil Dependency," http://www.cfr.org/publication/11683/.
[22] Thomas Homer-Dixon, *Environment, Scarcity, and Violence*, Princeton NJ.: Princeton University Press, 1999, pp. 26-43.
[23] See James N. Rosenau and Ernst-Otto Czempiel, *Governance Without Government: Order and Change in World Politics*, Cambridge University Press, 1992, pp. 12-14.
[24] Grubb, Michael, "The UK and European Union: Britannia Waives the Rules?," Detlef Sprinz (ed.), "Climate Change After Marrakech: The Role of Europe in the Global Arena," available at<http://www.deutsche-

advocate of international action against global warming and climate change. The EU has used its dual status as the biggest economic bloc and its growing role as a major advocate of international commitments on climate change. The EU is one of the largest donors of environmental aid and the strongest supporters of the Kyoto Protocol during COP conferences. The EU's leadership on climate change has international legitimacy.[25]

The EU spends "more resources on initiating more awareness of climate impacts in developing countries."[26] Moreover, European countries try their best to persuade other countries to ratify the Kyoto Protocol. At the EU Council Meeting on May 31, 2001, the EU decided to strengthen the capacity building of developing countries against global warming. The EU supported Kyoto mechanisms such as joint implementation among Annex I countries, but was concerned that the U.S. would avoid a reduction in domestic carbon emissions by trading environmental emissions with developing countries. A carbon tax is also a good experience for EU climate change policy implementation.[27] The policy has been introduced by many signatories to the UNFCCC. In 2004, the EU's willingness to trade support for Russia's accession to the WTO for ratification of the Kyoto Protocol gave an unprecedented impetus to the international struggle against climate change. In 2007, the EU's endeavors saved the Bali Roadmap, preventing sharp conflicts between rich and poor countries.

The United States, which is the largest emitter, is central to the global collective action. Since 1997, the U.S. State Department has published its annual Environmental Diplomacy Report,[28] which evaluates global climate change diplomacy. "The United States was a global leader in the early development of policies and regulatory programs to protect environmental quality."[29] Under the Clinton administration, the U.S. announced a $1 billion five-year effort to help developing countries cut emissions and meet the goals of the climate change treaty. However, after 2001, the Bush administration put climate change on the back burner. The U.S. government argued that the Kyoto Protocol was unfair to the United States, and the Bush administration withdrew from the Kyoto Protocol in 2001. Under the Bush administration, the U.S. has shifted more responsibility to private industry to guide pollution-cutting efforts in the Third World.[30] In 2001, the Bush administration declared that it would reduce the amount of money set aside in the U.S. budget for programs intended to help countries such as Brazil, India, Indonesia, the Philippines, Mexico, Poland, and Russia, in order to increase their industrial development with only minimal contributions to global warming.[31] In 2005, Hurricane Katrina battered the U.S. Gulf Coast and caused great economic costs. Hurricane Katrina forced the Bush administration to place an emphasis on global environmental protection. The United States is working with other countries through a

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aussenpolitik.deSprinz.Climate_Change_After_Marrakech.GFPD.vol2(6)2001>, *German Policy in Dialogue*, vol. 2, No. 6, 4th Quarter 2001, Trier, Germany.

[25] Sandrine Labory, "EU Climate Change Policy and Flexible Mechanisms: Where Do We Stand After the Bonn Meeting?" available at <http://www.ciaonet.org/pbei/ceps/las01/index.html>, *EU Commentary*, Centre for European Policy Studies (July 24, 1998).

[26] Sprinz, Detlef, "Germany: European Leadership, Active Climate Policy and Wall-Fall Profits," Detlef Sprinz (ed.), "Climate Change After Marrakech: The Role of Europe in the Global Arena," available at<http://www.deutsche-aussenpolitik.deSprinz.Climate_Change_After_Marrakech.GFPD.vol2(6)2001>. German Policy in Dialogue, Volume 2, Number 6, 4th Quarter 2001, Trier, Germany.

[27] Richard N. Cooper, "Toward a Real Global Warming Treaty," *Foreign Affairs*, vol. 77, issue 2(1998), pp. 66-77.

[28] The U.S. State Department: http://www.state.gov/www/global/oes/earth.html

[29] Gary C. Bryner, "The United States: 'Sorry—Not Our Problem,'" in William M. Lafferty and James Meadowcroft (eds.), *Implementing Sustainable Development: Strategies and Initiatives in High Consumption Societies* (New York: Oxford University Press, 2000), p. 273.

[30] John Heilprin, in Washington, "Bush Aims to Cut Aid on Global Warming," SCMP, July 8, 2001, p. 4.

[31] John Heilprin, in Washington, "Bush Aims to Cut Aid on Global Warming," SCMP, July 8, 2001, p. 4.

series of bilateral or multilateral forums launched by top government leaders on global warming. These include Major Economies Meetings, G8, and AP6.

Common goods mean joint supply and the impossibility of excluding others from consumption once these goods are supplied to some members of the community.[32] This means that any country, including India, China, Japan and the U.S., should contribute to mitigating global warming, and that they cannot seek to withhold goods from other countries.[33] Thus, Western countries are working hard to avoid "free-rider" behaviors and are trying to persuade China to join the campaign. The U.S., EU and other developed countries are urging China, India and other developing countries to assume responsibility for reducing carbon emissions as soon as possible. Otherwise a rapid increase of carbon emissions in the developing world may counterbalance the endeavors of the rich countries. The Bush administration argues that the Kyoto Protocol is unfair to the United States and other industrialized nations because it exempts 80 percent of the world, particularly China, from compliance.[34]

Figure 1: The Common Goods

Exclusiveness	Private Goods	Collective Goods
No Exclusiveness	Common Pool Resource	Public Goods

Interestingly, in some carefully selected areas, developing countries have discretely cooperated with the U.S. in UNFCCC negotiations. For instance, China agreed with the U.S. that employing adaptation measures—such as transferring funds and technologies from developed to developing countries to help the latter minimize the impact of climate change—was the preferable way of addressing the problem. Among developed countries, the EU places more emphasis on mitigation than on adaptation in climate change negotiations. But the United States, China, India and members of the OPEC believe that adaptation should be a priority. By shifting the focus of climate talks to adaptation, both the U.S. and China could actually avoid hurting their economies and refused immediate commitment to fixed emission cuts. Moreover, both the U.S. and China are skeptical about a global carbon tax supported by the EU as a mitigation measure from which revenue could be spent to finance technological transfers. They believe that both producers in China and consumers in America would be overburdened.

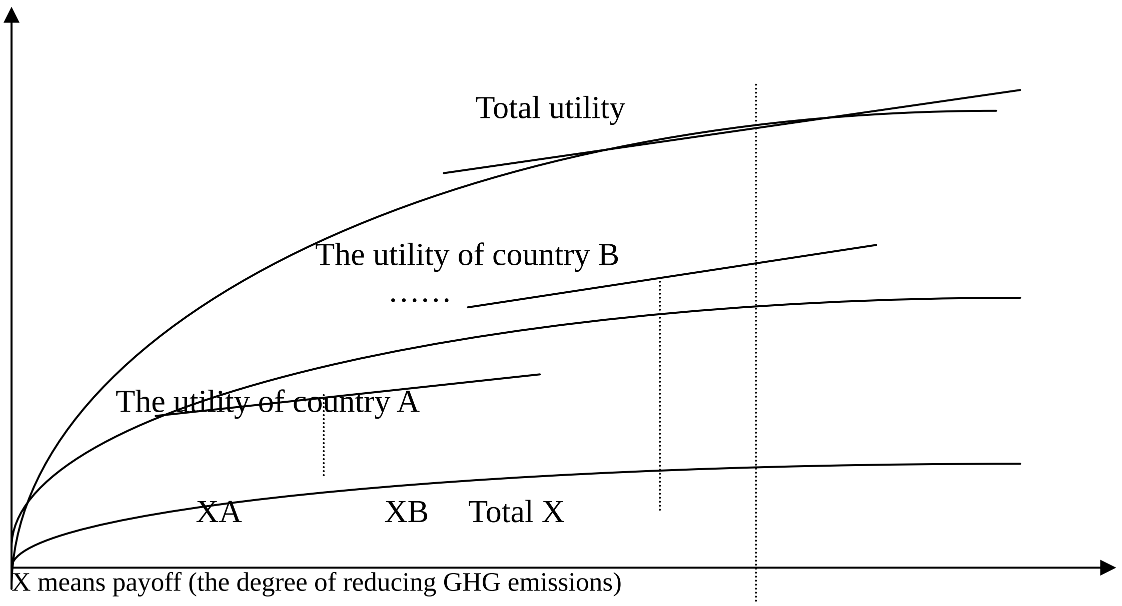
2.2. Developed against Developing: Common but Differentiated Responsibilities and Equity in Collective Action against Global Warming

While the U.S. and other developed countries enjoy a relatively plentiful, wasteful and competitive use of energy, most developing countries struggle for the very basic needs of industrialization, urbanization and life's physical necessities. The developing world considers it an inalienable right to advance its economy and enjoy the same standard of living as people in developed countries. It's an inalienable right of the developing world to further develop its economy, improve living standards, and enjoy the same living standards as people in the developed countries. Of the world's six billion people, one-third enjoys electricity. And one third—two billion people—simply lack access to modern energy services and live on less

[32] Dennis C. Mueller, *Public Choice II – A Revised Edition of Public Choice,* Cambridge University Press, 1989, p. 11.
[33] Mancur Olson, *The Logic of Collective Action*, Harvard University Press, 1965, p. 14.
[34] Environmental Diplomacy, Environment and U.S. Foreign Policy (State Department, January 20 2001). Retrieved from the World Wide Web:
<http://www.state.gov/www/global/oes/earth.html>

than $2 per day. For the poor countries, ensuring economic growth and lifting people out of poverty are necessarily important priorities. Greater energy use by these countries and greater emissions from them are therefore inevitable.[35] For China, the largest developing country, global warming issues have been intimately linked with efforts to modernize the economy and the energy strategy employed to fuel that modernization. If China decreases its emissions of greenhouse gas (GHG) by 10-20%, its GDP will decrease by 2%. When per capita income grows by 5.1%, GHG emissions increase by 1.29%.[36] Mukund Govind Rajan argues that "India's sustained increase in energy production and use was to play a central role in fueling economic development. There is a very low per capita consumption of greenhouse gases as compared to the world average."[37] According to Mukund Govind Rajan, "It is the developed countries which have created and continue to add to the threats of climate change, and it is primarily their responsibility to reverse the situation by setting limits on their emissions of greenhouse gases. Developing countries contribute little to the problem, though their share is increasing. Their resources are scarce and they do not have ready access to the required technologies. They need technical and financial assistance to adopt environmentally benign technologies. Even given adequate resources their socioeconomic backwardness may prevent them from fully attaining the desired results."[38]

Figure 2: The Payoff Structure in Climate Change



The figure below shows that different states can have different payoffs and utility in the international campaign against global warming. Some states' payoff is very high, while for others it is very low. Some states have no payoff at all, but they can also enjoy the utility from the cooperation. Even those who do nothing to limit their carbon emissions can share

[35] According to International Energy Agency data, the per capita total primary energy supply of the U.S. was more than six times higher than China's and nearly 15 times that of India's in 2004; the per capita emissions of carbon dioxide by these countries followed a similar pattern.
[36] Zhang Zhongxiang, "Macroeconomic Effect of CO2 Emissions Limits: A Computer General Equilibrium Analysis," a paper presented at the 7th Annual Conference of the European Association of Environment and Resource Economists, Lisbon.
[37] Mukund Govind Rajan, *Global Environmental Politics: India and the North-South Politics of Global Environmental Issues* (Oxford University Press, 1997), p. 259.
[38] Mukund Govind Rajan, *Global Environmental Politics: India and the North-South Politics of Global Environmental Issues* (Oxford University Press, 1997), p. 105.

the benefits of reduced carbon emissions, in disregard of the moral hazard, ill reputation or punishment involved.[39] Such "free-riding" behaviors frustrate the endeavors of other countries. Any country, including China, can try to enjoy the technology transfer, environmental loans and other utilities without trying to reduce carbon emissions. On the other hand, different countries will have different utilities from international cooperation against global warming. Poor countries pay more attention to technology improvement and economic development than environmental gains. On the contrary, most developed countries prefer a better natural environment and put more emphasis on environmental security. From this point of view, developing countries should contribute more to reducing carbon emissions.

The game theory is the study of people's behavior in strategic situations, so it can be used to analyze the two logics of the climate change games when people make different choices on cooperation in climate change. Developing countries have two choices: A) refrain from reducing greenhouse gas emissions unless developed countries provide the technology and funds; B) reduce carbon emissions unconditionally. If developing countries choose strategy B, as they have promised to share global responsibility for global warming, developed countries will be confronted with two choices: C) decide against providing technology and funds to developing countries; D) decide to provide technology and funds to developing countries. If developed countries choose C, developing countries may consider slowing down the increase in their carbon emissions because they lack advanced technology and funds. So the gains will be –1 and –3. If developed countries choose D, developing countries will be able to afford to reduce carbon emissions by building a low-carbon society. So they both gain +5.

Figure 3: The game between developing and developed countries

Developing Countries	A	B
Developed Countries C	-5 , -5	-1 , -3
D	-5 , -5	+5 , +5

Developed countries are the principal emitters of pollutants and should therefore bear the primary responsibilities in addressing the climate change problem. The principle of "common but differentiated responsibilities" is a global consensus in the UNFCCC and other international environmental laws. This principle means that the industrialized, wealthy countries of the world bear responsibility for global warming because of their historic emissions of greenhouse gases for more than 300 years. Furthermore, developed countries' per capita emissions remain far above those of developing countries, meaning that their responsibility continues. According to the UNFCCC, "The largest share of the historical and current global emissions of greenhouse gases has originated in developed countries, [while] per capita emissions in developing countries are still relatively low and the share of global emissions originating in developing countries is growing to meet their social and development needs."[40] However, developing countries are deeply dissatisfied with developed countries in this respect because the latter refuse to pay sufficient attention to the technological backwardness of developing countries as far as energy is concerned. Developed countries tend to play down the role of technology transfer while maintaining high prices for intellectual property rights linked with these technologies.

Since its inception, the Global Environment Facility (GEF) has promoted technology transfer, grants and loans from the developed world for reducing carbon emissions through a

[39] See Mancur Olson, *The Logic of Collective Action*, Harvard University Press, 1965, p. 15.
[40] *The United Nations Framework Convention on Climate Change*, May 9, 1992, www.unfccc.int.

series of projects in developing countries. However, since its launch in 1991, the GEF has only allocated about $4 billion in grants.[41] Through CDM, industrialized countries could also meet part of their obligations for reducing their emissions under the Kyoto Protocol by receiving credits for investing in projects that reduce carbon emissions in developing countries.

2.3. International Norms and Climate Change Cooperation in Poor Countries

The UNFCCC reads, "Acknowledging that change in the Earth's climate and its adverse effects are a common concern of humankind; acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions; determined to protect the climate system for present and future generations..." Katzenstein argues that the concepts of international norms refer to collective expectations for the proper behavior of actors with a given identity. Norms thus either define (or constitute) identities or prescribe (or regulate) behaviors, or they do both.[42] This means that international norms in collective action influence the behavior of individual states. Considering the question of what is the most important international factor motivating China to improve its climate change coordination work, it is necessary to analyze the influence of various interest-based factors on the global climate change action from 2003 to 2007.[43]

Figure 4: What is the most important international factor affecting coordination work in China? 2003

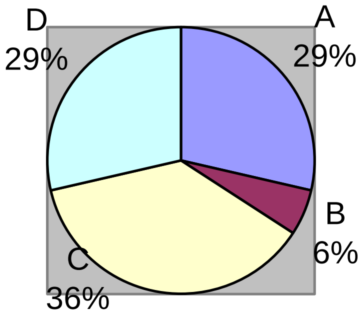
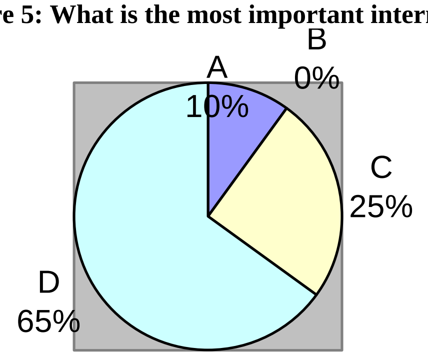


Figure 5: What is the most important international factor affecting coordination work in China? 2007



41 http://www.gefchina.org.cn/

42 Katzenstein, *The Culture of National Security Norms and Identity in World Politics*, (1996), 12-31.

43 The meanings of different options: A. International norms; B. International expertise and international training; C. International environmental loans and aid; D. International negotiation requirements; E. Other.

3. The Logic of International Competition for New Energy

Generally speaking, climate change is a major issue that has brought a lot of pressure to global energy and environmental conservation efforts. Although most countries have recognized the seriousness of the crisis and the need for emission reductions, the United States and the EU are still thinking of ways to curb carbon emissions and reduce demand for energy in developing countries. The conclusion is clear: on the surface, climate change is just a problem of collective action on how to handle the crisis and stabilize carbon emissions, but on the deep level it is a problem of energy sources and development potential that could affect the transition of power in the international system in the long term.

3.1. Transition in the Traditional Energy System

The contemporary world is based on oil, and global energy security is crucial to economic growth and people's livelihood in all countries. Energy is also fundamental to the prosperity and security of nations. The advent of globalization, the growing gap between the rich and poor, and the need to fight global warming are all intertwined with energy concerns. There is a pressing need for strategic thinking about the international energy system. Supply and demand on the international energy market are imbalanced. Areas rich in oil resources are still at the center of geopolitical, political and military conflicts. Energy exporting nations use energy weapons to implement their political and economic goals. Major energy suppliers—from Russia to Iran to Venezuela—have been increasingly able and willing to use their energy resources to pursue their strategic and political objectives.[44] It is also important to take a long-term perspective, deepen energy cooperation, increase energy efficiency, and facilitate the development and use of new energy resources.

Climate change will bring dramatic changes in the international economic system, and national competition advantages will be built on the basis of clean and alternative energy. The advent of global warming and energy security pose a great challenge to humankind. Competition in the energy chain will determine power struggles based on innovation and influence power transition in the international system. New energy is not only an important constituent of the next-generation energy system, but will also change the scenario of the future international power arrangement. Preventing an environmental disaster like climate change is, at its core, an energy challenge. Different economies struggle and compete for this historical opportunity to increase energy efficiency, and facilitate the development and use of new energy resources.

3.2. Power Transition and the New Energy Chain

There is a correlation between energy competition driven by climate change and the international political economic environment, know-how, ability and possession of resources. The interaction of these factors constitutes a complete energy chain. The energy chain comprises the institutions and activities related to the search for, development, and utilization of energy resources. The discovery of new energy sources, revolutionary changes in the energy chain, and the corresponding changes in the political economy and the innovation system, have combined to lay the groundwork for a more effective use of energy, which is fundamental to the rise of big powers. Historically, the emergence of great powers has been accompanied by a rise of a new generation of energy. Since the establishment of the modern international system, the energy chain has undergone two major changes. The first change was the first industrial revolution of the 1860s ushered in by the United Kingdom and marked by a transition from “the fuel-wood or bio-fuel times” to the “coal era.” The second change

[44] Foreign Relations Council, “National Security Consequences of U.S. Oil Dependency,” http://www.cfr.org/publication/11683/.

was the second industrial revolution of the 1920s started by the United States and marked by a transition from the “coal era” to the “oil age.” Today a third revolution is taking place based on clean and low-carbon energy. Under the long-cycle theory, possession and use of new energy is closely related with national technological and institutional advances. Countries with a dominant position in new energy must have an institutional and technical advantage stemming from their possession and use of new energy. They have to break through constraints imposed by previous economic, political structures and ideology, which leads to major changes in the global industrial chain, allocation of resources and national competitiveness. Therefore we have every reason to believe that those new energy powerhouses will ultimately change the global arrangement of power through international competition in the future. As history shows, every significant structural change in the international system has been due to the revolution in the energy chain. The country or non-state entity that seized a new energy chain or a part of it attempted to challenge the international status quo.

3.3. The Domination of Rich Countries in New Energy Competition

As the scarcity of traditional energy and climate change emerged as serious problems, economic growth patterns in various countries gradually evolved in a direction that suited new energy. The EU and the United States as global superpowers aspire to corner future energy markets through negotiations on reducing carbon emissions coupled with a desire to dominate the drive toward clean energy and energy efficiency and innovation throughout building a climate change regime. In December 2007, the United States passed a new energy bill that aims to boost the development of clean and alternative energy. President Bush said, “Energy dependence harms the U.S. economically through high and volatile prices at the gas pump, creates pollution and contributes to greenhouse gas emissions. It threatens our national security by making us vulnerable to hostile regimes in unstable regions of the world.”[45]Under the new energy bill, production of renewable fuels is expected to exceed 136 billion liters annually by 2022. More than half of all ethanol must come from sources other than corn, such as wood chips or switchgrass. The law also sets tougher efficiency standards for the construction of new commercial properties and improvements in federal buildings.

The EU has taken many measures to reduce carbon emissions among member states in line with the UNFCCC and the Kyoto Protocol. There are four major objectives of the EU’s climate policy: “1) a regulatory approach, 2) fiscal measures, 3) burden sharing among member states, and 4) the scope for complementary action at the national level.”[46]Since the sixth Environmental Action Program, the climate change issue has caused great concerns.[47] According to the EU National Communications to the UNFCCC, “The European Commission has proposed in particular: (1) to reduce greenhouse gas emissions beyond the Kyoto commitments, by 1% of their 1990 levels every year until 2020; (2) To set more ambitious environmental targets for energy taxation, such as automatically indexing taxes at least to the level of inflation; to phase out all subsidies for fossil fuel production and consumption by 2010, undertaking steps to develop alternative sources of employment for the sectors concerned. The European Union also needs to think about the specific situation of coal in some candidate countries, within the framework of the accession negotiations; (4) that

[45] U.S. Department of Energy, “President Bush Signs H.R. 6, the Energy Independence and Security Act of 2007", <http://merln.ndu.edu/archivepdf/nss/WH/20071219-6.pdf>. Accessed on December 12, 2008

[46] Nigel Haigh, “Climate Change Policies and Politics in the European Community,” in: Tim O’Riordan and Jill Jager (eds.), *Politics of Climate Change: A European Perspective* (Routledge, New York, 1996), pp. 160-165.

[47] The UNFCCC(2004), *The Kyoto Protocol to the United Nations Framework Convention on Climate Change*, available at <http://unfccc.int/resource/docs/convkp/kpeng.pdf>, Accessed on May 10, 2004.

by 2010, alternative fuels, including biofuels, should account for at least 7% of the fuel consumed by cars and trucks."[48]

The EU is struggling to agree on the details of its plan to reduce the 27-nation bloc's greenhouse-gas pollution by 20 percent by 2020 compared with the benchmark year 1990. They promised to deepen this to 30 percent if another industrialized power followed suit. They also pledged to boost the share of renewables in the EU energy mix to 20 percent, including a 10-percent share for bio-fuels.[49]

Most developing countries follow a growth-oriented, unsustainable and resource-constrained economic model. These countries face the crucial need to promote development while joining the global struggle against global warming and contributing to global economic growth. As countries undergo industrial development, they move through a period of intensive, and often inefficient, use of fossil fuel. Efficiencies improve along this development trajectory, but eventually tend to level off. Industrialized countries such as EU member states, Japan and the United States are at a knowledge-intensity and energy leveling-off stage, while developing countries such as China are at the energy-intensive development stage. Both factors are decreasing the global efficiency of fossil fuel use and increasing energy consumption. But a high growth of energy consumption is required for the capital-intensive industrialization period in today's China and other developing economies, and will be reduced at post-industrialization stages sooner or later. However, developed countries have not displayed enough enthusiasm transferring advanced clean energy technologies to the developing world.

In facing the continuing economic rise of the emerging countries, the United States, or even the European countries and Japan, would not give these countries the core technologies.[50] They would, on the one hand, prevent the other countries from acquiring the core technology, thus to weaken their competitiveness; on the other hand, they are worried that the emerging countries would not protect the intellectual property rights of the advanced technologies. Moreover, the United States is unwilling to see China and other emerging countries improve their structure of energy production and use. From the viewpoint of the United States, if China successfully transformed itself to the way of sustainable development, the Chinese model of development would threaten the soft power of the U.S.

On December 2007, the United Nations Development Program (UNDP) said in one of its reports that in addressing climate change issues developed countries "did not take the responsibility to help developing countries." In 2007, at the United Nations Climate Change Conference in Bali, Oxfam Hong Kong, an independent development and relief agency based in Hong Kong, said that the international community needs some $1-2 billion to make the least developed countries adapt to the most urgent requirements of climate change; however, developed countries have donated no more than $67 million for this purpose.[51] In December 2007, the Bali Roadmap was adopted whereby developed countries undertook to assist developing countries in clean energy development; however, no clear commitments have been made in this process so far.[52]

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[48] "EU Aims for Moral High Ground With Swingeing Climate Change Package," *The Guardian*, January 24, 2008.

[49] Aoife White, "EU leaders meet to fix targets to cut greenhouse gases, use more renewable energy," 2007.

[50] "G8 Summit 2007 Heiligendamm—Working Together to Counter Climate Change," http://www.g-8.de/Content/EN/Artikel/2007/02/2007-02-13-merkel-blair__en.html.

[51] United Nations Framework Convention on Climate Change (UNFCCC) (2003) "GHG Emissions and Reduction Targets:" http://unfccc.int/text /resource/country/china.html.http://www.un.org/chinese/News/daily/pdf/2006/20092006.pdf

[52] "Bali Action Plan, Decision -/CP.13",http://www.unfccc.int.

4. The Implications of the Two Logics of Climate Change Games for China

4.1. The Influence of the Two Logics of Climate Change Games

The two logics of the climate change games influence China on three counts. First, developed countries continue to dominate international climate change negotiations. The fight against global warming can be described in terms of common goods. Even though there are many internal contradictions among rich countries, they share a common interest in trying to keep and widen the development gap and in staving off the rise of emerging powers. As a result, wealthy countries maintain their leading position in the post-Kyoto climate regime building process. Developed countries initially communicated with and consulted big greenhouse gas emitters in a bid to establish a rational and efficient post-Kyoto system that would safeguard and coordinate balanced development between energy consumption, the Earth's climate, and economic growth. At the same time, developed countries tried to persuade developing countries to accept soft and hard environmental constraints. Western countries argue that the Kyoto Protocol placed little responsibility on developing countries, and that the December 2009 Kyoto meeting in Copenhagen will impose carbon emission limits on China and India.

Second, due to the early-development advantage of developed countries and the late-development advantage of developing countries, any major energy innovation would bring about a new industrial revolution and the reallocation of global industry. Developed countries have even launched a climate or carbon tax to put limitations on the economic growth of the developing world, particularly China. Developing countries are gradually assuming the obligations of stabilizing GHG. But because they lack new energy sources and advanced technology, developing countries only become emerging markets for Western multinational companies, while developed countries are making full use of climate change opportunities to strengthen their technical and competitive edge. As a result, they continue to dominate the international system. Obviously, the situation is the same for the environmental trade regime, which would let developing countries bear the programmed baseline costs, while developed countries bear incremental costs. Developed countries are doing that to increase the environmental constraint for developing countries and eventually restrict the development of developing countries with a hard law.

Third, efforts to establish a benign two-logics-of-climate-change-games regime for global warming, though indispensable to solve the problem of climate change, have run into many problems. These include restrictions imposed by both hard and soft laws, international competition in innovation, and non-commercial technical assistance. The distribution of environmental capacity and energy innovation require a healthy competitive environment and mechanisms that will not only promote common progress in energy technologies and economic restructuring but will also help the world embark on a low-carbon economy and sustainable development.

China as the new developing industrial power and India are trying to meet their growing demand for energy, and are also ironing out tensions as countries compete to secure direct access to stable supply sources. Because of globalization, urbanization and industrialization, energy consumption in developing countries has been growing rapidly. In its *World Energy Outlook 2006*, the International Energy Agency pointed out that the economies and populations of developing countries were growing faster than those of the wealthier nations, "shifting the center of gravity of global energy demand." It estimated that more than 70 percent of the increase in global primary energy demand between now and 2030 will come from developing countries.[53]The IPCC's Fourth Assessment Report estimates that carbon dioxide emissions from energy use could rise by 45 percent to 110 percent

[53] N. Gopal Raj, "Meeting the Challenge of Climate Change," *The Hindu*, May 23, 2007.

between 2000 and 2030. The report indicates that two-thirds to three-quarters of the increased emissions would come from developing countries. The report also makes it clear that the greater the efforts to reduce global greenhouse gas emissions, the less severe would be the impact of climate change.[54]

4.2. Internal Responses to the Two Logics of Climate Change Games

China's current per capita energy consumption is well below that of the developed world (although above that of many poor countries), but by 2020 China will match the current global average—meaning that China alone will account for almost one-third of the world's total carbon emissions between 1990 and 2020.[55] To be sure, China's current per capita emissions are low compared with industrialized countries, but with its almost 1.3 billion population, China's aggregate contribution to global warming is huge and growing. This prospect becomes clear when one considers the burgeoning middle class in China, whose lifestyle choices will lead to dramatic increases in per-capita energy use. China's overall carbon emissions by 2030 could reach 11 billion tons, well above those in the United States (8 billion tons), Europe (4.5 billion tons), and India (nearly 2 billion tons).[56] China has undertaken a number of policies and national development strategies, and created related domestic institutions, specifically those related to climate change.[57]

Under its 11th five-year plan, the Chinese government expects to "accelerate the pace of building a resource-efficient and environment-friendly society, and promote the harmonization of economic development with the population, resources, and the environment, reducing energy consumption per unit of GDP by some 20 percent."[58] China issued its National Action Plan on Climate Change in June 2007, and the government selected a number of goals to reach by 2010: a 20-percent cut in energy intensity; increasing renewable energy to 10 percent of the primary supply of energy, a substantial increase in coal-bed methane production, and promotion of nuclear power.[59]

4.3. External Responses to the Two Logics of Climate Change Games

China has been intimately involved in the international debate on climate change. Like other participants in the climate change negotiations, China wants to protect its interests and promote development while also joining international efforts to address this problem. However, it has consistently opposed efforts to require GHG limits by developing countries—even those calling for voluntary commitments to restrict future emissions increases. Instead, China has joined other developing countries in demanding that developed countries reduce their carbon emissions first and provide assistance to developing countries to help them cope with climate change and to implement sustainable development. It has usually resisted any links between financial and technical assistance from developed countries in the context of the climate change regime. Instead, it has demanded transfers of funds on noncommercial and preferential terms, and has rejected many of the market-based

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[54] http://www.unfccc.int/.
[55] Wang, Xiaodong and Smith, Kirk R. (2003), "Near-Term Health Benefits of Greenhouse Gas Reductions:" http://www.who.int/environmental_information/Information_resources/ worddocs/Greenhousegas/phe99-1-2.doc.
[56] "Melting Asia: China, India, and Climate Change," *Economist*, vol. 387 No. 8583, pp. 29-30.
[57] CONCCCC (ed.) (2003), "China's GHG Emission in the World," http://www.ccchina.gov.cn.
Cooper, Richard (1998), "Toward a Real Global Warming Treaty," *Foreign Affairs*, 77, vol. 2: 66-80.
[58] National Development and Reform Commission (NDRC): 11th Five-Year Plan for China National Economic and Social Development Report, 2006[http://en.ndrc.gov.cn/hot/t20060529_71334.htm].Accessed on May 5, 2007.
[59] Xinhua News Agency, "China National Action Plan on Climate Change," [http://news.xinhuanet.com/politics/2007-06/04/content_6196300.htm], accessed on March 3, 2008.

international mechanisms for emissions reductions advocated by developed countries and their industries.[60]

China has made some noteworthy contributions to climate-related international negotiations, notably when doing so would help codify requirements that developed countries help developing countries in the context of climate change. It proposed a resolution on technology transfer, which was adopted by the first conference of the parties (COP) held in Berlin in 1995. During COP2, China proposed that developed countries list in their national communications measures they were undertaking to implement technology transfer to developing countries. China has sometimes used a form of passive resistance during climate change negotiations, articulating a policy of "no response" to some international events, such as the Bush administration's rejection of the Kyoto Protocol. In 2000, China put forward a "no regrets" policy for the FCCC negotiations, meaning that it would share some concrete responsibilities to reduce carbon emissions provided they do not adversely affect its economic development.

Despite pressure from the United States, Europe and some other countries to reduce its carbon emissions, China has to date refused to take on concrete commitments toward this end. It expects the developed, wealthy countries of the world to substantially reduce their emissions before China and other developing countries are expected to do so, in accordance with the principle of common but differentiated responsibility adopted at the 1995 Berlin conference of the parties. However, a significant shift in China's energy policy and attitudes toward the Kyoto Protocol arguably occurred when it endorsed the Bali Roadmap in 2007, notably its paragraph on developing-country commitments: "Nationally appropriate mitigation actions by developing country parties in the context of sustainable development, supported and enabled by technology, financing and capacity building, in a measurable, reportable and verifiable manner" (Secretariat of the United Nations Framework Convention on Climate Change 2007: 3).[61] While this is hardly an embrace by the government of limitations on China's carbon emissions, it may be a harbinger of future acceptance of them.

At the 2007 APEC Summit, China's President Hu Jintao put forward four proposals for tackling climate change. These proposals have been regarded as China's updated response to international climate change negotiations: "First, cooperation is indispensable to global efforts to tackle climate change. Second, efforts are needed to pursue sustainable development, as climate change is ultimately a development issue and it can only be addressed in the course of sustainable development. Third, the United Nations Framework Convention on Climate Change should be upheld as the core mechanism for addressing climate change. The Convention and its Kyoto Protocol constitute the legal basis of international cooperation on climate change and are the most authoritative, universal and comprehensive international framework for the issue. Fourth, efforts should be made to promote scientific and technological innovation, as science and technology are important means for tackling climate change."[62]

Conclusion

The new century is an important milestone in the history of human development as half of the world's population is about to enter into resource-intensive industrialized societies that may

[60] Linnerooth, Bayer J. (1999), "Climate Change and Multiple Views of Fairness," in: Ference L. Toth (ed.), *Fair Weather? Equity Concerns in Climate Change*, London: Earthscan.

[61] The Secretariat of the United Nations Framework Convention on Climate Change: "Bali Action Plan," [http://unfccc.int/documentation/decisions/items/3597.php?such=j&volltext=/CP.13#beg], accessed on March 12, 2008.

[62] "Hu Jintao Expounds China's Stance on Climate Change at APEC Meeting," September 2007 [www.ccchina.gov.cn/cn/NewsInfo.asp?NewsId=9167], accessed on May 3, 2008.

seriously affect traditional North-South relationships and international environmental systems. Obviously, the climate crisis and energy resource difficulties would be the direct consequences, while fierce competition among major powers in the distribution of responsibilities, rights and interests of future development would be one of the potential implications affecting power transition in the international system. Nowadays, as the U.S. and EU economies recover and developing countries muster sustained economic growth, energy supply is out of step with demand. The environmental pressure is growing, and the geopolitical situation of the main oil-producing areas is unstable. Energy competition among countries is concerned not only with the success of collective action, but also with the transition of energy power in the international system.

This article endeavors to explain the two logics of the climate change games by linking international competition for energy know-how and carbon emission negotiations. There is a pressing need for rethinking the two-layer games in global climate change politics: environmental governance and energy innovation competition between different countries. On the one hand, it is now universally acknowledged that international cooperation and collective action are necessary to mitigate global warming. On the other hand, the need to secure access to new energy and know-how has increased and encouraged a growing number of states to join the fray.

The need for access to energy resources has increased and more countries are making greater demands for them. The loss of balance between human energy activities and the preservation of nature in many parts of the world is attributed to environmental degradation, in particular global warming. According to Jeffrey D. Sachs, “The global energy strategy must satisfy three objectives: low cost, diverse supply, and drastically reduced carbon dioxide emissions.”[63]

The world could benefit from the growth of developing countries, particularly China, if a workable model could be devised that would truly manage the balance of energy and the environment. A concerted transition to a low- or zero-carbon economy is the road that China must choose, especially with financial and technical aid from the developed world. However, such aid from the developed world is not enough. It is essential that climate change be fully integrated into development policy, and rich countries should help developing countries build the equity-based, sustainable, clean and low-carbon growth model. Otherwise collective action against global warming is hopeless.

Western countries are uneasy about new rising countries such as China that would probably confront the environmental status quo or the future allocation mechanism of resources and try to seek ways, including hard and soft laws, to contain them. Under such conditions, China’s strategy should be to be involved in these negotiations, on one hand by actively coordinating the conflicts and competition triggered by the allocation of environmental resources between different parties; and, on the other hand, by promoting the global sharing of the achievements in technological innovation, while following the “common development” approach to solve international environmental and political problems.

China could, and we argue should, show moral leadership on climate change, something that has been lacking among the developed countries. Alas, bearing in mind what we have said, it seems unlikely that China would undertake such a pro-environment leadership role in the Asian Pacific region or among developing countries more broadly. There are clearly many Chinese scientists and concerned officials who would like China to do much more. But there are also vested economic interests, exacerbated by China's infatuation with rapid economic growth and wealth creation, which overwhelm the environmentalists.

[63] Jeffrey D. Sachs, “Washington’s Way Will Undermine Oil Security,” *Daily Star*, October 2, 2006.

There is a burgeoning car culture—the same mistake as that made in the West—with a rapacious appetite for petroleum. More broadly, there is an effort to emulate the West's development and Western people's lifestyles, but with this comes an emulation of their terrible history of pollution. This is unfortunate because a concerted transition to an economy that produces fewer carbon emissions is possible, especially with financial and technical aid from the developed world. However, such aid would have to come with clear restrictions that the Chinese government has shown an unwillingness to accept. The upshot is that in the future there will be some improvements that will limit the increases in China's carbon emissions compared with what they might be otherwise. For the most part, however, at least in the near term, it will be business as usual particularly in the long term.

Differentiating (Historic) Responsibilities for Climate Change:
Exploring The Case of China

Christian Ellermann[1] and Niklas Höhne[2]

Abstract

Following the conclusion of the official work of the Ad hoc group for the modelling and assessment of contributions of climate change (MATCH), this paper takes a look on the politically more sensitive aspect of the Brazilian Proposal, namely the issue of differentiating (historic) responsibility for, and not merely (causal) contribution to climate change. Its aim is (i) to highlight the fact that, while related, the two issues ('contribution to' and 'responsibility for') are fundamentally different and should not be confused, (ii) to propose a methodology of calculating shares of responsibilities as opposed to the shares in causal contribution arrived at in the MATCH results, and (iii) apply these conceptions in depth in the case of China. Two conceptions of responsibility ('strict' or 'limited') are applied to operationalise the notion of 'respective capabilities' given in Article 3.1 of the UNFCCC. The key message resulting from the calculations is that causal contribution – while an important indicator of (environmental) relevance to the problem – must not be confused with moral responsibility for it. The rather large difference between the responsibilities at the two extremes of the scale under both conceptions does give pause for thought as to what sorts of burdens can justly be demanded in any application of the UNFCCC principle of common but differentiated responsibilities, whether in the context of the Brazilian proposal or beyond.

We apply these conceptions of responsibility to the case of China and discuss how they can inform the discussions over future commitments under a Copenhagen agreement.

1. Introduction

Climate change is increasingly acknowledged to have strong ethical dimensions, and global solutions are unlikely to be crafted, or stable, without some broad conception of what would be fair (IPCC 1996, Stern 2006). There is a burgeoning literature on these dimensions (Gardiner 2004, Brown et al. 2006, Klinsky & Dowlatabadi 2009). Some recent work has focussed on a particular dimension, namely that of historical responsibility. Early on, the work of the *ad-hoc group for the modelling and assessment of contributions of climate change* (MATCH) that was motivated by the Brazilian proposal (UNFCCC 1997) concentrated on the causal attribution of historical greenhouse gas (GHG) emissions to countries (Höhne & Ullrich 2003, den Elzen et al. 2005a).

It had been criticised that the past work on historical contributions for climate change, by focussing on the technical, natural science aspects, neglected the ethical and interpretational aspects. While the MATCH work avoids the ethical dimensions of historical responsibilities, some new publications carefully approach the challenge to distinguish causal contribution to climate change from historical responsibility for climate change (Botzen et al. 2008). Discussions of the earlier work showed a clear demand for a deeper analysis of these normative and moral aspects (Botzen et al. 2008). In an earlier paper (Müller et al. 2009) we respond to this demand. The present paper is based largely on this previous work, but gives particular attention to the role of China.

Following the Brazilian proposal, the notion of historical responsibility for climate change of Annex I parties has been regularly evoked by many developing country parties. It is one of the main lines of arguments underlying the principle of common, but differentiated

[1] Environmental Change Institute, University of Oxford, email: christian.ellermann@ouce.ox.ac.uk
[2] Ecofys, email: n.hoehne@ecofys.com

responsibilities in the UNFCCC or the polluter pays principle more generally. The discussion on equity – i.e. a political economic approach to historical responsibility (Friman 2007) – has been widely present in the Chinese debate on climate change. It is indeed one of the main discursive elements in China (Ellermann & Mayer 2009), thus framing the understanding of the country's ethical position vis-à-vis developed countries and the rest of the world. This paper therefore turns the issue from a scientific into a moral question concerning the interpretation of the results of the MATCH group, and focuses on the position of China.

2. The Conceptual Framework

2.1. Contribution Versus Responsibility

Climate impacts – be they anthropogenic, due to natural variability or anything else – will inevitably have a large multitude of causes, each causally contributing to the impacts in question. The (moral) responsibility for climate impacts will also typically be shared by a number of actors. The key difference between being morally (partly) responsible for, and (causally) contributing to is that the former is a blameable matter which only makes sense if the impacts are anthropogenic, while the latter is not. The 1628BC eruption on the Aegean island of Thera (Santorini), it has been argued, led to an average global cooling of 1.5°C over the following one hundred years, and consequently to the downfall of the Minoan civilization, but it would be considered odd to hold the mountain morally responsible.

The problem is that in the case of anthropogenic impacts, the difference, while remaining, is sometimes not quite as self-evident. There is a link between a moral agent causally contributing to an impact and being morally (partly) responsible for it, but that does not mean that the two are the same. Their difference becomes clear when considering that they generally imply different shares.

The MATCH project modelling has focussed on determining the causal contribution of time series of greenhouse gases covered under the UNFCCC to certain climatic impacts, in particular to changes in mean global temperature. The lesson has been that one really cannot speak of causal contributions to climate change per se, at least not if one is intent on specifying numerical shares thereof.

The advantage of focussing on the effects of emission time series on certain climate parameters was the purely scientific nature of the exercise, which was meant to safeguard the discussions from being dragged into normative or even moral debates. Even in the context of establishing shares in causal contribution, normative issues could not be completely avoided. One of the key normative decisions was the way in which emission time series were associated with particular countries. It is one thing to say that this and that series of emissions has contributed a certain percentage to the increase in global mean temperature over the 20th Century, and quite another to say that the United States of America have done so. The former is purely scientific; the latter involves a normative decision of how to identify 'the emissions of the US' (at a given time). The implicit assumption of the MATCH team was that (a) the (anthropogenic) emissions associated with a country for a given period are those emitted over its sovereign territory, and (b) the sovereign territory is changing over time.

There are a number of problems with this traditional conception, not least that it does not lend itself easily to accommodate 'bunker fuel' emissions from international travel and transport. Another, lesser known problem with this sort of traditional sovereignty based definition is that it does not lend itself to take account of joint contributions and responsibilities, short of pooling the sovereignty of the territories in question. This shortcoming shall be discussed briefly in the context of Article 4 of the UNFCCC, which can be interpreted as implying joint North-South responsibility over the (increments in) emissions in developing countries since the Convention was signed in 1992. For the rest of the article, the traditional sovereign territory definition of countries' 'anthropogenic' emissions shall be followed however, both for determining their relevant causal contributions and moral responsibilities.

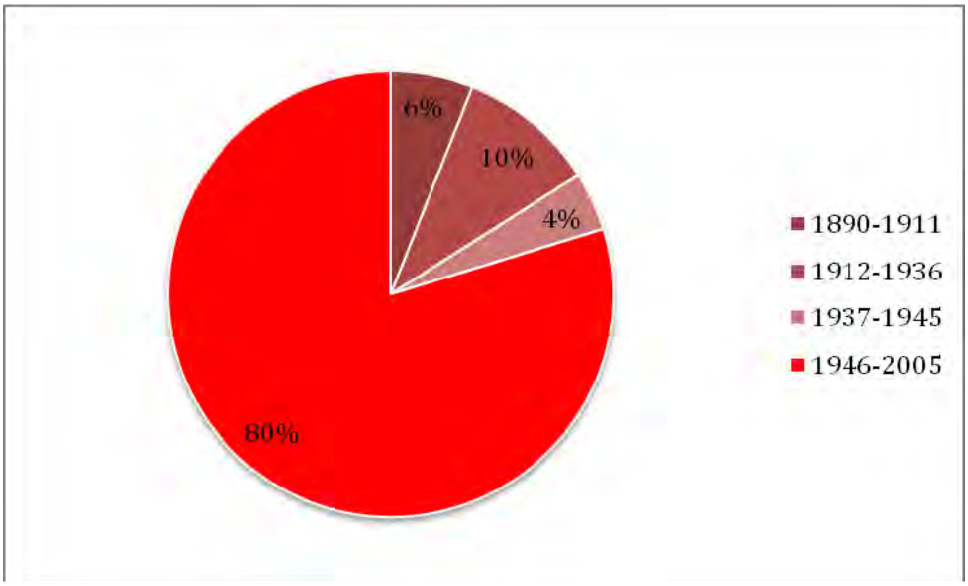

Figure 1. China's emissions of greenhouse gasses during different historical periods.

The normative issue of identifying the sovereign emissions of China is not completely straightforward. During the observation period from 1890 to 2005 several changes occurred in what is now the sovereign territory of the People's Republic of China. We have to rely on the decisions regarding the attribution of the emissions made by the MATCH team that included Chinese scientists and reflect these here. The data recorded for China during this period is largely dominated by emissions from fossil fuel combustion as recorded in Marland et al. (2005) and thus follows their definition of "mainland China".

Figure 1 displays the shares of emission contributions made to total emissions during different historical periods. Until 1911 China was under the rule of the Qing Dynasty and during parts of this time period, small parts of the country were occupied by foreign powers. There was however no major colonial rule over China that would warrant a deeper discussion of the attribution of emissions during that time, which amount to 6% of total emissions between 1890 and 2005. 1912 to 1937 saw major domestic conflict with warlords fighting over regional rule in the Republic of China, but there should be little question over the attribution of emissions during this time, which amount to 10%. Contrary to this, major parts of China were occupied by Japan between 1937 and 1945. Marland attributes these emissions to China, mirroring similar decisions like the attribution of pre-independence emissions over Indian territory to India and not to Great Britain. In spite of the regionally rapid industrialisation and deforestation during this time, the share of these 9 years amounts to only 4% of total Chinese emissions. From 1946 on, sovereign rule over mainland China became again clearly Chinese, and this historical period contributed 80% of the emissions from 1890 to 2005. Emissions in Taiwan, Hong Kong and Macao are not included in the China dataset.

While the question of Chinese sovereign emissions is not absolutely straightforward, the contribution shares during historical periods that could be contentious (1890 to 1911 and 1937 to 1945) make up merely 10% of total Chinese emissions. In practice, the relevance of the normative decisions surrounding this issue is therefore limited.[3]

[3] They nevertheless certainly have to be noted in an ethical paper on Chinese historical emissions.

2.2. Types of Responsibility: a Loosely Aristotelian Framework

To be responsible for something harmful is to be worthy of blame for it.[4] Aristotle contends that *blame* and praise are bestowed on *voluntary* actions, while *involuntary* ones are *pardoned*. The key to responsibility for actions is thus their voluntary status, for which he gives two necessary conditions:

> "First, there is a **control condition**: the action or trait must have its origin in the agent. That is, it must be up to the agent whether to perform that action or possess the trait — it cannot be compelled externally.
>
> Second, Aristotle proposes an **epistemic condition**: the agent must be aware of what it is she is doing or bringing about"[5]

However, ignorance *per se* seems to be slightly too easy for pardoning, which is why the condition is usually strengthened insofar as the agent *could have reasonably been expected to know*.

Aristotle's conception of 'responsibility' is based in his theory of virtue, which concerns 'passions and actions.' But there are other theories which see the concept rather in the context of duties, in particular in derelictions of duty, which are not (necessarily) actions but equally liable to give rise to blame. Figure 1 is an attempt at representing the interplay between the distinctions of voluntary/involuntary, harmful/harmless, agency-/duty-based, and the type/level of blameworthiness (responsibility) attached to their combinations.

Aristotle's conditions on assigning blame to actions (and, *eo ipso* agents) are about whether they are carried out voluntarily or involuntarily. However, as illustrated in Figure 1, blame can also be assigned or withheld regardless of this distinction. If, for example, the effects of an action are *harmless* (category I), then clearly no blame should be attached to it, even if it was voluntary. Moreover, there are situations where, contrary to Aristotle conditions, 'strict' blame (responsibility) is handed out simply on the ground that the effects are harmful, regardless of whether the harm was done voluntarily or involuntarily (category III.b).

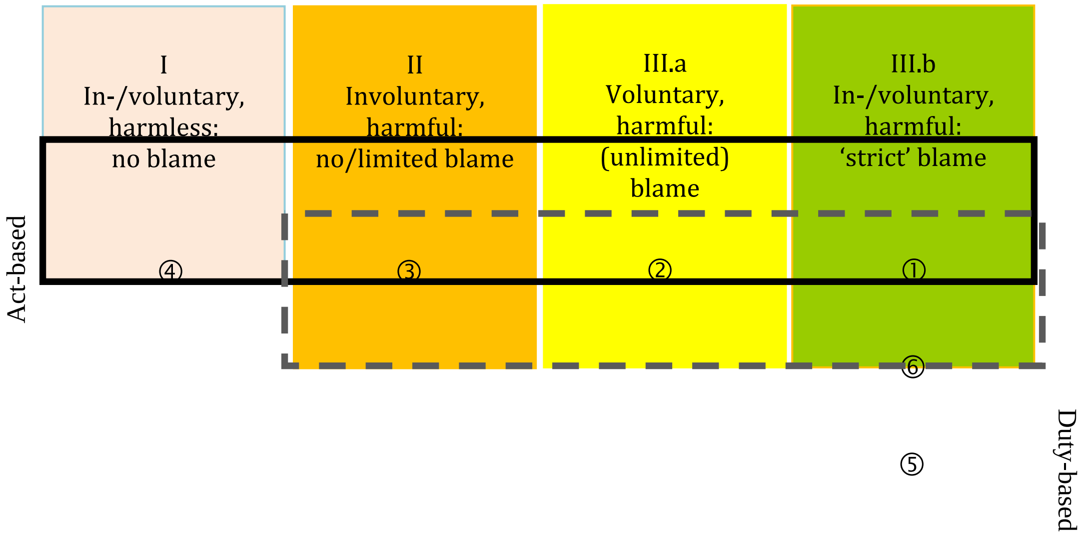

Figure 2. Categories of blame/responsibility.

Act-based blame. In the context of climate change, blame/responsibility is usually seen as applying to certain acts, namely the emission of greenhouse gases – i.e. it is act-based. For example, if someone drives a car, and if the emissions resulting from this act are deemed to be harmful, then they may be judged to deserve unreserved blame just because the emissions are harmful (strict blame, ① in Fig. 1), or because they drove voluntarily, in the

[4] Strictly speaking it is either blame- or praiseworthy, but in the present context the former suffices.

[5] Eshleman A (2004) Moral Responsibility. In: Stanford Encyclopaedia of Philosophy. Stanford University. See also Aristotle (1908) Nicomachean Ethics, Vol. Clarendon Press, Oxford: III.1-5, 1110a-1111b4.

full knowledge of the harmfulness of the emission and without coercion (unlimited blame, ②). If, however, they can plead reasonable ignorance or coercion, then they may get a (limited) pardon (no/limited blame, ③). Finally, if the emissions in question are classified as harmless, then no-one can justly be blamed (no blame, ④).

Duty-based blame. What is not usual is to consider blaming someone for certain harmful emissions not because they were actively engaged in emitting, but because they had duty to prevent them. Thus if two individuals, say Jane and John, enter a contract that Jane is to reduce her emissions and that John is to bear her additional costs, then it can be argued they both have a joint-duty to reduce Jane's emissions, and that if the reduction does not occur, that they could be jointly blamed. The blame may, of course, not lie equally. Jane may have wished to reduce but did not receive the money to do so, or John may have wished to pay for Jane's emission reduction, but Jane having no inclination to do so. The point being that John might have to take responsibility for a certain amount of emissions, even though they were not actually emitted by himself (⑤), while Jane may not have to take responsibility for the whole of the emission increment she failed to reduce, because there was a joint dereliction of duty (⑥).

3. Differentiating Contributions and Responsibilities

3.1. Methodologies

3.1.1. Causal Contribution Shares: The MATCH Methodology

The methodology of the MATCH project was designed to establish the relative causal contributions by countries to changes in global average temperature. The MATCH percentage figures for countries' shares in contributing to these changes are determined by the anthropogenic emissions that have historically been emitted from their sovereign territory. These percentage shares are themselves relative to the type of impact chosen, and they depend on the sequential order of the emission series in question. However, to simplify the calculations, it is possible to use the sum of the historic emissions – or rather their relative size – as a reasonable approximation for the purpose of this paper for their relative causal contributions (den Elzen et al. 2005b, Hope 2008). Instead of using the MATCH project modelling techniques, the aggregate historic country emissions – using the 1995 Global Warming Potentials (GWPs) for different gases as used under the Kyoto Protocol – emitted between 1890 and the present (2005) are simply used here as determinants of the contribution as well as responsibility shares in question. The proportion between countries' historic emissions since 1890 is used as a proxy measure of the relative size of their contribution to climate change impacts.[6]

3.1.2. Responsibility Shares: The Allowance-Based Methodology

The issue of how to measure and compare responsibilities has been controversial for some time, not least with respect to comparisons between the 'large emitters,' such as the US and China. In a recent newspaper article, the IEA chief economist was reported to predict that

[6] We would like to emphasise, however, that our methodologies could easily be adapted to be used with the full MATCH modelling techniques. We need to note that using GWP factors can only be considered an approximation, as over the long time spans considered here, static factors ignore the feedbacks and long term changes in global warming potentials. While the radiative impact of additional emissions declines with increasing concentration in the atmosphere, the damaging impacts of climate change increase non-linearly. This leads Hope (2008) to the conclusion that marginal damages of a unit of emission are to a reasonable approximation independent of concentration, which allows us to use aggregate contributions to GHG emissions to form causal contribution shares.

"China may overtake the United States as the world's biggest source of greenhouse gases within months", however, he also "accepted that on a per capita basis, people in rich countries still emit far more than individual people in China. […] Historically, China has also contributed little to the present build-up of greenhouse gas emissions in the atmosphere." (Vidal 2007)

The problem with either aggregate (i.e. country-wide) or per capita emissions measures is that, while they may capture some facet of the relevant notion of 'responsibility,' they both fail in capturing others. The percentage shares derived from the aggregate figures clearly capture the causal contribution aspect of responsibilities, but they cannot, by definition, reflect other potentially relevant country aspects, such as population size. Per capita emission figures, on the other hand, do reflect population size, but they are unable to reflect causal contributions, with the effect of assigning the same responsibility to both China and Latvia with 0.8tC/cap, but a 500-fold difference in aggregate emissions. (WRI 2009)

There is no general answer to whether responsibility should be measured in absolute (single parameter) or in relative (multi parameter) terms. There are cases of emission-based responsibilities, which should be quantified in absolute terms, i.e. in terms involving only one parameter, namely physical emissions. In other cases, it may be necessary to relativise these figures in terms of other relevant parameters, such as population sizes – when talking about group/country responsibilities – or wealth/economic production. Traditionally, these relativisations have been operationalised by simple parameter divisions such as the well-known per capita and per unit of economic output (GDP) measures. [7]

Aggregate – i.e. country or regional – responsibility for climate change (impacts), is argued in this paper, *does* need to be relativised in the sense that it has to be measured in multi parameter terms, including – apart from emissions – the size of (certain) populations. However, the traditional operationalisation in per capita terms over-simplifies the situation. Instead a (bottom-up) allowance-based methodology is proposed, which generalises both the traditional absolute and per capita measures.

The idea is that allowances may be allocated to emitters, which they can use against their emissions in calculating their level of responsibility. It is, in general terms, analogous to the system of tax allowances used in most countries in differentiating the tax burden. There can be different kinds of such 'climate change responsibility allowances', depending on the (moral) justification for why they should be allocated. For example, if a certain level of (greenhouse gas) emissions is deemed to be harmless, then one would have to allocate what we call '*basic allowances*' to cover these harmless emissions, on grounds of the fact that no-one should be held responsible (blamed) for a harmless activity.

Other allowances could be allocated on the basis of basic needs, in turn justified by way of the Aristotelian 'control condition' that one cannot be held responsible for what is not in ones control. This kind of allowance has been implemented by looking at '*subsistence allowances,*' based on the assumption that poverty eradication is an over-riding moral aim, and that in present circumstances it can only be achieved through activities which generate a certain amount of emissions. There may, of course, be other (basic) needs-based allowances, which might have to be considered, such as the need to keep the ambient temperatures within certain boundaries in order to survive. The Aristotelian epistemic condition that one should not be held responsible for actions which one could not have reasonably been expected to

[7] Baer et al. (2007) for example name "cumulative per capita CO_2 emissions from fossil fuel consumption since 1990" as a "reasonable" definition of responsibility. Ultimately however they use country-wide emission contributions adjusted by measures of income distribution in the population to calculate global responsibility shares because it is impossible to express the percentage responsibility of a per capita share (Baer P, Athanasiou T, Karthao S, Christian Aid, Heinrich-Böll-Foundation, EcoEquity (2007) The right to development in a climate constrained world. The Greenhouse Development Rights framework., San Francisco)..

know were harmful – mere ignorance is not sufficient – could also be used to justify the introduction of what might be called ‘epistemic allowances.’ The main difference between these Aristotle-based allowances and the above-mentioned basic kind is that while the latter can be seen as ‘certificates of harmlessness’, the former are merely ‘responsibility wavers’ applied to emissions which would otherwise have been counted as harmful and blameworthy. The main consequences of this is that while basic emissions should be transferable, these ‘responsibility wavers’ should not, and that the latter ought to be used only as ‘back-up’ to the former, should both be issued, and not as complement.

Apart from the question of what sort of allowances should be admitted to be counted against one’s responsibility (for climate change), the key issue with this sort of methodology is, how to allocate those that have been admitted. We believe that in the case of basic and subsistence allowances, a ‘bottom-up’ approach to country allocations – i.e. a definition of country allocations in terms of personal ones – is the most appropriate one. Note that this does not imply that country emissions have to be defined in the same way. In particular, this bottom up approach to allocating basic and subsistence allowances is perfectly compatible with the traditional definition of country emissions as the emissions originating from their sovereign territories.

In the case of epistemic allowances – meant to operationalise Aristotle’s epistemic condition – there is no need to take recourse to such a bottom-up approach to country allocations, particularly if one adheres to the traditional definition of country emissions. All that is necessary, on either the personal or the country level, is to ensure that all the emissions which happened in justifiable ignorance of their harmfulness be covered by allowances.

As concerns personal basic allocations, it can be argued that they should be allocated on an egalitarian principle for the same reasons that support the per capita allocation of global emission permits.[8] The bottom-up methodology then implies that countries can disregard $b \times p_i$ of their emissions in responsibility calculations, where b is the global per capita figure of harmless emissions, and p is the population of country/region i. This illustrates how population figure enters the allocation-based country responsibility measures, and that they are quite different from the traditional per capita measures.[9]

The difference becomes even more marked if some of the other population-related allowances are considered. While there are arguments for a differentiated allocation (in accordance to particular needs) in the case of subsistence allowances, it is clear that if they are equally allocated they would normally not be allocated to the whole population of a country, but only to those who are eligible by living below some poverty line. In other words, it is possible that the allocation of subsistence allowances to a country is dependent on population size, thus generating a (population-) relative responsibility measure. But – unlike in the traditional per capita methodology – the populations in questions are not all inhabitants, but only special needs groups, namely the country’s poor. The proposed allowance-based methodology thus manages to reflect certain population sizes in establishing country/regional climate change responsibilities without the danger of unjustifiably diminishing in-country responsibility differences – by letting the responsible (carbon) rich

[8] Note, however, that the two are *not* the same: to be allocated an emission permit, *per se*, is not tantamount to being given a responsibility allowance for the specified amount of emissions, in the same way in which being given the legal licence to produce tobacco does not give one immunity with respect to the consequences of tobacco use!

[9] For example, if it is agreed that all the emissions in question are harmful, then the basic global per capita allocation $b = 0$ implying that the resulting basic country allocations are equally 0 for all countries regardless of their population size, and thus that the allocation-based responsibility measures are independent of population figures. Per capita measures, by contrast, reflect population size by definition.

hide behind their (carbon) poor compatriots – as can happen in the case of the traditional per capita methodology.

3.2. Data

The calculations made in this article are based on data coming from a variety of sources. The same emissions dataset as in the latest modelling effort of the *ad hoc group for the modelling and assessment of contributions of climate change* is used. It includes 192 countries for three sectors: energy and industry (CO_2, CH_4, N_2O), agriculture/waste (non-CO_2) and land use change and forestry (CO_2) from 1750 to 2100. It is derived with an algorithm that combines emission estimates from various sources in the following hierarchy: National submissions to the UNFCCC published in the GHG emission database (UNFCCC 2007); CO_2 emissions from fuel combustion as published by the International Energy Agency (IEA 2006);[10] emissions from CH_4 and N_2O as estimated by the US Environmental Protection Agency (USEPA 2006); CO_2 emissions from fuel combustion and cement production as published by Marland et al. 2003 as retrieved in 2006 and regional past data of Edgar/Hyde (Klein Goldewijk & Battjes 1995). The emissions of different greenhouse gasses are multiplied by their global warming potential and added up, leading to a single amount of carbon dioxide equivalent emissions.[11]

Future emissions data (i.e. beyond 2005) as used in section 5.4 are derived by multiplying 2005 actual emissions by the average growth rate of six IPCC SRES scenarios for 17 world regions (IPCC 2000).

The source data takes into account changing geographical borders, but only for energy and industrial CO_2. Other gases and sectors are based on current sovereign territory. If a currently existing country did not exist over the whole period, emissions were backward extrapolated based on the country's current sovereign territory.

Historical population data are taken from the HYDE database (Klein Goldewijk 2007) and Penn World Tables (PWT 2006) and, where not available, the World Development Indicators (World Bank 2006).[12] Poverty headcount ratio (as % of population) at \$1 and \$2 a day and GDP data (PPP current international \$) are obtained from the same source for calculating the size of poor populations.[13]

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[10] This dataset was supplemented by process emissions from cement production from Marland G, Boden TA, Andres RJ (2003) Global, Regional, and National Fossil Fuel CO_2 Emissions. In: Carbon Dioxide Information Analysis Center ORNL, U.S. Department of Energy (ed) Trends: A Compendium of Data on Global Change, Oak Ridge, Tennesse., U.S.A. Available online at: http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm. to cover all industrial CO_2 emissions.

[11] See Höhne N, Blum H, Matthews B, Fuglestvedt J, Skeie RB, Kurosawa A, Hu G, Lowe J, Gohar L, Salles ACNd, Ellermann C (forthcoming) Contributions of individual countries' emissions to climate change and their uncertainty , section 2.1 for a detailed description of the emission dataset including issues of completeness and uncertainty.

[12] Because population data for the years 1890 to 1959 are not obtainable for 29 small countries (making up 11 million inhabitants of approximately 3 billion worldwide in 1960), their emission allowances of these 70 years are not counted towards their total share. This leads to very slight increase in the share of LDC+AOSIS in the calculation of responsibility with emissions allowances 1890-2005.

[13] Poverty data of 24 least developed countries was unobtainable. For these countries, the poverty headcount ratios at \$1 and \$2 a day have been set to a level comparable to that of other LDCs (50% and 75% respectively). The time series of poverty data is not complete for all countries. Poverty shares have therefore been extrapolated for the missing years using existing data.

4. The View From China

4.1 Views From the Literature

Historic responsibility for climate change has been discussed in Chinese publications, but the authors concentrate mainly on direct historic contribution of countries to the main greenhouse gas – that is CO_2 emitted through the use of energy – and unfortunately do not provide information on the source of data (He et al. 2000, Zhao 2007, Xu & Yu 2008). According to these authors, developed countries bear responsibility for climate change as they have emitted 77% of CO_2 emissions from fossil fuel use between 1950 and 2000.[14] He et al. (2000) argue to actively use the notion of developed country historical responsibility to "protect China's interests". To corroborate their point and "refute arguments of 'common responsibility' and the like", they calculate that developing country annual emissions will only surpass Annex I emissions in 2037 and cumulative emissions in 2147.[15]

An analysis that goes beyond directly equating contribution shares to historic responsibility is lacking, and the level of depth largely stops at the Annex I – non-Annex I divide. Chen et al. (1999) however analyse the topic starting with the *Brazilian Proposal* of 1997, its underlying concepts and calculations of contribution to climate change. Comparing current (1990-2010) with historic contribution shares, they conclude that China's interests would not be served if it was singled out from the group of developing countries in analysing historic responsibility for the approach of the *Brazilian Proposal*.[16]

4.2. Official View

As China has put forward a coherent climate policy since 2007, the government's views on the application of historical responsibility and China's position in it have become manifest in various official documents.

> "Both developed and developing countries are obligated to adopt measures to decelerate and adapt to climate change. But the level of their historical responsibilities, level and stage of development, and capabilities and ways of contribution vary. Developed countries should be responsible for their accumulative emissions and current high per-capita emissions, and take the lead in reducing emissions…" (China NDRC 2008)
>
> "According to the principle of 'common but differentiated responsibilities' of the UNFCCC, the Parties included in Annex I to the Convention should take the lead in reducing greenhouse gas emissions. For developing countries with less historical emission and current low per capita emission, their priority is to achieve sustainable development. As a developing country, China will stick to its sustainable development strategy […] and make further contribution to the protection of global climate system. (China NDRC 2007)
>
> "Developed countries shall take responsibility for their historical cumulative emissions and current high per capita emissions to change their unsustainable way of life and to substantially reduce their emissions and, at the same time, to provide financial support and transfer technology to developing countries. […] Given their historical responsibility and development level and based on the principle of equality, developed

[14] This number is in the same range of the MATCH results for the same type of emissions and time period (72.3%). Taking all Kyoto gases into account, the Annex I share for this time period drops to 54%.

[15] According to the MATCH calculations, non-Annex I annual emissions (all gases) have surpassed non-Annex I emissions in 1992 and developing country cumulative emissions (all gases) will have surpassed developed countries by 2024.

[16] "中国一旦脱离广大发展中国家的支持，必将陷于孤军奋战的不利境地。"(Chen et al., 1999).

> countries shall reduce their GHG emissions in aggregate by at least 40% below their 1990 levels by 2020 and take corresponding policies, measures and actions." (China NDRC 2009)
> "Climate change is primarily caused by developed countries' historical emissions over many years". (China MOFA 2008)

Similar to the Chinese academic views reviewed above, the official line is that firstly, China is a developing country, and secondly, developing countries have little responsibility for climate change. While low per capita emissions are discussed directly for the case of China, in the case of historic responsibility, China is not mentioned individually, but as a member of the group of developing countries with little responsibility overall.

The Chinese position on historic responsibility has become more clearly defined over time. On the outset, China subscribed to a version of the Brazilian position that does not allow for global reduction commitments, but differentiates reduction targets for Annex I countries by historic responsibility only. More recently, China has started to formulate their own position, a *cumulative per capita emissions convergence* approach. This „hard ball" position (Hallding et al. 2009) requires equality of cumulative country emissions divided by the population at the time of the target year – 2100 in the Chinese proposal.[17]

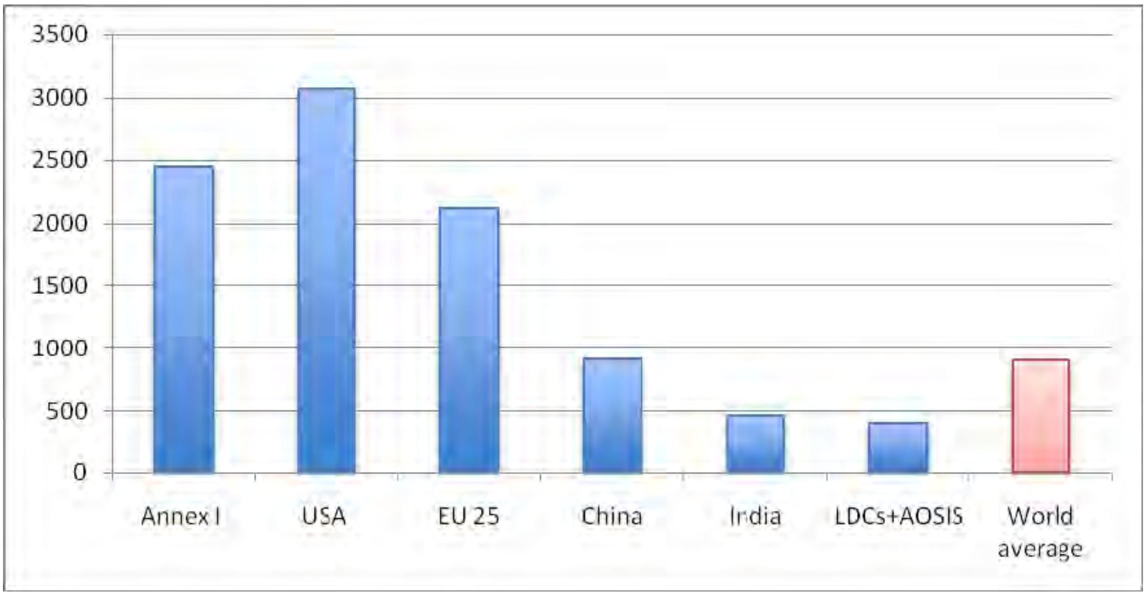

Figure 3. Cumulative per capita (2100) emissions by 2100 according to MATCH data.

5. Results

5.1. Context

Causal contributions were calculated for all countries, but for expository reasons we have chosen to focus on three countries – USA, China and India – and three groups – the group of industrialised countries listed in Annex I of the UN Framework Convention on Climate Change (Annex I), the European Union after the 2004 enlargement (EU25) and the Alliance of Small Island States combined with the Group of Least Developed Countries (AOSIS+LDC, 76 countries). In order to understand the contribution and responsibility figures to be discussed in the following two sections, it is important to appreciate certain

[17] Chinese presentation at the *AWG-LCA Shared Vision workshop* at COP14 in Poznan, 2008. This simplified metric circumvents the problem that there is no logically meaningful expression of average per capita *and* per year emissions. Figure 3 shows this calculation based on MATCH data.

basic economic and demographic facts about these entities, concerning their relative wealth and population sizes.

Figure 4 depicts three non-emission parameters for the year 2005 that are of interest in the subsequent analyses of contribution to and responsibility for climate change by these countries and country groupings, namely their share in global wealth (defined in terms of current GDP (PPP)), in global population, and in global poverty, measured in terms of the number of people living on $1 per day, or below. Not surprisingly, the developed and developing world (Annex I/non-Annex I; North/South) are not the same with respect to these three dimensions: While the 20% of the world population that lives in Annex I countries produces 56% of global wealth, the non-Annex I countries are home to 99.2% of the global very poor. These proportions will have some impact in our responsibility calculations, which is why it is important to keep in mind that they can change considerable depending on the level of poverty one considers. This issue will be re-visited below in the sensitivity analysis section, but just to give an example, and to give an idea of what these shares stand for in absolute terms, consider the fact that China's global share in abject poverty of 12% translates into 129m people, and India's 35% into 377m, while the population of those living below $2 (PPP)/day is 454m in China and a staggering 881m in India.

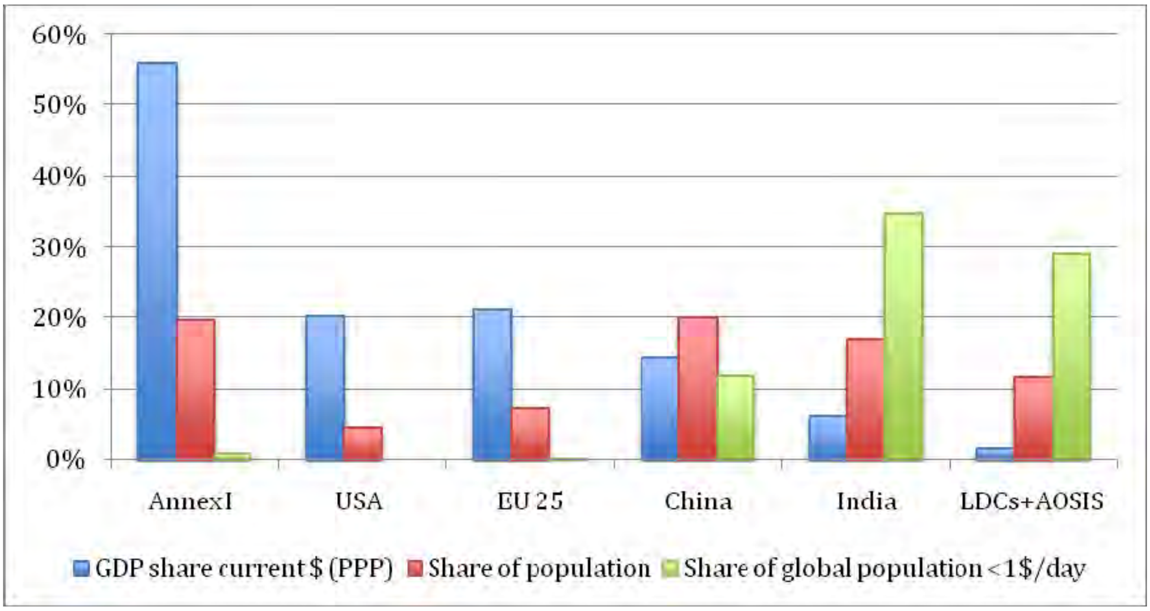

Figure 4. Economic and demographic context (2005).

5.2. Differentiating Causal Contributions

According to the simplified methodology chosen for the purpose of this paper, the share of a country's – or group of countries' – contribution to climate change is given by their share in global historic GWP-weighted greenhouse gas emissions. However, to be able to calculate these shares, some further parameters need to be specified, such as the time frame, the types of emissions, and the countries or group of countries to be considered. For the purposes of this paper, the chosen time horizon is 1890,[18] and the emissions are those considered under the Kyoto Protocol.

[18] Data before 1890 is less complete. Roughly 10% of the effect of total aggregated emissions is left out, when starting in 1890 instead of 1750, the start of industrialisation, see Höhne N, Blok K (2005) Calculating Historical Contributions To Climate Change - Discussing The 'Brazilian Proposal'. Climatic Change 71:141-173.

5.2.1. Reference Case (RC) Contributions

Historically, industrialised countries (as listed in Annex I) have contributed the majority of greenhouse gases, namely 54.5% – a figure which in the present simplified methodology represents their share in the causal contribution to the climate change problem. The causal contribution shares in detail, as represented in Figure 5, are (in descending order of magnitude) as follows: USA (19.7%), EU25 (17.8%), China (10.8%), AOSIS+LDC (5.7%) and India (3.9%).

These proportions can vary significantly depending on the sorts of gases and sources/sinks that are taken into consideration. For example, if emissions from land use, land use change and forestry (LULUCF), which are relatively uncertain, are excluded, Annex I contributions increase by almost a fifth (+10.2 percentage points), most of it absorbed by the US (+5.2%pts) and the EU (+4.3%pts), with chief beneficiaries Brazil (–2.3%pts, not shown here), Indonesia (-2.9%pts, not shown here) and AOSIS+LDC (–2.3%pts). The Chinese contribution does not change drastically (-0.4%pts), meaning that its share of emissions from LULUCF in total emissions is not very far from global average.

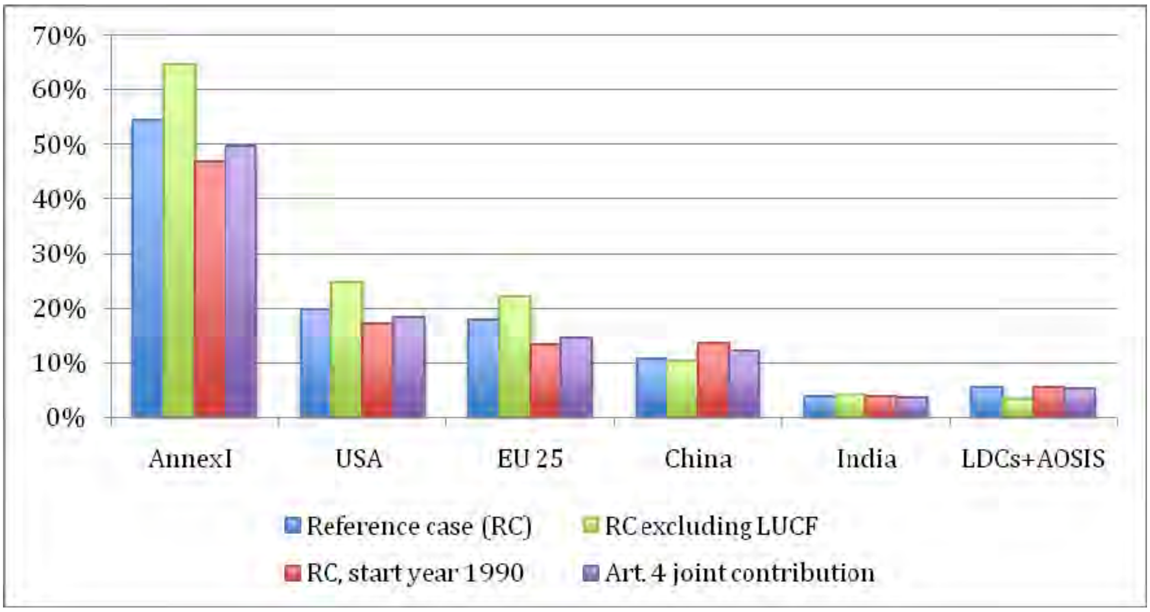

Figure 5. Causal contribution to climate change.

However, if one is talking of 'causal contributions to climate change' *tout court*, all (officially) recognised sources and sinks – including those from LULUCF – should be taken into account, which is why the Reference case is chosen for determining causal contribution shares.

5.2.2. Joint Contributions

As mentioned earlier, there are reasons to think that certain emissions, even though emitted over the sovereign territory of one country, should be given joint responsibility between different countries. The example put forward above was the case of emission increments in developing countries since 1992, when the world adopted the UNFCCC, and in particular its Article 4.

There may be other reasons as to why one might wish to introduce a joint responsibility for certain parts of 'sovereign' emissions, such as the ones embedded in exports, accounting for one third of total emissions in 2005 in China for example (Peters & Hertwich 2008, Weber et al. 2008). Indeed, a recent study contends that:

> "… the extent of 'exported carbon' from China should lead to some rethinking by government negotiators as they work towards a new climate change agreement. It suggests that a focus on emissions within national borders may miss the point. Whilst the nation state is at the heart of most international negotiations and treaties, global trade means that a country's carbon footprint is international. Should countries be concerned with emissions within their borders (as is currently the case), or should they also be responsible for emissions due to the production of goods and services they consume?" (Wang & Watson 2007a)

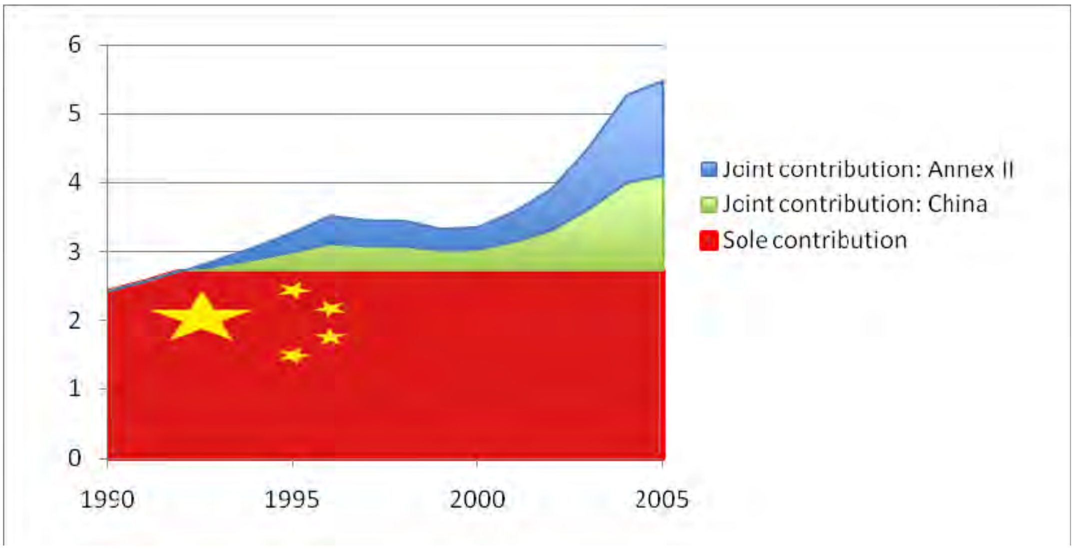

Figure 6. China's joint contribution.

The method of determining shared responsibilities used in this paper is able to accommodate this sort of joint responsibilities by introducing 'joint contributions.' And while the actual calculations of responsibility shares below will all be based on the more traditional sovereign-contributions-only approach embodied in the Reference Case (incl. LULUCF), it is useful to just give an illustration of how the inclusion of such joint contributions might change the picture. The exemplary implementation of joint-contributions (illustrated in Figure 6 for China) which is meant to reflect the duties under Article 4 simply assumes that the increment in emissions since and above the 1992 level are to be shared 50:50 by the countries in question and the rich industrialised (Annex II) countries[19] – divided among them in proportion to their GDP.

In order to have any significant variance from the sovereign country measures at all, the time horizon has also been limited to start in 1990. For the industrialised world, the switch to this sort of 50:50-joint contribution would mean in increase of 3 percentage points since 1990, most of it going in roughly equal to the US and the EU (+1%pt each), and benefiting mostly China (-1.3%pts). Given these differences would practically disappear if one were to use the Reference Case (beginning in 1890) it was decided not to proceed along these lines for the moment.

[19] As it happens, in 2004, the share of Chinese CO_2 (energy) emissions allocated to Annex II in this fashion is precisely the share of its embedded export emissions as calculate by Wang T, Watson J (2007b) Who owns China's carbon emissions. Report No. 23, Tyndall Centre for Climate Change Research, Norwich.

5.3. *Differentiating Moral Responsibilities*

5.3.1. *Strict Responsibility*

Strict responsibilities, according to the adopted allowance-based approach, are determined by the level of aggregate historic emissions – representing causal contributions – and a per capita allocation of the global total of harmless emissions. There has been some debate in the literature as to how much could be globally emitted without imposing harm, particularly in the context of defining what has become known as 'ecological space.' MacGregor (2006), for example, explains his choice of 4GtCeq (14.7GtCO$_2$eq) as follows:

> "The earth's natural ecosystems (both land and sea) currently absorb roughly half of the anthropogenic emissions of CO$_2$, thus buffering us from the full climate impacts of our emissions. However, this is a 'moving target' since future changes in climate will affect this rate of natural absorption. This in turn influences the future rate of change of atmospheric CO$_2$ since the warmer climate accelerates decay of carbon in soils and leads to large release of CO$_2$, which causes further warming. Moreover, the population is projected to increase. The current size of the global natural carbon sink is estimated to be 3-5 billion tonnes of carbon (GtCeq) – approximately 2 GtCeq by ocean and 1-3 GtCeq by land, depending on differing rates of deforestation. A global level of 4 GtCeq is often used (Monbiot 2007; Retallack 2005)." (MacGregor 2006)

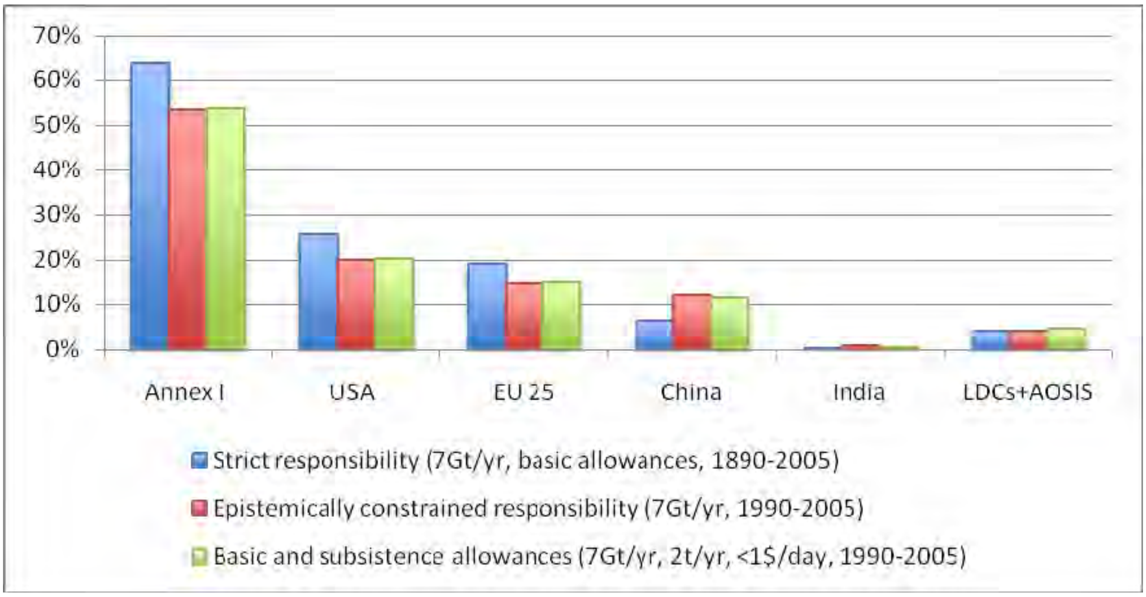

Figure 7. Moral responsibilities for climate change.

Agarwal, Narain and Sharma (1999) in turn contend that "terrestrial sinks are national property, but oceanic sinks, which absorb to the order of 2GtC [7.3GtCO$_2$] per year, belong to human kind and are common global property." (Agarwal et al. 1999) 7GtCO$_2$ as the global total of basic allowances has been adopted here, for the present purposes to be allocated – in accordance with their global commons status – on a per capita basis.[20]

As can be seen in Figure 7, numerically, this choice implies an overall industrialised country (historic) climate change responsibility of 64%. The largest single country share is that of the US with 25.6%, followed by the EU (19.1%), China (6.4%) and finally a number of countries with low if not negligible responsibility: AOSIS+LDC (4.1%) and India (0.3%).

[20] Strictly speaking, we should also have allocated basic allowances according to the sinks capacity of the respective sovereign territory, but given the uncertainties on how much these are, we decided to err on the side of caution and just consider oceanic sinks.

While it will not be surprising that individual SIDS and LDCs have really no historic responsibility for the climate change problem (on average 0.05%), what may be less expected is to find India at the very end of our responsibility spectrum. The reasons for the extremely low Indian responsibility share are its relatively modest causal contribution share of around 4%, and its rather large share in global population share (16.9%).[21]

5.3.2. Limited Responsibility I: Epistemic Constraints (EC)

There has been a robust difference of opinion – more often than not along the developed/developing country divide – whether it is fair to use this sort of strict historic responsibility, or whether countries should be granted mitigating circumstances, such as ignorance of the effect of one's actions. For the present purposes this sort of Aristotelian epistemic constraint of full responsibility has been implemented here by excluding emissions before 1990 from the calculations, on the grounds that after that year, which saw the beginning of the UNFCCC negotiations and the publication of the first IPCC reports, no government could reasonably plead ignorance of the problem.[22]

This plea for ignorance as mitigating circumstance does shift the burden of responsibility significantly from industrialised to developing countries, with Annex I as a whole losing 10 percentage points. The US (20.1%) and the EU (12.3%) both lose over a fifth of their responsibility relative to their historic strict responsibility shares, while China (12%) picks up about the same number of percentage points, but in this case this means almost a doubling of responsibility relative to the strict measure. In relative terms, by far the worst off is India (1%), which more than triples its responsibility under such a switch to ignoring most of the historic contributions. And yet it remains at the bottom of our responsibility scale, due to the extremely low base line. However, the developed/developing country picture is not quite as homogeneous as might be expected ("industrialised countries lose responsibility, developing countries gain"). Japan (3.7%, not shown here), for one, gains a third in responsibility, while Brazil (5%, not shown here), and AOSIS+LDC (4%) would actually be slightly better off. But, on the whole, the fact remains that in general a limitation of responsibility by considering only post-1990 contributions benefits industrialised countries.

5.3.3. Limited Responsibility II: EC With Subsistence Allowances

As mentioned earlier, Aristotle's conditions on limiting full responsibility lend themselves not only to justify these epistemic dispensations, but also a certain dispensation for subsistence emissions, or rather emissions needed to overcome (abject levels of) poverty. For the purposes of this paper, these needs based dispensations have been implemented as an additional constraint on the above-mentioned epistemic dispensation case. In other words, pre-1990 contributions continue to be disregarded in this context. This leaves two parameters to be determined: who should be eligible for the subsistence allowances, and how much should they be. The most readily available data are listed in the World Bank Development Indicators, which contains figures for people living on less than $1 and 2$ per day. As to the question of how much should poor people be allowed to emit without incurring responsibilities, per capita subsistence allocations of less than the relevant global per capita

[21] The position of Japan in this strict responsibility scale (2.8%) also suggests that burden sharing according to responsibility alone may not really be tenable, and that it would have to be complemented with some 'respective capacity' component, as referred to in Article 3.1 on the UNFCCC.

[22] This is, of course, not quite the same as saying that they could not have reasonably been expected to know even before this – as referred to above – but for the sake of argument, we shall use 1990 in accordance with the principle of the presumption of innocence ("Giving the defendant the benefit of the doubt").

basic allowance will not register.[23] Given that the per capita emissions of the developing world are currently estimated to be 3.7 and 2 tCO_2eq with and without LULUCF, respectively our decision was to allocate $2tCO_2$ per poor inhabitant per annum, to be subtracted from the aggregate historic emissions (instead of the basic allowance)

In this case of 1$/day as 'poverty threshold' – referred to simply as 'Limited Responsibility' – the annual subsistence allowance of $2tCO_2eq$. (which is larger than basic allowance per capita level) is used instead of the basic one for each inhabitant with an income of less than 1$ per day. The results benefit developing countries more than developed ones, and yet the shift of half a percentage point in responsibility towards Annex I (53.8%) is clearly not compensating for the shift in the other direction due to the introduction of the epistemic constraint. The US gains 0.2 percentage points relative to the epistemologically constrained case, while India and China jointly loose nearly one. And the situation does not differ significantly if one moves the poverty threshold to 2$/day: The US gains another 0.6 percentage points, while China and India jointly loose 1.2 percentage points. In other words, the choice of poverty threshold – at the assumed level of $2tCO_2eq$. for the subsistence allowance – is not a particularly sensitive one, certainly not in comparison to the effects of the chosen epistemic constraint, or the overall level of basic allowances.[24]

5.4. Mitigation Through Population Control?

Since the end of the 1970s, China has taken extraordinary measures to curb the growth of its population. Based on the undoubted achievements of the policies that were implemented, Chinese politicians have repeatedly argued that population control is one of the most successful strategies to curb emissions and coin it as one of the key mitigation efforts of China. The underlying assumption is that the increase in emissions would have been faster with higher population growth.[25]

Estimates vary on the size of the current population in absence of the policies that were implemented, and there is not any single number that is more correct than any other when looking at this hypothetical case. To simplify, we extrapolate 1978 population figures to 2005 at the growth rate of the population from the founding of the People's Republic in 1949 to 1978, leading to a hypothetical population of 1.62 billion instead of 1.3 billion in 2005. We then calculate the hypothetical emissions for the years 1978 to 2005 by multiplying actual emission with the factor of actual to hypothetical population of each year, which results in hypothetical Chinese emissions of $8.7GtCO_2eq$. instead of $7GtCO_2eq$. in 2005.

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[23] 16 (1990-2005) times the annual basic allowance budget of $7GtCO_2eq$, divided by the sum of global annual population figures over the period = $1.2tCO_2eq$.

[24] See Müller et al. (2009) for a full sensitivity analysis for varying choices of Basic and Subsistence allowances.

[25] It can be questioned if the difference in hypothetical to actual emissions growth would have been the same as the difference in hypothetical to actual population growth. Economic growth, industrialisation and modernisation since the end of the 1970s may have rather been hampered by overpopulation, leading to an elasticity lower than 1.

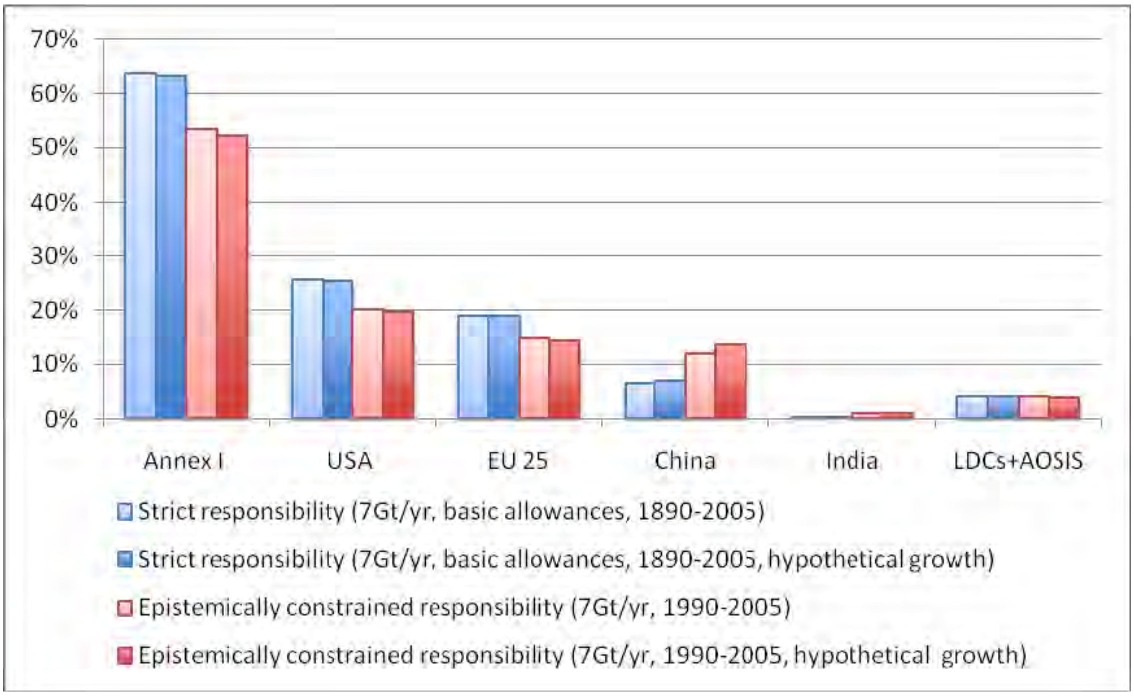

Figure 8. Hypothetical responsibility with faster Chinese population growth.

Figure 8 shows the new responsibility shares for a higher Chinese population and emissions growth. Note that the increase in the allocated share of basic allowances for its hypothetical population offsets part of the increase in responsibility for China.

Shares in strict responsibility and epistemically constrained responsibility for Annex I countries (-0.5/-1.1%pts.), USA (-0.2/-0.4%pts.) and EU25 (-0.2/-0.3%pts.) are lower in this hypothetical case and the shares of LDCs and AOSIS remain virtually unchanged. Interestingly the responsibility shares of India increase by 10%/8% (but still less than 0.1%pt.) because in relation to its low emissions the country profits most from the allocation of basic allowances, part of which are diverted to China due to a higher share in world population. The share of China's strict responsibility increases to 7.1% from 6.4% and for epistemically constrained responsibility to 13.6% from 12%. With all the caveats noted regarding the assumptions underlying this hypothetical calculation, China has reduced its responsibility for climate change by 10% and 13.5%[26] respectively by means of population control.

5.5. What is The Future of Historical Responsibility?

China has undoubtedly started to implement numerous policies that have a climate change mitigating effect (Ellermann et al. 2009 forthcoming). In the deliberations of the coming 12th Five-Year-Plan for China's development strategy, a general consensus exists for a more sustainable development path. However, proponents of a low-carbon future for China face opposition by others who suggest that China should focus on unrestrained business-as-usual development until 2030 before worrying about (unilateral domestic) climate change mitigation.

The 12th Five-Year-Plan plan covers the years 2011 to 2015 and will among other things provide guidance for economic restructuring and major investments in infrastructure and capital with long turnover rates like energy generation and heavy industry facilities. Decisions made this year therefore predetermine to a large degree China's general emissions trajectory over half a century or so to come. A careful look into the future (up to the often-

[26] Note: percent, not percentage points.

cited year 2030) and its potential responsibilities including historical (pre-2005) and new emissions therefore seems to be warranted. Figure 9 and Figure 10 corroborate this point, as emissions between 2006 and 2030 make up the largest part of total emissions since 1890, with an average annual contribution of over 1.6% after 2005.

We are mindful of the difficulty of predicting future emissions and rely directly on the MATCH calculations. The MATCH group used latest available emissions data (2005) and extrapolated country emissions using an average of the six basic IPCC SRES scenarios for 17 world regions, avoiding a judgement on the probability of any single scenario to be more "correct" than others. The point of this paper here is ***not*** to come up with a reliable number of future emissions, but to illustrate the potential future direction of historical responsibility. In contrast to the previous sections, this paper cannot provide a clear ethical argument for the metric used (and as a consequence the use of the results), as it builds the sum of *actual* historic emissions and *potential* future emissions, complicating the interpretation of the results. The numbers provided are therefore simple results of a calculation based on the scientific consensus of the IPCC over future emissions, but lack the power of an ethical analysis of future historical responsibility. [27]

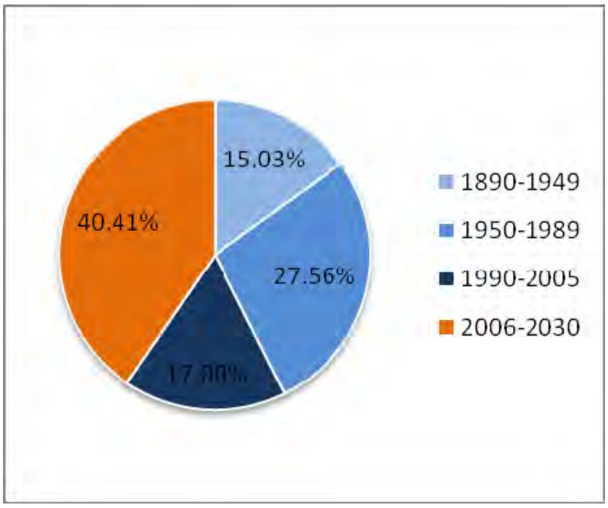

Figure 9. Total contribution during different time periods.

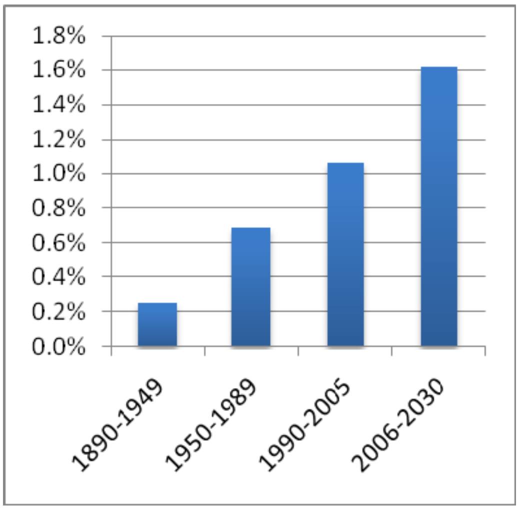

Figure 10. Annual contribution during different time periods.

The look into the future reveals potentially significant shifts in the shares of responsibilities of countries and regions (Figure 11, lighter colour shows actual historical responsibility, darker colour shows "potential future historical responsibility"). Strict responsibility of Annex I countries would be 53.8% (-10.1%pts), epistemically constrained responsibility would be 45.2% (-8.1%pts.). The shares of the USA would decline by 5%pts. to 20.6% and 3.9%pts. to 16.2%, and EU25 to 15.8% and 12.6% respectively (-3.3/-2.1%pts.). China's share of strict responsibility would rise sharply to 12.1% (plus 5.7%pts. or 88.3%) and epistemically constrained responsibility would increase by 4.8%pts. (or 40.4%) to 16.8%, overtaking the potential shares of the USA and the EU25 and potentially amounting to more than a third of Annex I total by 2030. India's potential responsibility shares rise to 2.6% and 4% respectively (2.3%pts./3%pts. and a drastic relative increase), while LDC/AOSIS potential shares drop slightly. The Rest of World responsibility shares

[27] The question of the use of future emissions – modelled in emission scenarios – to calculate the historic responsibility at an end year that lies in the future should be an interesting research topic in this field. An argumentation could perhaps start in this direction: In the case one considered pre-2030 emissions completely predetermined by today's decisions on energy strategy, etc. and considered the modelled emission scenario an accurate description of future development, these future emissions could already be assumed to be historic today. Then they could be summed up with actual historic emissions.

change moderately from 25.3% to potentially 27.8% and 29.7% to 30.5%, meaning that its emissions would grow around world average, especially after 1990.

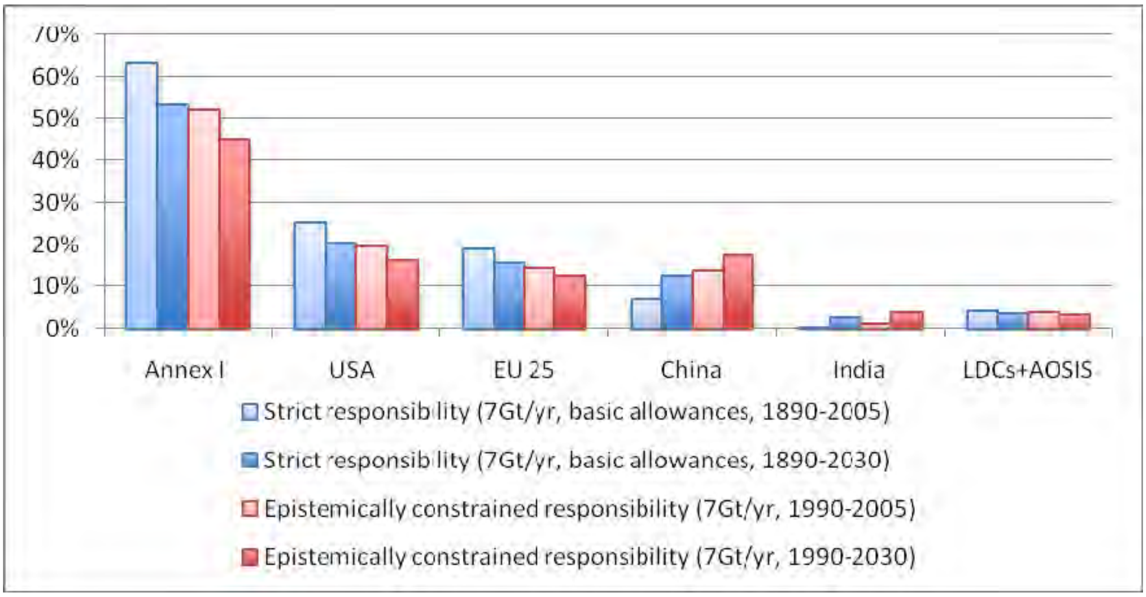

Figure 11. A scenario for future (historical) responsibility for climate change.

The direction of these numbers – which as noted before should not be interpreted as an ethical analysis of future historic responsibility but merely as a calculation based on commonly agreed emission scenarios – could potentially have great implications for the ethical debate surrounding climate change and point to the use of future emissions scenarios as an important research topic when looking at historical responsibility.[28] So far there is no ethical concept for combining actual historic responsibilities and potential future responsibilities, and the calculations here cannot be used for their absolute numerical results. Their direction however suggests that by 2030 historical responsibility shares could be distributed quite differently from today, changing the force of the principle of "common but differentiated responsibility" for some major players. China could potentially become similarly responsible for climate change as the USA or the EU25, and India's responsibility could surpass that of Germany or Japan. Undoubtedly – and this is important – this still leaves intact low per capita emissions as the other major argument for "common but differentiated responsibility", and it does not affect the argument of limiting capabilities of now developing countries to combat climate change.

6. Concluding Remarks

The aim of this paper was to put forward and discuss a methodology for the numerical differentiations of responsibilities for climate change as opposed to calculating causal contributions to climate change. For expository purposes, this was done on the basis of aggregate GWP-weighted historic emissions as a proxy. Moving to fully fledged climate modelling techniques as used in MATCH could be done in the future, but would change the relative contributions and resulting responsibilities by at most 10%[29] for most countries.

This paper is not aimed to engage in a debate which of the two conceptions of responsibility ('strict' or 'limited') with the chosen parameter values is more appropriate, or whether the causality of developing country emissions should be partially attributed to Annex

[28] Chen et al. (1999) early on pointed out the changing trend of contribution shares, comparing pre-1990 historical contribution with estimated contribution over the period of 1990-2010.

[29] Percent, *not* percentage points.

II countries, not least because the answer may well depend on what one wishes to do with the results. However, the order of magnitude difference in the responsibility of the two extremes of the scale under both conceptions does give pause for thought as to what sorts of burdens can justly be imposed, particularly given the discrepancy between the affluence and wealth of the exponents at either end of the spectrum of responsibilities we considered in this paper.[30]

While the ethical argumentation for these two conceptions of responsibility are pretty developed and less contentious, it is still not very clear how future potential emissions can be incorporated into a (historic) responsibility concept to include the most likely emission scenarios for the coming one to two decades. We can predict with some certainty that the historic responsibility of countries in 2030 will look quite different from today. Our ability to see this today points to the need for increased research on this matter – on the future of historic responsibility.

It stands to reason that burden sharing on the basis of historic responsibility alone – as proposed in the original Brazilian proposal – without taking into account the second and lesser quoted element mentioned in Article 3.1 of the UNFCCC, namely ‘respective capabilities’, would not be appropriate. In other words, fair burden sharing would have to be based on a mixture between the responsibility shares discussed here and some differentiated index of capability.

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[30] Affluence (GDP per capita, PPP): US = $41,890, India = $3,452. Wealth (GDP, PPP): India = $3.8tr, US = $12.4tr. (both in 2005). Source: World Bank (2006) World Development Indicators 2006, Vol. World Bank, Washington D.C..

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The Chinese [Climate] Box:
A Scalar Approach to Evaluating Ethical Obligations in Climate Strategies for China

Erich W. Schienke, Ph.D.[1]

Abstract
Assuming that all nations have the ethical obligation to reduce emissions to their global fair share, this paper investigates how distributive and procedural justice obligations, under the broader rubric of Ethical Dimensions of Climate Change program, play out across various political and ecological scales in China. As China is such a large and necessary player in any global strategies for addressing climate change, it is imperative that the nation receive closer ethical investigation across scales and sectors, and that other nations and multi-national corporations do their fair share in helping China's various regions and sectors reach its obligations in a post-Kyoto regime. To address the challenges to distributive and procedural justice that emerge at global, regional, national, intra-regional, provincial, urban, and small town & village levels, this paper proposes a multi-scalar ethical framework for evaluating China's climate strategies as the nation formalizes its obligations to the principle of "Common but Differentiated Responsibility," (CDR) and to a framework of Contraction and Convergence (C&C). Part of the difficulty in addressing China's mitigation obligations is in the ongoing articulation of the problem as primarily an obligation of national level governance, a structural result of UNFCCC requirements. However, due to China's complexity in both size and population, both CDR and C&C require a more nuanced and complex articulation of ethical and practical problems across political and ecological scales. As such, implementing China's National Climate Change Programme (CNCCP) will require mitigation management targeting not just political, but ecosystem scales as well. In addition, the Central Government will need to allow or provide for a "lateral" political agency for ecosystem management efforts, so that institutions at similar scales can plan and co-ordinate more readily.

1. Introduction

Assuming that all nations have the ethical obligation to reduce emissions to their global fair share, this paper investigates how obligations to ethics and justice, under the broader approach developed through the Ethical Dimensions of Climate Change Program, play out across various political and ecological scales in China. As China is such a large and necessary player in any global strategies for addressing climate change, it is imperative that the nation receive closer ethical investigation across scales and sectors, and that other nations and multi-national corporations do their fair share in helping China’s various regions and sectors reach its obligations in a post-Kyoto regime.

This paper will perform an analysis across eight ethical issues, first developed in the whitepaper on the Ethical Dimensions of Climate Change (Brown, et al 2006), which can inform us of China's national obligations to meeting its fair share of global emissions. The eight ethical concerns map onto the following issues: responsibility for damages; atmospheric targets; allocation of global emissions among nations; use of scientific uncertainty in policy making; cost to national economics; independent responsibility to act; potential for new technologies; and procedural fairness. This normative analysis will provide an ethical baseline for national obligations; however, in producing a normative analysis considering national obligations, it becomes readily apparent that what may be coherent at the national

[1] Assistant Professor - Science, Technology, and Society Program, Rock Ethics Institute, Asian Studies Program & the Center for Sustainability, The Pennsylvania State University, University Park, PA 16802, USA, email: erich@psu.edu

level (of governance) becomes difficult to interpret into clear ethical directives at other scales of governance and/or ecological system. Thus, ethical issues and policy obligations require a more nuanced analysis which is introduced here as the "climate box". (See Table 1.)

To address the challenges to distributive and procedural justice that emerge at global, regional, national, intra-regional, provincial, urban, firms, and small town & village enterprise levels (TVE), this paper proposes a multi-scalar ethical framework for evaluating China's climate strategies as the nation formalizes its obligations to the principle of "Common but Differentiated Responsibility," (CDR) and to a framework of Contraction and Convergence (C&C). Part of the difficulty in addressing China's mitigation obligations is in the ongoing articulation of the problem as primarily an obligation of national level governance, a structural result of UNFCCC and other international regime requirements. However, due to China's complexity in both size and population, both CDR and C&C require a more nuanced and complex articulation of ethical and practical problems across political and ecological scales than has been thus far fully articulated. As such, implementing China's National Climate Change Programme (CNCCP) will require mitigation management targeting not just political, but ecosystem scales as well. In addition, the Central Government will need to allow or provide for a "lateral" political agency for ecosystem management efforts, so that institutions at similar scales of governance (such as mayoral and provincial governments) can plan and co-ordinate mitigation efforts more readily and effectively.

2. Analysis of China's Ethical Obligations to Address Climate Change according to Ethical Dimensions of Climate Change Program (EDCC)

Issue One: Responsibility for Damages. Who is ethically responsible for the consequences of climate change, that is, who is liable for the burdens of: a. preparing for and then responding to climate change (i.e. adaptation) or b. paying for unavoided damages?[2]

Arguably, China has contributed far less to historical emissions than most OECD countries with higher Human Development Index (HDI) profiles, particularly in relation to the US (HID of .951).[3] Therefore, China's obligation to addressing such costs is rather low in relation to past emissions output and state of development in relation to the US. Further, various regions across China are subject to experiencing higher frequency and severity of climate impacts. Sichuan and regions east moving towards the Gobi desert will most likely experience more frequent and more severe droughts in addition to more severe flooding events in the region. Mountainous regions in Tibet, Sichuan, Yunnan, and Xinjiang are already subject to increased flooding (even under the threat, in some regions, of glacial lake outburst floods) and the eventual decrease of snow and ice pack during winter months. With decrease in glacial run-off, both fresh water and hydropower in the regions along the Mekong, Yangtze, and Yellow Rivers (as well as the Ganges to the west) will experience a long-term decline in water resources. Continued damming along these rivers will also exacerbate this process. The coastal regions, where China's populations are most dense, are also subject to increased risk due to rising sea levels, and in some regions, will be vulnerable to a projected increase in frequency and intensity of storm activity. These risks, however, also extend to other countries in the region. Moving forward, however, these risks to China's interior and coastline alone justify the need to take immediate and appropriate mitigation

[2] These eight ethical questions are taken directly from the Ethical Dimensions of Climate Change whitepaper, which can be downloaded at: http://rockethics.psu.edu/climate

[3] This paper will mainly compare China to the US in terms of obligations towards reduction. While China's population is significantly larger than the US, their emissions outputs are both each approximately 20% of all global emissions. (Together, the US and China comprise over 40% of global emissions. Their collaboration is both essential and an ethical imperative.)

efforts. China will incur a debt towards future generations of its own vulnerable populations if it does not bring emissions down to its global fair and ethical share, regardless of past emissions. Further, China is quickly closing the historical emissions gap.

As the world's largest emitter nation, by most accounts, China is responsible for preparing for and responding to climate change within its capacity to do so. With an HDI of .77, China is not amongst the least developed countries in the world, and is developing a significant affluent population in urban regions such as Beijing and Shanghai. As such, the nation will inevitably be required to tap its growing affluence, particularly in the coastal regions, to adequately adapt to coming climate impacts. Further, in addressing the distributions of harms and benefits resulting from climate change, the country (central, provincial, and urban governments) will need to continue developing means to address the disparities between the wealthier regions along the coast and the poorer interior, particularly as the increase of drought and flood impact the interior. In addition, as China becomes a more affluent nation in the region, it also becomes more attractive for migration for populations in other countries bordering it. North Korea, regardless of the dire political-economic situation the country faces, could provide a massive influx of refugees if severe famine were to occur due to climate change or severe flooding.

The question of China's responsibility for climate impacts based on past emissions is up for debate, but consideration of future responsibility of climate impacts indicates clear and present ethical obligations towards immediate action.

Issue Two: Atmospheric Targets — What ethical principles should guide the choice of specific climate change policy objectives, including but not limited to, maximum human-induced warming and atmospheric greenhouse gas targets?

Arriving at an ethically satisfactory level of global emissions is to be determined by the degree of warming and ensuing damages that would not cause exceptional harm or endangerment to particularly vulnerable populations, especially those poorer populations that will both cannot afford adaptation costs. A relatively "safe" level of warming would be at 2°C or under, projected at roughly 450ppm. The level of global emissions is already expected to surpass this, even if all significant emissions were immediately reduced. To meet this goal, total output needs to be reduced to about 70-80% of current levels.[4]

Climate change and the obligations to adhere to a global obligation towards reduction are supported by a theory of global ethics. Global ethics are primarily argued under the ethical theory referred to as cosmopolitanism, i.e. a universal ethics applying to everything within the cosmos. (Dower 2002) There are multiple critiques that call into question the legitimacy of a global ethics, namely communitarianism and relativism.

"Advocates of global ethical responsibilities respond to relativism and communitarianism by making several arguments including the following:

- Although it may be true that not all people agree with global ethical principles, they ought to as a matter of ethics accept global obligations;
- Those that believe in relativism have no principled way of condemning atrocities of one group on another such as the conquistador's treatment of the Aztecs.
- Even though moral obligations may arise from social relations with others, there is no reason why ethical principles developed at a local scale should not be extended to a global scale;
- Because people are often members of more than one cultural group to which they

[4] China will likely argue for a 550ppm global cap in the coming Copenhagen negotiations.

acknowledge duties, there is no reason why they should not acknowledge obligations to the global community." (Brown 2009, Dower 2002)

In terms of reducing GHG output, China considers its primary obligation, like any nation, to its own population and economy first, then to those nations that support its interests. However, when we begin to consider the interconnected nature of and the actions China takes in the areas of economy & trade, security, disease, sporting events, technology, and others, the nation cannot make the argument (within cosmopolitan ethics) that on one hand there is a need to participate in and even lead the global economic community, while on the other, it does not need take a leading role in the case of global climate mitigation. That is, China cannot argue for global participation in the case of economy and not also play a supporting role in the case of climate change. Further, China needs to participate in global emissions limits to prevent "leakage" of emissions, i.e. displacement of emissions from moving manufacturing from countries with heavier regulations to those with far more lax standards.

***Issue Three: Allocating Global Emissions Among Nations* —** What ethical principles should govern the allocation of responsibility among people, organizations, and governments at all levels to prevent ethically intolerable impacts from climate change?

The main issue at stake here is the determination of an ethically appropriate and relevant GHG output for China. As is articulated in Ott et. al. (2004), various ethical systems converge on the conclusion that overall atmospheric levels of GHGs ought to be stabilized at the lowest possible levels of concentrations. Determining precisely what this level ought to be for China is, politically, a highly contentious issue. As a nation, the per capita emissions are relatively low. From 1990 the per capita emissions grew from 2.1 tons to about 3.84 tons in 2004 (source: CDIAC 2005), still at levels about one quarter to one sixth of that in the US, depending on lifestyles. Nevertheless, in 2004 China was the world's second highest emitter nation, just behind the U.S., and has recently surpassed those levels. Further, as China continues to develop infrastructure, increases the use of personal automobiles, and expands the housing footprint in a sprawling megablock approach to urban development, the country, particularly urban areas, will continue to expand its per capita GHG footprint in the coming decades. As well, there is a growing disparity between per capita emissions for those living in the city versus those living in the rural and agricultural regions.

Based on principles of an egalitarian distributive justice across the globe, some account of per capita emissions needs to be considered when determining China's fair share of global emissions. However, this obligation must internally extend to how emissions ought to be determined at a per capita level within the country. That is, based on both egalitarian and welfare (Rawlsian) approaches to distributive justice, China is ethically obligated to ensure that per capita emissions are not unfairly distributed across its population. In other words, China cannot make the argument that a per capita emissions approach to determining its national fair share at a global level, which at the same time allowing per capita emissions allocations to range from 0.6 tons/yr in rural regions (which contains over 70% of the nation's population) only to allow citizens living in wealthier urban regions to continue growing per capita outputs to levels that are equivalent to those in highly developed regions of the world, at per capita levels of around 25 tons/yr. Ethically, China cannot reasonably allow its poorer populations to displace the emissions of the wealthier populations of the country, and would further be obligated to ensure a per capita cap for the wealthier regions as the poorer regions continue to develop.

***Issue Four: The Use of Scientific Uncertainty in Policy Making* —** What is the ethical significance of the need to make climate change decisions in the face of scientific uncertainty?

Some countries and political communities have deliberated some aspect of the certainty of the severity or actuality of climate change, and have argued against taking actions based on claims of scientific uncertainty. For years in the U.S., claims about scientific uncertainty underpinned many of the reasons for either not taking action, as the costs of action would far outweigh any possible costs of impacts. Since the IPCC 2007 report, the reality of climate change and the tremendous costs of coming impacts was stated to be unequivocal. By 2009, most national governments acknowledge the reality of climate change; yet continue to hesitate on adopting strict caps and developing comprehensive mitigation plans moving forward to bring down global levels.

For the most part, China has tended to adopt some of the more optimistic of projections about climate change impacts while choosing to take less seriously the higher risk scenarios. China is all too familiar with the problems of severe flooding along its major rivers, so ignoring such warning signs seems socially, economically, and politically unwise. On the one hand, using claims of scientific uncertainty to argue against confronting wicked political-economic problems, such as what to do about the nation's massive dependence upon coal, only belay and intensify the severity of a decision that will need to be made down the line. On the other hand, scientific uncertainty cannot be ignored when proposing mitigation solutions, such as the risk and effectiveness of carbon capture and storage from the burning of fossil fuels.

China needs to continue increasing its scientific capacity in studying the global and regional carbon cycle, particularly in relation to its industrial output. Further rationalizing process such as urban development would also go a long way towards improving efficiency in infrastructure. Increasing the capacity of research networks, such as China FLUX (at CAS Institute for Geography and Natural Resource Research), will allow the nation to better monitor its overall terrestrial carbon flux. Improving and enforcing industrial monitoring standards, particularly in the capacity of the local and regional offices of the Ministry of Environmental Protection (MEP) will significantly reduce uncertainty and margins of error in carbon accounting.

Even with significant scientific certainty about the location, severity, and costs of climate impacts, scientific results alone will not provide policy makers with an appropriate framework for action. Scientific results and accounting of carbon flows will play a significant role in improving planning and policy making and reducing overall uncertainty in the system. However, ultimately, when and what China ought to do about climate change requires making ethical decisions about both about its own population and about its impact on the global commons.

***Issue Five: Cost to National Economies* —** Is the commonly used justification of cost to a national economy for delaying or minimizing actions to reduce the threat of climate change ethically justified?

Many nations have resisted calls to reduce their GHG emissions based first on the costs to national economies across various sectors, and second, because most cost-benefit analysis used to determine or justify such actions will not conclude the reduction of GHG emissions as a worthwhile investment now as opposed to in the future. (Brown 2002, Nordhaus 2007) Both the U.S. and China have put forth the argument through various drafts of the UNFCCC (Kyoto protocol) and became a primary reason argued by the US for pulling out of the accord in 1997.

China has argued, as a non-Annex I nation, that its number one priority is to its continued economic development, which has been roughly 8-10% per year for roughly the past 30 years, and is currently mandating a sustained 8% ("protect 8") growth rate moving forward. China's rapid and peaceful rise as one of the world's leading economic superpowers has not come without significant costs in emissions. The U.S. has been the world's leading historical emitter nation since 1850, but this is a gap China is also quickly narrowing.[5] Further, the very broad category of non-Annex I countries provides very little granularity in definition or degree of development and, according to development indices such as the Human Development Index (HDI), China is certain not amongst the least developed nations and cannot continue to leverage the argument and its position in international accords as though it is. (Hu 2009) Further, costs of emissions reductions will likely adversely impact the economies of some regions while not impacting others. Shanxi, a major coal-producing province (one-third of all of China's coal deposits), is under the national average per capita GDP. Dislocating coal jobs in these regions will have a greater economic impact than on the wealthier coastal and urban regions where the energy from coal is primarily used. However, as Hu (2009) argues, it is the wealthier regions that need to make the reductions first, allowing interior and western regions to continue developing while wealthier regions take on the burden of beginning the process of contraction and convergence across sectors.

China can no longer reasonably argue the cost of not taking action on its economic growth while simply arguing the benefits of not taking action. Implementing a Green GDP would already bring the high growth rates down to five to six percent. Further including overall pollution costs on human and ecological health, in some particularly polluted areas, can even put the growth rate into the negative column, from zero to minus two percent. Continuing development with a business as usual approach in China will only likely exacerbate the medium and long-term bottom line costs on development and do little to improve overall efficiency across various sectors. Further, the use of Cost-Benefit Analyses (CBA) to determine whether, how much, what kind and when to begin mitigation actions are typically employed without the full tally of costs a full inclusion of critical climate system thresholds, such as the shutdown of the Meridional Overturning Circulation (MOC) (McInerney and Keller 2007), the loss of the Greenland ice sheet, or the loss of snow pack in the Himalayas.

Any nation, but particularly the leading emitter nations, cannot ethically argue costs to national interests alone when the impacts affect populations through the world. Because, "no person or nation has a right either to harm others as a means to achieve their economic health or to endanger others' life, health, or security." (Brown et al 2006)

Issue Six: Independent Responsibility to Act — Is the commonly used justification for delaying or minimizing climate change action that any government need not act until all others agree on action ethically justified?

In a similar vein as arguments about costs to national economies, some nations (particularly the U.S. and China) have put forth the argument that they have no responsibility to lower their emissions until other nations do. China has strongly argued throughout its engagement with the UNFCCC, that it certainly is not obliged to reduce its emissions before the US, particularly because of the potential setbacks this would have on development. This is a significantly more reasonable argument, at the face of it, than the US position that it will not reduce emissions until China is fully on board in the Kyoto/post-Kyoto process.

[5] The US leads the world in historical emissions from 1850-2002 at a total of 29.3%, while China only contributed 7.9% of historical emissions. However, as revealed in a study forecasting China's emissions, the emissions growth rate from 2000-2010 is projected at an annual rate of 11.05–11.88 percent, increasing China's annual emissions output from 1000 MMTCE in 2002 to 2600 MMTCE in 2010. (Auffhammer 2008: 245)

However, even if in this case the US was to begin significant reductions and China was not, this would likely result in emissions leakage in the further displacement of manufacturing in the US to China, such as the case of consumable goods, steel, aluminum, and other energy intensive manufacturing. (That is, labor is not the cheaper commodity as much as lax emissions regulations would be.)

Some nations within the East Asian region, such as Bhutan, are already experiencing heavy impacts and are under the threat of severe flooding and loss of cultural artifacts (Schienke and Nidup 2008), yet have contributed next to nothing to global emissions levels. Developed nations, such as the US, have contributed most to this problem. Yet, as mentioned earlier, China is quickly closing this historical emissions gap and cannot justly make the argument that it has a right to continue business as usual practices.

Under the UNFCCC, developed (Annex I) nations such as the US agreed they would reduce GHG emissions first based on issues of equity to prevent dangerous changes to the climate system based on human activity. From this agreement, and as has been heavily argued by China, nations acknowledged a "common but differentiated responsibility" (CDR) to take action on emissions reduction. However, in practice, no significant responsibility or action has been taken this far on the part of either the US or China. Further, such a standstill has actually proven mutually beneficial to the political-economic elements that are proponents of business as usual practices.

There is a tolerable limit to global emission where nations can emit without adversely affecting the global climate system. As such, nations such as the US and China who refuse to reduce their emissions have the burden of demonstrating that emissions are below the nation's just share of global emissions. While determinations of what precisely is a just or fair share of global emissions continues to be a contentious issue among nations, and a CDR approach seems just and reasonable, worldwide emissions need to reduce to about 20% of 2004 levels. For the US, this would require somewhere in the neighborhood of a 90% reduction of current levels. China alone, according to a recent Global Carbon Project report (GCP 2008, Gregg et al 2008), accounts for at least 18% of 2004 global emissions, and has very probably increased this amount somewhat significantly in the buildup to the 2008 Beijing Olympic Games.

Much attention in this buildup has been put on China's increased energy consumption in the form of coal, but cement is likely a significant factor as well, as one ton of cement equals one ton of CO2 emissions. That is, if China were only to hold steady at current emissions levels and the rest of the entire world were to cease any emissions, China would still continue to increase global emissions at a much slower but still unsafe rate. As such, China in particular can make no ethically justifiable argument at this point for not taking immediate action towards reduction, let alone put forth an argument for the continued growth of emissions levels as the country develops.

China has an immediate duty to cease activities that are both harming other populations and its own population, regardless of the actions of any other nation. Further, actions such as excessive emissions or pollution may be considered as wrongful under international law, "even in the absence of a violation of a specific agreement such as the UNFCCC." (Brown et. al. 2006) China has an ethical obligation to begin reducing emissions immediately, regardless of the actions taken by other nations. Even more so, all developed nations have a duty to reduce emissions immediately, regardless of China's actions.

***Issue Seven: Potential New Technologies* —** Is the commonly used justification for delaying or minimizing climate change action until less costly technologies are invented ethically justified?

The question of new technologies is perhaps one of the most interesting in terms of ethics, international obligations, and in the practicality of holding promise in the future. Some nations argue that reduction of emissions should be delayed until newer, more appropriate and less costly measures are developed and become available on the market. The reasons given for waiting tend to be premised on at least four main assumptions: 1) existing technologies are too costly and will hurt the economy; 2) new technologies that can help to reduce emissions now will be less costly in the future; 3) waiting for new or less costly innovations will not cause harms; and 4) that there are no unintended consequences or high risks that come with the new technologies. (Brown et. al. 2006) Further, it is assumed that market pressures and demands will catalyze the development of newer technologies. However, considering current financial markets, it is not likely wise to wait for market incentives to drive the demand for such innovation, and will likely only come at the level of governmental directives/initiatives for guiding innovation in energy efficiency and emissions reductions.

There exists a wide variety of technologies that China needs to consider carefully when adopting an innovation strategy and for purposes of mitigation and efficiency improvements. I will quickly address two technology paths that, on the face of it, seem quite appealing but can quickly bring a variety of ethical problems in their adoption, namely, carbon capture and storage and biofuels. Other technologies requiring further ethical analysis would include transportation (all sectors), other forms of “clean energy,” buildings and urban layout plans, nuclear energy, land-use strategies, sanitation, and food.

Carbon Capture and Storage: The first technology path considered here is that of carbon capture and storage (CCS),[6] a process that captures CO2 from coal-fired and natural gas based power plants and stores it in underground geological formations, such as saline aquifers, spent oil fields, and others. The primary problem is that coal provides China with approximately 75% of its energy, yet coal releases more GHGs per unit of energy than any other form of fossil fuel combustion. The general principle of capturing carbon from either burnt coal or natural gas seems quite appealing at the outset, particularly because it can be used in the retrofitting of some existing power plants. Because of its appeal and the opportunities it presents to continue burning one of the cheapest and most abundant sources of energy throughout the world, i.e. coal, many governments have lauded the possibility of CCS strategies and have counted them as amongst their nations' most accessible strategies for GHG sequestration from the energy production.

The technology of geologic carbon storage remains unproven and can pose significant risks to human and ecosystem health. For example, the geologic sequestration of CO2 is limited in space and time, in that it is highly unlikely that there will be enough ideal space for storing necessary CO2 over the long-term as many saline aquifers could be saturated/filled in a matter of a few decades if the burning of coal were to continue at current projected rates. The issue of suitability of a site poses significant uncertainty in determining, whether under great pressure, if a cap rock would prove sufficient and that there would be no other pathways for CO2 to leak from. Long-term studies about the suitability of sties have not been conducted, and the technology is primarily based on models and maps of possible locations, not so much on long-term empirical testing.

[6] Please note, CCS is a different technology than “clean coal”. There are two generations of clean coal technology. The first generation of clean coal technology is based on a process where the coal is heated underpressure at 2000 F, thus allowing for heavier impurities such as sulfur and mercury to be removed, allowing for a mixture of hydrogen and carbon monoxide (http://www.governing.com/articles/4coal.htm) to remain. This mixture can then be either burned as directly as a gas or liquefied into a variety of other fuels. However, these first generation processes do not remove the primary greenhouse gas, namely CO2. While the process is helpful in reducing SO2 and M, first generation clean coal is not a viable option for addressing the mitigation of greenhouse gasses, and therefore should not be considered a viable solution to increasing any nation's energy portfolio moving forward.

The primary problem and biggest risk posed by CCS is not necessarily the long-term suitability and plausibility of the technology, but of basing business-as-usual practices of burning coal at ever increasing rates on the less-then-certain promise of how much and how safely CCS can deliver in terms of CO2 mitigation. For a nation like China, which depends on coal mainly from its own supply for 75% of its energy, CCS will likely seem very appealing as a way forward in terms of mitigation. However, the Chinese government and industries would be unjust if they began counting the potentials of CCS already in the plus column of mitigation strategies.

Biofuels: The second technology path concerns the use of biofuels for use in automotives, heating, and other forms of power generation. Biofuels are combustible fuels extracted from feedstocks through a variety of fermentation and extraction processes. Ethanol, methanol, biodiesel, and methane are the most common forms of biofuels readily available today, and many are in wide use around the world. Common feedstocks include corn, soybean, palm oil, sugarcane, pulpy wood fibers, grasses, and discarded foodstuffs.

Biofuels are not all equal in efficiency and output. A recent study conducted by Adler et al (2007), produced a lifecycle assessment of various crops for use in biofuels production. The findings suggested that, "compared with the lifecycle of gasoline and diesel, ethanol and biodiesel from corn rotations reduced GHG emissions by ~40%, reed canarygrass by ~85%, and switchgrass and hybrid poplar by ~115%." (Adler et. al. 2007) With relatively modest reductions of GHGs of ~40%, corn again does not seem like the best option, particularly when compared with the GHG emissions savings of reed canarygrass, switchgrass, or hybrid poplar. (Schienke 2007)

Beyond obvious choices about energy efficiency, many biofuel feedstocks are coming under increasing demand, a demand that is directly competing with food prices. Corn is an excellent example in this case. In North America, corn prices are being driven up by demand for use in ethanol production in the U.S., a demand that is directly influencing the prices of corn used for tortillas in Mexico. Poorer populations are being required to pay more for a basic food staple because U.S. policy is requiring the increased use of ethanol. This could very easily be the case in China if corn or soybean begins being used as a major feedstock for ethanol or biodiesel. In addition to competing with food prices, biofuels also present extensive challenges to land-use policies. This may be a slightly less pressing issue in a country such as the U.S., but presents tremendous challenges for a country like China with a vast and dense population. In China, the land use tradeoffs alone for producing biofuel crops make it a prohibitive option, all except for a few possibilities with cellulosic methanol.

To briefly summarize the ethical issues at stake in considering biofuels production, principles of distributive justice require that the benefits and burdens of biomass production be distributed fairly across stakeholders. Distributional consequences of environmental change are likely to arise in the consideration of how planting of biofuels stock can affect livelihood changes such as changing access to environmental and ecosystem services, the disruption of clean water, hunting and fishing grounds, and/or natural scenery. In addition, consideration will be given to possible impacts on human health brought on by resulting environmental changes from farming biomass feedstocks, from the location of biomass processing sites, and from the disposal of wastes generated by biomass processing facilities. Whereas, principles of procedural justice require the economically and demographically fair and representative selection of citizens in decision-making processes. For China, the most ethical and energy efficient approaches to the use of biofuels appear to be in the use of hybrid poplars and switchgrasses for cellulosic methanol and ethanol, particularly in regions that require reforestation and planting of grasslands in assisting desert reclamation projects, such as in Ningxia and in the Gobi. In addition, further development and use of biogas digesters in rural areas also seems efficient and just, and should receive further investment from the government and NGOs.

Issue Eight: Procedural Fairness — What Principles of Procedural Justice Should be Followed to Assure Fair Representation in Climate Change Decision Making

Both within the nation and in relation to China's engagement on the world stage, adhering to the principles of procedural justice in climate policy development will require vigilance. Procedural justice demands the participation of stakeholders, in this case those stakeholders who will be subject to climate impacts, to have a representative voice in the decision making process. At the international level, this would likely take multiple forms. First, China needs to assure the global community that it is fully participating in the IPCC and post-Kyoto climate regimes. Second, China needs to continue being a leading voice for the robust participation of developing nations, while at the same time assuring that its size and scale do not entirely dominate the discourse and procedure for other developing countries, particularly within the East Asian region, and as China continues to move forward with investments in Africa. At the national level and below, the nation will need to ensure that the voices of those being impacted the most will be part of the decision-making process. However, the current political arrangements does not well support this kind of input from communities and this will not likely change without further pressure from both the outside and from the bottom up.

Currently, local participation in China tends to mean participation by men, and men in positions of authority. This form of participation is not thorough, nor is it representative. The problem is that it is often assumed that those already in positions of authority, such as local politicians and administrators, are in a better position to represent the needs of the people, as opposed to “ordinary” citizens. Decision-making capacity at the local level would likely improve significantly on the side of implementation, for example if the community infrastructure of local “Ju Wei Hui” (居委会) was used to gather, observe, and report on key issues concerning carbon and environmental compliance more generally. In this regard, at least observational data would be gathered and compiled for further review over the long term. The retired community would also be useful in gathering data and observing, in that they would be able to oversee data collection and federation, producing simple environmental reports that could be compiled over districts, counties, and provinces. Direct action in local politics may not be the answer for China’s current political structure, but some form of observation and reporting would be helpful and could easily be based on public participation and local community involvement.

3. A Multi-Scalar Approach to China's Ethical Obligations to Act on Climate Change.

While directives implemented and followed through at the national level are a necessary and crucial dimension to fulfilling climate change obligations, the scale of problems in China presents the situation that an analysis of national directives alone does not get at the deep complexity and conflict facing the country across multiple scales of governance. Further, engaging China only at the level of the national government does not ensure the robust participation of the many levels of governance below it. As briefly described below, collaborating with China on engaging climate change can and will need to happen across multiple scales and proper funding and support will need to follow in kind.

As Table 1 attempts to illustrate, the directives and problems for proper climate mitigation policies are different for different levels of administrative authority, i.e. governance. In some cases, both ethical directives and policy directives can be in conflict with directives at other levels of governance and would require ensuring that emissions “leakage” would not occur through tightening regulation at one level, such as the national or provincial level, while leaving bureaucratic gaps at the urban/local level or, especially, at the small town and village enterprise (TVE) level. For example, it would make much sense that energy policy at the national level be directed towards the overall reduction of coal fired power plants with a move towards renewable energy sources, while at the urban/local level energy the gains are lost through lack of regulation and enforcement of building codes concerning something as simple as proper and sufficient insulation for heating and cooling of residential structures.

Each one of the levels of governance in Table 1 represents a place for further intervention/participation from both the Chinese government and from outside influences. Of particular import will be the compliance with regulations at the TVE levels, where the greatest pressure to increase GDP is countered with the strongest expectations to comply with and adopt cleaner and more efficient solutions. Following closely behind this trend, firms and industrial facilities are pushing hard to develop a profit in an ever more competitive global economic setting. The first thing to be sacrificed in such situations is going to be cleaner production methods and investments into newer facilities. Outside firms operating or cooperating with local Chinese firms are going to need to be vigilant in demanding that less carbon intensive production is demonstrated thoroughly and robustly, and that local Chinese firms are not shifting production to other, less-clean facilities within the country.

Moving forward, dimensions of Chinese carbon governance will need to work coherently together across scales if contraction and convergence towards a national cap is to be implemented properly and cohesively, without further exacerbating problems around the distribution of harms and benefits, particularly to poorer regions.

Table 1. Ethical issues across scales of governance in China in moving towards Contraction and Convergence

Scale	Ethical Obligation for China	Policy Goals
Global	Global safe levels met	Ensure participation in and support of global climate regime and that safe levels of CO_2 are met.
Regional	Assuring fair share with regional partners, in this case East Asia.	Responsibility to manage regional carbon flux and industrial outputs between cooperating nations
National	Ensure nation's just/fair share of global emissions. Addressing independent responsibility to act and bring emissions to fair share.	Ensure compliance at all scales below. Determining directives for energy sector, infrastructure, innovation, and technology transfer.
Intra-regional	Cooperative and procedurally fair planning across provinces and ecosystems. Ensuring emissions spillover does not occur.	Emissions balance across regions within China on economic and ecosystem based collaborations, and encouragement of collaboration between urban regions.
Provincial	Determination of fair share amongst provinces and ensuring fair share even if growth is sacrificed.	Ensuring fair share even at cost of growth. Implementing provincial level emissions caps. Increasing procedural capacity and representation of participation of various levels of authority.
Urban/Regional	Ensuring cost-effective reduction method and active planning goals around CO_2 reduction.	Planning goals for urban development, anti-sprawl measures, coherent transportation networks, inter-urban collaborations.
Urban/Local	Ensuring on the ground implementation of larger scale development and fighting unregulated development. Improvement of local participation in procedural process.	Strict implementation of planning codes. CO_2 reduction in project choice. Support for choosing green buildings. Controlling developers. Improving insulation in buildings.
Firms/business	Ensuring firm or business is complying with CO_2 regulation and that emissions leakage is not happening internally.	Increasing CO_2 reduction compliance. Installing cleaner more energy efficient technologies. Demanding proof of compliance with other partner firms. Engaging in robust technology transfers for efficiency gains.
TVEs	Enforcing cleaner production and adoption of cleaner technologies. Ensuring compliance on the ground.	Implementing clean development and production strategies on the ground. Most difficult regulatory issues here, and impetus for business as usual is strongest.
Individual	Reducing personal GHG footprint as much as possible.	Conscious effort of consumption habits. Changing personal preferences and habits. Understanding carbon footprint in every dimension.

4. Conclusions

There are multiple conclusions that can be drawn from this brief analysis of ethical issues facing climate change governance in China. Based on an analysis of the eight main issues developed in the EDCC whitepaper, the most challenging issues will likely be questions concerning: 1) China's responsibility to other nations for damages due to climate change; 2) the potential for new technologies, investments into cleaner technologies and technological innovation paths; and 3) ensuring procedural fairness both on the international stage, but also at the level local of public participation.

Many questions remain. How much should China be funding adaptation and mitigation costs for other, lesser-developed nations? This is a question that will require greater investigation and deliberation on the international stage. How much should China invest in new technologies now versus investing in innovations or in waiting for technology costs to lower in cost? In terms of procedural fairness and justice, China faces significant challenges in improving accountability from below and ensuring participation of local administrators as well as the general public, in some form or another.

Chinese climate governance, in moving towards a contraction and convergence approach, is going to require a scalar methodology of oversight, resembling something similar to the approach presented in section three. Ensuring this "climate box" is tightly sealed will be a necessary and wicked problem for the government, otherwise emissions leakage will most certainly occur at multiple scales. Further, achieving ethical compliance at all scales is also going to be necessary to ensure that the distribution of harms and benefits is not occurring in an unfair or unjust manner. Further, constructive and helpful interventions from the outside into China ought not be focused only on interfacing with the national level of governance. Each of these levels (scale) of governance represents an opportunity for intervention by foreign governments, NGOs, firms, and other significant parties that have an interest in seeing China contract and converge its emissions to the nation's fair share of global emissions. Again, the primary challenge for China itself will be "on the ground" compliance and accountability of climate strategies and in developing a more robust form of public participation in ensuring this is the case.

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The Right to Equal Aspirations and The Obligation to be Different, as a Basis for a Common Future

Olivia Bina[1]

Abstract

By virtue of its sheer size and growth trajectory, China knows it cannot be ignored. The question is whether it can offer leadership in terms of greater responsibility, both towards its own people and the rest of the world. The climate change crisis is the ultimate expression of unsustainable patterns of growth. Based on this perspective of the climate change debate, I explore the theme of responsibility as traditionally focused around the need to limit emissions, but also in terms of the obligation to pursue development aspirations through a different path. I consider the argument that China's leadership has an opportunity to embark on a path that is consistent with the need to secure a 'common future', and highlight both the promise and contradictions of current policy. I conclude by challenging the idea that there is a significant difference between the position of China's Government and that of most developed nations, and suggest that the promise of a new path for development might still be met if contradictions are finally acknowledged, and experimentation is adopted to pursue bold alternatives, rather than efficient growth models.

'All this is happening before our eyes, and yet we act as if we had all the time we want, and all the solutions…
If you don't know how to fix it, please stop breaking it…
I am only a child and yet I know we are all part of a family, 5 billion strong, in fact 30 million species strong and borders and governments will never change that….
we are all in this together and should act as one single world, towards one single goal…
even when we have more than enough we are afraid to share,
we are afraid to let go of some of our wealth…

Severn Suzuki speaking at UN Earth Summit 1992

In 1992, as representatives of state met in Rio de Janeiro for the *United Nations Conference on Environment and Development*, the world had enough evidence to know that growth was taking its toll on the planet, and that its benefits were very unevenly distributed. It also knew that dependence on fossil fuels to deliver most of those unevenly distributed benefits (registered as annual GDP growth) was resulting in dangerous concentrations of greenhouse gases into the atmosphere. Even children knew it (Suzuki 1992: xvii).

Fast-forward almost two decades and little has changed. A staggering amount of information, reports, renewed commitments and a regularly rediscovered urgency with which the 'crises' ought to be addressed, characterised the 1990s and the first decade of this millennium like a relentless, yet muffled, beat. Climate change is emblematic of the extent of our impact, the urgency for a response and the seemingly endless postponement of action. Although it is but the final symptom of a long chain of effects (MEA 2005) caused by humanity's 'continuing transformation of the earth' (Schellnhuber *et al.* 2005: 13) in its

[1] Assistant Professor, Department of Geography and Resource Management, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong S.A.R., email: o.c.bina.92@cantab.net

pursuit of prosperity, climate change stands out as the issue that best illustrates our interdependence, not just between nations but with all species and habitats on whose services we 'fundamentally depend' (MEA 2005: v). It is not the quintessentially global dimension of this crisis that has focused the minds of heads of state over the last few years, but rather, its implications given our interdependence: a characteristic of the earth system that globalisation has exacerbated into an economic and social dimension, as well as an ecological reality.

Against this backdrop, China has rapidly taken centre stage, at once as 'victim' of historical transformation and pollution of the biosphere by developed nations, and 'perpetrator' – as it steals the title of 'first polluter' from the richest country in the world (Bina and Soromenho-Marques 2008). By virtue of its sheer size and growth trajectory, China appears to have focused the minds of leaders across the world on the physical limits of our planet and the challenge of having to share its common resources with a growing population, in ways that *Limits to Growth*, *Our Common Future*, *Agenda 21* and the *Millennium Ecosystem Assessment* have frustratingly failed to do (Meadows *et al.* 1972 ; WCED 1987 ; UNCED 1992 ; MEA 2005). Economic growth and the environment have never looked quite so in conflict as in the case of China. The contribution of this growth to climate change is raising alarm inside and beyond the country's borders, precisely as a result of the ecological interdependence so strenuously ignored thanks to the successful separation of the world of economics from the biosphere.

The climate change crisis is the ultimate expression of unsustainable patterns of growth. The tension surrounding climate change negotiations is therefore inextricably linked to the fundamental unresolved question of how to reconcile an increasingly widespread pursuit of growth with the finite nature of our planet.[2] Based on this perspective of the climate change debate, I explore the theme of responsibility as traditionally focused around the need to limit emissions, but also in terms of the obligation to pursue development aspirations through a different path. I consider the argument that China's leadership has an opportunity to embark on a path that is consistent with the need to secure a 'common future', and highlight both the promise and contradictions of current policy. On balance, evidence suggests that this opportunity is still to be taken, while there is a risk of falling into undifferentiated irresponsibility for all parties. I conclude by challenging the idea that there is a significant difference between the position of China's Government and that of most developed nations, and suggest that the promise of a new path for development might still be met if contradictions are finally acknowledged, and experimentation is adopted to pursue bold alternatives, rather than efficient growth models**.**

Framing The Issue of Responsibility

The Chinese Government does not deny the science or the importance of the climate change crisis (NDRC 2007b). Ambassador Yu Qingtai (2008), China's Special Representative for Climate Change Talks, acknowledges that climate change 'affects not only the development of the global economy and prosperity, but also the very existence of mankind', and confirms that his Government actively supports 'the leadership role played by the United Nations in responding to climate change'. Within this international framework of negotiations three points seem crucial (Yu Qingtai 2008): 1) the centrality of UN Framework Convention on Climate Change (UNFCCC) 'fundamental principle of Common But Differentiated Responsibilities' as the 'very foundation for international cooperation'; 2) 'the concerns by the developing countries over adaptation, technology transfer and financial resources should

[2] The use of energy is illustrative. According to the International Energy Agency (IEA 2007) China accounted for four fifths of the growth of industrial production and carbon dioxide emissions during the past 25 years. It predicts that between 2004-2030 China and India will account for approximately 75 percent of global coal demand and 35 percent of oil demand, and for 35 percent of global power generation capacity.

be addressed in real earnest'; and 3) 'the effectiveness of participation by the developing countries [to the international effort] will, to a significant extent, depend on whether the developed countries will take substantive actions on financial and technological assistance… and capacity building, *to facilitate their achievement of sustainable development*' (emphasis added). Together, these three points define the strengths as well as the contradictions in the approach of China's leadership to responsibility.

The first reference to common but differentiated responsibilities refers to the need to limit emissions and is central to the debate and impasse in the negotiations. While this is not the interpretation of responsibility used in this paper, it is the starting point for the argument whereby responsibility ought to relate to *how development is conceived* rather than to *how to responsibly clean up after development*, or at least after a certain level has been achieved.[3] Amongst the arguments used by the Chinese Government to resist adopting emission targets is an appeal to the concept of historical responsibility. Quite apart from the intrinsic weaknesses of the concept (Miller 2008), reference to the presumed irresponsibility of England, Germany and the USA (followed by the rest of the developed nations), seems hardly a justification for the Government's insistence it can focus on improving efficiency rather than limiting total emissions. The richest 20 percent of the world uses over 75 percent of global resources and emits 51 percent of carbon dioxide to maintain its way of life:[4] undoubtedly, developed nations contributed to a significant part of current concentrations of greenhouse gases in their quest for development, and while the benefits (development and lifestyle) are confined to political borders, the price of those benefits is being shared by humanity as a whole. Developing countries see the current crisis as the price for the development path chosen by rich countries to reach current levels of wealth. The price in terms of impacts affects all forms of life (but especially those in developing countries: UNDP 2007), the benefits have instead remained carefully contained within political boundaries. The perceived injustice explains the appeal to notions of responsibility: responsibility in relation to choices of development paths, which however cannot be raised against past choices without implying that current and future development paths ought to avoid irresponsible choices. This has important implications for the choice of China's leaders.

The pressure on China's Government is rising as it attained the dubious honour of 'first polluter' for energy-related carbon dioxide emissions in 2006 (Levine and Aden 2008). Its response has been to counter charges of environmental irresponsibility by reframing the climate debate as a problem of 'development', essentially appealing to the right to develop (NDRC 2007b).[5] In the words of President Hu Jintao: 'climate change is ultimately a development issue and it can only be addressed in the course of sustainable development' (cited in Feng Qinghu 2007). Accordingly, China's leaders take every opportunity to remind the rest of the world that they must still battle with poverty reduction and that in per capita terms, the country's energy, emissions and overall resource consumption levels are well below the average for developed nations (see for example: CCICED and WWF 2008). They also point out that the 'ownership' of those emissions, and related responsibility, is a matter

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[3] In the case of China, as I go on to show, this level is likely to be the moderately prosperous society of approximately USD 4000 per capita.

[4] This figure represents million metric tons of CO2 emitted by all 'high income countries' in 2003; the figure for all 'developed countries' is 61 percent (data source: IEA in EarthTrends (http://earthtrends.wri.org) Searchable Database Results, accessed: 9/6/09).

[5] The right is rooted in the provisions of the Charter of the United Nations (United Nations 1945: preamble) promoting 'social progress and better standards of life in larger freedom'. During the last 75 years the number of commitments to this right have multiplied, and its articulations have explored the link with nature (United Nations Conference on Human Environment, Stockholm 1972) and subsequently found expression in the notion of human development by Mahbub ul Haq and Amartya Sen, popularised by the United Nations Human Development Reports (UNDP 2007).

for discussion, since approximately 33 percent of China’s domestic carbon dioxide emissions were due to production for export in 2005 (Weber *et al.* 2008).

The link between the risk of climate change and development is indeed at the heart of the problem, and the binding factor is energy. The use of energy plays a major part in shaping the interaction between the various parts of human society and the rest of the ecosystem. Societies grow in size and complexity thanks to ever increasing use of energy, and to date 80 percent of the world’s primary sources are fossil fuels (Evans 2007). Development depends on energy, all the more so in a country that has grown at an average of 9-9.5 percent over five decades, primarily thanks to industrialisation and, since 2002, heavy and energy intensive industries. Even if all the efforts to promote a clean(er) and more efficient use of energy were to bear their fruits (NDRC 2007b ; NDRC 2007a), the main source of energy will remain coal for decades to come (IEA 2007). This, combined with the growth projections for China, is bound to wipe out most benefits. By linking its right to develop with the need to remain free of any binding commitments (emission reduction targets), the Government is effectively expecting to take its turn on the irresponsible path. The same path tread by Euro/American societies. Is the appeal to historical responsibility combined with the right to pursue development the equivalent of wanting to extend a right to irresponsibility for all nations, albeit at different times in history? The Government aims for persistently high rates of growth until it reaches a moderately prosperous society is not only justified on grounds of poverty reduction, but also as a way of legitimizing the ruling Party and maintaining social stability:

> ‘[t]aking economic development as the central task is vital to invigorating our nation and is the fundamental requirement for the robust growth and lasting stability of the Party and the nation’ (Hu Jintao 2007).

Since the reform era began, China’s remarkable growth has meant an equally remarkable – though less admirable – increase of its ecological deficit. Since the mid-1970s it has been demanding more capacity than its own ecosystems could provide, and is now requiring ‘the equivalent of two Chinas' worth of biocapacity (CCICED and WWF 2008: 13). Given the record of environmental pollution linked to its development, which is affecting the lives of its people as well as contributing to the climate change crisis (Liu Jianguo and Diamond 2005 ; Pan Yue and Zhou Jigang 2006), the leadership’s appeal to notions of historical responsibility could result in denial of the whole concept of responsibility, both within and beyond its country’s borders.

Ambassador Yu Qingtai’s (2008) message contained two further points that complete the link between (ir)responsibility, pollution and development. There is a lot that developed nations ought to do, and offer – funds and technology – to enable developing countries to catch up in the general rush to ‘develop’ before the latter is willing to engage in greater levels of responsibility. This is even more true about engaging with *undifferentiated* levels of responsibility, which would result from calls to reduce the responsibility gap between ‘developed’ and ‘developing’ nations that achieved high levels of growth since the categories were adopted in the Kyoto Protocol.[6] The general failure to comply with commitments and promises by rich nations within the context of the Kyoto Protocol and subsequent negotiations has been noted: ‘It is a pity that developed countries have shown insufficient sincerity and made inadequate efforts to fulfil… obligations’ in terms of financial resources

[6] China’s representatives reveal an uncompromising stance on this issue, as it allows them to maintain differentiated, low, levels of responsibility, but also to claim a higher moral ground by depicting their efforts as significant: ‘China is making huge efforts to combat climate change despite the fact that it remains a low-income developing county’ (Xie Zhenhua 2009). For an interesting discussion see (Hu Angang 2009).

and transfer of technology (Feng Qinghu 2007), and implicitly used by developing nations to support their claims.

The weakness of developed nations' commitments and implementation record reveals a failure to grasp the significance of the challenge posed by their development model. This is not surprising: climate change is but the final symptom of a long chain of effects whose science was far less controversial, but which still await the political will needed to address them effectively (Jordan and Lenschow 2008 ; MEA 2005). Nevertheless, neither controversial definitions of 'developing country', nor failure to deliver by developed ones can justify the pursuit of *undifferentiated irresponsibility*. Such path would contradict the Chinese Government's message to the world (NDRC 2007b), exemplified by the recent article in *The Guardian* signed by Xie Zhenhua, Hu Jintao's special representative on climate change:

> 'With a deep sense of responsibility for its own people and the entire human race, China will continue to implement proactive policies and measures to address climate change and make unremitting efforts to protect Earth' (Xie Zhenhua 2009).

Opportunity and Expectation: A Promised New Path

How can one reconcile a claim to differentiated, essentially limited, responsibility with the proclaimed objective to achieve 'sustainable development' and 'protect Earth'? The Chinese Government claims it wants to pursue a new development path that would make it responsible to its people by improving the state of the environment at home, and to humanity as a whole by improving the efficiency with which it uses energy and other resources (Xinhua 2006). It is this promise, encapsulated in the political programme of 'scientific outlook on development' (*kexue fazhan guan*) and 'ecological civilization' (*shengtai wenming*) that suggests China's rise might be an opportunity for its people and for a common future. The pursuit of a new path acknowledges that economic growth is being 'realized at an excessively high cost of resources and the environment' (Hu Jintao 2007). The cost, depending on whose calculation is considered, varies between two and twenty percent of China's GDP (China Daily 2006 ; Liu Jianguo and Diamond 2005). As a result, the *Economic Work Conference of the Communist Party Leadership* of 2006 marked a departure from the uncompromising pursuit of rapid growth that has characterised the last five decades, concluding that the country must 're-engineer the economy' and search for 'a new growth pattern that is energy-saving, environmentally friendly and sustainable' (Xinhua 2006). A year later, the change was enshrined in Hu Jintao's *Report to the Seventeenth National Congress of the Communist Party of China,* as 'scientific outlook on development' (Hu Jintao 2007).

The program for a scientific outlook on development encompasses a range of ideas on and around the sustainability of development. It emphasizes the pursuit of 'a better life and sound ecological and environmental conditions' and embraces principles of efficiency, resource (primarily energy) saving and decoupling – all of which occupy a special place in driving the modernization of the State (Yao Runming *et al.* 2005). It is also seen as a driver for the new, people-oriented, more compassionate, direction of China's development that responds to increasing social disparity (Liu Guoli 2007). However, to date this new path is primarily one based on technological fixes: improved efficiency as the principal delivery mechanism of 'a resource-conserving and environment-friendly society' (Hu Jintao 2007), which has found expression in concepts of circular economy (reduce, reuse, recycle) (Jin Yong 2008 ; NDRC 2007a). It is efficiency and the pursuit of a circular economy that will enable a quadrupling of GDP by 2020 while ensuring 'sound ecological and environmental conditions' (Hu Jintao 2007). And the current stimulus package of 400 trillion RMB is testament to this focus. Several investments within the 10 Point Plan include an energy efficiency element; 210 billion RMB are specifically earmarked for energy and the environment, for example for upgrading refineries (World Bank 2009).[7] In a country with twenty percent of the world population, and seven percent of the world's land and water, efficiency in the use of resources makes eminent sense, and the significant role of heavy and energy intensive industry over the last decade has meant that a reduction of energy intensity by 20 percent per unit of GDP by 2010 (against 2005 levels) is now a national priority (NDRC 2007a). Similarly, great effort and resources are being devoted to the more efficient use of scarce land, especially agricultural land, and water. Beyond the generic statements of intention there is a very significant body of practical and administrative measures that, especially since the approval of the *11th Five Year Plan* (2006-2010), have been attempting to balance the pursuit of economic growth with greater attention for the needs of the environment and of the less fortunate sections of China's rural society more closely in contact with the devastating effects of the former (NDRC 2007a ; Pan Yue and Zhou Jigang 2006 ; Song Guojun *et al.* 2008).

Ecological civilisation was officially introduced together with scientific development at the *Seventeenth National Congress of the Communist Party of China*. Although official discourse refers to both the scientific outlook on development and ecological civilisation, often with no clear distinction,[8] it is suggested here that the scientific outlook and ecological civilisation are not two dimensions of the Government's promised new path, but rather the former might be usefully considered as the means to the latter. The means focuses on efficiency, the end questions the development paradigm and aspires to a new era for humanity. Ecological civilisation represents a wider mission statement in response to the ecological crisis that is affecting the country. An acknowledgement of the need to rethink traditional models of growth in a country with limited biocapacity and limited options to export waste and pollution beyond its borders. The idea is to provide a cultural basis from which to transcend industrial civilisation and capitalism, advocating the pursuit of material and spiritual wealth through an ecological harmony rooted in traditional Chinese cultural ethics that recognises value in both man and nature (Beijing Review 2006). In the words of Pan Yue (2004? : 47-56) it represents a 'historical mission' for China to promote an 'advanced culture' that recognises Man as 'inseparable from other forms of life in nature' and which can only coexist through mutual restraint:

> 'all advanced cultures exist in nature… Man has the right… to enjoy material lives and seek freedom and happiness. However, such rights must be limited by the scale and environmental capacity'.

This interpretation is in line with the idea of interdependence and necessary limits introduced in the late 1960s and rediscovered with renewed urgency ever since. It reflects the leadership's concern with 'the future of global civilization' given global constraints as well as global ecological problems epitomised by dangerous climate change (Ma Jun 2007). Ecological civilisation subscribes to the idea proposed here, that the right to human development aspirations must be accompanied with the obligation to pursue a different development path. This is of course true for China as it is for the rest of the world, since limits and restraint can only make sense when national perspectives are transcended and consideration is given to the Earth system (I return to this in the conclusions).

Chinese official discourse on the need for a new development path has thus witnessed

[7] It is worth noting that the updated version of the plan (from November 2008 to March 2009) has witnessed a significant contraction of the amount devoted to 'sustainable environment' in favour of 'technology and industry' and 'housing' (The Economist 2009).

[8] Government representatives like Jia Zhibang (2009), director of the State Forestry Administration, links the scientific outlook of development with ecological civilisation and the need to 'protect[…] global ecological security and sustain[…] human culture' acknowledging climate change as 'a prominent threat to the progress of civilization'.

interesting developments since the *Sixteenth National Congress* of the Party. It suggests the Government intends to take a responsible approach both towards its people and towards the rest of the planet, which represents an opportunity to avoid dangerous climate change. Whether such opportunity materialises will depend on the further articulation of both the means (scientific outlook on development) and the end (ecological civilisation), as well as the capacity of Government to deliver on its promises. It is worth noting that the promise has been matched by expectations across the world. Internationally renowned scholars – including Jeffrey Sachs and Joseph Stiglitz, and commentators – including Sir Crispin Tickell, Lester Brown and Jonathon Porritt, have in recent years expressed the hope that China might lead the world to a new era of sustainable development. China as 'a relatively late comer to the industrial world… has the opportunity to leapfrog over the mistakes of others' (Tickell 2007), technology will play a crucial part in delivering more sustainable development (Brown 2006; Sachs 2007a), and there is 'no reason why China shouldn't become the world's number one nation in terms of eco-efficiency', according to Porritt – who defines the situation in China as 'an ecological apocalypse' (Green Futures 2006:3).

It seems there is almost 'a *desire* for hope' that makes most commentators tread the uneasy path between hope and despair, as if afraid to contemplate the wider consequences of China's possible demise (Bina 2007). A substantial part of this hope is supported by faith in technology and efficiency gains as the foundations of a sustainable future. This faith is shared by the developing discourse of scientific outlook on development, and related circular economy. However, based on the Chinese Government's current policies and funding priorities, a number of contradictions can be identified, which suggest that the solutions devised by the scientific development programme (the means) may not lead to the radical changes needed to shift to the new development paradigm of ecological civilization (the end). The result could be a failure to address the underlying causes of China's environmental crisis, and to contribute to avert dangerous climate change.

The Contradiction in The Promise

Considering the most recent policies, economic plans and funding priorities from the angle of the promise of greater harmony seems to have been left behind, and the opportunity for containing the risk of dangerous climate change that might have come from a new path may be significantly weaker than expected.

The primary contradiction is perhaps the simplest and one which remains unresolved in many parts of the world, not only in China: that between environmental protection and development. Sustainable development has only contributed to muffle rather than solve this tension, and it seems that the Chinese concepts of scientific outlook on development and ecological civilisation might be heading in the same direction, judging from the content of the more recent public plans explicitly designed under the auspices of such concepts. While Hu Jintao's speech delivered at the opening ceremony of the Boao Forum for Asia annual conference (Boao, Hainan, 12 April 2008) suggests there is still a desire to 'explore and improve our development path and model in keeping with China's national conditions', he also confirms a 'commit[ment] to promoting the sustained and steady growth of the world economy' (Hu Jintao 2008). The contradiction between improving the quality of development and the need for rapid growth persists. The Government advocates 'sound and rapid economic growth' though the quadrupling of per capita GDP of the year 2000 by 2020, and expects this growth to deliver 'balanced development' by 'reducing consumption of resources and protecting the environment' (Hu Jintao 2007). China's *11th Five Year Plan* is meant to promote this balanced outcome, yet a mid-term evaluation suggests it has failed to live up to the promise: 'insufficient progress on macroeconomic rebalancing and changing the economic and industrial structure has [meant] limited progress on energy and water intensity, and environmental quality' (World Bank 2008: 11).[9] The development path remains inspired by a traditional model of industrial growth and a market economy that depends on global exports. The plans for the forthcoming 12th Five Year Plan suggest little change is to be expected until well into 2020. The environmental chapter of the national plan is being drafted not in order to address the ecological crisis, but rather to support the imperatives of economic growth and social stability through the achievement of a moderately prosperous society by 2020.[10] Initial proposals suggest that 'the pre-ordained economic development model determines environmental progress' and that until 2020 China can expect the relationship between economy and the environment to be in 'contradiction' and only 'preliminarily harmonious' by 2030 (China Environmental Law 2009). Once again, the model seems unlikely to change in any significant way. The implementation of the much-praised 'green' stimulus package of 400 trillion RMB is also revealing its contradictions as environment and social concerns are sidelined in favour of economic priorities, mainly expressed in terms of infrastructure investment (The Economist 2009 ; Tan Yingzi 2009). In the words of Zhou Shengxian, Environment Minister: 'environmental protection [is] not being highlighted in the overall plan' and recent reviews show a relaxation of the already bland implementation of pollution controls, and new environmental problems arising from many of the industrial plans in the Centre and West regions (Li Jing 2009).

The overall approach that transpires from the last decade of planned economic growth suggests that China's leaders are waiting for the environmental Kuznets Curve to reach the theoretical point of industrialisation and per capita income after which pollution levels begin to drop. Quite apart from the critiques of the curve's assumptions (Caviglia-Harris *et al.* 2009), this mode offers nothing that can be defined as a new, more responsible, path of development. Instead, the brief overview of high profile plans suggests business as usual for at least a few decades to come.

Given the efforts by the Government to redefine China's path to development, these results might seem surprising, were it not for a deeper contradiction within the overall promise: a contradiction between the ultimate need for restraint, intrinsic to ecological civilization (the end) and the unquestioned pursuit of growth, albeit efficient growth, central to the programme for a scientific outlook on development (the means). The latter is arguably aimed at 'putting people first' (Hu Jintao 2007), but its foundations in greater efficiency of resource use, primarily energy resources, seem to have sidelined the social dimension and the need to work within the country's biocapacity limits. It is because of the efficiency credentials that the scientific outlook is being considered a contribution towards climate change policies (NDRC 2007b). This appeal, almost fascination, with the potential of efficiency to deliver sustainable development can be linked to a desire to rationalise, control and shape nature (uprooting forests, redirecting rivers) which has characterised China's

[9] The analysis explains how the country's capital-intensive, industry-led pattern of growth continues to be a key driver of economic and social imbalances: 'First, the capital-intensive, industry-led growth had been particularly intensive in energy, natural resources, and environmental degradation, thus accentuating the associated imbalances noted above. While energy and natural resource intensity was declining in several sectors, the relatively rapid growth of industry increased the weight in GDP of the most energy and resource intensive sectors. Second, capital-intensive growth created fewer jobs than a services-led growth pattern, limiting the absorption of surplus agricultural labor and contributing to the rising rural-urban income inequality and rural poverty' (World Bank 2008: 3).

[10] The four key stages of economic growth were summarised thus by Wu Shunze, Deputy Director General of the China Academy of Environmental Planning: 1) industrialisation to be completed by 2030, 2) peak in the use of resources and energy between 2020-2030, 3) modernisation, including growth of the service industries and a reduction of pressure on the environment, to be attained between 2030-2050, and 4) mature urbanisation, high-income status and largest world economy by 2050 (China Environmental Law 2009).

leaders for millennia (Elvin 2004).[11] However, it seems to ignore a fundamental weakness: the inefficiency of China's industry is well known and certainly will benefit from greater efficiencies, but historical evidence shows that higher efficiency of energy conversion leads eventually to higher, rather than lower, energy use, ultimately negating the initial benefits (Smil 2005).[12] This is especially true for a country that is planning rapid and sustained economic growth, as well as unprecedented urbanisation by 2050. There is therefore a second contradiction in the promise of China's leaders: it can be expressed as faith in efficient growth.

In spite of the rhetoric invoking a different – responsible – development path, there is enough evidence to suggest that the leadership is pursuing the same path and committing the same mistakes that today's richest countries experienced. Both sides seek to mediate their responsibilities towards emission reductions through the seemingly unquestionable right to growth and to the pursuit of ever-higher standards of living. The result is likely to be one more step towards undifferentiated irresponsibilities. Efficiency *per se* ensures no harmony between man and nature. It acknowledges their interdependence, but without reference to limits and the need for restraint, it cannot lead to lasting harmony. This is of course the problem with the 'limited' responsibility at the heart of the Government's position in the climate change negotiations. Many of the arguments explored above will support limited responsibility on the grounds of equity. In practice however, the Chinese Government is confronted with the simple fact that by virtue of having the largest population in the world, and being one of its largest economies, it is also one of the largest and fastest growing pressures on the planet. Being a responsible player both at home and abroad will take more than efficient growth, and the shortcomings of recent plans confirm this.

Embracing Contradictions: The Obligation To Be Different

The analysis of the contradictions and limitations of current proposals echoes with that of O'Riordan (1983) who reminds us that contradictions lie at the heart of modern environmentalism. Environmentalism has its origin in divergent ideological modes of interpreting the environmental question: the ecocentric mode that assumes a natural order that man has the power to disturb, potentially leading to the destruction of the biosphere, and the technocentric mode that focuses on rational, value-free scientific managerial techniques to shape the natural environment and man's destiny (O'Riordan 1983). The first mode is concerned with 'ends', and the moral and spiritual dimension of choices, while the latter is primarily interested in the potential of science to develop the necessary 'means' of human progress. In many ways, technocentrism has succeeded in defining both the problem (be it climate change or development) and the solution (efficient growth, green economy). Ecocentrism instead struggled to translate generic consensual objectives into concrete policies and actions. The nature of the divide between ecocentrism and technocentrism echoes that between the idea of ecological civilisation and scientific outlook on development (although the former is not to be equated to econcentrism). If the Chinese leadership is to live up to its promise, and to the hope and growing expectations that it has contributed to create around the world, it will have to address the contradictions of its scientific outlook on

[11] The relationship with nature is also characterised by contradiction, as successive governments sought to control key resources for political and military reasons, all the while demonstrating a remarkable sensitivity and respect for nature's beauty and spiritual dimension: 'classical Chinese culture was as hostile to forests as it was fond of individual trees' (Elvin 2004: xvii; see also: Beijing Review 2006).

[12] The emphasis on energy efficiency so as to "produce more with less", has well known limits and even risks, as well as obvious immediate and short term benefits. The Jevons Paradox and the Khazzoom-Brookes postulate warn of rebound effects whereby savings accruing from more efficient use of energy lead to lower prices and eventually lead to increased consumption (see for example: HoL 2005 ; York 2006 ; Smil 2005).

development and invest greater energy in defining more clearly the nature of an ecological civilisation – its end, before choosing the means to achieve it. Taking responsible action to avert dangerous climate change will require much more bold proposals than those tabled to date, which subscribe more to a *responsibility for cleaning up after development*, than *for redefining development* in ways that openly addresses the limits we face.

As Harvey (1996) notes, globalisation is characterized by a time-space compression, and the turn of the century has been marked by a renewed awareness of the Earth as a closed system, with clear limits in terms of capacity and resources. These limits are made more tangible thanks to the projected population growth in China, India and Africa, and the sheer impossibility of extending the current lifestyle of rich countries to the 'newcomers' (for a detailed discussion, see: Brown 2006). The Chinese leadership seems fully aware of this:

> 'I cannot accept the argument that I, as a Chinese, am only entitled legally to one quarter of what you are entitled to…But… being equal to an American when it comes to per capita emissions would be a nightmare for the Chinese' (Ambassador Yu Qingtai cited in: Heilprin 2008).

Responsibility must therefore include limits and mutual restraint for the benefit of the commons and thus, our common future. This is true for China's representatives as for those of all countries. Indeed, a question inevitably arises from this analysis: can any country be reasonably expected to define a new development path in an interdependent and globalised world? Given the current state of the global commons and the implications for dangerous climate change, the time for limited responsibility, whether by developed or developing countries – no matter how poor, seems to be over, and a new development path may have to be a global obligation.

The acknowledgement and analysis of contradiction is a distinctive characteristic of Chinese political thought, as much as experimentation is a unique trait derived from its revolutionary past (Dirlik forthcoming). Perhaps the greatest contribution from China towards finding a solution to the multiple crises the world is facing could be to place on the global agenda the contradiction between environment and development that is the legacy of Euro/American capitalism, forcing heads of state across the world to acknowledge what they must surely already know: that 'win-win' situations are rare and their pursuit is encouraged only thanks to the vagueness of sustainable development concepts. The climate change crisis is the ultimate expression of such contradiction. Chinese leaders have an opportunity to show a different path, living up to the promise of an ecological civilisation that is not simply a rehearsal of technocentric beliefs and efficiency-driven solutions. There is a need for radically different ways of thinking about the medium term – for long-term is now a luxury of the past if the conclusions of the IPCC are to be taken at face value, and a need to experiment now with models that will have to be in place in a matter of decades, not centuries. Only if world leaders are prepared to see the contradiction inherent in simple numbers, such as the energy figures from the International Energy Agency, will they take steps towards addressing – rather than discussing – the dangers linked to climate change. Only then will they show the long awaited responsibility and leadership they owe to our common future, averting the decline and fall into a pattern of undifferentiated irresponsibility.

In the words of a twelve year-old:

'do not forget why you are attending these conferences, who you are doing this for.
We are your own children, you are deciding what kind of world we are growing up in…
I challenge you, please make your actions reflect your words'.
Severn Suzuki speaking at UN Earth Summit 1992

Acknowledgments

I wish to thank Arif Dirlik for a challenge that has been the greatest encouragement, and Andrea Ricci, for his many questions.

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Climate Duties, Human Rights and Historic Emissions

Derek Bell[1]

Abstract

The problem of global climate change cannot be resolved without the cooperation of both China and the USA. However, neither government appears close to signing up to mandatory emissions reductions. Both nations defend their climate policies by appealing to ideas of fairness, equity and justice. This paper outlines the arguments offered by Chinese opponents of mandatory emissions reductions, highlighting three central claims about historical responsibility, ability to pay and the right to development. The first part of the paper examines these claims, the arguments supporting them, the relationships among them and their implications for a just global climate regime. Two different interpretations are suggested – the 'overlapping consensus' account and the 'hybrid' account. It is argued that only the hybrid account offers a coherent ethical position. The second part of the paper critically examines the hybrid account of global climate justice. On this account, the historical responsibility claim appears central to the Chinese argument that the West should pay the costs of tackling climate change. Several arguments against the historical responsibility claim are considered and detailed attention is paid to the argument from excusable ignorance, which suggests that the West should not be held responsible for those emissions generated before the risks of anthropogenic climate change were widely recognised. It is argued that many of the common replies to the argument from excusable ignorance are not convincing. However, a new (but limited) reply, which draws on the link between basic human rights and energy use, is proposed. The final part of the paper shows how the new reply requires a re-formulation of the hybrid account. The paper concludes by considering the implications of this new account for a just global climate regime and, in particular, China's duties to contribute to it.

In 2007 the Intergovernmental Panel on Climate Change (IPCC) declared that:

> Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (IPCC 2007: 30).

Global climate change has already happened. The IPCC has also become increasingly confident about the causes of climate change:

> Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG [greenhouse gas] concentrations (IPCC 2007: 39; original emphasis).

The IPCC defines an outcome that is 'very likely' as one that has an 'assessed probability of occurrence' of more than 90% (IPCC 2007: 27). There is greater than 90% probability that humans have caused global warming. The IPCC predict that:

> Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century (IPCC 2007: 45).

[1] Newcastle University, email: derek.bell@newcastle.ac.uk.

If we continue with a business-as-usual emissions policy, we are '*likely*' (=more than 66% probability of occurrence) to see global average temperature rises in the range of 1.7 – 6.4°C by the end of the 21st century (IPCC 2007: 45). The IPCC project that this will have significant impacts on ecosystems and on humans. It is, for example, '*likely*' that the 'resilience of many ecosystems … [will] be exceeded this century' (IPCC 2007: 48). Similarly, there is 'high confidence' (= 8 out of 10 chance) that:

> The health status of millions of people is projected to be affected through, for example, increases in malnutrition; increased deaths, diseases and injury due to extreme weather events; increased burden of diarrhoeal diseases; … and the altered spatial distribution of some infectious diseases (IPCC 2007: 48).

We can expect that climate change will cause many people to die from malnutrition, extreme weather events (including flooding, heat waves, wildfires and hurricanes), diarrhoeal diseases, infectious diseases and lack of water. We can expect that the lives of billions of other people will be seriously negatively affected by climate change. In short, human emissions of GHGs will cause (and have already caused[2]) harm to other humans.

This has led some activists and philosophers to argue that we should conceive of climate change as a human rights issue: we violate human rights by emitting greenhouse gases. This contrasts sharply with the dominant cost-benefit analysis approach to assessing how we should respond to climate change, which is used by economists. On the human rights approach, we do not try to calculate the economic costs of death, injury, malnutrition, water-stress or illness and then weigh them against the opportunity costs of reducing greenhouse gas emissions.[3] Instead, we recognise human rights to life, physical security, subsistence and health that should be protected from violation by human action. If anthropogenic climate change threatens to violate these basic rights, each one of us has (at least) a duty to pay his or her fair share of the costs of preventing anthropogenic climate change.

The major problem for any theory of climate justice is to determine how the costs of preventing anthropogenic climate change should be shared. What is a fair allocation of the costs of preventing the harms of anthropogenic climate change? The Chinese Government, like many others in the global South, has consistently argued that the global North should pay the costs of climate change because they have caused the problem. It is the global North's historic greenhouse gas emissions that have caused anthropogenic climate change, therefore, the global North should pay the costs of protecting people from the harmful effects of anthropogenic climate change. The aim of this paper is to consider the role that historic emissions should have in a theory of global climate justice. More specifically, I aim to outline a distinctive approach to global climate justice – which is grounded in basic human rights – and to consider the role that historic emissions should have in the proposed theory.

In section one, I offer a brief defence of the claim that anthropogenic climate change violates basic human rights. In section two, I consider Onora O'Neill's well-known objection to rights-based theories of justice, namely, that they do not tell us how to allocate the correlative duties. I consider a response to this objection and I distinguish three kinds of duty that should be included in a full theory of climate duties. In the remaining sections of the paper, I consider these three kinds of duty in more detail and in relation to historic emissions. In section three, I consider (what I call) the 'general climate duty', namely, the duty to promote effective institutions for the fair specification and allocation of particular climate

[2] See IPCC (2007: 33).

[3] I discuss the contrast between a cost-benefit approach and a justice approach in more detail in Bell (2009a).

duties. More specifically, I consider when this duty might have been first acquired by citizens and states in the global North. In section four, I consider principles for specifying and allocating climate duties under just (fair and effective) institutions. In particular, I consider the claim that the global North should be held responsible for historic emissions because its citizens have exceeded their equal per capita share of emission rights. In section five, I outline an account of the duties of rectification that anyone who fails (or has failed) to comply with the general climate duty should incur and I suggest that this has important implications for how we think about arguments from historic responsibility. Section six summarises the arguments of the paper.

1. Basic Human Rights

The United Nations Office of the High Commissioner for Human Rights has highlighted the impact of climate change on human rights:

> Global warming could result in hundreds of millions of people suffering from hunger, malnutrition, water shortages, floods, droughts, heat stress, diseases triggered by extreme weather events, loss of livelihood, and permanent displacement. Indeed, climate change poses a direct threat to a wide range of universally recognized fundamental rights, such as the rights to life, food, adequate housing, health and water (United Nations 2007).

The suggestion is that climate change is a ‘direct threat’ to some of the most basic human rights.

Similar arguments have been made by political philosophers writing on climate change. For example, Henry Shue has argued that there is a human right to ‘physical security’ and that this right is threatened by anthropogenic climate change (1999, p. 39). Simon Caney has identified several human rights that are threatened by climate change, including the right to life, the right to health, and the right to subsistence (Caney 2009).[4] Caney has also argued, in other papers, that there is a human right ‘not to be exposed to dangerous climate change’ (Caney 2008, p. 539; Caney 2006, p. 263). A similar climate-specific human right has been defended by Steve Vanderheiden, who suggests that:

> Since rights exist in order to protect interests, a strong case can be made from the critical importance to human welfare of climatic stability for a right to an adequate environment with the corollary that the right includes a claim to climatic stability (Vanderheiden 2008, p. 252).

Vanderheiden builds on Tim Hayward’s argument for a human ‘right to an environment adequate for (human) health and well-being’ (Hayward 2005, p. 29).

Some of these accounts have appealed to widely recognized human rights, including the rights to life, physical security, health and subsistence. Other accounts have defended ‘new’ climate-specific human rights. In this paper, I will focus on arguments that anthropogenic climate change violates widely recognized – or basic – human rights. If anthropogenic climate change violates basic human rights, we may not need to defend more

[4] He has also suggested that: ‘It is arguable that climate change jeopardizes a human right to development … Furthermore, one might argue that there is a human right not to be forcibly evicted … and that climate change violates this because people from coastal settlements and small island states will be forced to leave’ (Caney 2009, p. 12).

controversial – or more ambitious – human rights claims to justify urgent action on climate change.[5]

The most straightforward way of defending any particular human right is to show that it has already been included in international human rights conventions. One attraction of this approach is that rights that have been widely recognized in international law may be less controversial than rights that have not been recognized in international law. Moreover, if we begin from legally recognized human rights, we may be able to avoid offering moral arguments to support our fundamental rights commitments. Basic human rights to life, physical security, health and subsistence can be readily defended in this way by appealing to major human rights documents, such as the Universal Declaration on Human Rights, the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights.[6]

However, the 'legal' approach to defending human rights is only a shortcut for most moral and political philosophers. The legal recognition of a human right is ultimately justified by a moral argument for that human right. Many different kinds of moral arguments have been offered for particular human rights.[7] However, basic human rights – including the rights to life, physical security, subsistence and health – are often defended by appealing to the interests that they protect:

> Virtually any argument in favor of a right will depend at bottom on emphasizing that the interest to which the right is asserted is genuinely important, fundamental, vital, indispensable, etc. (Shue 1980, p. 8).

Basic human interests provide the grounds for basic human rights. We have seen that human rights provide the strongest (moral) protection that we can offer, therefore, they must be connected to our most important interests. As Griffin argues, in defence of his own account of human rights:

> I choose those features [autonomy and liberty among others] precisely because they are important human interests. It is only because they are especially important interests that rights can be derived from them; rights are strong protections, and so require something especially valuable to attract protection (Griffin 2008, p. 35).

Similarly, 'especially important' human interests in life, physical security, subsistence and health might reasonably be taken as grounds for basic human rights to life, physical security, subsistence and health.[8]

The 'important human interests' argument provides a relatively straightforward way of defending particular human rights. If we accept the argument for human rights to life,

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[5]Of course, different accounts of human rights may have quite different implications for action on climate change (and on other issues). For example, Hayward's human right to an equitable share of ecological space is the basis for a particularly demanding egalitarian theory of global justice, which goes beyond standard conceptions of human rights as 'the morality of the depths … the line beneath which no one is allowed to sink' (Shue 1980, p. 18).

[6]For an argument of this type see Caney (2009). Caney combines this approach with a commitment to minimalism – i.e., he defends the human rights that he proposes by showing that they are less demanding than human rights that have been recognized in these international human rights conventions.

[7]For a useful survey see Caney (2005, chapters 3 and 4).

[8]Caney offers 'important interests' arguments for the human right 'not to be exposed to dangerous climate change' (2008, pp. 537-9) and the human right 'not to suffer the ill-effects associated with global climate change' (2006, pp. 259-64). See also Vanderheiden's defence of the human rights to an adequate environment and climatic stability (2008, p. 241).

physical security, subsistence and health, it also seems a relatively straightforward step to the claim that anthropogenic climate change violates – or threatens to violate – these human rights. Caney has claimed that 'it is clear that anthropogenic climate change violates [the right to life]' by, for example, increasing the frequency of extreme weather events, including storm surges, which can be expected – based on previous experience – to cause 'very high mortality' among the coastal population of Bangladesh (Caney 2009, p. 7).[9] As we saw earlier, there is ample evidence in the latest IPCC reports to show that anthropogenic climate change is likely to kill, injure, starve and cause illness to many millions of people. In short, anthropogenic climate change will violate their human rights.

2. The General Duty and Particular Duties

Onora O'Neill has argued that the problem with rights-based theories is that they do not tell us who has the duty to protect rights.[10] O'Neill's particular target is positive rights, such as rights to welfare or education, because she assumes that we can specify the duties that are correlative to negative rights, such as the right *not* to be killed or injured. However, O'Neill's concern about unspecified duties extends to negative rights when those rights can be violated by the cumulative actions and collective practices – working through complex causal chains – of many millions of people.[11] In the context of anthropogenic climate change, a human rights-based theory does not seem to tell us what we most need to know: Who has a duty to do what? When do a person's greenhouse gas emissions – or other actions – violate the human rights of victims of anthropogenic climate change?

In reply to O'Neill's concerns, Elizabeth Ashford has suggested that we can identify a duty that is correlative to basic human rights – namely, the duty to promote and maintain effective institutions that will fairly 'specify and allocate' the particular duties needed to ensure the protection of basic human rights (Ashford 2007, p. 217). If we take human rights seriously and we do not have clear and widely acknowledged criteria for specifying and allocating correlative duties, then we should recognise a duty to promote and maintain effective institutions that will fairly specify and allocate the duties needed to ensure the protection of human rights. Let us call this the 'general duty'. In the context of climate change, we might recognise a 'general climate duty' – namely, the duty to promote and maintain effective institutions that will fairly specify and allocate the particular duties needed to ensure the protection of basic human rights *from the threat posed by anthropogenic climate change*. The general climate duty is implicit in the broader general duty once we recognise anthropogenic climate change as a 'standard threat' to basic human rights (Shue 1980, p. 13).[12]

The main problem with both the general duty and the general climate duty is that they still do not specify or allocate particular duties to individuals. Instead, they attempt to defer the problem by requiring us to promote institutions that will solve the problem for us by fairly specifying and allocating particular duties to individuals. However, the problem cannot be so easily deferred for two reasons.

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[9] Caney quotes from – and bases his claims about the effects of storm surges on – McLean and Tysban (2001, pp. 366-7).

[10] See, for example, O'Neill (1986, pp. 101-3; 1996, pp. 129-35).

[11] Hayward has argued that the problem of unspecified duties extends to all negative rights, including, for example, the right not to be tortured: 'the circumstances under which a right not to be tortured is violated are not brought about simply by numbers of individuals failing to recognize their negative duty, but rather are a result of a systematic organization of power within which specific responsibilities are murkily dispersed' (Hayward 2005, p. 53).

[12] For a fuller discussion of the role of 'standard threats' in an account of human rights and correlative duties see Bell (2009b).

First, the duty to promote institutions that will fairly specify and allocate particular duties to individuals might plausibly be re-described as a duty to promote just institutions. The justice of institutions might be understood in two broad ways: substantively or procedurally. If the justice of institutions is understood substantively, I can only fulfil my duty to promote just institutions by promoting a particular substantive conception of justice. However, a particular substantive conception of justice will be (or will entail) an account of how particular rights and duties should be specified and allocated to individuals. In other words, we can only fulfil our duty to promote (substantively) just institutions if we already have an account of how particular duties should be specified and allocated to individuals. On this understanding of justice, the general (climate) duty cannot be fulfilled unless we have a prior account of (or principles for) the fair specification and allocation of particular duties.

We might be able to avoid this problem by adopting a procedural theory of just institutions. If the justice of institutions is understood procedurally, I can fulfil my duty to promote just institutions without promoting a substantive conception of justice. Instead, I need only promote institutions that use just procedures to decide on substantive principles of justice that will determine (or guide) the specification and allocation of particular duties to individuals. So, for example, if I subscribe to a conception of procedural justice as aggregative democracy, I need only promote the institutions of an aggregative democracy and then 'leave it to the people' (or their representatives) to decide how particular duties should be specified and allocated to individuals. On this account, the specification and allocation of duties will be just if and only if the procedure is just.

However, there are two problems with adopting a purely procedural theory of justice in this context. First, the most popular accounts of procedural justice in contemporary political philosophy are deliberative rather than aggregative. So, I might be able to promote the procedurally just institutions of deliberative democracy without promoting a substantive conception of justice but I will not be able to be a good citizen in a deliberative democracy without taking an active part in the debates about how particular duties should be specified and allocated. In other words, even if we were to adopt a procedural theory of just institutions, we would have a duty to try to work out how the particular duties that are correlative to human rights should be specified and allocated by fair and effective institutions. Second, our starting point was a commitment to (substantive) basic human rights. It seems odd to adopt a purely procedural theory of justice for the specification and allocation of particular duties to protect basic human rights, which have been specified (and allocated to all humans) on substantive rather than procedural grounds. If we believe that substantive justice is relevant to the specification and allocation of rights, why would we ignore it for the allocation of the correlative duties?

I have suggested that the first reason that introducing the general (climate) duty does not solve our initial problem is that it does not alleviate the need for a substantive theory that specifies and allocates particular duties to individuals under fair and effective institutions. The second problem with the general (climate) duty is that it produces an additional problem of specification and allocation – namely, the problem of specifying and allocating the general (climate) duty itself. If the promotion of fair and effective (or just) institutions is a collective endeavour, we will need to work out what the duty to promote just institutions requires from particular individuals at particular times and places. It is, for example, plausible that the general duty requires different actions from President Obama than it does from the average US citizen. Similarly, it might require different actions from the average UK citizen than it does from a person living on less than a $1 per day in a developing nation. In other words, a full account of the general (climate) duty will include an account of the fair specification and allocation of the duty to promote just institutions. Moreover, the specification and allocation of the general (climate) duty cannot be purely procedural because it is logically prior to the realisation of just institutions.

These important objections to the general (climate) duty might lead us to the conclusion that we should look for an alternative response to O'Neill's criticism of rights-based theories. However, I think that would be premature. We have seen that the general (climate) duty cannot offer a complete solution to the problem of identifying the duties that are correlative to basic human rights. However, I want to suggest that it does offer us a useful way of approaching the problem. The general (climate) duty suggests a particular structure for an account of our particular duties.

We have seen that the general (climate) duty points us toward two sets of particular duties that a complete theory of human rights-based duties will need to specify and allocate. First, we need principles for the allocation of the duty to promote just institutions (i.e., fair and effective institutions for the specification and allocation of duties). These principles will tell us how to determine who should do what to promote just institutions. Second, we need principles for the specification and allocation of particular duties (to protect basic human rights) under fair and effective institutions. These principles will tell us who should do what when we have just institutions to protect basic human rights.

In addition, a complete theory of human rights-based duties may need to specify duties of rectification if our duty to promote just institutions is not fulfilled.[13] So, the third part of an account of human rights-based duties should include principles for the specification and allocation of duties that arise from the failure of some people to comply with their particular duties to promote just institutions. For example, if the failure of some of us to comply with our duty to promote just institutions prevents or delays the development and implementation of just institutions, we need to work out how (if at all) this affects the future duties of both the compliers and the non-compliers.

In the remainder of this paper, I will consider how we might begin to develop these three parts of an account of human rights-based duties in the particular context of climate change. More specifically, I will consider the role and relevance of historic emissions in the proposed account of climate duties. In section 3, I consider when we might first have acquired the general climate duty. I relate this discussion to the claim that the global North should pay the costs of anthropogenic climate change because it is morally culpable for its historic emissions. In section 4, I consider one account of how climate duties should be allocated under just institutions. I argue that we should reject the idea of a universal right to equal emissions (or 'equal emissions over time') and, therefore, I suggest that all historic emissions should not be counted equally. In section 5, I consider duties of rectification. I outline some important duties of rectification and I suggest that it is the recent (historic) emissions of the global North that are likely to generate the most significant duties.

3. Climate Duties 1: The Duty to Promote Fair and Effective Institutions.

On this account, the *general duty* to promote fair and effective institutions for the protection of basic human rights is a duty that has existed for as long as human rights have existed. However, the *general climate duty* to promote fair and effective institutions for the protection of basic human rights from the threat posed by anthropogenic climate change may be better understood as a newer duty. The basic human rights that are threatened by anthropogenic climate change are not new human rights that have only come into existence with climate

[13]We might also need principles to specify and allocate duties when some people do not comply with just (or fair and effective) institutions. However, for institutions to qualify as 'effective', and therefore as 'just', they must prevent large scale non-compliance. I will not address the problem of non-compliance under just institutions in this paper. Instead, I make the simplifying assumption that we can make fair institutions effective by designing appropriate penalties and punishments for non-compliance.

change. They are basic human rights that can be violated in many different ways. Anthropogenic climate change is a new threat – or a new way of violating – those rights. Therefore, the original formulation of the basic human rights could not plausibly have identified climate-related duties. This is a case where changes in 'circumstances which were not predicted … give rise to a new duty which was not predicted in advance' (Raz 1986, p. 185). The duties that are correlative to basic human rights will change over time because the 'typical major threats' will change over time (Shue 1980, p. 33). Anthropogenic climate change is a new way of violating basic human rights, which gives rise to new duties, including a new general *climate* duty to promote fair and effective institutions for the protection of basic human rights *from the new threat posed by anthropogenic climate change*. This is a normal result of the 'dynamic character' of basic human rights (Raz 1986, p. 185).

I have suggested that the general climate duty is a relatively new duty but when did it come into existence? More generally, we might ask: what factors are relevant to determining when the general climate duty came into existence? I want to suggest that two factors are important here.

First, we have seen that the general climate duty is a response to the new 'standard threat' posed by anthropogenic climate change to basic human rights. Therefore, the general climate duty cannot have come into existence before anthropogenic climate change posed a 'standard threat' to basic human rights. Two points of clarification are in order here. First, we should distinguish between the time at which anthropogenic climate change became a 'standard threat' to basic human rights and the time at which humans could reasonably have recognised anthropogenic climate change as a 'standard threat' to basic human rights. It is, at least, possible that anthropogenic climate change posed a serious threat to basic human rights before humans knew or could reasonably have been expected to know about it. Second, any judgement about when anthropogenic climate change became a 'standard threat' to basic human rights is likely to be contestable. However, it is clear from the evidence that anthropogenic climate change should now be recognised a 'standard threat' to basic human rights. We know that the effects of anthropogenic climate change have already violated the basic human rights of some people and are likely to violate the basic human rights of many millions of people in the near (and far) future.

It is less clear when anthropogenic climate change first posed a 'standard threat' to basic human rights. Was it at the very beginning of the Industrial Revolution when humans developed the capacity to emit large quantities of greenhouse gases? Was it early in the twentieth century when the mass production of motor vehicles began? Was it shortly after the Second World War when the global population exceeded 2.5 billion? Perhaps, the most plausible way of approaching this question is to consider when the probability of anthropogenic climate change causing widespread violations of basic human rights (and, thereby, posing a 'standard threat') exceeded some threshold. So, for example, we might imagine that the probability that humanity would take the route that it has taken since the Industrial Revolution (e.g., the technological change, the population increases, and the social and economic changes) may have been quite low so that the likelihood of anthropogenic climate change violating basic human rights might also have been quite low. We might, therefore, conclude that anthropogenic climate change did not pose a 'standard threat' to basic human rights until more recently.

I have suggested that the first condition on the existence of the general climate duty is that it cannot have come into existence until anthropogenic climate change posed a 'standard threat' to basic human rights. The second condition is that the general climate duty – like all duties – should not be unreasonably demanding. We might distinguish two ways in which the general climate duty might be too demanding. First, the general climate duty might require us to promote fair and effective institutions for tackling anthropogenic climate change before we could reasonably be expected to know about anthropogenic climate change and its effects. If at time t we are excusably ignorant of the effects of our use of fossil fuels, it seems unreasonable either: at t to claim that we have the general climate duty; or at t+1 to claim that we should be held morally responsible for our 'non-compliance' at t with the general climate duty. So, the general climate duty can only be imputed to an agent that is either knowledgeable or *in*excusably ignorant about the link between fossil fuel use and the rights-violating effects of anthropogenic climate change. Judgements about excusable ignorance will, of course, be contestable. However, I think we might plausibly argue that most ordinary citizens in the global North were excusably ignorant of the effects of fossil fuel use until (at least) the mid 1980s. It might be possible to argue that Northern states had a much greater responsibility to consider and conduct research into the effects of their actions (and the actions of their citizens) and, therefore, that their ignorance became *inexcusable* much earlier.

The second way in which the general climate duty might be too demanding is that it might ask people to sacrifice too much. The general climate duty asks us to make two kinds of sacrifice. First, it asks us to pay the opportunity costs of devoting time to promoting just institutions. In some circumstances, this might be too much to ask of an agent. For example, a person living on less than a $1 a day has more urgent demands on their time, energy and resources and the general climate duty should not be imputed to them. Second, the general climate duty asks us to pay the opportunity costs of living under and complying with just institutions (after they have been successfully promoted and implemented). If institutions are genuinely just, they should not ask too much of individuals. Therefore, agents should be willing to pay the opportunity costs of complying with just institutions. However, we should note that the general *climate* duty focuses only on the promotion of fair and effective institutions for the protection of basic human rights *from the threat posed by anthropogenic climate change*. There is a risk that if we try to develop 'climate-specific' institutions, we may develop institutions that are not fair or just in a broader sense. It is, therefore, important to locate any theory of climate justice – and especially climate duties – in a broader theory of justice. We should not endorse institutions that specify and allocate duties in a way that protects basic human rights from the threat posed by anthropogenic climate change but fails to protect basic human rights from other threats (or causes any other kind of injustice).

In this section, I have discussed the general climate duty to promote fair and effective institutions for the specification and allocation of particular duties to protect basic human rights from the threat posed by anthropogenic climate change. In particular, I have considered when the general climate duty should be understood to have come into existence – or, when an agent might be said to acquire the general climate duty. I have argued that the general climate duty could not have come into existence until the probability of anthropogenic climate change violating basic human rights became significant. I have also suggested that the general climate duty should only be imputed to an agent when: (a) that agent has knowledge of or is *inexcusably* ignorant of the link between fossil fuel use and rights-violating anthropogenic climate change; and (b) complying with the general climate duty (and complying with the proposed just institutions) does not make unreasonable demands on the agent.

This understanding of the 'birth' of the general climate duty is significant because it poses an important obstacle to historic responsibility arguments. On one understanding of the historic responsibility argument, Northern states and their citizens should pay the costs of tackling anthropogenic climate change because they are morally responsible for the problem. However, the proposed theory of human rights and duties suggests that only the current generation of ordinary citizens in Northern states might be considered guilty of any climate-related moral failure. The general climate duty cannot reasonably be imputed to ordinary citizens before the mid-1980s. It might be possible to make an argument that Northern states acquired the general climate duty earlier but it seems unlikely that they acquired it before the beginning of the twentieth century. Therefore, the most ambitious arguments for historic responsibility – grounded in moral responsibility or moral failure and extending back to the beginning of the Industrial Revolution – should be rejected.

4. Climate Duties 2: The Specification and Allocation of Particular Duties Under Fair and Effective Institutions.

I have argued that the general climate duty is a relatively new duty for ordinary citizens of the global North. In this section, I want to consider how fair and effective institutions should specify and allocate particular duties (to protect basic human rights from the threat posed by anthropogenic climate change). In other words, what principles for the specification and allocation of climate duties should people who comply with the general climate duty be trying to promote? In particular, I want to consider the possibility that fair principles will allocate climate duties based on historic emissions. We have already seen that there are good reasons for thinking that the North's moral failure with respect to climate change is relatively recent. Therefore, if we want to allocate climate duties based on historic emissions (over a longer period of history), we will need a different kind of argument to support that claim. In this section, I will consider one important argument that has been offered to support the claim that the allocation of particular climate duties should be proportionate to historic emissions.

The central claim of this argument is that there is a universal right to equal greenhouse gas emissions irrespective of the time and place that a person lives. We might call this 'equal emissions'. Let us assume that we are seeking to promote fair and effective institutions for the specification and allocation of climate duties at time t. If we accept equal emissions, we will take into account the historic emissions of each person in allocating their future emissions (to ensure that over their lifetime they do not exceed their 'equal emissions' allowance). Moreover, if we find that some persons have already emitted more than their 'equal emissions' allowance, we may reasonably require them to compensate others (assuming that there is some commensurability between emissions permits and other 'goods') by, for example, paying for adaptation.

There are several problems with 'equal emissions'.[14] I want to highlight two important problems. First, it is not at all clear why there should be a universal right to equal emissions. We do not normally distribute particular resources – even newly discovered resources – in an egalitarian manner (Beckerman and Pasek 1995). Indeed, there are very few resources that are distributed equally in the contemporary world. Of course, we need not endorse the distributive principles that appear to operate in (or between) contemporary ('real world') societies (even so-called 'liberal democratic' societies). Instead, we might (and probably should) adopt a more egalitarian theory of global justice.

However, the second problem with equal emissions is that there are good reasons for advocates of egalitarian theories of global justice to support an unequal distribution of emissions. I will suggest two reasons. First, different persons may need different resources to achieve the same levels of welfare or realise the same capabilities. Emission permits are a resource just like the fossil fuels that produce them. Some persons may need to use more energy (and emit more greenhouse gases) than other persons to achieve the same level of capabilities. If we are concerned about equality of (or, at least, sufficiency of) capabilities, we may reasonably reject equal emissions. Second, circumstances may vary between different times and places such that the marginal opportunity costs of not emitting greenhouse gases vary considerably. This variation may be due to a range of factors, including, the availability and cost of non-fossil fuel energy and the energy required to achieve a sufficient

[14] I have discussed some of these problems in Bell (2008).

level of capabilities given the social, economic and technological structure of one's society. For example, it may be reasonable to suggest that current generations should not be entitled to emit as much as previous generations because we have non-fossil fuel energy technology available (or potentially available) to us at an affordable cost, which is consistent with maintaining a sufficient level of capabilities. If the marginal opportunity cost for many citizens in the global North of reducing our greenhouse gas emissions is lower than it is for both previous generations in the North and for current generations in the global South, equal emissions is not the most plausible interpretation of fairness (even for an egalitarian).

I have argued that we should reject equal emissions. If we reject equal emissions, we cannot treat all emissions at all times and places equally. Therefore, we will need to be rather more careful about how we take historic emissions into account in determining future responsibilities to reduce emissions and pay the other costs of protecting basic human rights from the threat posed by anthropogenic climate change. In particular, I have suggested that one unit of emissions from the global North at the beginning of the twenty-first century should not count equally with one unit of emissions from the global South at the same time or with one unit of emissions from the global North at the beginning of the twentieth century. The marginal opportunity cost – measured in an appropriate metric, such as impact on basic capabilities – of reducing greenhouse gas emissions should be considered as well as the level of historic emissions when we try to develop principles for the fair specification and allocation of climate duties. In other words, historic emissions may be relevant in determining the fair allocation of climate duties under just institutions but historic 'subsistence emissions' (with a high opportunity cost) should not be treated in the same way as historic 'luxury emissions' (with a low opportunity cost) (Shue 1993).

5. Climate Duties 3: Duties of Rectification.

So far, I have discussed the general climate duty to promote just institutions and the specification and allocation of climate duties under just institutions. In this section, I will briefly discuss duties of rectification. The general climate duty assumes that the specification and allocation of more specific duties must be done by effective institutions that aim to protect basic human rights from the effects of anthropogenic climate change. This suggests that we have no specific duties – for example, to limit our individual greenhouse gas emissions – until there is 'an actual [and "authoritative"] allocative scheme, operative and in force' (Feinberg 1984, p. 30). This is morally problematic because it suggests that we can continue with 'business-as-usual' greenhouse gas emissions until there are fair effective institutional regulations in place that specify the level at which we are required to limit our emissions. This creates a perverse incentive for continuing non-compliance with the general climate duty: if we don't comply with the general climate duty and just institutions are not created, we do not violate any human rights-based duties by continuing to emit high levels of greenhouse gases.[15] If we want to avoid this problem, we need to go beyond the general climate duty.

I want to suggest two further duties that take us beyond the general climate duty. I will argue that both duties follow from the general climate duty. First, we have a duty to rectify the wrong that we have done if we fail to comply with the general climate duty. On our account, if a person does not comply with the general climate duty, he violates the correlative human rights. We generally recognise that if a person violates another person's human rights, they have a duty to rectify the wrong that they have done.[16] What does rectification require in the context of the general climate duty? Let us assume that

[15] We are, of course, violating human rights by not complying with the general duty to promote just institutions for the protection of basic human rights from the threat posed by climate change.
[16]There may also be reason to punish them for the wrong that they have done.

rectification cannot take place until just institutions are in place and duties are specified and allocated. I would suggest that rectification requires that those who have not complied with the general climate duty should be allocated more burdensome duties, including, for example, lower limits on their future greenhouse gas emissions and a greater share of the monetary costs of adaptation measures. The minimum requirement should be that they are not advantaged over the course of their lifetime by their failure to comply with the general climate duty. Moreover, non-compliers might legitimately be required to accept a worse outcome if rectification (or compensation) of the situation of the victims of human rights violations caused by anthropogenic climate change (who might have been protected but for non-compliance with the general climate duty) requires it. In sum, the general climate duty implies a duty of rectification: under effective institutions, previous non-compliers must accept more burdensome duties that may make them worse off than they would have been if they had always complied with the general climate duty.

The second duty that follows from the general climate duty is the duty not to accept benefits that result from actions that violate someone's human right. If there were full compliance with the general climate duty, we might plausibly assume that effective institutions for specifying and allocating duties to protect basic human rights from anthropogenic climate change would quickly be implemented. Let us assume that some people comply with the general climate duty but others do not and as a result just institutions are not implemented. Some of the compliers may benefit from the delayed implementation of just institutions if, for example, they have been enjoying a lifestyle dependent upon a higher level of emissions than they would have been permitted under just institutions. We might reasonably say that they are benefiting from the actions of the non-compliers. In other words, they are benefiting from actions that violate human rights. It is, however, surely wrong for someone who takes human rights seriously to accept benefits that result from human rights violations. Therefore, I would suggest that the general climate duty also implies a duty not to accept benefits that result from the failure of other people to comply with the general duty.

What does this additional duty require? I would suggest that it requires each person: (1) to reduce their greenhouse gas emissions to a level that they can reasonably believe would be consistent with the specification and allocation of duties by just institutions; and (2) to accept that just institutions can legitimately take into account the historic emissions (and other relevant actions) of those who have complied with the general climate duty (as well as those who have not complied) during the period that just institutions were delayed by non-compliance. In other words, the duty not to accept benefits requires both individual action now in advance of just institutions and compliance with institutions that (fairly and effectively) specify and allocate duties 'retrospectively'.

If this account of duties of rectification is plausible, the failure of Northern states and Northern citizens to comply with the general climate duty over (at least) the last twenty or thirty years has significant implications for their duties now and in the future. The North is guilty of a moral failure in recent times and should seek to rectify that failure. Northern citizens are not only required to comply with the general climate duty (and 'do their bit' to promote just institutions) but are also required to limit their own current and future emissions to a level that they can reasonably believe would be consistent with the specification and allocation of duties by just institutions. Moreover, Northern citizens should be seeking to promote just institutions that will demand a lot from them, including, compensation for the excessive (unjust) emissions that they have emitted since they acquired the duty to promote just institutions (to protect basic human rights from the threat posed by anthropogenic climate change) in the late twentieth century. The demands on Northern states – and, therefore, indirectly on their citizens – might be even greater if it can be successfully argued that

Northern states were culpably ignorant of the threat posed by climate change to human rights much earlier in the twentieth century.

6. Conclusion

I have discussed three kinds of climate duty. First, we have a general climate duty to promote just institutions that will protect basic human rights from the threat posed by anthropogenic climate change. I have suggested that a reasonable account of this duty undermines one important argument – the argument from 'moral failure' – for taking *all* historic emissions into account when we allocate climate duties. We cannot justifiably claim that Northern citizens or Northern states should be held morally responsible for their historic emissions prior to the time when they can reasonably be said to have acquired the general climate duty. However, they can be held morally responsible for their failure to comply with that duty since they acquired it. If we assume that Northern citizens only (directly) acquired the general climate duty in the 1990s, we should regard their pre-1990s emissions very differently from their emissions since the 1990s.

Second, we have a duty to comply with effective institutions that fairly specify and allocate duties to protect human rights from the threat posed by climate change. I suggested that one common argument for taking historic emissions into account when allocating climate duties was based on the idea of a universal right to equal emissions. I offered two criticisms of this argument. First, it is unclear why we should be egalitarians about greenhouse gas emissions when we are not generally egalitarians about other resources. Second, I suggested that egalitarianism about emissions ignores the difference between luxury and subsistence emissions and, more generally, does not take into account the variation between the marginal costs of emissions reductions (measured in a relevant metric, such as capabilities) for different people in different places and at different times. Therefore, I have suggested that a fair allocation of emissions (or emission permits) is not likely to be an equal allocation. Instead, a fair allocation of emission permits should reflect the (marginal) opportunity costs (measured in reduced capabilities) of not emitting greenhouse gases for particular individuals in particular places at particular times.[17]

It is important to be clear about the limits of this argument. First, the criticisms of 'equal emissions' are not intended to show that historic emissions, including pre-1990 emissions, are irrelevant when we are designing just institutions for the specification and allocation of climate duties. Instead, they suggest that most historic emissions should not be counted equally with current and future emissions. So, a fair allocation of emission permits – i.e., duties to limit emissions – and other particular climate duties under just institutions should not be based on a principle of equal emissions over time. Second, 'equal emissions' is not the only possible argument for taking historic emissions into account. For example, it is commonly argued that Northern citizens should pay the costs of anthropogenic climate change because they are benefiting from historic emissions. I have not addressed this (or other) arguments for taking historic emissions into account in determining a fair allocation of climate duties under just institutions. Therefore, there is much more work to be done to offer a fully worked out account of the relevance and role of pre-1990s historic emissions in principles for the fair allocation of climate duties.

The third kind of climate duty that we have identified is duties of rectification. I have suggested that most Northern citizens do have duties to rectify their failure to comply with the general climate duty (since they acquired it in the 1990s). These duties include a duty to reduce their own emissions now to a level that they can reasonably believe is consistent with the allocation of climate duties under just institutions. In addition, Northern citizens should –

[17] If we are capabilities egalitarians, we should seek to equalise the marginal costs of emissions reductions.

to comply with the general climate duty and the duties of rectification – be seeking to promote a global climate regime and effective institutions that will make severe demands on them. In particular, most Northern citizens should expect to be required under just institutions to pay compensation for their unjust post-1990s emissions.

Climate change poses a very serious threat to basic human rights in the twenty-first century and beyond. We have a duty to protect basic human rights from the threat posed by anthropogenic climate change. In this paper, I have offered the outline of a distinctive account of how we should understand our (correlative) climate duties. In particular, I have explored the relevance and the role of historic emissions in the allocation of climate duties. The Chinese Government, like many in the global South, has argued consistently that the global North should be held responsible for the costs of climate change because it is their historic emissions that have caused the problem. I have suggested that this claim should not be accepted without further consideration and some refinement. Specifically, I have suggested that the citizens of the global North do have a duty to pay compensation for our excessive (unjust) emissions during the last twenty or thirty years. However, I have also suggested that earlier emissions should not be treated in the same way. Earlier emissions may be relevant for the allocation of climate duties under just institutions but they are not relevant in the straightforward way that often seems to be assumed in climate justice debates.

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Mitigation of Short-Lived Greenhouse Gases as The Foundation for a Fair and Effective Climate Compromise Between China and The West

Frances C. Moore[1] and Michael C. MacCracken[2]

Abstract

Short-lived greenhouse gases that also contribute to air pollution are playing a major role in global warming. Black carbon alone is likely the second or third most important climate forcing agent. The short atmospheric lifetime of these pollutants means that, unlike CO_2, reducing emissions produces a decrease in atmospheric concentration and a reduction of the radiative forcing that drives climate change. Black carbon and tropospheric ozone also have large negative effects at the regional and local level contributing substantially to indoor and urban air pollution and the formation of Atmospheric Brown Clouds that disrupt regional climate. Moreover, technologies to reduce emissions are available, cost-effective, and have already been widely deployed in developed countries.

Reducing these short-lived greenhouse gases is therefore a mitigation pathway for industrializing countries that is both appropriate to their level of development and highly climatically effective. It is also consistent with both responsibility and capability fairness principles, both of which play important roles in the international climate regime. As such, it offers a way out of the current deadlock between developed and developing countries in which each group asks for more substantial emissions reduction commitments from the other before taking action. China, as the world's largest black carbon emitter, should push for substantial CO_2 mitigation commitments from the developed countries in return for aggressive action to reduce its own soot emissions. This action is consistent with China's own development strategy and would contribute substantially to the mitigation of climate change.

Introduction

The U.N. Framework Convention on Climate Change (UNFCCC), signed at the Rio Earth Summit in 1992, sets as its objective the stabilization of greenhouse gas concentrations at a level that would avoid "dangerous anthropogenic interference with the climate" (Article 2). Although 'dangerous' is a perhaps deliberately subjective terminology, a limit of no more than 2 degrees Celsius above pre-industrial temperatures has been widely discussed and was proposed by the European Union as the policy target for global mitigative action (European Commission, 2009). In order to have a reasonable chance of meeting this target, total global emissions need to peak and begin declining no later than 2020 (Meinshausen, 2006).

Despite the urgency of the climate change problem, the current international regime has been relatively ineffective. The Kyoto Protocol that came into force in 2004 limits the emissions of relatively few states and sets a goal of only 5 percent emission reductions below 1990 levels in the 2008-2012 compliance period. Moreover, a number of states including Canada, New Zealand and Japan are unlikely to meet even the limited commitments they have undertaken through the Kyoto Protocol (Barrett, 2008).

Governments are currently negotiating a successor to the Kyoto Protocol, due to be agreed in Copenhagen this December. The likely compliance period (2013-2017) means that this treaty will be critical in determining whether or not global warming is constrained to below the two degrees threshold. A key element of the negotiations has revolved around how to engage major industrializing countries in mitigation activities. Developing countries currently account for only 25 percent of global radiative forcing but this will grow to over 70

[1] Yale School of Forestry and Environmental Studies, email: frances.moore@yale.edu.
[2] Climate Institute.

percent by 2100 (Moore & MacCracken, 2009).[3, 4] Developing countries have nevertheless refused to accept caps on emissions, pointing to the substantially larger per-capita emissions in the developed North as well as the historical association between use of fossil fuels and economic development (for example, Singh, 2008). On the other hand, developed nations have pointed to the rapid growth in emissions from industrializing countries as a reason why a future climate agreement should have full participation from major emitters (for example, Connaughton, 2007).

China plays a critical role in this part of the negotiations. In 2006 it surpassed the United States to become the world's largest greenhouse gas emitter. Moreover, its rapid economic growth means emissions grew a remarkable 80 percent between 2000 and 2006 alone (Boden, Marland, & Andres, 2009). Nevertheless, its per-capita emissions are only just above the global average (1.27 tons of carbon in 2006 as compared to an average of 1.25), its per-capita GDP is less than half the global average, and more than a quarter of its population lives on less than $2 a day (WRI, 2008). China will therefore be a critical player in solving the climate change problem but, along with other developing countries, is wary of any proposal that would require it to cap its carbon dioxide emissions. Overcoming the current deadlock between developed and developing countries will require finding ways around the major standoff over who should reduce CO_2 emissions in order to identify energy sources and mitigation options that are at once consistent with national development strategies in industrializing countries and have the potential to substantially mitigate global warming.

This paper will outline one such strategy, namely the mitigation of short-lived greenhouse gases that are also air pollutants, and will evaluate it with respect to principles of fairness embodied in the international climate regime, particularly the principles of responsibility and capability. The following section will summarize the role played by short-lived greenhouse gases that are also air pollutants and will outline the key elements of the 'lifetime-leveraging' proposal. Then the burden sharing of the mitigation effort that would result from such an agreement will be assessed relative to fairness principles based on both responsibility and capability metrics.

Short-Lived Greenhouse Gases and the Lifetime Leveraging Proposals

Climate change has for a long time been considered the quintessential long-term environmental problem with the most serious impacts affecting the grandchildren and great-grandchildren of current decision-makers. While it is true that much of the carbon dioxide released now will remain in the atmosphere for tens of thousands of years, it is also the case that some pollutants are short-lived (i.e., have an atmospheric lifetime of weeks to decades) and have a substantial impact on climate over policy-relevant decadal timescales (Archer, 2005). For example, the atmosphere already contains enough long-lived greenhouse gases to raise global temperature by over 2°C (assuming a climate sensitivity of approximately 3°C). Of that, 0.8°C of warming has already been realized, 0.6°C will be realized as the climate system comes to equilibrium, and the remainder is being offset by the cooling effect of (very short-lived) sulfate aerosols (IPCC, 2007b, p. 204).

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[3]Radiative forcing is a useful measure for directly comparing diverse factors that affect the Earth's climate. Measured in Watts per meter squared (Wm^{-2}) , the value describes the equivalent change in net solar irradiance at the tropopause (top of the troposphere) caused by a given climate driver (for example, an increase in greenhouse gas concentration or a change in albedo).

[4]Based on the IPCC B2 scenario (IPCC, 2000).

Agent Emitted	Net Change in Radiative Forcing in 2005 due to Emissions 1750-2005 (Wm^{-2})	Atmospheric Lifetime	Primary Sources
CO_2	1.56	Centuries-Millennia	Fossil fuel burning, deforestation and land use change, cement production.
CH_4	0.86	12 years	Landfills, natural gas leakage, agriculture.
N_2O	0.14	114 years	Fertilizer use, livestock sector, fossil fuel combustion.
CFC / HCFC	0.28	100-1000 years	Aerosols, cleaning products and refrigerants.
CO / VOC (O_3 precursors)	0.27	CO – months VOC – hours (O_3 – days)	CO – incomplete fossil fuel combustion; VOCs – petroleum production and consumption, solvents.
Black Carbon	0.44-0.9	1 week	Fossil fuel combustion, biomass burning.

Table 1. Change in radiative forcing from 1750 to 2005 due to emission of various agents
Source: IPCC (2007b, p. 33, 207) and new results for black carbon from Ramanathan and Carmichael (2008).

Table 1 summarizes the major warming agents, their relative importance, atmospheric lifetime and principal sources.[5] The Intergovernmental Panel on Climate Change (IPCC) estimates forcing from black carbon at 0.44 Wm^{-2}, making it the third most important anthropogenic warming agent after carbon dioxide and methane (IPCC, 2007b, p. 207). New results from Ramanathan and Carmichael (2008) that include observational evidence suggest that warming from black carbon may be as high as 0.9 Wm^{-2}, making it the second most significant warming agent. Black carbon, moreover, has a disproportionate warming effect in vulnerable regions: it is scavenged out of the atmosphere by ice and snow particles, so changing the albedo in sensitive areas such as the Arctic and alpine regions (Hansen & Nazarenko, 2004; Jacobsen, 2004). In addition, black carbon emissions in South Asia have a particular impact on China because many remain in the region and contribute to the formation of Atmospheric Brown Clouds (ABCs), the largest of which sits over the Himalayas where it contributes to the retreat of glaciers on the Tibetan Plateau that form the headwaters of the Yangtze and the Huang He rivers and disrupts the Asian monsoon cycle (Menon, Hansen, Nazarenko, & Luo, 2002; Ramanathan, et al., 2008; Ramanathan, et al., 2007). Tropospheric ozone is not included in Table 1 because it is not emitted directly but the IPCC estimates that it is responsible for 0.39 Wm^{-2} of warming (IPCC, 2007b, p. 207).

Apart from their role in global climate change, black carbon and tropospheric ozone both contribute to air pollution. Approximately 20 percent of black carbon emissions come from the burning of traditional biomass fuels (IGSD, 2008). These emissions are a major component of indoor air pollution, globally the 8th most important health risk factor responsible for 2.7 percent of the global burden of disease (WHO, 2005). In China alone, indoor air pollution is responsible for over 380 thousand deaths a year, or 16 percent of the annual total (WHO, 2007). In addition, both pollutants contribute to urban air pollution, which causes an additional 275 thousand premature deaths in China each year (WHO, 2007).

[5] Although tropospheric ozone and black carbon are collectively referred to in this paper as ‘short-lived greenhouse gases’ for convenience, it should be noted that black carbon is strictly speaking not a gas but a particle aerosol.[Just a grammatical note—“particulate” is an adjective—as in particulate matter, so one needs to use both words, or shorten it to “particle”]

Finally, ozone pollution causes cellular damage in plants and has a substantial effect on primary productivity both in natural and agricultural ecosystems. Ozone-associated agricultural losses in Asia are expected to reach $8 billion by 2020 (Wang & Mauzerall, 2004).[6]

The multiple order of magnitude differences in atmospheric lifetime shown in Table 1 have significant policy implications. The long-lived greenhouse gases regulated by the Kyoto Protocol are 'stock' pollutants in that a reduction in emissions will reduce the rate of increase of atmospheric concentration but cannot reduce the total amount of gas in the atmosphere.[7] In contrast, black carbon and tropospheric ozone are 'flow' pollutants, meaning that a reduction in emissions will decrease the atmospheric concentration and the corresponding radiative forcing. Figure 1 shows the implications of this difference for climate policy. Because of its long lifetime, halting emissions of CO_2 today would result in a decrease in associated radiative forcing of only 38% by 2050. In contrast, halting emissions of black carbon, methane and ozone precursors would eliminate the radiative forcing from these pollutants. With the world already flirting dangerously with the two degree warming threshold, mitigation of short-lived greenhouse gases offers one of the only opportunities to actually reduce radiative forcing in the near term, so 'buying time' to control and begin reducing emissions of long-lived greenhouse gases.

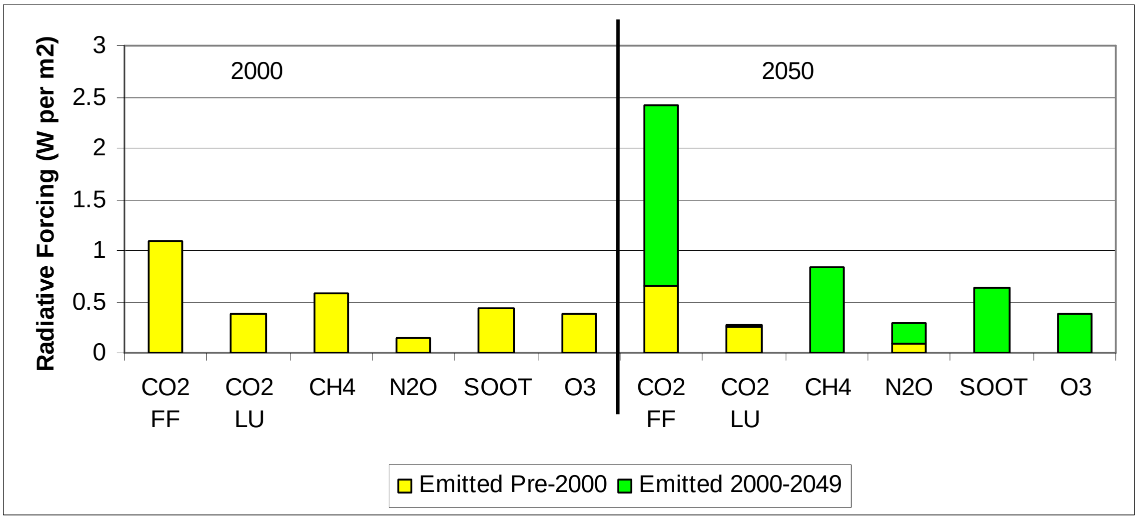


Figure 1. Radiative forcing from CO_2 from fossil fuels, CO_2 from land use change, methane, nitrous oxide, soot (black carbon) and tropospheric ozone in 2000 and 2050. Yellow represents warming from emissions that have already occurred. Green represents warming from emissions taking place between 2000 and 2049 which can therefore be controlled through emissions policies put in place today. Adapted from Moore and MacCracken (2009).

In a 2009 paper, Moore and MacCracken outlined a 'lifetime leveraging' proposal for a post-Kyoto agreement that would use mitigation of short-lived greenhouse gases to achieve early reductions in radiative forcing that would offset continued growth in CO_2 emissions

[6] Ozone is also an important part of what may become a significant carbon-cycle feedback. Warmer temperatures due to global warming accelerate the rate of ozone production which in turn harms forest ecosystems, weakening the land carbon sink and accelerating the build up of CO_2. Modeling studies indicate that the indirect radiative forcing from this feedback effect in 2100 will be comparable to the direct forcing from elevated O_3 concentrations (Sitch, Cox, Collins, & Huntingford, 2007). Ozone abatement policies can thus directly mitigate global warming while also protecting the land carbon sink.

[7] Methane, the only one of the bundle of six greenhouse gases regulated by the Kyoto Protocol with an atmospheric lifetime less than a century, is the exception. With a 12 year residence time, methane might be considered a stock pollutant for the purposes of the (5 year) Kyoto commitment period but is a flow pollutant for the purposes of long-term (multi-decadal) policy-making.[good point]

from industrializing countries (Moore & MacCracken, 2009). In the 'lifetime leveraging' architecture, developed nations (those with a per-capita GDP greater than $10,000) would commit to ambitious reductions in all greenhouse gas emissions, middle-income nations (per-capita GDP $3,000 to $10,000) would commit to similar reductions of black carbon, tropospheric ozone and methane, as well as improvements in energy efficiency and carbon intensity. Countries would graduate between groups and take on additional mitigation commitments as they developed, with graduation based on both per-capita and emissions and per-capita GDP indicators. Preliminary modeling shows that for realistic but ambitious emissions cuts by developed countries, on the order of 80 percent by 2050 and 90 percent by 2100, this proposal would result in an equilibrium temperature increase of between 2 and 2.5 degrees Celsius (MacCracken & Moore, 2009).[8]

In order to be effective, a post-Kyoto treaty must be both climatically rigorous, with a reasonable chance of limiting warming to less than two degrees above pre-industrial temperatures, and within the 'political-contract zone' of major emitters if it has any chance of being agreed to and enforced. Climatically, in addition to the sharp emission cutbacks in the developed nations, the key to the 'lifetime leveraging' proposal is the early abatement of short-lived greenhouse gases in middle income countries. This action produces a reduction in radiative forcing that offsets continued growth in CO_2 emissions in industrializing nations, which remain uncapped for several decades.[9] Politically, the question is whether the central trade-off in which middle-income countries begin working on short-lived greenhouse gas mitigation in return for uncapped CO_2 emissions in the near term will be considered fair and politically acceptable to those governments and constituencies. The following sections will consider the fairness question by evaluating the 'lifetime-leveraging' framework with respect to the fairness principles of common but differentiated responsibility and respective capabilities embodied in the UNFCCC under Article 3.

Responsibility

Perhaps because it is a principle that can mean many things to many people, the common but differentiated responsibility (CBDR) principle has become near-universal in mitigation burden sharing proposals. CBDR is usually understood to mean that while all nations have an interest in the protection of the Earth's climate, their duty to protect it is linked to the degree of responsibility they bear for the problem. Nevertheless, its interpretation has not been uncontested since the signing of the UNFCCC in 1992. While developing countries argue that CBDR means they have should have no binding emission reduction commitments until developed countries have made substantial progress on cutting emissions, developed nations, particularly the United States, have focused on the 'common' nature of the responsibility to argue for universal participation in the mitigative effort (Harris, 1999).

Even if the CBDR principle is accepted in theory, implementing it in practice by assigning mitigation commitments according to some responsibility metric is not a purely objective exercise. Instead, the flexibility of CBDR interacts with national political-economic circumstances to produce a multitude of proposed responsibility criteria, usually not unrelated

[8] This would not be the warming in 2100 because the Earth's temperature takes some time to equilibrate to changes in radiative forcing. Instead this equilibrium temperature rise would be realized over the course of one to two centuries.

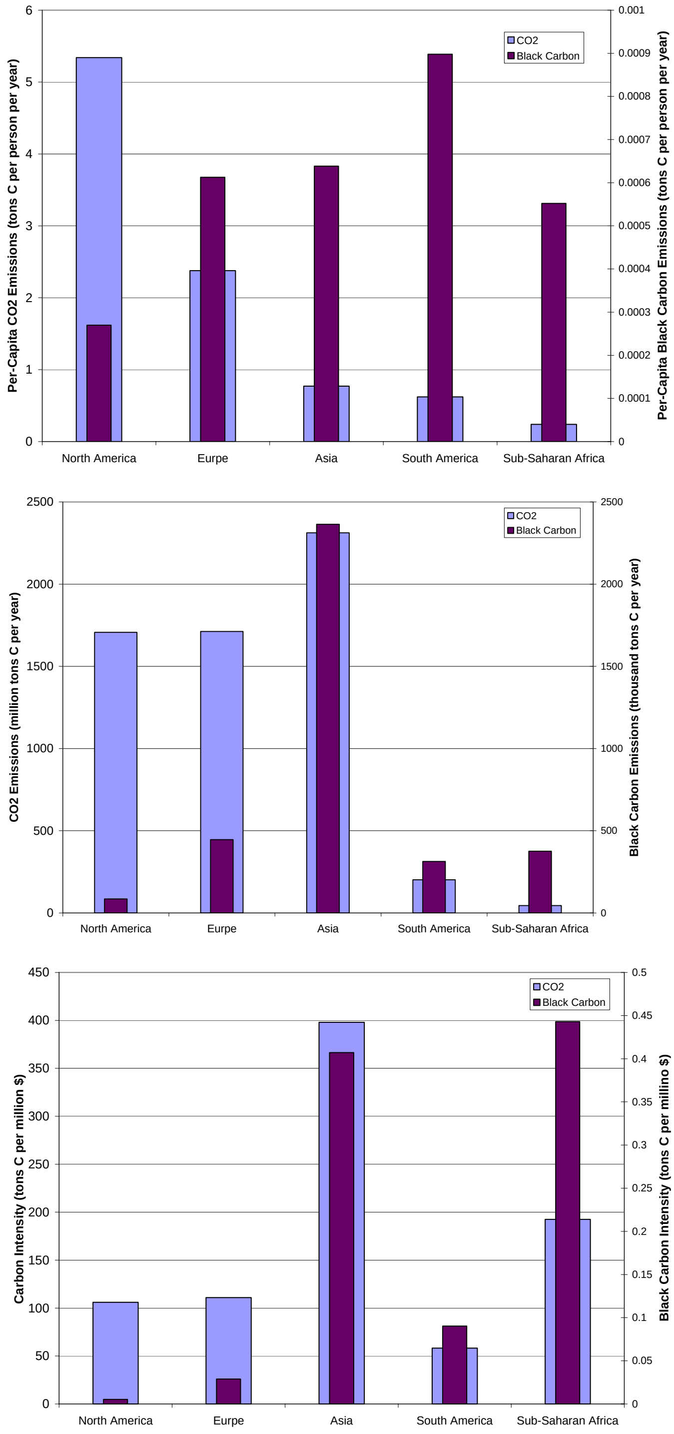
[9] To the extent that the industrializing nations can begin reducing the growth in their CO2 emissions and prepare for later beginning to cut emissions back, there would be a further reduction in the warming influence. [One of the interesting results from the EMF-22 study was that the overall costs for mitigation are lower if the industrializing countries early on the set the date that they will join in starting to reduce CO2 emissions—this has the effect that those in the industrializing nations plan ahead and do not keep constructing coal plants right up to the time of the changeover, etc.—so there is a push to get those countries to set a date certain to join in cutting emissions—and this would require looking ahead more than 5 years.]

to the self-interest of those proposing them (Ringius, Torvanger, & Underdal, 2002). A principal question is whether responsibility should be differentiated according to current emissions or, given the long atmospheric lifetime of CO_2, whether historic emissions should be taken into account? With a long industrial history, the United States has repeatedly rejected taking past emissions into account (Grubb, 1995).[10]

Basing responsibility purely on absolute emissions is also unsatisfactory because it fails to take into account variations in national circumstances between countries. For example, China and the United States produce roughly the same amount of greenhouse gas emissions but China has four times as many people and so many would agree it should be considered less responsible than the US. The principle of per-capita emissions as a metric for assigning responsibility, stemming from the idea that all should have equal access to the atmospheric commons, is perhaps the most widely-accepted responsibility metric (for example, Baer, Athanasiou, Kartha, & Kemp-Benedict, 2008). Nevertheless, other normalizing criteria have been suggested. The Bush administration evaluated progress on combating climate change based on carbon intensity (emissions per unit GDP), reflecting an assumption that economic growth and production are socially-beneficial and should not be sacrificed to protect the climate (White House, 2002). Similarly, Russia, the largest country in the world, proposed that responsibility should be based on greenhouse gas density (emissions per unit land area; Ringius, et al., 2002). This analysis will look at both per-capita, absolute emissions and intensity metrics (since the greenhouse gas density proposal has received little support in the international negotiations), though recognizing that the per-capita principle is better established as a responsibility metric and that significant controversy remains around the use of carbon intensity. The analysis will also focus on black carbon and fossil fuel CO_2 emissions, for which good emissions data are available, as representative examples of short- and long-lived greenhouse gases respectively.

Figure 2 shows emissions of fossil fuel CO_2 and black carbon in major regions, as well as emissions normalized by population and GDP. The per-capita emissions graph is particularly interesting, showing an almost perfect inverse relationship between per-capita CO_2 emissions and per-capita black carbon emissions. North America, with by far the highest level of per-capita CO_2 emissions nevertheless has the lowest per-capita black carbon emissions. Similarly, Asia, South America and sub-Saharan Africa have very low per-capita CO_2 emissions but high black carbon emissions. This difference is a combined result of the deployment of black carbon abatement technologies that has reduced industrial emissions in the US and Europe, inefficient and polluting coal combustion technologies in use in industrializing economies, and the widespread burning of traditional biofuels in Africa and Asia.

[10] Note that the question of historic emissions is less relevant for short-lived greenhouse gases because they are rapidly removed from the atmosphere. Nevertheless, because of a lag in the equilibration time between radiative forcing and global temperature, a long history of short-lived greenhouse gas emissions adds energy to the Earth system that has an impact even after emissions have ceased and the gasses have been removed from the atmosphere.



A

B

C

Figure 2. A: per-capita CO_2 and black carbon emissions. B: absolute emissions. C: CO_2 and black carbon intensity (normalized by GDP). (World Bank, 2008; Bond, et al., 2007; UNPOP, 2009; WRI, 2008).

Assigning responsibility solely on the basis of absolute emissions would again result in North America and Europe having high responsibility for CO_2 emissions but far lower responsibility for black carbon. Asia is responsible for high-levels of both while South America and sub-Saharan African release minimal levels of both. In the context of this paper it is interesting to note the relative responsibilities for CO_2 and black carbon emissions. So while North America, Europe and Asia are responsible for roughly equal proportions of total CO_2 emissions (30-40 percent), Asia is responsible for a far greater proportion of the black carbon emissions (66 percent) than either Europe (12 percent) or North America (2 percent). Similarly, Africa is responsible for less than one percent of CO_2 emissions but over 10 percent of black carbon emissions.

Using the carbon intensity metric shows low responsibility in the service-based economies of North America and Europe but high responsibility in both Asia and Africa. As noted above, the intensity metric is of dubious use as an indicator of responsibility because it obscures the historical increase in greenhouse gas emissions associated with GDP growth, which is a key structural fact of the climate change problem. Nevertheless, comparing the most efficient with the least efficient gives an impression of the scope for improvement. So a unit of wealth produced in Asia is associated with 3.5 times more CO_2 emissions but with over 75 times more black carbon emissions than an equivalent unit produced in North America. At first glance, this suggests there may be significant scope for improvement, though this conclusion is questioned by some researchers that point to an offshoring of environmentally-damaging production by rich countries to poorer countries, resulting in artificially low carbon intensities in wealthy nations (Heil & Selden, 2001; Roberts & Parks, 2006, pp. 163-169).

Fairness principles based on responsibility are more difficult to apply than it would first appear because widely varying political and economic national circumstances lead to conflicting claims over fair ways of evaluating responsibility. In a complex and morally-ambiguous world in which understandings of fairness are contextual and socially-constructed, it is counter-productive to arbitrarily select any one definition of responsibility. Instead, a useful way forward is to evaluate multiple metrics and develop policy based on findings that are robust under multiple assumptions. The analysis above shows that under all measures of fairness Asia is responsible for a high proportion of the black carbon problem whereas North America and, to a lesser extent, Europe have a low level of responsibility. In contrast, the two commonly used measures of responsibility (per-capita and absolute emissions) show the developed world as having a large responsibility to mitigate CO_2 emissions. Moreover, all responsibility metrics show the developing world as *relatively* more responsible for black carbon than for the CO_2 problem. In the face of mitigation resource constraints, this finding suggests that it is fair for mitigation actions to be differentiated according to the 'lifetime-leveraging' proposal so that industrializing nations such as China work on reducing long-lived greenhouse gas emissions and industrializing nations work on short-lived emissions and particularly black carbon.

Capability

Although less frequently cited as a principle of mitigation burden sharing than CBDR, differentiating responsibilities based on 'respective capabilities' (Article 3, UNFCCC) is also an important principle of the Convention. The principle finds its roots in a long-standing and fundamental tradition of international environmental policy – that developing nations should not have to sacrifice scarce resources to environmental improvement in the face of more pressing basic development needs (Bernstein, 2002). Implementation of this principle has seen many international environmental treaties include temporary exemptions for developing countries or financial transfers from the North to the South to aid compliance with commitments.

In terms of climate change specifically, implementation of the capability principle has been developed through research into the determinants of mitigative capacity. Originally proposed by Yohe (2001), mitigative capacity has been defined by the IPCC as "a country's ability to reduce anthropogenic greenhouse gases or enhance natural sinks" (IPCC, 2007a, p. 696). The determinants originally proposed by Yohe include the range of viable technological options available to a country or community, the range of viable policy instruments, institutional structure and the stocks of human and social capital (Yohe, 2001). In developing the concept further, Winkler et al (2006) explicitly link mitigative capacity with development pathway and use two indicators of capability, the Human Development Index and per-capita GDP. Similarly, indicators proposed by the World Resources Institute include life expectancy, literacy rate, per-capita GDP and energy use (Jones, 2009 citing WRI, 2008).[11]

A solid theoretical foundation for differentiating mitigation commitments based on capacity (essentially synonymous with level of development) exists in the literature and is being employed in the international climate regime. However, the lack of any empirical evidence that high mitigative capacity actually corresponds to mitigation (Jones, 2009) suggests that the mitigative capacity concept may be playing a normative role in the negotiations: it is not so much that countries with high mitigative capacity (developed countries) can or do mitigate more, so much as they *should* mitigate more. Seen this way, the capability-based fairness principle is already playing an important role in the negotiations.

As can be seen from Table 2, there are significant disparities in the proposed mitigative capacity / development indicators, particularly in the GDP per capita and energy use variables. Not only are the developing countries of Asia, South America and Africa less responsible for the climate change problem (as demonstrated in the previous section), they are also less able to implement solutions. This is may be part of the reason why so much of the climate negotiation process seems to revolve around entrenched divisions between developed and developing countries (Grubb, 1995). Nevertheless, climate change cannot be solved by developed countries alone: even if emissions in OECD countries were to go to zero in 2013 after the expiry of the Kyoto Protocol, the two-degree threshold of radiative forcing would be reached before 2050 based solely on emissions growth in the developing world (Moore & MacCracken, 2009). Given that key industrializing countries will have to be part of an effective climate agreement, the rest of this section will ask whether these nations are *more* capable of mitigating short-lived as opposed to long-lived greenhouse gases, again using black carbon and fossil-fuel CO_2 emissions as representative examples.

	Life Expectancy	**Literacy Rate**	**Per Capita GDP**	**Energy Use**
	Years	Percent	$ per Year (PPP)	Tons of Oil Equivalent per Person per Year
North America	78.1	99	41,141	7.9
Europe	74.8	98.7	21,513	3.8
Asia	68.9	78.4	4,547	1.1
South America	72.4	90.8	8,263	1.2
Sub-Saharan Africa	49.9	59.9	1,755	0.7

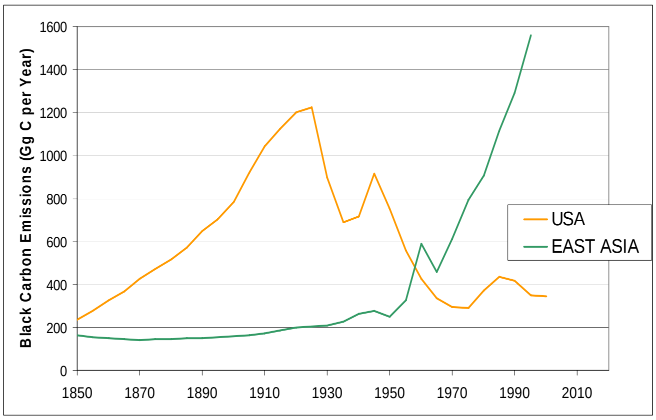
Table 2. Selected capability indicators from WRI (2008).

Figure 3 summarizes the key differences between mitigation of short-lived and long-lived greenhouse gases, using the US and East Asia as examples of developed and developing

[11] In its current formulation, mitigative capacity can become conceptually confused with responsibility because it is generally accepted that the capacity to reduce emissions increases with emissions (note both the technological options determinant proposed by Yohe (2001) and the energy use indicator included by WRI (2008)). This is a result both of the observed relationship between economic development and emissions and of the idea of subsistence emissions (the emissions needed to provide basic human needs) as opposed to luxury emissions that are easier to mitigate (Shue, 1993). This not only makes it more difficult to distinguish between responsibility and capability principles, but also results in the paradoxical conclusion that enhancing mitigative capacity requires increasing emissions (Jones, 2009).

regions respectively. Technologies to reduce black carbon (and to a lesser extent tropospheric ozone) have already been developed and deployed in the United States in order to abate air pollution, resulting in a reduction of black carbon emissions by over half between 1950 and 2000 and by almost three quarters since emissions peaked in 1920. Similar declines have occurred in Western Europe since the 1950s. In contrast, no developed nation has managed to truly bring fossil fuel CO_2 emissions under control and there are no examples of large, wealthy countries with per-capita emissions low enough to be considered sustainable. In other words, it is as yet unclear what a low carbon society with a high standard of living would look like, which is not the case for short-lived greenhouse gases that are also air pollutants.

The fact that air pollution abatement technologies were deployed in the North long before global warming became a serious policy concern speaks to another element of the capability principle. Pollution control confers benefits as well as costs and a country is more capable of controlling pollution to the extent that it can benefit from those efforts – not only does it make it more economically beneficial, but also more politically feasible in that measures can be justified to constituents on the basis of local environmental improvements. However, in the case of long-lived greenhouse gas emissions, this aspect of capability becomes irrelevant because it would require states likely to suffer the most from climate change to be responsible for the most mitigation. This not only runs in direct opposition to the responsibility principle but is entirely impractical given that the most vulnerable states are the least developed countries with extremely limited resources (Ringius, et al., 2002). Nevertheless, in the context of mitigating short-lived greenhouse gases, which has substantial local and regional co-benefits, the distribution of abatement benefits may have a significant impacts impact on a country's capability to take action.



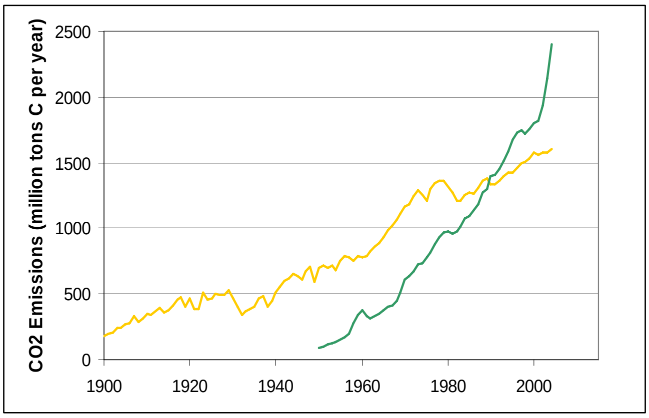


Figure 3. Left – black carbon emissions in the US and East Asia. Right – Fossil fuel CO_2 emissions (Bond, et al., 2007; WRI, 2008).

		Local	Regional	Global
Black Carbon and O_3	Benefit:	Reduced morbidity and mortality from indoor and urban air pollution.	Reduced ABC formation and associated glacier melt, monsoonal disruption and surface dimming.	Reduced impacts from global climate change.
	Relative Magnitude:	Substantial	Small to moderate	Moderate
	Time Scale:	Immediate	Immediate to decadal	Multi-decadal
Fossil Fuel CO_2	Benefit:	None	None	Reduced impacts from global climate change.
	Relative Magnitude:	NA	NA	Very Substantial
	Time Scale:	NA	NA	Multi-decadal

Table 3. Comparison of the geographical and temporal distribution of benefits for short-lived greenhouse gases and fossil fuel CO_2 emissions. The magnitude of the benefits is subjectively assessed and is relative to the total benefits for that action. Variations in time scale result from differential responses of different natural systems. Based on Ramanathan (2008) and WHO (2005).[12]

Table 3 compares the geographical and temporal distribution of direct benefits from the abatement of short-lived greenhouse gases and fossil-fuel CO_2 emissions. Industrializing countries will be more capable of mitigation to the extent that a greater fraction of benefits occur locally and immediately as opposed to globally and in the distant future. In this respect, it is clear that abatement of short-lived greenhouse gases is a far better fit with the capabilities of industrializing countries in that it would result in an immediately-apparent improvement of local air quality. In fact, governments in developing countries are already implementing policies to improve local air quality: New Delhi is switching the municipal bus system to compressed natural gas to reduce air pollution while Beijing is considering making pollution-control measures implemented for the Olympics permanent (Oster, 2008). Integrating these existing and emerging policies with climate change mitigation efforts could both generate significant improvements for the climate and overcome the developed-developing state deadlock in the negotiations.

It appears from the analysis above that industrializing countries will be more capable of mitigating short-lived greenhouse gases than CO_2 emissions. Not only does the technology to reduce these emissions exist, but it has already been widely deployed in developed countries with demonstrated success. Moreover, these policies were implemented because of air quality concerns alone, which are becoming increasingly serious in major industrializing countries. Many of these countries are already looking to improve air quality. Because of this, incorporating these policies into the climate regime, with its associated financing and technological transfer benefits, is far more likely to be within the capacity of developing countries than setting a cap, even an expanding cap, on fossil fuel emissions.

[12] Mitigation of fossil fuel CO_2 emissions can have significant side benefits in terms of reduction of co-emitted air pollutants such as sulfates, NO_x, and particulate matter (including black carbon; IPCC, 2007a, pp. 619-690). The magnitude of these benefits will vary depending on mitigation strategies used. For example, they may be substantial for fuel switching to renewables but minimal for carbon sequestration.

Conclusions: China and Lifetime Leveraging

Despite the fact that it is still an emerging economy, China, as the world's largest greenhouse gas emitter, is coming under increasing pressure to reduce its role in global climate change. Partly in response to these concerns, the Chinese government has already adopted ambitious energy intensity, carbon intensity and renewable energy targets (Wong & Light, 2009). Moreover, the country is one of the world's largest investors in renewable energy with a rapidly growing wind energy sector and the world's largest solar hot water market (Martinot & Junfeng, 2007). Nevertheless, it has continued to resist accepting a binding cap on its greenhouse gas emissions in the international negotiations (Doyle, 2009).

Adopting aggressive mitigation of short-lived greenhouse gases such as black carbon, tropospheric ozone and methane as proposed in the 'lifetime leveraging' architecture would not only reduce China's contribution to climate change by reducing the atmospheric burden of these pollutants and the associated radiative forcing, but would also address its substantial air quality problems. China contains four of the ten most polluted cities in the world and urban air pollution is responsible for approximately 1 in ten of every death in China (WHO, 2007). Policies to improve industrial combustion efficiency, to replace traditional biomass burning with improved stoves, and to reduce tropospheric ozone formation all have substantial health co-benefits consistent with China's national development strategy. Moreover, the technology to implement these policies exists and has already been deployed in developed nations.

The analysis above of the responsibility and capability fairness principles has shown that 'lifetime leveraging' would be a fair and highly climatically effective way for China to engage in climate change mitigation. Furthermore, engaging in such a strategy would give China political leverage to demand more ambitious mitigation targets for long-lived greenhouse gases from the developed world, as well as similar cuts in short-lived greenhouse gases from other industrializing nations. Taken together, these actions by developed and industrializing countries would be enough to give the world a good chance of avoiding the two degree threshold and of achieving the UNFCCC objective of avoiding 'dangerous anthropogenic interference with the climate'.

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Social Economic and Political Aspects of Climate Change

Anandi Sharan[1]

Abstract

Instead of the notion that "developing countries will be able to use emission backed currency units to pay off their debts", we find "developing countries must forgive developed countries their $ debts so that the ecbu-based climate regime can be introduced." Looking at foreign debt as it stands, India may not yet have an interest in an emission backed currency unit (ecbu), and other developing countries might or might not either, or too, not until the dollar mess is sorted out. More important before the introduction of the emission backed currency unit is the demise of the dollar economies and their demise cannot be hastened by the introduction of the ecbu because the quantum of ecbu bears no relation at all to the quantum of foreign exchange circulating in the developed country economies today. The data suggests that the old international economy based on dollars is finished. There is no way these countries can ever pay back their debt, nor should they, because they would need fossil fuels to do so. Therefore all debts in all currencies in all countries must be forgiven. This is the same as saying the economies have to collapse. Once these economies have agreed to collapse, a new climate bank is established. Every person gets three point eight emission backed currency units and three point eight permits in the first year, declining to one permit per person in 2050. In this period the world trades, gently, prudently, as India has been doing, just to get what we need from the international market, which is basically renewable energy systems.

Five Tracks for Achieving Equitable Sustainable Outcomes

India is lower on the Global Hunger Index than at any time in its history. We will not fix this if we go it alone. In order to achieve an equitable sustainable outcome for India and all developing countries at the UNFCCC, the post 2012 agreement will consist of three, and ideally four and, for a global economy based on equitable arrangements, five parallel tracks of actions.

One - Cuts

One will be the 40% reduction against 1990 levels by developed countries by 2020, or 50% if CDM is still in the picture (but is it still needed? see item four below).

Two – Contraction and Convergence

Two will be a global agreement to achieve the objective of the Convention based on the Bali Plan of Action, in which a contraction and convergence scenario will see a global commitment to a reduction to 1 tonne carbon dioxide equivalent per person by 2050. This is a global cut of 50% against 1990 levels by 2050.

Three – Country-Specific Trajectories

Three, all countries with emissions above the equitable sustainable emissions level will track their trajectory against the commitment to achieve a reduction of emissions to the global equitable sustainable per capita level of one tonne per person by 2050. If this is agreed, the UNFCCC would have to create country-specific emissions trajectories, to be agreed as a

[1] Women for Sustainable Development, 32/2 Kempapura Road, Hebbal, Bangalore 560024, Karnataka, India
Tel 00918023637007, Tel 00918023624546,www.bloganandi.blogspot.com, email: Sharan.anandi@gmail.com

follow up to Copenhagen, where the commitment might be that each country agrees to finalise its trajectory with the Secretariat by the following CoP 16 and begins implementing it thereafter.

Four – Cap and Share

Four involves monitoring of items one, two and three which will be much facilitated if the emission reductions under track one above for developed countries and a reduction by high emitting developing countries to the equitable sustainable per capita emissions level by 2020 under tracks two and three are managed through global cap and share, and replace CDM. Cap and share will replace CDM as the trade relationship between developed and developing countries under the UNFCCC, and has the advantage of avoiding several peculiarities of the CDM system such as offsetting, additionality and incremental costing. Cap and share is a simple trade regime for transfer of financial resources for new technologies for the developing countries based on equitable and sustainable per capita allocation of permits in a global regime AND thus making it more difficult for developed countries to escape their obligations. Under cap and share the UNFCCC converts the global cap every year into a per capita equal emissions entitlement. It allocates these entitlements to each citizen in the world equally, and oil importers and coal producers must buy them from the banks and post offices that act as bundling agencies of these permits in each country as citizens sell them in return for money. The money helps citizens to some extent adjust to rising energy prices, though it will not be enough for citizens in developed countries who must cut their emissions to stay within equitable sustainable per capita emission limits and must therefore change their development path radically. Developed countries will buy permits from developing countries in order to back the emissions required to build renewable energy systems for export. In any case no producer anywhere can emit greenhouse gases if they are not backed by permits. In this scenario developed countries will still not be at the equitable sustainable global average by 2020, but will reach this sometime between 2030 and 2040. On the other hand higher emitting developing countries like China will begin their reduction path now and may be at the equitable sustainable per capita emissions level earlier. The trajectories of all countries may be watched against the global equitable sustainable per capita emission level. But it is the permit system of cap and share by a new UNFCCC bank/fund/CoP agency that will ensure that reductions take place as does development through financial flows from selling permits from permit-surplus countries to permit-deficit countries. Only if a country is above the equitable sustainable per capita emissions level will it have to buy permits from outside the country. If it is below it gains from selling permits. India will double or triple its GDP overnight. As the permits limit oil, coal and gas production to within the global sustainable emission reduction trajectory, the price of permits can be left to the market, but see five. Under cap and share monitoring of a country's emissions becomes a subset of monitoring coal, oil and gas production which must not take place without permits. This is a different type of policing than there has been hitherto (there has not been any) and will require cooperation from governments through their climate and energy ministries. This is no big deal as industrialisation in India has not served the poor in any case.

Five – Emission Backed Currency Units

Unlike a real currency the UNFCCC permits cannot be horded and they expire at the end of the year of issue. The USD and the Euro, the Pound Sterling and all other currencies of high emission countries will lose value rapidly as they adjust to their buying power in relation to permits. At present there is much too much of this consumer money in circulation in developed countries and on the other hand money for food and livelihoods and energy equity is not circulating to the developing countries. Thus there is a need for a new global currency backed by permits. The currency is distributed on the basis of population, as are permits, and starts off at the parity value of one emission backed currency unit to one permit. Thus if Ireland needs permits it must sell something to India for which India pays in ecbu, with which Ireland in turn can buy permits for its excess oil or coal requirement, and there may be competition for permits which will see their price rise to 2 or 3 emission backed currency units for one permit. In this case the UNFCCC money management institution will recognise that there is too much demand for fossil fuels and too much global trade, and it will take these emission backed currency units (ecbu) out of circulation the following year to restore the parity between the ecbu and a permit.

These are the five parallel tracks of action needed. After 2050 the emissions of 1 tonne carbon dioxide equivalent per person will be reviewed in the context of global and country-level sinks and the UNFCCC will move the world towards a net zero emissions of greenhouse gases regime. Most emissions will probably be used for high value internet communication to facilitate the UNFCCC process. The sustainable per capita emission level is assumed to be 3.8 tonnes carbon dioxide equivalent in Year 1, which is the average for 2006 less 15% for the Adaptation Fund. The projected transfers of permits from 2010 to 2050 are given in table 1. It is not possible to track the price of permits in ecbu at this stage, but it should never remain very far away from parity given the monetary management expected. You see that India and the USA are at opposite ends in the table. India has an historic interest in achieving agreement on all five tracks to meet the objective of the UNFCCC.

Table 1: Surplus deficit of permits year 1

Country	Surplus/deficit of permits Year 1
Adaptation Fund	-4,003,329,227
India	-3,202,273,334
Indonesia	-602,359,134
Bangladesh	-577,122,495
Pakistan	-558,600,283
Nigeria	-480,077,152
Brazil	-350,630,579
Ethiopia	-317,078,777
Philippines	-279,995,995
DR Congo	-255,017,837
Vietnam	-241,663,971
Myanmar	-178,049,307
Tanzania	-165,681,206
Egypt	-158,768,549
Sudan	-150,399,983
Kenya	-142,993,063
Uganda	-126,420,095
Colombia	-110,275,003
Nepal	-110,273,357
Afghanistan	-109,894,166
Morocco	-89,482,937
Mozambique	-83,267,400
Peru	-81,033,480
Cote d'Ivoire	-74,276,669
Madagascar	-73,788,081
Yemen	-71,745,654

Cameroon	-67,750,991
Sri Lanka	-65,199,600
Burkina Faso	-60,673,115
Niger	-58,792,174
Malawi	-58,461,586
Cambodia	-56,487,810
Mali	-49,766,105
Zambia	-47,362,181
Chad	-43,473,718
Senegal	-42,822,650
Guatemala	-41,664,705
Angola	-38,609,195
Rwanda	-38,170,458
Guinea	-37,750,882
Zimbabwe	-37,371,416
Haiti	-36,566,614
Algeria	-34,481,228
Turkey	-34,262,889
Burundi	-31,972,287
Benin	-31,905,135
Ecuador	-26,455,697
Syria	-24,632,493
Bolivia	-24,266,749
Laos	-23,869,183
Togo	-22,698,551
Honduras	-21,181,677
Sierra Leone	-21,018,539
Paraguay	-20,816,887
Papua New Guinea	-20,528,356
Dominican Republic	-19,549,858
Tajikistan	-19,390,903
Eritrea	-19,046,658
Tunisia	-18,044,098
El Salvador	-17,844,930
Nicaragua	-17,348,817
Central African Rep	-16,783,330
Kyrgyzstan	-15,822,965
Liberia	-14,527,837
Cuba	-14,332,723
Georgia	-11,812,743
Costa Rica	-11,081,797
DRKorea	-10,606,507
Serbia	-9,856,000
Mauritania	-9,586,202
Congo	-8,672,265
Ghana	-8,455,930
Albania	-7,893,824
Lesotho	-7,696,482

Moldova	-7,376,513
Uruguay	-6,588,310
Gambia, The	-6,319,267
Guinea-Bissau	-5,799,760
Namibia	-5,492,988
Timor-Leste	-4,449,800
Somalia	-3,716,362
Swaziland	-3,470,953
Iraq	-3,321,820
Western Sahara	-2,964,531
Jordan	-2,795,646
Botswana	-2,791,521
Comoros	-2,512,863
Mongolia	-2,414,803
Bhutan	-2,344,613
Fiji	-1,992,518
Solomon Islands	-1,831,340
Cape Verde	-1,631,478
Guyana	-1,258,291
Gabon	-1,140,999
Armenia	-1,003,403
Reunion	-837,000
Vanuatu	-810,296
Mauritius	-751,427
Montenegro	-626,000
Thailand	-592,811
Maldives	-557,616
Sao Tome	-541,794
Samoa	-537,749
Lebanon	-455,856
Martinique	-406,000
Kiribati	-343,804
Macedonia	-303,729
Saint Lucia	-265,890
Tonga	-254,332
Saint Vincent	-225,495
Dominica	-163,737
Belize	-112,822
Grenada	-79,651
Saint Kitts and Nevis	-11,712
Saint Helena	-8,083
Cook Islands	-5,239
Niue	-2,000
Montserrat	23,226
Saint Pierre	48,430
Latvia	94,756
Nauru	98,471
Bosnia and Herz.	259,910

Suriname	266,386
Djibouti	278,220
Cayman Islands	307,654
Barbados	395,102
Greenland	401,997
Antigua & Barbuda	515,937
Faroe Islands	533,729
Seychelles	641,222
Macau	671,167
Guam	1,306,107
Jamaica	1,527,429
Malta	1,632,962
Argentina	1,729,514
Lithuania	1,910,194
Panama	2,531,660
Iceland	2,532,316
Equatorial Guinea	3,167,739
Chile	3,632,776
Croatia	4,268,862
Bahamas	4,385,629
Gibraltar	4,848,949
Cyprus	6,658,053
Taiwan	9,385,118
Brunei	9,399,051
Slovenia	10,056,585
Azerbaijan	10,156,854
Luxembourg	11,061,444
Romania	13,193,266
Estonia	13,731,819
Switzerland	17,133,262
Uzbekistan	17,379,950
Slovakia	17,396,367
Hungary	20,703,957
Bulgaria	21,187,067
Oman	21,467,632
Portugal	21,663,489
Sweden	23,810,380
New Zealand	24,011,775
Puerto Rico	26,975,051
Belarus	27,581,063
Bahrain	27,953,597
Mexico	28,100,318
Norway	29,092,971
Turkmenistan	32,235,045
Libya	34,489,864
Ireland	35,502,289
Denmark	38,633,034
Finland	39,272,332

Israel	43,745,103
Austria	46,330,550
Trinidad & Tobago	54,454,473
Hong Kong	59,574,415
Venezuela	61,763,385
Greece	69,537,306
Czech Republic	78,737,621
Malaysia	81,014,270
Kuwait	82,758,270
Qatar	86,540,003
Belgium	111,460,877
Singapore	133,554,765
UAE	147,097,930
Ukraine	147,707,064
Poland	154,944,297
Kazakhstan	160,921,584
France	175,190,674
Netherlands	199,720,566
Spain	245,786,595
Italy	255,396,764
Iran	259,074,556
Saudi Arabia	312,206,059
South Africa	314,995,398
South Korea	326,587,142
Australia	360,997,273
Great Britain	362,960,584
Canada	508,748,111
Germany	541,980,442
Japan	759,097,869
China	1,055,916,534
Russia	1,150,537,573
America	5,075,395,262

The Gold-Dollar System and Its Demise

It is no use getting ahead of one's self and writing about economic ideas that have no bearing on the real world - yet. Thus for our ideas to move to a second stage – where details are worked out –the first stage must be completed. In so far as it is demonstrable, we wish to demonstrate here why an emission backed currency unit (ecbu) to replace the USD as the global trading currency will not suffer from the same short comings that caused the gold-dollar system of the last few decades to collapse; and this, it is argued here, is because of the specific circumstances that make it necessary for central banks to adopt the new global currency, not as a reserve currency, but as a trading currency. Reserves, under this new system, will be entirely in the national currency. There will be sink capacity and food production capacity and land and such like. But it will not be possible to hoard or save the global trading currency, the ecbu, as it is linked to the declining supply of permits. Globally it will be interesting, to say the least, whether it will still be possible or advisable let alone desirable for the middle class to hold property or investments in second countries. How will they get there to enjoy them, after all? It is apparent that the comparative benefits of holding an emission backed currency unit relative to dollars cannot be calculated. In other words, central banks cannot know what reserve policy will make their country better off – and perhaps they cannot even define precisely what "being better off" is. This was said by Milton Gilbert, in 1968, with regard to holding gold or dollars, but applies as much to ebcus. However today we know that "being better off" at the very least means avoiding the temperature rise associated with excessive anthropogenic greenhouse gas emissions. Thus the purpose of this section is to provide some arguments for cap and share and for adoption of the ecbu and to lay to rest some misgivings that people might have because of their experience of the international gold-dollar system. Ideally this section will contribute to answering objections there still might be that have kept the nearly twenty- year long proposal for a global climate bank first mooted by G77 and China and AOSIS in 1991 out of consideration; and therefore thus to hurry forward its acceptance at CoP 15.

India, ever since 1898, has provided the classic instance of the working of an exchange standard. (The Gold Standard in Theory and History, 1985).

India has for at least one hundred years adjusted its currency system to the imperatives of the global economy, first as a colony, and then as an independent state. To understand India's position we must first understand that the reluctance of all and sundry to criticise America is rooted in this evolution of the colonial system into what we have today. The reason America did not sign the Kyoto Protocol was that there were "few in official circles bold enough to draw the apparently logical conclusion that the dollar was in fundamental disequilibrium". (Adapted from Milton Gilbert, 1968). No one questioned the value of the economic growth that was made possible by the USA's large balance of trade deficits. With or without the oil-dollar investments and the tortuous commercial banking instruments to get them into circulation of recent months and years, official circles never drew the next logical conclusion of moving to devalue the dollar, and instead they thought up, are continuing to think up "all sorts of pseudo measures for the long run correction of the deficit." "However, there is not a single successful case of long-run adjustment of a sizeable balance-of-payment deficit – apart from the special cases of reconstruction of war damage to the productive potential of the economy. .. The United States of America in particular has had a long-term programme to restore balance for seven years and yet the goal is as elusive as ever. Failure to face up to this reflects political attitudes – not economic analysis." (Milton Gilbert, 1968). In 1964 Albert Hart, Nicholas Kaldor and Jan Tinbergen proposed an international commodity reserve currency (ICRC). "The scheme [was] not designed to stabilize national price levels because countries are free to pursue autonomous monetary and exchange rate policies but rather it [was] intended to stabilize the "real value" of the international unit of account." (Richard N. Cooper, 1982). Gold would be stabilised against the ICRC. Others proposed indexation instead. Underlying all these attempts at reform was thus the hunt for the holy grail of "real value" to control money supply globally. Today this real value is climate stability and thus economic policy and monetary policy must adapt to become agencies to limit emissions. This in turn has led to the call for establishing cap and share on the basis of population.

Will The Supply of Emission Backed Currency Units be Too Tight?

Consideration of the emission backed currency unit involves three quantities: the ecbu, paper money (including demand deposits) called Rupees; and some composite of goods and services in which members of the public are directly interested, for example a composite that we can call goods. There are three prices linking these three quantities: the Rupee price of goods, the ecbu price of goods, and the Rupee price of ecbus, or the other commodity terms of trade between the ecbus and other goods. Because any one of these relative prices can be derived from the other two, only two of them are independent: (Rs/goods) = (ecbu/goods) x (Rupee/ecbu) or (Rs/G) = (e/G) x (Rs/e) where G stands for Goods, and e stands for ecbu and

Rs stands for Rupee. Inflation involves the first of these three prices, Rs/G. Now because India will have a large stock of ecbus, officials in attempting to limit inflation would fix the third price, the Rupee price of the ecbu. This can be done because the government has a sufficiently large stock of ecbu relative to the stock of Rupees outstanding and it can thus devote control of the supply of the Rupee to that objective. Alternatively if the economy must be managed to fit with the global economy through which ecbus and thus permits to use fossil fuels are available, inflation can be avoided by going to a pure ecbu currency in which 'Rupees' are ecbu. Now if 'Rupees' are ebcu, India will in effect have the new global trading currency as its national currency. Every year as the supply of permits tightens, the 'Rupee/ebcu' should become more valuable, but as its supply is limited by the cap on permits and by the need to limit global growth, the Rs/e remains constant. Economic activity is internal activity based on the availability of permits to buy fossil fuels. In India this scenario is possible because of the large ebcu surplus in relation to requirements. Now if on the other hand 'USDs' are ebcus in America, America will also have the new global trading currency as its national currency, but it will have a deficit, as its demand for fossil fuels is much greater than its allocated permits. Thus America must devalue its currency and withdraw large quantities of USDs from circulation in order to manage its balance of payments. This process of adjusting to the ebcu will in effect be the transition to an economy designed to ensure climate stability and equal access to energy that the globe has been waiting for from the USA, but which was not possible to achieve for the USA without the rest of the world figuring out how to a control of the global money supply, which is the same as saying controlling America's balance of payments deficit. (Everyone, incidentally, will be able to pay off their dollar loans with ebcu and thus get out of the dollar). So whilst India will find it easy for 'Rupees' to be ebcus, America will find it exceedingly difficult in direct proportion to its inability to generate wealth without fossil fuels. In the transition they will earn some ecbus by exporting renewable energy systems. This is because their economy in the transition requires them to demand more ecbus than their fair share and they thus must trade for a time. What will stop this system falling apart due to a too tight a regulation of the global money flows and global trade is the fact that permits expire and ebcus are withdrawn from circulation if the ebcu price of a permit rises above 1. As there is no incentive to hoard (save) ecbus, trade is encouraged, until every country has a demand for ecbus that is identical to the equitable sustainable per capita supply, and trade falls off. At this point trade will be very low, and this will occur at the very latest once caps are at the equitable sustainable level of 1 tonne per person per year in 2050; all people in the USA will be walking and cycling to work just as they do in India. Fossil fuels will hardly be burnt at all, but used for very high value purposes. Only the UNFCCC with some part of the Adaptation Fund ecbus will have some free ecbus to trade for precious oil in case its renewable energy supplies are not enough to run its giant computer. Thus India and the rest of developing countries that are under the equitable sustainable level of greenhouse gas emissions today will benefit from global trade in permits allocated on the basis of population; and will benefit from the introduction of the ecbu that ensures that only a recognised global trading currency can be used for buying ecbus, thus effectively limiting unsustainable purchasing power in developed countries and forcing them to build up their export trade in renewable energy technologies that developing countries will be able to pay for in their ecbus which are also allocated on the basis of population.

Is There Too Much Discretion?

Another objection, other than the objection above that money will be too tight, might be that the ecbu authorities are empowered to vary periodically the official price of permits, and since thus the system would embody discretion rather than automaticity, it would be bereft of its central feature which is to introduce price stability. But this is to confuse an emission backed currency system with other gold-dollar systems of the past. Automaticity in global monetary affairs is an illusion and goes counter to the need to stabilize the “real value” of the international unit of account, which today is the value of the limited global resource, viz. climate stability . Thus we are not interested in price stability primarily, but rather in the preservation of an underlying “real value”. In fact India will be able to decide as time goes on whether it allows inflation, i.e. rise in price of goods in Rupees, Rs/G. Instead of sticking to the pure ecbu currency in which Rupees are ebcus, officials would allow a floating third price, the Rupee price of the ecbu. This can be done as we mentioned above if the government has a sufficiently large stock of ecbu relative to the stock of Rupees outstanding and if, when necessary, it devotes control of the supply of the Rupee to that objective. In India this is nothing other than what has been going on all this time in relation to the gold-dollar system. This time round however there is no scarcity of foreign reserve currency as the limiting factor, but the scarcity of permits. Because we have less demand for permits than what we are entitled to, we have a surplus with which to buy what we need and even after the transition, we will never be in a position that is worse than where we are now, i.e. at one tonne carbon dioxide equivalent per person per year – this is provided we control population somewhat and make efforts to improve sinks, which will be easy once we no longer have to contend with the industrial model of development that was patently not suited to our purpose.

Thus India has nothing to lose what so ever in agreeing to a global climate regime based on contraction and convergence, with the proviso that a new global emission backed currency unit must be introduced to control global trade to within the limit set by the global cap. If India wishes to continue in the global system it has a responsibility to design a global system that works. Though others might argue that it is incumbent on the USA as the country with the deficit to solve its deficit problem, the fact is that unless the world argues strongly for the viability of an alternative, the USA will remain the de facto provider of global trade and investment capital. This scenario is incompatible with an equitable solution where everyone must have energy equity in the context of global caps to preserve climate stability.

Relationship Between Foreign Debt and Climate Stability

Let us analyse now the interesting relationship between foreign debt and climate stability – the gross foreign debt of some countries is listed in the Reserve Bank of India reports. We will analyse them in relation to their position on the emission rankings table, with the aim of understanding the effect of introducing an emission backed currency unit (ebcu). Remember that the reason we are introducing the ebcu is because we found what economists have been hunting for the holy grail of “real value” underlying the international economy and that we think they can now be pointed to global climate stability as that holy grail. Here is the table (see table 2).

What we find is that instead of the notion that “*developing countries will be able to use ecbus to pay off their debts*”, what we are finding is “*developing countries must forgive developed countries their $ debts so that the ecbu-based climate regime can be introduced*.” Looking at foreign debt as it stands, India may not yet have an interest in an emission backed currency unit, and other developing countries might or might not either, or too, not until the dollar mess is sorted out. More important before the introduction of the emission backed currency unit is the demise of the dollar economies and their demise cannot be hastened by the introduction of the ecbu because the quantum of ecbu bears no relation at all to the quantum of foreign exchange circulating in the developed country economies today. The table suggests that the old international economy based on dollars is finished. There is no way these countries can ever pay back their debt, nor should they, because they would need fossil fuels to do so. Therefore: All debts in all currencies in all countries must be forgiven. This is the same as saying the countries have to collapse, well, not the countries we should say, but their economies. Once these economies have agreed to collapse, a new climate bank is established. Every person gets three point eight emission backed currency units and three point eight permits. Then the world starts trading again, gently, prudently, as India has been doing, just to get what they need from the international market, which is basically renewable energy systems. Government concentrate much more on doing what is right for the people, and forget about the international rat race they could not keep up with. So now we have the global ecbu economy. If the price of a permit goes above 1 ecbu, the surplus ecbus are taken out of the market the following year.

Are Emission Backed Currency Units Really Necessary?

Let’s think it through again. We must again look at the table below. We must again wonder what would happen if there were only caps and no global emission backed currency unit. Well, perhaps the rembini would step in, and perhaps the Rupee. But this transition from the dollar to the rembini is fraught with difficulties because the USA and the rest of the developed countries would not go quietly. The table shows the countries with the biggest per capita foreign debts today in the first column and their per capita foreign debts in the second column. In the fourth column a positive number denotes that the country is a permit deficit country, i.e. the country has to reduce its emission of greenhouse gases and buy permits from a country with surplus ecbus (a surplus is denoted by a minus symbol). A developed country can only get permits by selling something to a developing country needs and is willing to pay for in ecbus; so that then the developed countries can then use the ecbus to buy permits for its own needs. The last column indicates that by 2050 there will be virtually no trade except between oil and coal producers and oil and coal consumers to the extent that the sinks in any one country allows such imports. This is what is meant by net zero emissions. National currencies will be generating local value through community economic systems, and the country governments will be managing the economy to ensure adaptation to climate change. We can see that by dollar standards neither China or India have much interest in international currency reform. Both have very low per capita gross foreign debt. But in ecbu standards India has much to gain, and its trade with China would increase. This would help bring up RETs in India, perhaps. India could also trade with the USA. In any case, it is seen that the developed country dollar debtor countries are all also emission debtors – in other words, there is a direct relationship between their profligacy in financial terms and their inability to control their emissions. Checking one, and I believe this is the argument we are making when we suggest introducing the ebcu, checks the other. But of course checking emissions can be done just with caps. There is in principle no need for global currency reform. Or is there? Looking at the numbers, one simply cannot see the transition occurring in developed countries without a total and utter bankruptcy of the countries, after which they submit to a global climate regime run democratically on an equitable basis. The high debt countries are resisting managing their foreign debt for the same reason they are resisting limiting their emissions. Now of course, ideally India would have found its holy grail earlier, in welfare, or enhancement of freedoms and such like, but these were all subsumed within a global economic paradigm shared with all other countries, and so even though economists tried to find something that India could specifically do that was different from what developed countries were doing, because the people were poorer and needed faster growth, in reality they did not do anything much different, but simply deployed technology and education and monetary and trade measures according to how they were taught to increase output faster and create more jobs, with the result that India’s GDP at factor cost at current prices in the year 2008-09 is around Rs. 49,89,804 crore, and the average income per person is apparently 38084 Rs per person per year, though it is very unevenly distributed. But leaving income inequality aside, India has fallen steadily on the Global Hunger Index, and by any measure it is not eradicating poverty.

A Reality Check

One may say that economists have failed us as indeed have politicians and political theorists who observe without prescribing and then laugh because of a sudden realisation of a lack of congruence between a concept and the real objects that had somehow been thought of by way of the concept, and thus they laugh to express the incongruence, and this laughter I think is probably happening more and more frequently in the halls of academic learning and indeed in the offices of finance ministries around the world. And of course this incongruence is a laughing matter, but that is not the end of the matter, because we realises that the people of India, each individual person, and indeed each individual person on earth, is hostage to the collective failure of these leaders to perceive things as they are, a relatively small group of people whom we here call officials, but who include politicians and other decision-makers. If we compare the gross foreign debts of the countries listed above with the emission backed currency units each of these countries would get, we find that there is absolutely no correlation. In other words these countries have been spending at the expense of climate stability, and we all just stood idly by, and watched, and complained, but joined in; and we will all continue to do so, unless we wake up, and then the “we” becomes “India”, and it is India who takes the lead and suggests at the UNFCCC that the global community take all hard currencies out of circulation and collapse these developed country economies and introduce the ebcu. So there we have the interesting relationship between dollars and emissions - an interesting relationship – of course why would there not be, we are looking at the numbers for the reason that of course it is. And just by the way, it is also interesting that the expected income in the UK from the sale of emission permits through the European Emission Trading scheme as it is today, is being handled by – yes, the UK Debt Management Office, which is managing a debt of no less than 10.746 trillion US dollars. Developed countries may have come up with the idea of emission permits, but it is up to developing countries to place them on the right footing. And in India we have known all along that there have to be equal per capita emission rights and convergence of per capita emissions to a global sustainable level of say 1 tonne of carbon dioxide per person per year by 2050. And in China an eminent professor in China too recently called for a global climate pact that would involve each country being allowed to emit a certain amount, based on their populations. So what we are saying here is nothing other than what any economist who reads and writes in order to present the facts as they are, would herself say, except that we must put the whole thing in relation to the massive foreign debts of these developed countries today, and the need to collapse them, as soon as possible. There will be welfare impacts of course, as there already are in Ireland. But there is no way these lifestyles can continue. All countries must have simple life styles – how many more different ways does this have to be said? PS: There was a rumour that Germany does not like foreign debts because of war-time memories. The figures indicate otherwise.

Table 2: Gross foreign debt exceeds by far available ecbus

Country	$/cap foreign debt	bn $ foreign debt	million ebcu deficit /surplus in 2010	target ebcu deficit /surplus by 2050
Ireland	520,956	2,391	35.52	0
Switzerland	187,725	1,426	17.16	0
United Kingdom	173,602	10,746	362.73	0
Netherlands	161,104	2,683	199.67	0

Belgium	151,314	1,619	111.47	0
Norway	115,038	559	29.08	0
Denmark	107,409	589	38.64	0
Austria	95,895	862	49.61	0
France	81,974	5,135	175.38	0
Germany	66,311	5,441	541.58	0
Finland	64,611	345	39.29	0
Spain	53,202	2,411	245.62	0
Portugal	46,627	500	21.68	0
Greece	44,725	500	69.56	0
United States	42,902	13,627	5075.90	0
Italy	42,454	2,551	255.42	0
Australia	38,992	839	360.97	0
Slovenia	28,166	57	10.06	0
Canada	24,058	815	508.69	0
Hungary	20,947	209	20.74	0
Estonia	20,169	27	13.74	0
Latvia	18,958	42	0.09	0
Japan	16,253	2,064	759.43	0
Israel	12,289	90	43.71	0
Croatia	11,746	52	4.28	0
Lithuania	10,235	33	1.92	0
Slovak Rep	9,801	53	17.37	0
South Korea	8,765	425	326.41	0
Czech Rep	8,429	88	78.71	0
Poland	6,966	265	154.81	0
Bulgaria	6,832	51	21.22	0
Kazakhstan	6,694	105	161.00	0
Chile	3,995	68	3.60	0
Russia	3,851	540	1151.01	0
Turkey	3,822	289	-34.07	0
Uruguay	3,324	11	-6.58	0
Argentina	3,146	128	1.63	0
Malaysia	2,949	82	80.95	0
Ukraine	2,321	105	147.66	0
Tunisia	1,928	20	-18.05	0
Mexico	1,915	212	27.66	0
Costa Rica	1,900	9	-11.09	0
Georgia	1,681	7	-11.81	0
El Salvador	1,674	10	-17.84	0
South Africa	1,535	78	315.07	0
Belarus	1,518	15	27.61	0
Brazil	1,397	273	-349.81	0
Peru	1,197	35	-81.11	0
Moldova	1,107	4	-7.37	0
Armenia	1,028	3	-0.99	0
Colombia	983	46	-110.19	0
Thailand	951	65	-0.68	0

Indonesia	653	152	-602.22	0
Kyrgyz Rep	604	3	-15.82	0
Bolivia	570	6	-24.28	0
China	501	678	1056.23	0
Egypt	385	32	-158.81	0
India	185	225	-3206.18	0
Adaptation Fund	0	0	-4003.33	-1500.00
Bangladesh			-577.12	0
Pakistan			-558.60	0
Nigeria			-480.08	0
Ethiopia			-317.08	0
Philippines			-280.00	0
DR Congo			-255.02	0
Vietnam			-241.66	0
Myanmar			-178.05	0
Tanzania			-165.68	0
Sudan			-150.40	0
Kenya			-142.99	0
Uganda			-126.42	0
Nepal			-110.27	0
Afghanistan			-109.89	0
Morocco			-89.48	0
Mozambique			-83.27	0
Cote d'Ivoire			-74.28	0
Madagascar			-73.79	0
Yemen			-71.75	0
Cameroon			-67.75	0
Sri Lanka			-65.20	0
Burkina Faso			-60.67	0
Niger			-58.79	0
Malawi			-58.46	0
Cambodia			-56.49	0
Mali			-49.77	0
Zambia			-47.36	0
Chad			-43.47	0
Senegal			-42.82	0
Guatemala			-41.66	0
Angola			-38.61	0
Rwanda			-38.17	0
Guinea			-37.75	0
Zimbabwe			-37.37	0
Haiti			-36.57	0
Algeria			-34.48	0
Burundi			-31.97	0
Benin			-31.91	0
Ecuador			-26.46	0
Syria			-24.63	0
Laos			-23.87	0

Togo		-22.70	0
Honduras		-21.18	0
Sierra Leone		-21.02	0
Paraguay		-20.82	0
Papua New Guinea		-20.53	0
Dominican Republic		-19.55	0
Tajikistan		-19.39	0
Eritrea		-19.05	0
Nicaragua		-17.35	0
Central African Republic		-16.78	0
Liberia		-14.53	0
Cuba		-14.33	0
Georgia		-11.81	0
DRKorea		-10.61	0
Serbia		-9.86	0
Mauritania		-9.59	0
Congo (Brazzaville)		-8.67	0
Ghana		-8.46	0
Albania		-7.89	0
Lesotho		-7.70	0
Gambia, The		-6.32	0
Guinea-Bissau		-5.80	0
Namibia		-5.49	0
Timor-Leste (East Timor)		-4.45	0
Somalia		-3.72	0
Swaziland		-3.47	0
Iraq		-3.32	0
Western Sahara		-2.96	0
Jordan		-2.80	0
Botswana		-2.79	0
Comoros		-2.51	0
Mongolia		-2.41	0
Bhutan		-2.34	0
Fiji		-1.99	0
Solomon Islands		-1.83	0
Cape Verde		-1.63	0
Guyana		-1.26	0
Gabon		-1.14	0
Reunion		-0.84	0
Vanuatu		-0.81	0
Mauritius		-0.75	0
Montenegro		-0.63	0
Maldives		-0.56	0
Sao Tome and Principe		-0.54	0
Samoa		-0.54	0
Lebanon		-0.46	0
Martinique		-0.41	0
Kiribati		-0.34	0

Macedonia		-0.30	0
Saint Lucia		-0.27	0
Tonga		-0.25	0
Saint Vincent		-0.23	0
Dominica		-0.16	0
Belize		-0.11	0
Grenada		-0.08	0
Saint Kitts and Nevis		-0.01	0
Saint Helena		-0.01	0
Cook Islands		-0.01	0
Niue		0.00	0

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The Non-Cooperator Pays Principle:
Pragmatic Norms and The US-China Mitigation Standoff

Jonathan Symons[1]

Abstract

If the US and EU agree to stringent emission targets in a post-Kyoto successor agreement but China does not, would carbon tariffs on Chinese imports be justified? A dominant view of climate justice affirms the 'polluter pays principle' as the most appropriate distributive principle for allocating the costs of mitigating climate change and asserts that carbon tariffs on developing world imports are unjust. Against this widely accepted standard of justice this paper defends the appropriateness of more pragmatic climate norms. In particular the paper defends a forward-looking 'non-cooperator pays' principle which states that under the condition of anarchy, actors negotiating to secure a public good that cannot be provided without wide-spread cooperation are justified in seeking to induce cooperation by imposing costs on non-cooperators, even if this cost-allocation would be considered unjust in the absence of the collective action problem. This principle's most likely application would be in the form of border tax adjustments (or carbon tariffs) that equalise the embodied cost of greenhouse gas emissions on imports and exports. This position is contextualised within a broader argument that the climate regime's norm of 'common but differentiated responsibility' is a barrier to the creation of an effective international climate agreement. Taking the interests of the most vulnerable climate victims seriously may require us to move beyond existing conceptions of inter-state justice and to accept that the distribution of costs under a climate agreement that is both effective and politically viable may not reflect historical responsibility.

1 Introduction

The first report of the Intergovernmental Panel on Climate Change (IPCC) in 1990 marked the beginning of what might be called a 'twenty years crisis' in the global climate regime. In the two decades since a scientific consensus emerged warning of the dangers of global warming, emissions of greenhouse gasses (GHG) have accelerated and the atmospheric concentration of CO2 has tracked steadily upward from around 350 ppm in 1988 to approximately 385 ppm in 2008 (Hansen et al., 2008). Predictions suggest that on the basis of existing emissions alone the globe is now committed to a period of significant warming, diminishing biodiversity, climatic instability and unnecessary human suffering. (Intergovernmental Panel on Climate Change, 2007: 45-54) This continuing failure of international cooperation has prompted many suggested reforms of the climate regime (e.g. Müller, 2008; Müller and Winkler, 2008; Prins and Rayner, 2007; Tickell, 2008). Most normative analysis calls on the developed world to finance the bulk of climate mitigation and adaptation measures and to repay their accrued 'climate debt' (Caney, 2005; Dobson, 2006; Mace, 2006: 55; Vanderheiden, 2008).

This article cuts against this analysis by arguing that there is a trade-off between fairness and effectiveness in the climate regime. It outlines why a more 'pragmatic' set of climate regime norms would be more likely to lead to stringent global emission cuts and proposes that these pragmatic norms might be normatively preferable to ineffective idealist

[1]Jonathan Symons is an Associate Lecturer in international relations at La Trobe University in Melbourne (Australia). Research for this paper was conducted during his time as a research fellow in the Hong Kong APEC Study Centre and the Environmental Studies Programme at Lingnan University. Email: jonsymons@gmail.com

norms. This argument draws on realist conceptions of political ethics such as those articulated in Edward Carr's analysis of the 'twenty years crisis' of 'idealist' policy-making which led to WWII (1946). I argue that the United Nations Framework Convention on Climate Change's (UNFCCC) incorporation of a norm of 'common but differentiated responsibility' (CDR) involves an analogous excess of idealism. CDR has become an impediment to effective global action.

My argument springs from comparative analysis of the domestic politics of climate change and the barriers within national political processes to the attainment of an effective global agreement. The Kyoto Protocol set emission limits for developed states but not for the developing world. In doing so it threatened to undermine the competitiveness of first world industry. As a result, trade-exposed industries became implacable domestic opponents of Kyoto's ratification and implementation. In several states including the US this opposition appears to have tipped the political balance against acceptance of significant emission limits. This analysis of barriers to collective action within both international and domestic politics of climate change forms the practical justification for the proposed 'non-cooperator pays principle'. Cooperation – in the form of international agreement to limit GHG emissions – is key to the success of the climate regime. And yet, for reasons relating to the uneven distribution of costs and benefits both within and between states, as well as the moral hazards that emerge from the spatial and temporal separation of pollution from its consequences, effective international co-operation remains unlikely. Given the value of the public good (a habitable climate) at stake, and the severity of the cooperation problem, I argue that traditional standards of justice might need to be suspended. It is more important that cooperation and non-cooperation be rewarded and penalized within an effective climate agreement than that the agreement achieves conventional standards of fairness.

The proposed 'non-cooperator pays principle' responds to the difficulty of solving collective action problems in the absence of government. It proposes that *under the condition of anarchy, actors negotiating to secure a public good that cannot be provided without wide-spread cooperation are justified in seeking to induce cooperation by imposing costs on non-cooperators, even if this cost-allocation would be considered unjust in the absence of the collective action problem*. This principle suggests that participants in an international agreement that promises to stabilise atmospheric greenhouse gas (GHG) concentrations would be justified in seeking to impose some costs on non-participants (e.g. through border tax adjustments). While it has long been recognised that the climate regime should contain incentives to attract developing world participation the 'non-cooperator pays principle' would also justify penalties, such as carbon tariffs, which are currently perceived as unjust to the developing world. The non-cooperator pays principle should not be the climate regime's only distributive principle. However, recognition of its normative appropriateness might be an important step toward a more effective climate regime.

My argument proceeds in four parts. Section two briefly outlines the origins of the norms of 'common but differentiated responsibilities' (CDR), 'historical responsibility' and 'polluter pays' and considers the relationship between these norms and the provision of global public goods. The third section reviews the failure of the UNFCCC and the Kyoto protocol to limit global GHG emissions. It argues that in the last two decades the climate regime's idealist norms have worked against the acceptance of stringent greenhouse policies within the domestic politics of many industrialised states.

Section four seeks to assess how this crisis of ineffective policy-making might be ended by drawing implications for the design of an effective global climate regime from comparative analyses of the national politics of climate policy. It proposes that if a global climate regime is to both set stringent emission limits and be politically viable within powerful industrialized states it must not disadvantage first world industry vis-à-vis developing world competitors. Just as the Montreal Protocol on Substances that Deplete the Ozone Layer induced developing world membership through a mix of carrots and sticks (technology transfer funding and trade incentives) so must the international climate regime restructure the calculus of state incentives so that participation is in the interest of the developing world. Border tax adjustments (BTA) are valuable tools because they protect the competitive position of developed world industries and also create incentives for developing world participation in the climate regime.

The final section articulates the case within non-utopian normative theory for 'pragmatic' measures, such as BTAs, which would impose costs on non-parties to a global climate agreement. It draws on the realist tradition of political ethics, which argues that international institutions must be designed, via a balance of pragmatic and idealist thinking, to work with the forces that motivate states. The argument for a non-cooperator pays principle emerges from the need for norms that are effective in solving collective problems. At first blush this argument – that an effective climate regime should be imposed on a reluctant developing world by powerful states, and that such an agreement must not disadvantage first world industry – might seem a piece of sophistry defending global iniquity. However, if we place a high value on averting a catastrophic climate outcome then a philosophical commitment to survival justify pragmatic norms. Likewise, assessed in terms of Rawls' difference principle (applied globally) the relative justice of competing approaches should turn on the empirical question of which is most favorable to the earth's least advantaged people.

2 Global Public Goods and Norms Promoting Cooperation

There are three distinct ethical questions at stake in an assessment of the non-cooperator pays principle. First, when, if ever, is it just for actors who contribute to securing a public good to *impose* a fair share of costs on actors who do not contribute. Second, is it ever just for actors to *induce cooperation* by promising to impose punitive costs on non-cooperators. Third, should normative standards for state behaviour take into account domestic constraints on the state's freedom of action, or should the state be judged against ideal standards.

The third question concerns how to judge ethics in the context of a 'two level game' where action in each game is constrained by conditions in the other game (i.e. statespeople whose international actions are constrained by domestic politics). Robert Putnam's (1988) analogy of international relations as being like a two-level game[2] describes the foreign policy decisions engage with both an international audience and a domestic audience. Making judgements about ethics in two levels games might require a understanding of the level of 'agential power'[3] or 'autonomy' the state possesses in respect of the pressures of domestic society and international structure (Hobson, 2000, pp 4-7). For example normative argument concerning the obligations of a nation-state may require actions that are politically impossible for a democratic government. If an ideal normative analysis says that state X owes $Y in compensation for the harms caused by its historical pollution, but this level of voluntary compensation is not possible given domestic political structures – how should we judge the government which achieves the maximum possible outcome?

If we combine the second and third question we come to the nub of the climate change dilemma. Imagine that an ideal normative analysis says that industrialised states should meet the total costs of climate change mitigation and adaptation in order to compensate the developing world for their historical responsibility for causing climate change. In this scenario state X should contribute $100 billion per annum to domestic climate

[2] Robert D. Putnam, "Diplomacy and Domestic Politics: The Logic of Two-Level Games," *International Organization* 42, no. 3 (1988).
[3] John Hobson, *The State and International Relations* (Cambridge: Cambridge UP, 2000) 4-7.

mitigation efforts and to mitigation and adaptation in the developing world. Now suppose that domestic political constraints mean this level of expenditure could not gain congressional approval. Instead, two different deals are possible. In one X commits only $40 billion meaning that a portion of the historic debt is repaid on just terms but that the mitigation and adaptation efforts will be insufficient and future generations will suffer unnecessary harm. The other politically possible outcome sees the state contributing a possible $60 billion but using the promise of adaptation payments and threats of punitive tariffs to extract $40 billion of contributions from the developing world. In this scenario the threat of climate change is dealt with effectively but on unjust terms. Future generations are spared unnecessary suffering by an unfair international agreement. This paper seeks to identify which of these approaches is more just.

The paper works from the premise that part of the purpose of social norms is to promote behaviour that is mutually beneficial. Norms coordinate behaviour into patterns that solve various forms of collective action problem. However the social norms with which we are most familiar (e.g. shouting drinks in turn) have evolved within small communities where the costs of non-compliance are obvious. The challenge posed by anthropogenic climate change has a number of features – such as a time delay between emissions and their environmental consequences, the difficulty of observing emissions, and the absence of an authority to enforce compliance – that might make norms that have evolved in other contexts ineffective in solving this global cooperation problem. For this reason, to understand the UNFCCC's failure we might begin with an analysis of the compatibility of the climate regime's norms and its stated goals.

'Common but Differentiated Responsibility'

The UNFCCC's most significant norm, established in Article 1, states that:

> the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their ***common but differentiated responsibilities*** and respective capabilities and their social and economic conditions

While the practice of differentiating responsibilities in multilateral agreements is long-standing, and 'differential and more favourable' treatment has previously been given to developing countries, the UNFCCC embodies differentiated responsibility as a central principle. (Stone, 2004: 278-9) Adoption of the norm of differentiated responsibility in the UNFCCC followed from earlier acceptance of the right to development. Once the right to development was accepted it would have been inconsistent (and unjust) to ask developing states to limit development by restricting GHG emissions. (Shue, 1995: 459).

While the UNFCCC contains no binding emissions targets, the CDR norm found its practical expression in the differentiated targets negotiated at the third annual 'conference of the parties' (COP-3) in 1997 and codified in the *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. The Kyoto Protocol establishes binding emission restrictions for Annex B states (developed plus some former communist eastern European states), but includes no mandatory targets for non-Annex B (developing) states. The decision to limit emission targets to Annex B states in this first commitment period appears to have been largely a tactical move to delay dealing with the thorny question of emission limits for developing powers such as India and China.(Vanderheiden, 2008: 69) The intractable problem here is that while a climate treaty that excludes India or China will not avert dangerous climate change, neither would these states accept emission limits that restrict their capacity to develop. By deferring resolution of this impasse to another day – negotiators left unanswered the question of whether it is possible to achieve a climate regime that is both effective and fair (as understood through UNFCCC norms).

'Historical Responsibility' and the 'Polluter Pays' Principle.

The argument in favour of CDR also draws on two subsidiary normative principles. The 'polluter pays principle' (Gardiner, 2004: 579; Shue, 1999: 534) (Jagers and Goran, 2008; Shue, 1999: 537) reflects both goals of *fairness* (that the beneficiary of pollution should pay for associated costs), and of *efficiency* (that collective wellbeing is optimised if full costs of production are internalised rather than imposed on the community as a whole). The Rio Declaration on Environment and Development makes the clearest articulation of the polluter pays principle in international law:

> *Principle 16. Internationalization of Environmental Costs* National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

In many cosmopolitan accounts of atmospheric justice, the 'polluter pays' principle of compensation for harm is supplemented by an 'ability to pay' principle (Caney, 2005; Jagers and Goran, 2008: 581-2; Shue, 1999: 537) or a 'beneficiary [of past GHG pollution] pays' principle (Page, 2008: 562-4) which is akin to the concept of 'historical responsibility' pushed by many developing states. For normative theorists allocation of responsibility for present day costs on the basis of historical emissions raises questions about the fairness of penalising acts whose harmfulness was not clear at the time (in the case of emissions pre 1990) or for imposing costs on present day generations for the actions of their parents and grandparents. (Caney, 2005; Jagers and Goran, 2008: 581-2; Shue, 1999: 537) Politically, the question of historical responsibility is also contentious because it demands enormous transfers of wealth from industrialised states to the developing world. By way of example, the UNDP's estimate of the annual cost of climate adaptation in 2015 is $86 billion. (UNDP, 2007: 194)

Christopher Stone divides CDR into three types. Rational bargaining CDR emerges from rational bargaining between parties who obtain an efficient agreement (Pareto-improving in the sense of leaving at least one party better off without disadvantaging others) by recognising that parties' contributions and benefits will differ. (Stone, 2004: 278-9) Equitable CDR describes a negotiation where parties are still committed to a Pareto-improving outcome but agree to constraints on bargaining that limit possible outcomes to those that 'tilt the cooperative surplus more favourably toward a designated group of parties'. (Stone, 2004: 278-9) In contrast to these two Pareto-improving forms inefficient CDR awards the poor more than the entire net surplus of cooperation. Instead the negotiated outcome seeks to correct previous injustices by transferring wealth from some parties to others. (Stone, 2004: 278-9)

Recognising that climate negotiations involve bargaining over the provision of a global public good helps to clarify why CDR may be an inappropriate norm for the climate regime. Global public goods are, by definition, goods that are both non-excludable and non-rival in the sense that once provided no state can be prevented from enjoying them, and no state's enjoyment of the good impinges on others. (Barrett, 2007, p. 1) Because public goods are non-excludable they are amenable to free-riding and so, in the absence of government, are likely to be undersupplied. A state choosing whether to spend money on climate change mitigation measures will be aware that the vast majority of the benefits of expenditure will accrue to others. In contrast the benefits of adaptation expenditure are exclusively local.

Further, since the benefits of adaptation spending are more immediate and tangible it is likely to attract greater political support. In the absence of a global agreement which guarantees proportionate state contributions to mitigation efforts it may be rational for states to preference adaptation to mitigation even if this approach is the less efficient (measured globally). For these reasons the public good of climate safety is likely to be underprovided. If climate regime negotiations are constrained by expectations of inefficient CDR then the motivation for powerful states to make the necessary investment will be very low. Analysis of the climate regime's failure over the last twenty years demonstrates this point in greater detail.

3 The Climate Regime's 20 Years Crisis

In 1988 the World Meteorological Organization and the U.N. Environment Programme established – with authorisation from the U.N. General assembly – the Intergovernmental Panel on Climate Change (IPCC). The IPCC is an intergovernmental panel of scientific experts charged with the responsibility to continually assess the risk of climate change caused by human activity and to provide policy-relevant summaries of scientific knowledge. By 1988 there was a high degree of scientific certainty that carbon dioxide (CO2) and other greenhouse gasses such as methane and nitrous oxide were accumulating in the earth's atmosphere and creating anthropogenic warming through their heat-trapping properties. Concerns about global warming were also gaining prominence in the international political agenda. The first IPCC report of 1990 confirmed the scientific evidence for anthropogenic climate change and prompted the negotiation of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) in the lead up to the Rio Earth Summit. Despite these clear warnings and promising early negotiations, subsequent inaction means that warming of considerably more than 2°C is now almost inevitable.

A picture of this coming crisis can be gained by comparing IPCC climate projections against emission trends predicted in the International Energy Agency's annual *World Energy Outlook* reports. The IEA's reference scenario, which predicts future carbon emissions factoring in only conservation measures that have already been committed to, sees global energy-related CO2 emissions rising from 28Gt in 2006 to 42 Gt in 2030. This projected increase 'puts us on a course of doubling the concentration of' GHGs 'in the atmosphere by the end of the century, entailing an eventual global average temperature increase of up to 6°C.'(IEA, 2008: 11). Warming of this speed and magnitude is unprecedented in human history. It is also possible that warming of this scale would take the planet past tipping points that would trigger catastrophic change. At minimum it would result in unprecedented harmful transformation to human and biological systems and mass extinctions of plant and animal species.

The IEA's assessment of alternative emission trajectories is also sobering. Two alternative emissions scenarios are considered. The more plausible – which nevertheless requires much more stringent emission limitations than we have seen to date – results in 550ppm CO2 equivalent that is projected to result in around three degrees of additional global warming. Warming in excess of 2°C is generally considered unacceptably dangerous. Limiting warming to this agreed 'safe' level would necessitate stabilizing atmospheric CO2 at 450ppm. The IEA's 450ppm emission trajectory would require unprecedented financial, scientific and political commitment. The IEA report notes:

> 'The scale of the challenge in the 450 Policy Scenario is immense: the 2030 emission level for the world as a whole in this scenario is less than the level of projected emissions for non-OECD countries alone in the Reference Scenario. In other words, the OECD countries alone cannot put the world onto the path to 450-ppm trajectory, even if they were to reduce their emissions to zero. Even leaving aside any debate

> about the political feasibility of the 450 Policy Scenario, it is uncertain whether the scale of the transformation envisaged is even technically achievable, as the scenario assumes broad deployment of technologies that have not yet been proven. The technology shift, if achievable, would certainly be unprecedented in scale and speed of deployment. (IEA, 2008)

Yet even this, seemingly unachievable goal, may be insufficient to avert dangerous warming. Some climate scientists argue that IPCC climate modeling, while accurate over a period of decades, does not model a set of slow feedback mechanisms that are apparent from paleoclimate data. According to this view "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO2 will need to be reduced from its current 385 ppm to at most 350 ppm." The possible consequences of prolonged overshoot of this target includes the "possibility of seeding irreversible catastrophic effects." (Hansen et al., 2008)

> The eventual response to doubling pre-industrial atmospheric CO2 likely would be a nearly ice-free planet, preceded by a period of chaotic change with continually changing shorelines.(Hansen et al., 2008: 16)

The IEA emission trajectories also illustrate the need for the climate regime to limit developing world emissions. In the reference scenario a full three quarters of the projected increase in energy-related CO2 emissions arises in China, India the Middle East, while 97% of increases are sourced from non-OECD countries as a whole. The pressure for emission increases from the developing world only adds to the urgency of cuts in industrialized states. For example, the IEA's 450ppm emission trajectory 'requires emissions in OECD countries to be reduced by almost 40% in 2030, compared with 2006 levels. Other major economies are required to limit their emissions growth to 20%.' (Agency, 2008) The IEA also points out that the long life of electricity infrastructure means that most of the emissions of the next 20 years are effectively 'locked in'. The cost of past policy failures is high. If the required future emission reductions look impossible a large measure of blame must go to the previous 20 years of policy inertia.

The Failure of the Kyoto Protocol

The Kyoto Protocol was always intended as a first step and a foundation upon which future negotiations would build. However, it is instructive to review how complete the failure to arrest emissions has been. In the period 2000 to 2006 global CO2 emissions increased at an annual rate of 3.1% - a rate of increase which is more than double that of the 1990s (van Vuuren and Riahi, 2008: 241). Whether this increase is a short term aberration, or is reflective of a long term shift that renders the IPCC emission scenarios on which climate predictions have been based as unduly conservative – is debatable (van Vuuren and Riahi, 2008: 241). What is clear is that emission levels are trending in the wrong direction and that the Kyoto Protocol has done little to alter this trend. Whatever the future of the UNFCCC process, the first 20 years since the creation of the IPCC has been a period of relatively unconstrained emissions growth in which atmospheric GHG concentrations have overshot a level of relative 'safety'.

Given that Kyoto was intended to be only the first round of an ongoing negotiation process, and only entered into force in February 2005 a defender of the UNFCCC process might argue that my negative assessment is premature. However, the delay in the protocol's adoption (it only came into effect once states 55 states responsible for 55% of global emissions had ratified) and the modest targets adopted might equally be seen as key aspects of the protocol's failure.

Even the European Union – generally regarded as the green demandeur of climate negotiations – agreed to aggregate targets under Kyoto that reflect little more than a business as usual emissions trajectory. (Harrison and Sundstrom, 2008: 5)Germany's post re-unification closure of inefficient industries in the east, and the UK's decommissioning of inefficient coal power stations as part of a switch to natural gas meant that these two states were recipients of windfall emission reductions. Together, their promised reductions account for more than 100% of EU wide commitments. (Harrison and Sundstrom, 2008: 5) Major states that took on significant reductions below a business as usual scenario in Kyoto either refused to ratify (the United States), ratified but subsequently announced an intention to not comply (Canada), or have adopted compliance plans based on investment in international flexibility mechanisms rather than domestic taxation or regulation (Japan). (Harrison and Sundstrom, 2008). While the Kyoto process has resulted in some efforts to limit GHG emissions, evidence suggests that this form of agreement is hopelessly ill-equipped to meet the challenge at hand.

A Cosmetic Treaty?

One possible explanation for the failure the UNFCCC process and its Kyoto Protocol is that some parties never intended them to succeed. During the cold war the term 'cosmetic treaty' described an arms-control treaty that created the impression of progress without implementing significant change. Such agreements might be domestically useful for both sides. The Kyoto protocol is not purely cosmetic – for example it has lead to the creation of a carbon market that today is worth over US$10 billion per year.(Tickell, 2008: 35) However, it seems likely that the protocol (and future treaties) may be cosmetic in the sense that their claimed benefits are not matched in reality. It would be logical for politicians facing a costly, long-term, complex problem whose solution involves significant short term costs and job losses to opt for an ineffective treaty that satisfies public expectations by creating the appearance of progress at minimal cost. Such a treaty would very likely be in the short-term political interests of all governments.

The Kyoto Protocol's lack of an effective compliance mechanism might be viewed as one sign of treatymakers' cosmetic intent. As Scott Barrett argues the Kyoto Protocol overreaches through reliance on its own specific compliance mechanisms. A failure to meet commitments in the first commitment period does attract a notional penalty of more onerous targets in the subsequent period. However, since subsequent commitments have not been negotiated yet future bargaining positions will reflect (and therefore negate) Kyoto penalties. Barnett contends that this problem arises because Kyoto fails to engage the 'elemental forces of sovereignty' and states' tendency to place their national economic advantage before the protection of global public goods. (Barrett, 2007: 93-4)

Fingering Common but Differentiated Responsibility as The Culprit

The inherent cooperation problem involved in provision of a costly global public good is surely one part of the explanation for the Kyoto protocol's ineffectiveness. However, the UNFCCC's idealist norms have been another culprit ensuring that Kyoto has not lived up even to its limited promise. Of particular significance is the expression of the norm of 'common but differentiated responsibility' in the Kyoto Protocol in the form of binding emission targets that are applicable to some states and not others. This differentiated treatment has been a significant contributor to the wasted years in which virtually no progress toward limiting GHG emissions has been made.

Most analysis of the climate regime by political scientists has sought to explain the prospects for international cooperation by considering the motivations of states as unitary actors. Recently this 'structural' international relations approach has been complemented by comparative research that explains the climate regime's ineffectiveness via analysis of the domestic processes through which national climate policy is formed. (Harrison and Sundstrom, 2008; Lantis, 2006) This research exposes the nature of the 'two-level' cooperation problem inherent in global climate change, and the way in which the norm of 'differentiated responsibility' has interacted with domestic political processes. International-level cooperation to achieve the deep emission cuts required, is only realizable after the resolution of domestic cooperation problems. By placing developed world industry at a competitive disadvantage the norm of 'differentiated responsibility' tilts the playing field of domestic politics: it gives powerful industries an additional economic incentive to lobby against effective national climate policy and arms them with an appealing nationalist argument. In advantaging developing states over developed, and in particular China over the United States the norm of 'differentiated responsibility' also defies the realist precept that internationally effective agreements should work with, rather than against, the forces that motivate states.

Across a variety of western states such as the United States, Canada and Australia, the seemingly one-sided nature of the Kyoto commitments empowered a nationalist argument that '*we should not reduce emissions unless developing states like China do so too*.' The US Senate's Byrd-Hagel Resolution (S. Res. 98, 2001) – which was passed unanimously and stated that the United States should not be a signatory to any protocol that does not include binding targets for developing nations as well as industrialized nations – is perhaps the most significant expression of this perspective. It is a clear demonstration of the political obstacles to US adoption of an international agreement that is obviously injurious to US economic competitiveness. President Bush's subsequent justification of his decision to withdraw from the Kyoto Protocol, underscores the point through its focus on the unfairness of differentiated responsibility:

> I oppose the Kyoto Protocol because it exempts 80 percent of the world, including major population centers such as China and India from compliance, and would cause serious harm to the U.S. economy. The Senate's vote, 95-0, shows that there is a clear consensus that the Kyoto Protocol is an unfair and ineffective means of addressing global climate change concerns.(Bush, 2001; cited in Vanderheiden, 2008: 64)

'Jumping as High as the Political System Will Tolerate'

US Special Climate Envoy Todd Stern's defense of the Obama Administration's climate policy that 'we are jumping as high as the political system will tolerate' underscores the reality that congressional representation of sectional interests limits the US's capacity for strong climate action. The limited change to US policy under the Obama administration perhaps provides the clearer evidence of domestic constraints than do Bush's words (above). Since the Bush administration appears to have been ideologically opposed to taking action on climate change Bush's words about fairness probably masked an underlying preference for inaction. In contrast, Barack Obama was elected on promises to address climate change. In the context of this apparent ideological support the limited emission cuts promised (20% reduction on 2005 levels by 2020) by the Waxman-Markey 'American Clean Energy and Security Act' (ACES) illustrate the enormity of the climate challenge. Even in the unlikely event that this Bill obtains congressional approval without further dilution, this Bill is not consistent with a global deal that even comes close to stabilization at 450ppm.

The evidence that the norm of 'common but differentiated responsibilities' has prevented (or been used to justify opposition to) climate action is strongest in the case the

United States and other opponents of the Kyoto Protocol. However the fact that no major polluter has achieved substantial emission reductions below business as usual projections during the Kyoto Protocol period suggests that this dynamic may be influencing the policy of many other states. EU members such as the UK and Germany which have pushed hardest for stringent emission cuts have largely been riding on the back of windfall emission reductions. Their incapacity to deliver substantial emission reductions despite a receptive political environment also suggests that the competition concerns of business may be at play.

The norm of 'common but differentiated responsibility' is responsible for one additional aspect of Kyoto's failure – that it has encouraged the relocation rather than reduction of GHG emissions. One consequence of a regime which limits emissions in some states, but not others, is that it has encouraged the relocation of GHG intensive industry but not the reduction of GHG intensive consumption. Analysis of the differences between 'production-based' and 'consumption-based' carbon accounting mechanisms is illustrative of this point. Whereas on the UNFCCC production based methodology, UK Greenhouse Gas emissions have fallen by 15% since 1990 considered in terms of consumption based accounting, the illustrative outcome is a rise of 19% over the same period' (Helm et al., 2007) While the de-industrialisation of the west is obviously beneficial for developing world economies it does not address climate change.

4 Practical Advantages of Imposing Costs on Non-Cooperators

> "The essential challenge of a treaty is to restructure incentives so that countries are better off participating than not participating, and better off complying than not complying. (Barrett, 2007: 93)

Addressing climate change is a strikingly challenging political problem because the immediate costs of action are high, the costs of inaction are delayed, and only cooperative multilateral action can address the problem. An international collective action problem (where states have differing commitments to addressing the problem, and all are reluctant to take unilateral action that would create an economic disadvantage) is layered on top of a series of national collective action problems (where the interests of polluting industries tend to outweigh more diffuse general interests in national political process). (Harris, 2007) Given the barriers to international cooperation the capacity to impose costs on non-cooperators – in particular through carbon tax equalization measures – is important because it: 1) can act as an incentive for participation in an effective international agreement; 2) reduces domestic political opposition to emission restrictions by protecting trade-exposed industries; 3) enables GHG emissions to be taxed at the point of consumption rather than production (a point with important equity implications as discussed later). This section first outlines debate over the legality and uses of carbon tariffs and border tax adjustment and then discuss these three arguments in detail.

Carbon Tariffs

Adoption of carbon tariffs in conjunction with domestic GHG trading or taxation schemes is the most likely form in which the non-cooperator pays principle might be applied. Amid growing attention to the trade-related aspects of climate policy, plans to impose countervailing duties, or equalizing 'border tax adjustments' are particularly contentious. BTAs are taxes or subsidies that level the playing field between domestic industries subject to GHG-limiting measures and competitors in states that do not take on binding emission limitations. Such measures promise to reduce GHG emission by limiting 'carbon leakage' while creating incentives for all states to participate in the post-Kyoto successor agreement.

Yet, despite their political appeal BTAs are commonly critiqued for amounting to 'green protectionism' that is both economically damaging and unjust when directed against developing states (Biermann and Brohm, 2005: 291). According to this view it is unjust to impose western environmental standards on the developing world as to do so defies the 'polluter pays principle'.

As we have seen key argument raised against emission trading schemes or tax regimes that create incentives to reduce GHG emissions is that such measures will harm the competitiveness of domestic industries. Border tax adjustments offer a solution to this problem by imposing equalizing taxes on imports from states where GHG emissions are not regulated, and by granting subsidies or tax-relief to exports. In so doing BTAs reduce domestic opposition to environmental measures, create incentives for other states to adopt similar laws and by protecting domestic industries from international predation encourage technological innovation that minimizes environmental harm.

While Article III.2 of the GATT allows for BTAs that adjust for direct taxes on both imports and exports there is no settled law on the question of whether adjustment is legal on 'an input that is fully consumed during production, such as energy'(Tarasofsky, 2008: 11). Indeed, some argue that rebate of 'taxes on embodied fuels is barred by the GATT Subsidies Code's ban on rebating *prior stage cumulative indirect taxes.' (Hoerner, 1998: 8)* Advocates of BTA's commonly argue that these measures are appropriate for use between developed economies but not against imports from developing economies. Such discrimination, which is justified by the developed world's historical over-use of the atmospheric commons, would probably be legal under WTO jurisprudence which must take into account widely ratified treaties (Biermann and Brohm, 2005: 291). In this context the UNFCCC's CDR norm probably provides legal cover for discrimination based on participation in a treaty that imposed differentiated burdens on different parties. (e.g. under the Bush administration many Europeans argued that BTAs should be used to target US imports.) Non-discriminatory application of the BTAs (application on imports from all non-parties to a Kyoto successor agreement) would obviously be less vulnerable to legal challenge.

Restructuring Incentives to Make Cooperation Attractive

In the past, global environmental cooperation has often been achieved through what Elisabeth DeSombre terms the 'internationalisation' of US domestic policies (DeSombre, 2000). In this process once environmental standards have been adopted domestically by the US, industry and environmentalists find common cause in demanding that these standards be imposed on other states through economic threats. The cost of the overhaul of global energy systems necessary to combat global warming is of an order of magnitude greater than any of DeSombre's examples of endangered species, air pollution, and fisheries conservation, so the situations are far from comparable. Further, the United States is neither able nor willing to impose global limitations on GHG emissions. However, it may be that if a group of influential states were to agree to place a price on GHG emissions and to create appropriate incentives for developing world participation, this agreement could be adopted widely.

The Montreal Protocol on Substances That Deplete the Ozone Layer (September 1987), although tackling a much simpler problem than global warming, offers an instructive model as to how this process might work. This protocol limited the global use of chlorofluorocarbons (CFCs), which were suspected to destroy stratospheric ozone. One of the most impressive elements of the agreement was that it was achieved prior to full scientific certainty about the link between CFCs and Ozone depletion. By offering funds to assist developing countries with adjustment costs, and using market access as carrots and sticks (parties to the Montreal protocol were given continued market-access during a phase-out period, but non-parties were immediately excluded) this agreement gained almost universal acceptance.

Eric Haas's analysis of this highpoint of international environmental cooperation reveals many of the reasons as to why Ozone-depleting substances and GHGs are not analogous. There were only seventeen companies producing CFCs in a $100billion industry with operations in sixteen countries. (1992: 197) In "this oligopolistic market, DuPont was the world leader" holding 50% of the US and 25% of the global market". In 1989 at the first government review of the Montreal protocol, 81 countries agreed on faster phase-out times, and to establish a fund to assist LDCs with adjustment costs (approx $240 mill with $40-$60 mil contributed by the united states). Since CFCs accounted for only about 2% of total corporate profits, DuPont was able to take a long-term view. (Haas, 1992: 197) The size of its other business made its corporate reputation more important than maximising profitability of CFC production. DuPont's scale also meant that once it decided to support a freeze and then phase-out of CFCs, other industry players were forced to follow. Yet, despite the obvious difference in the number of players and size of the industry affected the Montreal Protocol example may still contain lessons for the climate regime as to how a group of powerful states can coax a reluctant world into a treaty.

Existing efforts to encourage developing world participation in a post-Kyoto successor agreement center on 'carrots' – such as technology transfer funding, adaptation funding, and participation in an emissions trading market. These carrots all involve transfers of resources from industrialized states to developing states and for this reason have, to date, been poorly funded. It seems unlikely that these inducements alone will be sufficient to motivate developing world acceptance of emission restrictions. The developing world also makes a strong argument that this assistance should not be conditional. Since industrialized states' emissions have created climate change – assistance is viewed as repayment of a historic debt. This is a key argument in favour of the 'stick' of BTAs. If avoiding taxes on GHG emissions gives a state a trade advantage this militates against their participation in a climate agreement. If participation instead carries an economic cost (via carbon tariffs) the incentives are partially reversed.

A likely riposte to this argument points out that the changing economic power of the industrialized world vis-à-vis developing powers like China and India means that it is no longer possible for a small group of powers to impose solutions on the globe. Further, the global character of GHG emissions – each state is involved – means that it is not possible to round up all major emitters in a single agreement. Against these arguments we can note first, that the severity of the challenge make rebutting counterproductive fairness arguments all the more important. Second, we can observe various concentrations of emissions that create possibilities for an effective treaty being reached by a limited number of parties. For example, the production emissions are heavily concentrated (looking out to 2050 the IEA predicts that the five largest emitters of energy-related CO_2 – China, the United States and the European Union, India and Russia will together account for almost two thirds of global CO_2 emissions;(IEA, 2008: 12) the consumption of GHG-intensive good is heavily concentrated in OECD countries, and that most GHG-intensive industries have a limited number of 'supply' points (such as oil refineries or coal washing states) whose regulation would have extra-territorial effect. (Tickell, 2008)

Changing Incentives Within Domestic Politics.

> "If other countries don't impose a cost on carbon, then we will be at a disadvantage…[and] we would look at considering perhaps duties that would offset that cost," - Energy Secretary Steven Chu[4]

We have seen that the tendency for costs to fall on a limited number of polluting industries creates strongly motivated opponents of GHG regulation, and thus tips the balance of domestic politics against effective action. The argument that unilateral action to place costs on GHG emissions will put domestic industry at a disadvantage is an important part of this opposition. Carbon tariffs address this argument by re-establishing an even playing field between domestic and foreign production. Obviously this change will not neutralise domestic opposition to emission limitations. Polluting domestic industries will continue to resist regulation of GHG emissions because they wish to minimise their costs. However, carbon tariffs will have two important advantages. First, in situations where domestic industries have lower emissions per unit of production than their competitors they may become advocates of BTAs. Further, a BTA scheme will create economic incentives promoting the transfer of low emission technologies even to states that are not party to a climate agreement.

The second domestic political advantage of BTAs lies at the level of rhetoric. As President Bush's argument about the unfairness of the Kyoto Protocol attests, arguments against national action on climate change are normally couched in nationalist terms. Fairness toward a state, and the risk of disadvantage in international competition are emphasized. BTAs neutralize this nationalist rhetoric. Without the claim of being disadvantaged internationally, polluting industries would be forced to argue against emission restrictions on other grounds. It seems likely that public opinion will be less sympathetic to polluters' arguments once the cloak of 'shared national interest' is removed.

Taxing Emissions at The Point of Consumption

A third advantage of a carbon tariff regime is that it allows emissions to be taxed at the point of consumption. At present in Europe consumption of domestically produced goods incurs carbon taxes, but imports do not. The developing world's argument that their right to development and improved living standards should not be sacrificed to protect western over-consumption is a strong one. But this argument militates in favour of, not against, carbon tariffs. For example if exports from China to the E.U. were subject to equalising GHG duties, this would mean that European consumers would be paying for the cost of GHG emissions but Chinese consumers would not.

The ethical argument for differentiated treatment of states ultimately rests on a concern for the wellbeing of people in developing states. This argument justifies opposition to limits on emissions that contribute to developing world consumption. It does not justify opposition to restricting emissions on developing-world production that is destined for first world consumption. BTAs in fact offer an ideal mechanism for targeting emissions that are linked to developed world consumption without penalising so-called 'survival emissions'

5 A Normative Defense of Pragmatic Norms

I characterised the post-1988 climate regime as the subject of a 'twenty years' crisis' both because of the manifest lack of effective action over the two decades since the scientific basis for global warming was firmly established, and to evoke E.H. Carr's analysis of the earlier 'twenty years crisis' where creation of overly idealist international institutions following WW1 ultimately led to the collapse of the international system and a second great war.(Carr, 1946) I suggest that the UNFCCC is at the centre of similarly ineffective and idealist climate

[4] http://online.wsj.com/article/SB123733297926563315.html?mod=googlenews_wsj

regime, and that if current trends continue the eventual outcome of flawed idealist policy may be a planetary catastrophe whose human impacts dwarfs WWII. The impacts on human wellbeing of the 6°C or more of warming anticipated by the IEA's 'reference case' projection are extreme and unknowable. If averting such potentially catastrophic warming can be considered an absolute moral good, then we might have reason to consider pragmatic policies that avert dangerous global warming as ethical, *even if they involve unfairness among states*. The argument in this section first outlines the lessons for non-ideal normative theory contained in the moral thinking of the classical realists. It then considers how a concern for probability of truly catastrophic climate change or for the interests of the least advantaged should influence our assessment of pragmatic climate norms.

Non-Utopian Ethics, Idealism and Realism:

Henry Shue describes 'non-utopian ethics' as amounting to an 'ethics of transition', asking how to move from the present toward the ideal (Shue, 1995: 464). Unfortunately, the timeline for addressing dangerous climate change is tight. Action to reduce emissions must begin now and be sustained over the coming century. It may be that no path leads toward the 'ideal' within the available timeframe. If so, then 'non-utopian ethics' must describe the politically practical path toward averting catastrophe that is least ethically repugnant. This is the ethics of the 'least bad' alternative, rather than an ethics of transition toward the ideal. Fortunately, a developed literature on the subject of pragmatic ethics can be found within twentieth century realism.

In his response to the interwar 'twenty years crisis' Carr, like most other classical realists, did not argue that there was no place for idealism or morality in international politics – but rather that 'idealist' policies which take insufficient account of the realities of power will generally be counterproductive. Whereas classical realism is often characterized as an amoral doctrine whose adherents advocate the naked pursuit of national interest, it might better be understood as a form of 'non-utopian theory'. For example, Carr proposes that moral outcomes must be pursued through realist analysis:

> All healthy human action, and therefore all healthy thought, must establish a balance between utopia and reality, between free will and determinism. The complete realist, unconditionally accepting the causal sequence of events, deprives himself of the possibility of changing reality. The complete utopian, by rejecting the causal sequence, deprives himself of the possibility of understanding either the reality which he is seeking to change or the processes by which it can be changed (Carr, 1946: 11-12)

This pragmatic approach to political ethics is echoed by other traditional realists. Morgenthau, proposes:

> The individual may say for himself: 'Fiat justitia, pereat mundus (Let justice be done, even if the world perish),' but the state has no right to say so in the name of those who are in its care…Realism then, considers prudence – the weighing of the consequences of alternative political actions – to be the supreme virtue in politics. Ethics in the abstract judges action by its conformity with the moral law; political ethics judge action by its political consequences.(Morgenthau, 1972: 10-11)

Within contemporary political rhetoric and academic literature there is a resurgence of the liberal view that order cannot be sustained without justice and that justice should be a goal of statecraft. This resurgence reflects a perception that international society is less fragile in a time of lowered global tension. Indeed this confidence in the potential of interstate cooperation and in the capacity for norms to constrain state behaviour seems to be strongest in relation to environmental and other ‘new agenda’ issues..

Survivalist Ethics: Political Ethics Under The Shadow of Catastrophe

The flourishing of twentieth century classical realism occurred in the shadow of potential nuclear annihilation. To understand the thinking of theorists as diverse as Raymond Aron, George Kennan, Hans Morgenthau or even Hedley Bull, we must remember the immanent risk of nuclear catastrophe that lead these writers to focus upon the attainment of order through balance and consensus among great powers. When Morgenthau spoke of the ‘moral principle of national survival’ or of working with, rather than against, the forces that motivate states his advocacy of pragmatic policy making was premised in the knowledge that the nuclear clock was set at five minutes to midnight. (Morgenthau, 1972: 10) Here, I advance the general proposition that where there is a serious risk of planetary catastrophe, that the goal of survival should be secured prior to recognition of claims of distributive or procedural justice.

Economists seeking to provide a cost benefit analysis of action to mitigate climate change have described the probably of a catastrophic climate outcomes (a fat tail in the relevant probability distribution function) as confounding efforts to develop rational policy. (Weitzman, 2009: 1). After identifying a 5% chance of a catastrophic outcome (greater than 10C of warming in the next two centuries) Martin Weitzman argues that the economics profession is simply unable to provide authoritative guidance on a rational response to such a risk. (Weitzman, 2009) Forming a response to the looming probability of catastrophe must be a collective, political decision.

As I have argued above, normative political theorists have overwhelmingly responded to this probable planetary catastrophe by demanding that the developing world shoulder the costs of climate adaptation and mitigation. Their analysis has not been troubled by the obvious political barriers to such altruism. Whether such idealism can be justified might depend on how significant we regard the risk of planetary catastrophe as being. If the risk of catastrophic climate change is as low as 5% then perhaps it would be wrong to accept present-day injustice in order to avert a possible greater injustice against future generations. However, this question – of the relationship between looming catastrophe and weighting of present day injustice, intergenerational injustice, and recognition of the practical constraints limiting on state action is one that deserves sustained attention.

Any coherent account of normative legitimacy must involve the application of *normative principles* via a process of *strategic reasoning* informed by contemporary *political realities*. (Macdonald and Macdonald, 2008) it proposes that potentially catastrophic situations may render actions which would ordinarily be considered grossly unjust, normatively legitimate. Any normative perspective which places survival as a primary value is likely to endorse exceptional actions in the face of potentially system-destroying threats. If actions that would normally be considered unjust, are necessary to ensure the survival of all actors in a system, then these actions may be normatively legitimate.

Climate Policy for The Least Advantaged

I have argued that the existing climate regime is not constraining emissions and will not lead to stabilization of atmospheric GHG levels at a safe level and that the norm of differentiated responsibility is a major obstacle to a more effective agreement. If these claims are true, and we also accept the IPCC’s finding that impacts of climate change ‘will fall disproportionately upon developing countries and the poor persons within all countries.’((IPCC), 2002: 12) then we might wonder if the interests of the earth’s most vulnerable people (now and in the future) would be best served by a climate regime that effectively limits GHG emissions – even if this occurs at the cost of some developing world growth. This is an empirical question whose definitive answer is beyond the scope of this paper. However, the answer to this question might also determine our assessment of the legitimacy of pragmatic climate norms. Assessed in terms of Rawls' difference principle (applied globally) the relative justice of competing approaches should turn on this empirical question of which is most favorable to the earth's least advantaged people. Given that most LDC growth processes initially bring few benefits for the rural poor – the empirical claim that it is not worth sacrificing a small amount of developing world growth in order to address climate change warrants careful examination. Assessed from a utilitarian perspective – wherein justice is held to depend upon achievement of the greatest good for the greatest number- the argument for pragmatic norms is even stronger. The present (practically ineffective) climate regime may incorporate norms that reflect standards of interstate justice – but an ineffective climate regime manifestly fails to achieve justice between people.

Conclusion:

In today's climate negotiations the developing world's claim for compensation for the consequences of climate change is presented as a moral entitlement. This paper has argued against the unconditional repayment of this historic debt for that practical reason that doing so would reduce the incentives to cooperate in mitigating future climate change. International assistance for climate mitigation and adaptation should instead form part of a climate bargain. Within the climate regime there appears to be a trade-off between justice and effectiveness. At present justice norms are being honoured at the expense of effectiveness. Norms do not erase states underlying material interests - they simply shape their expression. If climate regime norms pull too far away from the interests of powerful states then it is likely that those states will seek to undermine regime effectiveness.

Even absent the CDR norm, the cost-benefit structure of climate change mitigation suggests that under-investment in climate protection is the most likely outcome. For this reason efforts should focus on attaining a global agreement that will win domestic acceptance. Fairness should be a secondary criterion. It seems likely that if a global agreement is to achieve favorable reception within the domestic politics of powerful states it must: not disadvantage the domestic industries of developed states vis-à-vis their major international competitors; seek to animate new political allies for emission-constraint policy by strengthening low emission industries in early negotiation rounds (in a process analogous to that through which successive rounds of trade negotiations have reshaped domestic politics by empowering the advocates of free-trade policies); separate politically challenging equity measures from measures that promote emission reductions so that the one is not sabotaged by the other; restructure incentives so that all states are better off participating and complying than not; and create price-signals that stimulate private-sector innovation and investment.

I do not argue that a norm of CDR would not be ideally appropriate. However, the application of CDR within the climate change regime has been counterproductive because it strikes the wrong balance between 'utopia and reality'. Nevertheless, it is important to observe that the pragmatic political ethics which counsels states to prioritise practical outcomes do not apply to individuals. If excessive first world consumption harms the global poor then first world people may have obligations to compensate. Those most disadvantaged by climate change have a *moral* entitlement to compensation, even if their *practical* interests will be best served through effective international cooperation. Taking the interests of the most vulnerable climate victims seriously may require us to move beyond traditional conceptions of interstate justice but the imperative for cosmopolitan justice among people has never been stronger.

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WTO Law as Leverage: An Inquiry into The Dynamics of Climate Negotiations Between China and The United States

Dan Partan[1]

Abstract

Current U.S. "cap & trade" federal legislative proposals seek to maintain competitiveness of U.S. industry by requiring certain importers to obtain greenhouse gas (GHG) emissions permits equivalent to the permits required from U.S. producers. Currently neither U.S. nor Chinese producers are subject to such a rule. If China does not adopt what the U.S. views as a "comparable" GHG emissions permit system, it is widely expected that the U.S. Congress will require GHG emissions permit for imports. It is also widely expected that China will challenge U.S. a GHG emissions permit requirement applied to Chinese exports as in violation of WTO trade treaty obligations.

This paper examines the expected contents of U.S. competitiveness legislation in relation to WTO treaty law, and assesses prospects for WTO constraints on the U.S. GHG emissions permit system applied to Chinese exports. It also assesses the prospects for utilizing a Chinese threat of WTO legal action to bridge the gap between U.S. and Chinese positions in international climate negotiations. Under what circumstances might China adopt a GHG emissions permit system that would be accepted by the U.S. as "comparable" to the U.S. system?

Might a U.S.-China bargain include credible U.S. commitments to provide technology and technical assistance sufficient to materially reduce China's GHG emissions? Might the Clean Development Mechanism (CDM) be revised and expanded in such a way as to substantially increase the flow of CDM revenues to China? Might the U.S. and China join together in coordinated efforts to solve technical issues hampering efforts to develop "clean coal", environment-friendly biofuels, and efficient means of long-distance energy transmission?

In sum, might moderation, cooperation, and agreement be possible given increased recognition of the cataclysm threatened by uncontrolled GHG emissions, together with the leverage provided by a credible threat of potentially successful WTO litigation?

In the United States, current legislative proposals for a "cap & trade" system seek to maintain the competitiveness of U.S. industry through two basic procedures relating to GHG emissions. First, the principal draft bill pending in the U.S. Congress[2] (American Clean Energy and Security Act [ACES], 2009) would cap overall domestic GHG emissions and allocate greenhouse gas (GHG) "emission allowances" to certain carbon intensive and trade sensitive industries without charge. In this paper I will call such emission permits "domestic

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[1]Professor, Boston University School of Law, email: partan@bu.edu.

[2] The "American Clean Energy and Security Act of 2009", H.R. 2454, 111th Congress, 1st Session (hereinafter cited as "ACES"). Unless otherwise indicated, the ACES provisions cited in this paper are taken from the text of H.R. 2454 adopted on June 5, 2009, by the House Committee on Energy and Commerce. Page references are to the ACES text as reproduced in the House Energy and Commerce Committee report, H. R. Rep. No. 111-137, 111th Congress, 1st Session (2009).

At this writing the ACES bill is pending before the House Ways & Means Committee which has jurisdiction over the revenue aspects of the bill. Although the schedule has not been announced, Ways and Means may hold its "mark-up" session for amendment of the bill by the end of June. However, to become law, the bill requires acceptance both in the House of Representatives and the Senate, followed by and the all-important final reconciliation through a House-Senate conference committee. At that point the bill will be submitted to the President for signature.

emission allowances". Second, in certain circumstances, the draft bill would require importers to obtain "international emission allowances" equivalent to the domestic emission allowances required from U.S. GHG emitters. Whereas domestic emission allowances account for actual GHG emissions resulting from production and process actions in the United States, international emission allowances account for GHG emissions assumed to have resulted from production and process actions occurring abroad with respect to certain products imported into the United States.

Currently neither U.S. GHG emitters nor Chinese exporters are subject to emissions allowance requirements. However, if China or some other major exporter does not adopt what the U.S. views as a "comparable" GHG emissions allowance system, it is widely expected that the U.S. Congress will require some form of GHG emissions permit for imports of certain carbon intensive goods. It is also widely expected that China or some other exporter will challenge U.S. a GHG emissions permit requirement as applied to their exports as in violation of WTO trade treaty obligations.

This paper examines the proposed contents of U.S. competitiveness provisions in relation to WTO treaty law, and assesses prospects for WTO constraints on the proposed U.S. GHG emissions permit system. With this in mind, the paper assesses the prospects for utilizing threats of WTO legal action to bridge the gap between U.S. and Chinese positions in bilateral or international climate negotiations.[3]

The following are among the issues potentially resolvable through such a strategy. Under what circumstances might China adopt a GHG emissions permit system that would be accepted by the U.S. as "comparable" to the U.S. system? Might a U.S.-China bargain include credible U.S. commitments to provide technology and technical assistance sufficient to materially reduce China's GHG emissions? Might the Clean Development Mechanism (CDM) be revised and expanded in such a way as to substantially increase the flow of technology and of CDM revenues to China? Might the U.S. and China join together in coordinated efforts to solve technical issues hampering such carbon emissions mitigation efforts as programs to develop "clean coal" power plants, environment- friendly biofuels, or efficient means of long-distance energy transmission?

This discussion has three parts. The first is a brief description of salient provisions of "ACES", the "American Clean Energy and Security Act of 2009"[4], which is the leading climate bill pending in the U.S. Congress (ACES, 2009). At this writing, ACES has been adopted as amended by the Committee on Energy and Commerce, which is the lead House committee on energy legislation, and is pending before seven other House committees, chief among which is the House Ways and Means Committee. As the House committee primarily responsible for revenue legislation, Ways and Means will examine and perhaps amend provisions concerning both emitters' rebates and importers' emissions allowances, which are discussed in the first part of this paper.

The second part of the paper briefly examines key WTO treaty provisions to assess their potential application in WTO litigation concerning the conformity of ACES with U.S. treaty obligations. The final part will suggest that the dynamics of China-U.S. climate relations may be materially affected by the availability of a WTO forum for interpreting WTO treaty provisions and applying them to climate measures such as ACES.

The key word here is "dynamics". With the election of Barack Obama and the

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[3] Although details of discussions have not been released, U.S. and British newspapers report recent meetings between U.S. and Chinese climate officials (Broder& Ansfield, 2009; Goldenberg, 2009).

[4] "Salient" refers to ACES bill provisions most closely related to treaty commitments under WTO agreements.

appointment of his “dream team” of energy and climate officials[5], the U.S. clearly expects to play a leadership role in international efforts to restrict global greenhouse gas emissions. Having surpassed the U.S. as the world’s largest source of current greenhouse gas emissions, and considering its increasing need for efficient energy resources, China is similarly poised for leadership. It may well be that the success or failure of the current international climate negotiations will depend upon the ability of China and the United States to reach a common understanding and a joint approach to the design of a post- Kyoto GHG emissions control system. Hence the inquiry here addresses the dynamics of the China-U.S. climate negotiations – and the important role that might be played by WTO treaty obligations and the WTO judicial process.

American Clean Energy and Security Act of 2009 (ACES)

Although the details of a U.S. “cap and trade” system remain unsettled, there is no longer doubt that the U.S. will adopt domestic GHG controls through a “cap and trade” system. Led by Barack Obama, the U.S. government now accepts that the global warming trend is real, and that anthropomorphic GHG emissions are the principal cause of global warming. The U.S. also accepts IPCC findings that climate change affects many natural systems, including rising sea levels, altered drought and rainfall patterns, and “poleward and upward shifts in plant and animal ranges” that affect human health through “changes in infectious disease vectors”[6] (Intergovernmental Panel on Climate Change [IPCC], 2007).

ACES is essentially a lengthy omnibus bill (originally 946 pages). The bill adds a new title VII (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 131 ff) to the existing U.S. Clean Air Act: “Title VII—Global Warming Pollution Reduction Program”, and names that Title together with scattered other ACES sections, the “Safe Climate Act” (ACES, 2009, § 301; H. R. Rep. No. 111-137, 2009, p. 131). The Act recites a legislative “finding” that “Global warming poses a significant threat to the national security, economy, public health and welfare, and environment of the United States, as well as of other nations” (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 131).[7] The bill’s “findings” further specify that: “Because they induce global warming, greenhouse gas emissions cause or contribute to injuries to persons in the United States”, including *inter alia* “disease and loss of life”, “damage to property and other interests related to ocean levels”, “scarcity of water”, and “worsening of tropospheric air pollution” (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 131-132).[8]

The Safe Climate Act sets goals of capping and progressively reducing GHG emissions from sources specified in the bill, which includes approximately 85% of total U.S. emissions. The cap is intended to achieve to the following reductions measured as percentages of U.S. 2005 emissions: reductions in 2012 to 97%; in 2020 to 83%; in 2030 to 58%; and in 2050 to 17% of emissions from covered GHG sources (ACES, 2009, § 311; H.

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[5] In contrast to the Bush administration, high officials appointed by President Obama are committed to actions that reduce and control U.S. greenhouse gas emissions. These include Steven Chu, Secretary of Energy, Gary Locke, Secretary of Commerce, Lisa Jackson, Administrator of the Environmental Protection Agency (EPA), Todd Stern, State Department Special Envoy on Climate Change, Carol Browner, White House “Climate Czar”, and John Holdren, Science Adviser to the President.

[6] Intergovernmental Panel on Climate Change (IPCC), 4th Assessment Report (2007). The referenced provisions are merely a brief sample of IPCC findings. The House Energy and Commerce Committee report reviews many domestic and international impacts of climate change including the findings of climate scientists and of the IPCC (H. R. Rep. No. 111-137, 2009, p. 300-316).

[7] Adding section 701(a)(1) to the Clean Air Act.

[8] Adding section 701(a)(3) to the Clean Air Act.

R. Rep. No. 111-137, 2009, p. 132-133).[9] Although these statutory goals fall short of the rate of GHG emission reduction called for by some scientists and by some other governments, the Safe Climate Act provides a measure of flexibility through the provisions described below.

Every four years beginning in 2013, the U.S. Environmental Protection Agency (EPA) is directed to submit to Congress an analysis of the status of worldwide GHG reduction efforts based on an extensive list of the latest scientific information (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 133-134)[10], including IPCC assessments. Beginning with its quadrennial assessment report in 2017, the EPA analysis is specifically required to include:

> … the status of worldwide greenhouse gas reduction efforts, including implementation of … policies, both domestic and international, for reducing greenhouse gas emissions, preventing dangerous atmospheric concentrations of greenhouse gasses, preventing significant irreversible consequences of climate change, and reducing vulnerability to the impacts of climate change (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 133).[11]

The quadrennial EPA assessment must specifically address whether the actions of the United States and other countries are "sufficient to avoid"

> (A) atmospheric greenhouse gas concentrations above 450 parts per million carbon dioxide equivalent; [and]
> (B) global average surface temperature 3.6 degrees Fahrenheit (2 degrees Celsius) above the pre-industrial average, or such other temperature thresholds as the [EPA] Administrator deems appropriate (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 135).[12]

As noted below, the bill's specifications of 450 ppm and 2 degrees Celsius as thresholds of dangerous atmospheric GHG concentrations do not reflect an international scientific consensus. Nevertheless some flexibility is provided by the authority of the EPA Administrator to find that some other temperature threshold is appropriate in light of an emerging scientific consensus.

Most importantly, each quadrennial EPA report must specify the quantity of additional global reductions in GHG emissions that would be needed to avoid exceeding the GHG concentration and the temperature thresholds specified in the bill or by the EPA Administrator (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 135).[13] Furthermore, the bill calls upon the premier independent scientific body in the United States, the National Academy of Sciences (NAS)[14], to review the EPA quadrennial report, and to analyze the

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[9] Adding 703 to the Clean Air Act.
[10] Adding 703 to the Clean Air Act, House Report pp. 132-33.
[11] Adding section 705(a)(3) to the Clean Air Act.
[12] Adding section 705(e)(2)(A) & (B) to the Clean Air Act.
[13] Adding section 705(f)(3)(B) to the Clean Air Act.
[14] The NAS by legislation signed by President Abraham Lincoln in 1863. As mandated in its Act of Incorporation, the NAS role is to "investigate, examine, experiment, and report upon any subject of science or art" whenever called upon to do so by any department of the government. NAS membership is composed of approximately 2,100 members and 380 foreign associates, of whom nearly 200 have won Nobel Prizes. Members and foreign associates are elected in recognition of their distinguished and continuing achievements in original research. The Academy is governed by a Council consisting of twelve members (councilors) and five officers, elected from among the Academy membership. [Based on the Academy website www.nasonline.org.]

technologies that would be needed to achieve the GHG emission reductions recommended by the EPA. Both the EPA quadrennial report and the National Academy analysis are to be submitted to Congress (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 135).[15] As is normal under United States law, each of the many federal agency reports in the climate review process will be available to the public, and several committees of the Congress will likely hold public hearings when additional GHG emissions restrictions are proposed.

Finally, at the White House level, two years after each quadrennial EPA report, the President is required to "direct relevant Federal agencies to use existing statutory authority to take appropriate actions identified" in the EPA quadrennial assessments (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 135).[16]

Furthermore,

> [I]n the event that the National Academy of Sciences has concluded … that the United States will not achieve the necessary domestic greenhouse gas emissions reductions, or that global actions will not maintain safe global average surface temperature and atmospheric greenhouse gas concentration thresholds, the President shall submit to Congress a plan identifying domestic and international actions that will achieve necessary additional greenhouse gas reductions, including any recommendations for legislative action (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 135).[17]

As is normal in so wide-ranging a legislative effort as ACES, ultimate control over changes in U.S. GHG emissions policy would be reserved to Congress. However, insofar as the GHG emissions cap is concerned, ACES vests considerable influence, regulatory authority, and operational control in EPA, which is an administrative agency within the Executive Branch. The quoted ACES provisions delegate to the EPA and also to the nongovernmental expert body, the National Academy of Sciences, two crucial issues rolled into a single question: whether the statutory danger thresholds and existing GHG emission controls are adequate to avoid climate catastrophe. While the adequacy of the danger thresholds may be addressed in terms of climate science, the question of the appropriate governmental response raises issues of societal values.

Much is now known about the climate change consequences of global warming, but the point at which atmospheric concentrations of GHG emissions could cause "runaway" GHG emissions remains subject to sharp differences of opinion among climate scientists. An example would be the loss of heat-reflective ice cover in Greenland and Antarctica, which would accelerate surface warming in Arctic and Antarctic regions. This would potentially cause vast areas of permafrost to melt, releasing large amounts of the potent greenhouse gas methane. Such an event has been seen as a so-called "tipping point" at which runaway GHG emissions can no longer be brought under control (H. R. Rep. No. 111-137, 2009, p. 297-298).

Through the statutory reference to "global actions [that] will not maintain safe global average surface temperature and atmospheric greenhouse gas concentration thresholds", Congress plainly calls upon the EPA and the National Academy of Sciences to assess the adequacy of the statute's danger thresholds: atmospheric concentrations increase to 450 ppm CO2 equivalent, and global average surface temperature increase of 2 degrees Celsius. Since these benchmarks function as the basis for the ACES GHG emissions cap, such a finding would imply an urgent need for more stringent measures to reduce carbon emissions. But

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[15] Adding section 706(a) to the Clean Air Act.
[16] The first occasion for Presidential action thus comes in 2015. Adding section 707(1) to the Clean Air Act.
[17] Adding section 707(2) to the Clean Air Act.

climate science can do no more than address the risk in terms of greater or lesser degrees of confidence (IPCC, 2005). Governments responding to such risks need to evaluate proposed measures in light of societal values.

If the EPA or the NAS were to determine that existing measures are not adequate to avoid danger levels, the operational question then becomes: what measures would be needed to maintain GHG emissions levels below the amount projected to exceed the danger point? Implicit in this issue is the degree of risk that would be responsible in light of the potential for harm resulting from exceeding a "tipping point". The stringency – and therefore the costs – of a government's response to such a risk more directly concerns societal values, which will be addressed by Congress, but are not likely to be the subject of international negotiation.

In this scenario it may be difficult to separate scientific issues from values issues, but such a separation is needed for clarity of analysis. The causal links between GHG emissions, climate change, and its consequences, are now subject to a growing body of scientific evidence – which increasingly provides a solid basis for policy analysis. In contrast, the value basis for tolerable risk levels is not subject to scientific analysis. Each government must clarify its societal values and strive for transparency in its choice of responsive measures. Care must be taken to view science – determining the causes and consequences of climate change – independently of societal values that structure tolerable risk levels and appropriate responses.

Structure of the ACES Emission Allowances Program

Beginning in 2012, the ACES emission allowance requirement applies to "covered entities" which include all electricity generators, and producers or importers of petroleum- or coal-based liquid fuels, or natural gas liquids where combustion of the fuel results in emission of more than 25,000 metric tons of carbon dioxide equivalent annually. In 2014 the emission allowance requirement is extended to industrial facilities that manufacture certain products or that burn fossil fuels at the same 25,000 metric ton emission standard as applied to producers of liquid fuels. Certain natural gas distributors are also covered entities beginning in 2016.[18]

The ACES emissions cap is structured to begin with issuance by the EPA Administrator in calendar year 2012 of the number of emission allowances equivalent to 97% of the GHG emissions by covered entities in 2005. The number of emission allowances issued in 2012 (about 4.6 billion) rises to about 5.5 billion in 2016 as additional facilities become subject to the emission allowance requirement. The emissions cap then tightens; the number of allowances issued drops by roughly 100 to 150 million per year until it reaches slightly over 1 billion for the year 2050 and following years (ACES, 2009, § 311; H. R. Rep. No. 111-137, 2009, p. 143-144).[19]

Although the Obama administration had originally wanted emission allowances to be auctioned with the auction revenue included in the federal government budget, the House Energy and Commerce Committee bill would initially auction less than 30 percent of emission allowances, which would drop to 17.5% by 2016 as additional entities became covered by the emissions cap. The remainder, i.e., 82.5% in 2016, would be distributed free of charge (H. R. Rep. No. 111-137, 2009, p. 362).

From 2016 through 2025, 35% of the emission allowances would be allocated to the electricity sector without charge for the benefit of electricity consumers, and 9% would be allocated for the benefit of natural gas consumers. In addition, for each year, 2012 through 2050, 15% of the emission allowances would be allocated for the benefit of low income

[18] Covered entities are more fully described in H. R. Rep. No. 111-137, 2009, pp 360-361.
[19] Adding section 721(e) to the Clean Air Act.

consumers. ACES provides for many other generally much smaller free allocations of emissions allowances for various purposes and varying time periods. These include home heating oil and propane consumers, support for carbon capture and sequestration, investment in energy efficiency and renewable energy, and rebates to certain energy-intensive, trade-exposed industries (ACES, 2009, § 321; H. R. Rep. No. 111-137, 2009, p. 177-180).[20] An economist who recently examined ACES allowances, their intended recipients, the purposes for which they would be issued, and the varying free distribution periods and percentages concluded that "80% of the value of [freely distributed emission allowances] accrue to consumers and public purposes, and some 20% accrue to covered, private industry." (Stavins, 2009). [21]

Emission Allowance Rebate and International Reserve Allowance Programs

In addition to freely distributed emission allowances, ACES establishes two programs that address the competitiveness impacts of the U.S. industry in light of the costs of the cap-and-trade program. First, the "Emission Allowance Rebate Program" provides rebates to certain industrial sectors to compensate for costs incurred in compliance with ACES emission limits. Second, the "International Reserve Allowance Program" authorizes the President to require that in certain circumstances, importers of certain products obtain "international reserve allowances" intended to address the competitive imbalance in the costs of production resulting from the difference between costs of complying with ACES and the costs, if any, of complying with GHG emission programs in other countries (ACES, 2009, § 401; H. R. Rep. No. 111-137, 2009, pp. 229-230).[22]

The basic purpose of the Emission Allowance Rebate Program is stated to be preventing "carbon leakage" by rebating the bill's GHG emission costs to firms in eligible domestic industrial sectors. "Carbon leakage" is defined as a "substantial increase" in GHG emissions "in other countries" if such increase is caused by a cost of production increase in the U.S. resulting from implementation of the ACES legislation (ACES, 2009, § 401; H. R. Rep. No. 111-137, 2009, p. 225).[23] To be eligible for a rebate, the firm must be in an industrial sector that satisfies one of the following two criteria:

> First. the sector must have *either* an "energy intensity" *or* a "greenhouse gas intensity" of at least 5%[24], *plus* a trade intensity of at least 15%[25]; or,
> Second, the sector must have a "very high energy or greenhouse gas intensity of at least 20% (ACES, 2009, §764(b)(2)(A)(ii); H. R. Rep. No. pp. 226).[26]

Calculations formulae (summarized in footnotes) show that access to rebates

[20] Emissions Allowance Rebate Program, adding section 782 to the Clean Air Act. The rebate program is separately described below.
[21] The writer states that his analysis is based on the Waxman-Markey ACES bill as amended by the House Energy and Commerce Committee.
[22] International Reserve Allowance Program, adding sections 766-767 to the Clean Air Act.
[23] Adding section 763(1) to the Clean Air Act.
[24] To calculate "energy intensity", *divide* (the cost of purchased electricity + fuel costs of the sector) *by* the (value of the shipments of the sector). To calculate "greenhouse gas intensity", *divide* [the number 20 *multiplied by* (the number of tons of direct and indirect CO2 equivalent GHG emissions)] *divided by* (the value of the shipments of the sector) (ACES, 2009, §764(b)(2)(A)(i); H. R. Rep. No. pp. 225-226).
[25] To calculate "trade intensity", *divide* (the value of total imports and exports of the sector) *by* (the value of shipments + the value of imports of the sector) (ACES, 2009, §764(b)(2)(A)(ii); H.R. Rep. No. 111-137, p. 226).
[26] Note that the criteria given here indicate *presumptively* eligible sectors; the EPA may designate additional eligible sectors. (ACES, 2009, §764(b)(3); H. R. Rep. No. pp. 227).

increases as either the sector's energy costs or its GHG emissions increase; trade intensity increase similarly increases access to rebates as either or both imports and exports increase.

The ACES Emission Allowance Rebate Program includes both "covered entities"[27] and firms that are not "covered entities", but operate in an eligible industrial sector that satisfies the criteria summarized above. Calculation of rebates differs according to whether the industrial entity is or is not a "covered entity".

For covered entities, rebates include both direct and indirect compliance costs, which are termed "direct and indirect carbon factors". Rebates for other industrial firms in an eligible sector are measured solely by indirect compliance costs. Direct compliance costs are carbon emission costs incurred by covered entities; indirect compliance costs are carbon emission costs passed along to both covered entities and other eligible entities by their electricity providers. Where emissions allowances were freely allocated to an electricity provider and used for the benefit of industrial consumers, rebates for indirect costs are adjusted to avoid rebates for costs that were not incurred by the industrial entity (ACES, 2009, §765(b)(1)-(3); H.R. Rep. No. 111-137, p. 228-229). The total distribution of rebates for any year is limited to the amount of emission allowances allocated to the Emission Allowance Rebate Program for that year (ACES, 2009, §321; H.R. Rep. No. 111-137, p. 178).[28]

As noted earlier, the ACES bill also provides for an "International Reserve Allowance Program" that authorizes the President to require importers' "international reserve allowances" intended to address the competitive imbalance resulting from the difference between costs of complying with ACES, and the costs of complying with a GHG emission program, if any, in the exporting country. The program applies to imports of "primary products" which are defined as products manufactured by an eligible industrial sector that are:

> (A) iron, steel, steel mill products (including pipe and tube), aluminum, cement, glass (including flat, container, and specialty glass and fiberglass), pulp, paper, chemicals, or industrial ceramics; or
>
> (B) any other manufactured product that is sold in bulk for purposes of further manufacture or inclusion in a finished product (ACES, 2009, §401; H.R. Rep. No. 111-137, p. 225).[29]

To invoke the international reserve allowance requirement with respect to imports of primary products in an eligible industrial sector, the President must first determine whether 70% or less of the global output[30] for the sector is produced or manufactured in countries that meet at least one of the following four criteria (ACES, 2009, §767(c); H.R. Rep. No. 111-137, p. 230):

> 1. The country is a party to an international agreement to which the United States is a party that includes a nationally enforceable greenhouse gas emissions reduction commitment for that country that is at least as stringent as that of the United States.

[27] "Covered entities" are defined in ACES section 312, adding Title VII to the Clean Air Act. (ACES, 2009). Also see the summary description earlier in this paper.

[28] Adding section 782(e) to the Clean Air Act, concerning "Trade Vulnerable Industries". The allocation is 2% of the emission allowances for 2012 and 2013, but 15% for the year 2014, and 15% multiplied by various factors for subsequent years.

[29] Adding section 763 to the Clean Air Act.

[30] Output means "the total tonnage or other standard unit of production (as determined by the [EPA] Administrator) produced by an entity in an industrial sector." (ACES, 2009, §763(5); H.R. Rep. No. 111-137, p. 222).

2. The country is a party to a multilateral or bilateral emission reduction agreement for that sector to which the United States is a party.

3. The country has an annual energy or greenhouse gas intensity … for the sector that is equal to or less than the energy or greenhouse gas intensity for such sector in the United States in the most recent year for which data are available.

4. The country has implemented policies … that individually or collectively impose an incremental increase on the cost of production associated with greenhouse gas emissions from the sector that is at least 60% of the cost of complying with this title in the United States for such sector, averaged over a two-year period (ACES, 2009, §767(b); H.R. Rep. No. 111-137, p. 230).

Next, the President must assess the extent to which either emission allowance rebates or the International Reserve Allowance Program either has or could mitigate or address carbon leakage in the industrial sector at issue (ACES, 2009, §767(c); H.R. Rep. No. 111-137, p. 230).

Upon making the 70% or less finding and the emission allowance and reserve allowance assessments, the President must then either modify the percentages that govern the direct and indirect carbon cost factors in calculating the emission allowance rebate, or implement the International Reserve Allowance Program for the primary products involved, or take both actions (ACES, 2009, §767(c)(3) and (e); H.R. Rep. No. 111-137, p. 231).

ACES provides that the International Reserve Allowance Program may not begin before January 1, 2025 (ACES, 2009, §766(a)(4); H.R. Rep. No. 111-137, p. 230). It is in essence a border adjustment program with the stated purpose of addressing "the competitive imbalance in the costs of producing or manufacturing primary products in industrial sectors resulting from the difference between" US GHG emission compliance costs and the "costs, if any, of complying in other countries with greenhouse regulatory programs" (ACES, 2009, §766(a)(2); H.R. Rep. No. 111-137, p. 230). Regulations issued by the EPA Administrator would require submission of "appropriate amounts" of international reserve allowances on importation of primary products, and prohibit "the introduction into interstate commerce of a primary product without submitting the required number of international reserve allowances" (ACES, 2009, §766(a)(1)(B) and 766(a)(1)(D); H. R. Rep. No. pp. 229-230).

WTO Treaty Compliance Issues

Brief comments about WTO jurisprudence may be useful before addressing WTO treaty compliance issues under key ACES provisions. The three ACES provisions that appear most vulnerable are: (1) The ACES grant of free allocations of emissions allowances; (2) the "Emissions Allowance Rebate Program"; and (3) the "International Reserve Allowance Program". Each provision is summarized above.

The WTO judicial process is more complex than that of other major international tribunals. In brief, there are four phases to the WTO judicial process: consultations between the parties; proceedings before a Panel; appeals to the Appellate Body; and compliance proceedings. Unlike the International Court of Justice, where the consent of the respondent state is required, WTO Members are obligated by treaty to submit their WTO treaty disputes to the jurisdiction of WTO tribunals. Although they do not bind other WTO Members, decisions of the Appellate Body – and, where not appealed, of WTO Panels – are binding with respect to the states parties to the dispute.

Under the WTO Dispute Settlement Understanding (DSU), the fundamental role of the WTO judicial system is to provide "security and predictability to the multilateral trading system." Hence the purpose of the WTO legal process is "to preserve the rights and obligations of Members under the covered agreements and to clarify the existing provisions of those agreements in accordance with the customary rules of interpretation of public international law." Article 3.2 adds that WTO dispute settlement rulings "cannot add to or diminish the rights and obligations provided in the covered agreements." (DSU, 1994, Article 3:2).

Thus, although WTO dispute decisions are to "clarify" existing WTO treaty provisions, they must "preserve" rights and obligations, without increasing or reducing those rights or obligations. This careful formulation appears to impose sharp limits on the "clarification" function of dispute settlement, but Article 3.2 structures those limits by mandating that the twin tasks of clarification and preservation be accomplished "in accordance with the customary rules of interpretation of public international law." (DSU, 1994, Article 3:2). In common with international practice generally, the Appellate Body reasonably accepts that customary international law rules of treaty interpretation are embodied in Articles 31-33 of the widely ratified Vienna Convention on the Law of Treaties (1969) ("Vienna Convention" or "VCLT") (*Japan—Taxes on Alcoholic Beverages*, 1996). Also in common with international practice generally, the Appellate Body acknowledges that some existing rules of treaty interpretation have not been codified in the Vienna Convention (*United States—Continued Dumping and Subsidy Offset Act*, 2000, ¶271).

I should emphasize that treaty interpretation is not a mechanical process that can be accomplished by routine application of clear rules or standards of interpretation to the text of a treaty. Rather, treaty interpretation requires close analysis of the treaty text, deep understanding of treaty interpretation methodology, and sophisticated appreciation of the limits to the interpreter's authority. Thus it is by no means assured that but a single "correct" result will be reached in any specific instance. What is desired and should generally be attainable, however, are interpretations that fall within a relatively narrow band of potential results.

In interpreting provisions of WTO agreements, the Appellate Body has often been quite rigorous and systematic in applying the "rules" of interpretation laid down in Articles 31-33 of the Vienna Convention on the Law of Treaties. Paradoxically, the Appellate Body's focus on rigorous application of international law treaty interpretive methodology is sometimes criticized from both ends of the spectrum: either as far too mechanical an approach or as enabling the Appellate Body to create law by masking insertion of its own unwarranted trade policy judgments into WTO agreements. Neither polar criticism is justified.

Typically Appellate Body review forcefully requires panels to begin with the "*ordinary meaning*" of the treaty text as mandated by VCLT Article 31:1, which calls for interpreting treaty text in light of "*context*" as is narrowly defined in VCLT Article 31:2, and in light of the "object and purpose" of the treaty. The net effect of these provisions is to focus the interpreter's attention on matters intrinsic to the treaty. Although these provisions constitute the "fundamental rule" of treaty interpretation, both panels and the Appellate Body typically need to resort to other provisions of the VCLT, and sometimes to canons of treaty interpretation found in customary international law outside of the Vienna Convention.

The concept of "*ordinary meaning*" is not defined. Although determining "ordinary" meaning will typically require the interpreter to invoke dictionary definitions of the language used in authentic treaty texts, the Appellate Body has observed that:

> [D]ictionaries, alone, are not necessarily capable of resolving complex questions of interpretation, as they typically aim to catalogue *all* meanings of words—be those meanings common or rare, universal or specialized (*United States—Gambling*

Services, 2005, ¶¶ 162-66).

A focus intrinsic to the treaty is equally clear in deriving meaning from the "*context*" of a contested term. Although the term "context" may often bear a broader meaning, the Vienna Convention gives the concept a narrow scope. VCLT Article 31:2 defines "context" as meaning the treaty text, including its preamble and annexes, together with agreements "relating to the treaty … made between all the parties in connexion with the conclusion of the treaty".

Article 31 also permits the interpreter to consult three other potential indicators of agreement of the parties regarding the interpretation of the treaty. The first is "any subsequent agreement" "regarding the interpretation of the treaty"; the second is "any subsequent practice" "which establishes the agreement of the parties regarding its interpretation" VCLT Article 31:3(a) & (b). The third reference is to "any relevant rules of international law applicable in the relations between the parties" VCLT Article 31:3(c). The interpreter's use of subsequent agreements and subsequent practice moves analysis beyond the text of the treaty, but the focus remains the text the treaty as drafted; to be considered by the interpreter, both subsequent agreements and subsequent practice must relate directly to the interpretation of the treaty. Hence the interpreter's resort to these factors is not a substantial departure from the concept of deriving meaning from indicators of intent "intrinsic" to the treaty.

Free Allocation of Emissions Allowances and Emission Allowance Rebate Program

To challenge free allocation of emissions allowances or the emission allowance rebate program as in violation of the WTO Agreement on Subsidies and Countervailing Measures (Subsidies or SCM Agreement), a WTO Member would need to show that the ACES measures constitute a "subsidy" and cause "adverse effects" to the interests of other Members as those terms are defined in the Subsidies Agreement.

The SCM definition of a "subsidy" includes, *inter alia*, the following potentially relevant forms of a "financial contribution by a government":

> (i) a government practice [that] involves a direct transfer of funds (e.g. grants, loans, and equity infusion) …;
>
> (ii) government revenue that is otherwise due is foregone or not collected …;
>
> (iii) a government provides goods or services other than general infrastructure…. (SCM Agreement, 1994, Article 1.1(a)(1)(i)-(iii)).

To be "actionable", the subsidy must be "specific" in the sense of applying to "enterprise or industry or group of enterprises or industries", in contrast to grants made pursuant to legislation which "establishes objective criteria or conditions governing the eligibility for, and the amount of, a subsidy". Furthermore, an "actionable" subsidy requires, *inter alia*, "serious prejudice to the interests of another Member", which may arise where "the effect of the subsidy is to displace or impede the imports of a like product of another Member into the market of the subsidizing Member"(SCM Agreement, 1994, Articles 2.1, 2.1(b), 5(c), and 6.3(a)). The quoted provisions may serve as the WTO treaty basis for a multifaceted challenge to the wide-ranging free allocation of emission allowances in the

ACES bill.[31]

If a subsidies case were brought by an exporter of goods to the U.S. market, the United States may seek to invoke the environmental exception of the General Agreement on Tariffs and Trade (GATT) Article XX(g), which provides:

> Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures:
>
> . . .
>
> *(g)* relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption; ….

Although the Subsidies Agreement adopted at the Uruguay Round in 1994 relates to certain articles in the original GATT agreement adopted in 1947, the GATT Article XX "General Exceptions" do not explicitly apply to the other Multilateral Agreements on Trade in Goods adopted at the Uruguay Round. Hence, quite apart from difficulties in interpreting the language of the introductory clause, termed the "chapeau" of Article XX, and its subparagraph (g), reliance on the General Exception of GATT Article XX may be rejected as a defense to claimed Subsidies Agreement violations.

The Emission Allowance Rebate Program presents much the same subsidy issues as presented by the free allocation of emission allowances, but the WTO analysis may differ owing to the specifications of the program. The eligibility tests imply more limited access to rebates in comparison to the wide scope given to free allocation of emission allowances. The focus on "carbon leakage", defined as a "substantial increase" in GHG emissions "in other countries" if such increase is caused by a cost of production increase in the U.S. resulting from implementation of the ACES legislation, implies that "leakage" refers to a shift of production to countries that do not limit GHG emissions. This might be seen as a "disguised restriction on international trade", disqualifying the program for the "general exception" provision of GATT Article XX(g).

Both measures, the free allocation of emission allowances and the Emission Allowance Rebate Program, thus offer considerable scope for WTO legal challenge, involving issues of interpretation and application of WTO treaties that are not easily answered.

The International Reserve Allowance Program offers additional potential legal challenges which, if anything, would be more complex than those arising under the free allocation and emission allowance rebate programs.

As noted, the International Reserve Allowance Program is explicitly intended to address the competitiveness of U.S. industry – the competitive imbalance that results from the difference between costs of complying with ACES, and costs of complying with a GHG emission program, if any, in the exporting country. The program would correct this imbalance – level the playing field – by requiring exporters to acquire emission allowances from the "International Reserve" established by the EPA Administrator.

The fundamental issue presented by the International Reserve Allowance Program is that imports from WTO Members that control GHG emissions in a manner similar to the U.S. are treated differently from exports from WTO Members that have not adopted such

[31] See text regarding Emissions Allowance Rebate Program, above.

controls. GATT Article I:1, General Most-Favoured-Nation Treatment, provides:

> With respect to customs duties and *charges of any kind* imposed on or in connection with importation . . . any advantage, favour, privilege or immunity granted by any [WTO] Member to any product originating in or destined for any other country shall be accorded immediately and unconditionally to the *like product* originating in or destined for the territories of all other [WTO] Members.
> [italics supplied][32]

The italicized words "*charges of any kind*" and "*like product*" raise the issues of whether the international emissions allowance requirement is in effect a "charge", and whether a product produced with GHG emission controls is "like" an identical product produced without such controls. The latter is the product versus process or production methods (PPM) issue which has arisen several times under GATT and WTO, but has yet to be finally resolved. Once again these issues provide ample opportunity for WTO litigation.

In addition, the International Reserve Allowance Program presents potential barriers to satisfying the requirements of the chapeau to Article XX. The General Exception clauses of GATT Article XX would of course apply to measures that violate the MFN clause of GATT Article I, but the question may be whether ACES International Reserve provisions violate the chapeau because "applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade". Since the International Reserve Allowances Program explicitly seeks to correct competitive trade "imbalances", its application will surely seek to restrict international trade, and it may be no defense that the program is not effective until January 1, 2025. The terms of the Article XX chapeau seem to contemplate a measure that has been "applied", which may be argued to postpone analysis until sometime after the effective date for the President's invocation of the International Reserve Allowance Program. Owing to their "chilling effect" on international trade, however, the WTO has, however, adjudicated cases challenging statutory provisions before they were implemented.

WTO Litigation as Leverage in Climate Negotiations

This brief survey of potential WTO legal challenges to ACES provisions is intended to show that the adoption of ACES may trigger potentially well-founded WTO cases unless agreement on GHG controls can be reached between major trading partners. In this context, potential WTO litigation may serve as an impetus to reaching broader agreement on climate issues. The filing of WTO cases will set in motion a lengthy and contentious process that might harden government positions, threaten the WTO dispute settlement system, and become yet another barrier to reaching climate agreement. Might moderation, cooperation, and agreement be possible given increased recognition of the cataclysm threatened by uncontrolled GHG emissions, together with the leverage provided by a credible threat of potentially disruptive WTO litigation?

Perhaps a credible threat of WTO climate litigation would add to the pressure on the United States to reach consensus on a post-Kyoto GHG emissions control regime. One scenario for reaching a broader agreement might be serious planning for a WTO challenge to the ACES legislation – planning that would necessarily be taken seriously by the United States which has always had high stakes in effective WTO trade regulation. Facing such a

[32] The original language of GATT Article I:1 referring to "contracting parties" was changed to WTO Members with the establishment of WTO (GATT 1994, ¶ 2(a), Explanatory Notes).

challenge, perhaps the United States may be willing move towards effective transfer of GHG emissions reduction technology to developing countries and even to entertain proposals for joint China-U.S. projects aimed at developing technology to address major GHG emissions reduction issues.

Some examples follow: With abundant coal resources, both China and the U.S. would profit from cost-effective carbon capture and sequestration. With rising pressures on food resources, and concerns about energy independence, both China and the U.S. would profit from cost-effective cellulosic ethanol production. With urgent plans to develop and market the plug-in electric car, both China and the U.S. would profit from improvements in electric storage battery technology. With rapid development of wind and solar power, both China and the U.S. would profit from cost-effective long-distance energy transmission.

China-U.S. cooperative research projects in any one of these fields, and in many others, could develop and disseminate needed technology, thereby contributing to the reduction of global GHG emissions. Research costs might be shared in proportions agreed between the two sides, and research facilities could be located in both countries. As is normally true of U.S. government sponsored research, technology developed in such projects should be placed in the public domain, available without cost to researchers and manufacturers in all countries.

In embarking on such joint research projects, both China and the United States would at least informally agree on the contours of a post-Kyoto climate agreement in which all participants would undertake to accept limitations on their GHG emissions and to develop national emission allowance trading schemes compatible with those of their treaty partners. The participants would also agree to accept border adjustments as GHG emission compliance mechanisms, and to support the adoption by the WTO Ministerial Conference of a climate-friendly interpretation of "like product" in relevant WTO agreements (Agreement Establishing the World Trade Organization, Article IX:2).[33]

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[33] Granting the WTO Ministerial Conference and General Council "exclusive authority to adopt interpretations … of the Multilateral Trade Agreements [by a three-fourths majority of WTO Members]." Since the authority granted is "exclusive", the WTO Appellate Body would no doubt accept a Ministerial Conference interpretation.

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Climbing The Great Wall:
How The Interplay Between China And The United States Will Affect Mitigation In A Kyoto Successor Treaty

Elizabeth Dinello[1]

Abstract

China and the United States have the ability to radically shape a successor treaty to the Kyoto Protocol. China's placement as a non-Annex I nation under the Kyoto Protocol has had significant negative consequences for climate change, and China is now the top emitter of greenhouse gases in the world. The United States has thus far refused to sign the Kyoto Protocol. China will not sign a Kyoto successor treaty unless the United States is on board and vice versa. If either party is uncooperative in negotiating a successor treaty, there will be no effective treaty. The Kyoto Protocol has in large part failed because of the roles China and the United States have played.

This paper will discuss how the interplay between China and the United States will affect mitigation in a Kyoto successor treaty. This paper argues that China and the United States must agree to reduce greenhouse gas emissions to eighty percent below 1990 levels by 2050. First, this paper will discuss basic climate change science, focusing on what the experts say greenhouse gases (including carbon dioxide) and temperature must be stabilized at as well as the mitigation measures necessary to achieve those stabilization goals. Second, this paper will summarize what happened at the Bali and Poznan conferences and how those two meetings set the stage for Copenhagen in 2009. Third, this paper will outline the necessary framework for mitigation in a Kyoto successor treaty. Fourth, this paper will address the challenges of implementing a Kyoto successor treaty in the United States and in China. Lastly, this paper will discuss how the world, and in particular the United States and China, is reacting and could react to mitigating climate change in light of the current economic crisis. With the recent approval of Todd Stern as the United States Special Envoy for Climate Change and the March 2008 elevation of China's State Environmental Protection Agency into a Cabinet ministry, both nations are now in the position to cooperate and lead the rest of the world in negotiating a successful Kyoto successor treaty.

Introduction

"My dear ones, your generation will face a series of environmental challenges that will dwarf anything any previous generation has confronted," the Udalls wrote to their grandchildren.[2] They then pointed out that the United States (U.S.) and China are responsible for forty percent of carbon dioxide emissions and that "consequently these two nations have a moral responsibility to be in the forefront of any global campaign to develop new technologies to cut the emissions of this damaging pollutant."[3] Stewart Udall, a former Secretary of Interior, "regrettably voted…for the Interstate Highway Program…act[ing] on the shortsighted assumption that cheap oil was super-abundant and would always be available…it haunts America today."[4] The U.S. has made a big mistake, and now China is following in America's footsteps. Americans are at fault, and we must take responsibility for our actions and make things right. Many rural Chinese strive to emulate the affluent lifestyle of Americans. Wu Yiebing and his wife, Cao Waiping, moved from a rural mountain village to Hanjing, and are

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[1] LL.M. Candidate, Environmental and Natural Resources Law and Policy, University of Denver Sturm College of Law, Denver, Colorado, U.S.A. email: edinello11@law.du.edu.

[2] Stewart and Lee Udall, *A Message to Our Grandchildren*, HIGH COUNTRY NEWS, March 31, 2008, available at http://www.hcn.org/issues/367/17613.

[3] *Ibid*.

[4] *Ibid*.

dependent on their new coal-supported lifestyle: "…they have tasted the rising standard of living from coal-generated electricity and they are hooked, even as they suffer the vivid effects of the damage their new lifestyle creates."[5] As Zhang Jianyu, program manager of Beijing's Office of Environmental Defense put it, " 'The fundamental problem is that China is following the path of the United States, and probably the world cannot afford a second United States.' "[6]

The Kyoto Protocol (Kyoto) has failed. Under Kyoto, developed nations were supposed to reduce their greenhouse gas emissions by five percent below 1990 levels. Not only have developed nations as a whole not reduced their emissions, they have actually *increased* their emissions. Professor Gwyn Prins points out that the European Union (EU), at the helm of Kyoto, actually increased its emissions by ten percent.[7] In an earlier article Professor Prins and Steve Raynor argued that Kyoto "failed…not just in its lack of success in slowing global warming, but also because it has stifled discussion of alternative policy approaches that could both combat climate change and adapt to its unavoidable consequences."[8] They insist that the "rational thing to do in the face of a bad investment is to cut your losses and try something different."[9] In an open letter to Barack Obama, journalist Michael Page points out that "Kyoto is noble but ineffective" and encourages Obama to abandon his cap and trade plan in favor of a tax-and-dividend system.[10] Since Obama has already pledged support for a cap-and-trade system, a carbon tax is unrealistic at this time.

Kyoto has in large part failed because of the roles China and the U.S. have played. Under the Bush administration, the U.S. refused to sign Kyoto. Bush consistently complained that China "was entirely exempted from the requirements in the Kyoto Protocol."[11] Bush also argued that "mandatory reductions in emissions will undermine the American economy…"[12] Eight years later, the American economy is in a shambles and the American people are angry—very angry at Mr. Bush. China has continued to follow America's lead in terms of economic development. Significant negative environmental consequences have come with this development. Professor Paul G. Harris argues that "the most profound environmental consequence of these developments is China's contribution to climate change."[13] Americans have set a horrible example for the Chinese. The U.S. has made the situation even worse by failing to take a leadership role in the global climate change arena and by failing to act at all. Even though the Chinese are racing to catch up to the Americans' affluent lifestyles, and in their race promising to increase carbon emissions to "600 million metric tons in 2010," citizens must remain optimistic that the two countries can come together and end this terrible game of "chicken."[14] As Margaret J. Kim and Robert E. Jones argue, "This global game of 'chicken' is a game that the world cannot afford to play.

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[5] Keith Bradsher & David Barboza, *Pollution from Chinese Coal Casts Shadow Around Globe*, N.Y. TIMES LATE ED., June 11, 2006, at Sec. 1 p. 1.

[6] N. Bruce Duthu, *Essay: Starbucks in the Forbidden City: Reflections on the Challenges and Opportunities for a U.S.-Chinese Partnership on Environmental Law & Policy*, 8 VT. J. ENVTL. L. 151, 152 (Spring 2007).

[7] Gwyn Prins, *Time to Ditch Kyoto: the Sequel*, in The Poznan Climate Change Conference Delagates' Book: Final, Oct. 25, 2008, available at http://sciencepolicy.colorado.edu/prometheus/prins-time-to-ditch-kyoto-the-sequel-4753.

[8] Gwyn Prins & Steve Rayner, *Time to Ditch Kyoto*, 449 NATURE 973, 973 (2007).

[9] *Ibid*.

[10] Michael Le Page, *Time for Change on Climate: an Open Letter to Barack Obama*, NEW SCIENTIST, Dec. 6, 2008, at 20.

[11] Erik Eckholm, *China Said to Sharply Reduce Emissions of Carbon Dioxide*, N.Y. TIMES LATE ED., June 15, 2001, at A1.

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[14] *Ibid*.

While the United States continues to drag its feet, knowing full well that China will not 'blink first,' China's emissions continue to grow at an alarming rate."[15] As Professor Harris says, "The great challenge, and opportunity, China faces is to chart a development path that doesn't imitate the destructive example of developed Western countries."[16] The U.S. and China must call a truce and together lead the world in creating a practical post-Kyoto framework.

This paper will discuss how the interplay between China and the U.S. will affect mitigation in a Kyoto successor treaty. This paper argues that China and the U.S. must agree to reduce greenhouse gas emissions to eighty percent below 1990 levels by 2050.[17] First, this paper will discuss basic climate change science, focusing on what the experts say greenhouse gases (including carbon dioxide) and temperature must be stabilized at as well as the mitigation measures necessary to achieve those stabilization goals. Second, this paper will summarize what happened at the Bali and Poznan conferences and how those two meetings set the stage for Copenhagen in 2009. Third, this paper will outline the necessary framework for mitigation in a Kyoto successor treaty. Fourth, this paper will address the challenges of implementing a Kyoto successor treaty in the U.S. and China. Lastly, this paper will discuss how the world, and in particular the U.S. and China, is reacting and could react to mitigating climate change in light of the current economic crisis. With the recent approval of Todd Stern as the U.S. Special Envoy for Climate Change and the March 2008 elevation of China's State Environmental Protection Agency into a Cabinet ministry, both nations are now in the position to cooperate and lead the rest of the world in negotiating a successful Kyoto successor treaty.[18, 19]

Climate Change Science—What The Experts Say

It is generally accepted in the academic community that humans have contributed greatly to global warming and that "Global atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years."[20] According to the Intergovernmental Panel on Climate Change (IPCC), "In order to stabilise the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilisation level, the more quickly this peak and decline would need to occur."[21] The IPCC stresses that we must take action quickly. The longer it takes us to initiate action, the harder it will be to stabilize greenhouse gas emissions

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[15] Margret J. Kim & Robert E. Jones, *China: Climate Change Superpower and the Clean Technology Revolution*, 22 NAT. RESOURCES & ENV'T 9, 13 (Winter 2008).
[16] Harris, *supra* note 12, at 89.
[17] This equates to the stabilization of greenhouse gases between 400 and 450 parts per million (ppm) carbon dioxide-equivalent concentration (ppm carbon dioxide equivalent).
[18] *Appointment of Special Envoy for Climate Change Todd Stern*, U.S. Department of State Website, available at http://www.state.gov/secretary/rm/2009a/01/115409.htm.
[19] THOMAS FRIEDMAN, HOT, FLAT, AND CROWDED—WHY WE NEED a GREEN REVOLUTION—AND HOW IT CAN RENEW AMERICA, 355 (Farrar, Straus and Giroux 2008). As Friedman notes, "in March 2008 China's politburo also elevated the status of the State Environmental Protection Agency, a famously toothless watchdog agency, into a full-fledged Cabinet ministry, with more staff and a bigger budget."
[20] IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, at 2, available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf.
[21] IPCC, 2007: *Climate Change 2007: Synthesis Report*, Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.), IPCC, Geneva, Switzerland, at 66, available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

at low levels: "Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels."[22]

At a 2005 conference hosted by the United Kingdom (UK) Met Office in Exeter, "preliminary findings were that a rise of 3 degrees Celsius (5.4 degrees Fahrenheit) relative to pre-industrial levels may by well past the edge of the comfort zone."[23] At the Exeter meeting, scientists "strengthened a consensus that a 2 degrees Celsius (3.6 degrees Fahrenheit) warming above pre-industrial levels, or about 1.2 degrees Celsius (2.1 degrees Fahrenheit) above today's global temperature, is the best goal for climate stabilization." Both NASA and the IPCC "have also endorsed the need to stop before warming by 2 degrees Celsius."[24] In the scientific community, "the consensus is that the limit should be 400 to have a good chance of restricting the global temperature rise to 2 degrees Celsius."[25]

It its Fourth Assessment Report, the IPCC states that "limiting temperature increases to 2°C above preindustrial levels can only be reached at the lowest end of the concentration interval found in the scenarios of category I (i.e. about 450 ppmv CO2-eq using 'best estimate' assumptions)."[26] In category I scenarios, emissions must peak between 2000 and 2015 and the change in global emissions in 2050 must be between fifty and eighty-five percent of 2000 levels.[27] Limiting the temperature increase to 2.4°C-2.8°C (category II) would mean that emissions must peak between 2000 and 2020 and the change in global emissions must be between thirty and sixty percent of 2000 levels.[28] Limiting the temperature increase to 2.8°C-3.2°C (category III) would mean that emissions must peak between 2010 and 2030 and the change in global emissions must be between five and thirty percent of 2000 levels.[29]

In a May 2008 letter, the Union of Concerned Scientists called for "reduc[ing] emissions on the order of 80 percent below 2000 levels by 2050." [30] The signatory scientists called for the first step to be "reductions on the order of 15-20 percent below 2000 levels by 2020, which is achievable and consistent with sound economic policy."[31]

The Road to Copenhagen: What Happened in Bali and Poznan

The Thirteenth Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 13)/ the Third Session of the Meeting of the Parties to the Kyoto Protocol (COP/MOP 3) held December 3-15, 2007 in Bali, Indonesia produced the Bali Roadmap. Bali saw the formation of the Ad Hoc Working Group on Long-

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[22] *Ibid*.

[23] Robert Henson, The Rough Guide to Climate Change 280 (Rough Guides Ltd. 2d ed. 2008).

[24] W.L. HARE, *A Safe Landing for the Climate*, in State Of The World 2009: Into a Warming World, 13, 18 (Worldwatch Institute 2009).

[25] *Beyond Our Means*, South China Morning Post, Dec. 1, 2008, at 16 (News).

[26] B.S. Fisher, N. Nakicenovic, K. Alfsen, J. Corfee Morlot, F. de la Chesnaye, J.-Ch. Hourcade, K. Jiang, M. Kainuma, E. La Rovere, A. Matysek, A. Rana, K. Riahi, R. Richels, S. Rose, D. van Vuuren, R. Warren, 2007: Issues related to mitigation in the long term context, In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, at 227, available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter3.pdf.

[27] *Ibid*. at 229.

[28] *Ibid*.

[29] *Ibid*.

[30] *U.S. Scientists and Economists' Call for Swift and Deep Cuts in Greenhouse Gas Emissions*, Union of Concerned Scientists Letter, May 2008, available at http://www.ucsusa.org/assets/documents/global_warming/Scientist_Economists_Call_to_Action_fnl.pdf.

[31] *Ibid*.

term Cooperative Action under the Convention.[32] The Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) is known as the "UNFCCC track" and runs parallel to the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Protocol (AWG-KP), the "Kyoto Protocol track." The creation of the new AWF-LCA is vital to the negotiation of a post Kyoto successor treaty by Copenhagen in 2009: "The key decision in Bali was the launch of a negotiating process under the Convention that will now run in parallel with the Kyoto negotiations with the expectation that – although not formally linked – the two tracks will converge in a comprehensive post-2012 agreement in 2009."[33] The two tracks must merge to create one cohesive regime.

At COP 13, both developed and developing nation parties adopted mitigation measures for the first time. Developed nation parties committed to "Measurable, reportable and verifiable nationally appropriate mitigation commitments or actions, including quantified emission limitation and reduction objectives, by all developed country Parties, while ensuring the comparability of efforts among them, taking into account differences in their national circumstances."[34] Developing nation parties committed to "Nationally appropriate mitigation actions by developing nation Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner."[35] Bali marked the first time that developing nations agreed to any kind of binding mitigation measures under either the UNFCCC or Kyoto Protocol tracks.

The Fourteenth Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 14)/ the Fourth Session of the Meeting of the Parties to the Kyoto Protocol (COP/MOP 4) held December 3-15, 2007 in Poznan, Poland served mainly as a "pit stop" on the road to Copenhagen and "barely produced any remarkable results."[36] Largely due to the political situation in the United States, most developing countries did not make significant moves in Poznan.[37] Poznan lacked the sense of urgency needed to lay an aggressive and attainable course on the road to Copenhagen. The EU called for reductions on the part of both developed and developing countries but developing countries called for "stronger support" from developed countries.[38]

In Poznan, the AWG-KP "reached no conclusions on the range of emission reductions to be undertaken by developed countries."[39] Most were "unprepared" to negotiate without the U.S. on board.[40] The AWG-LCA managed to accomplish significantly more at Poznan than the AWG-KP. The AWG-LCA "resolved to 'shift into full negotiating mode in 2009' "[41] and "adopted a work program authorizing its chair to draft the documents needed to carry its

[32] Pew Center on Climate Change, Bali Summary, at 3, available at http://www.pewclimate.org/docUploads/Pew%20Center_COP%2013%20Summary.pdf.
[33] *Ibid*.
[34] U.N. Framework Convention on Climate Change, Conference of the Parties, Thirteenth Session, Bali Action Plan para. 1(b)(i), Decision 1/CP.13, U.N. Doc. FCCC/CP/2007/6/Add.1 (March 14, 2008) available at http://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf#page=3.
[35] *Ibid*. at para. 1(b)(ii).
[36] *Pit Stop Poznan. An Analysis of Negotiations on the Bali Action Plan at the Stopover to Copenhagen*. Wuppertal Institute for Climate, Environment and Energy, at 2, available at http://www.wupperinst.org/uploads/tx_wibeitrag/Pit-Stop-Poznan.pdf.
[37] *Summary of the Fourteenth Conference of the Parties to the UN Framework Convention on Climate Change and Fourth Meeting of Parties to the Kyoto Protocol: 1-12 December 2008*, 12 EARTH NEGOTIATIONS BULLETIN 395, available at http://www.iisd.ca/download/pdf/enb12395e.pdf.
[38] Pew Center on Climate Change, *Poznan summary*, at 1-2, available at http://www.pewclimate.org/docUploads/PewCenterCOP14Summary.pdf.
[39] *Ibid*. at 2.
[40] *Ibid*.
[41] *Ibid*.

work forward."[42] The documents are 1) "a document 'describing areas of convergence in the ideas and proposals of the Parties, exploring options for dealing with areas of divergence and identifying any gaps that might need to be filled in reaching an agreed outcome;' " and 2) "a negotiating text for consideration at the AWG-LCA's second session next year, in June [2009]." A disagreement also arose in Poznan as to the "kind of legal outcome aimed at in Copenhagen."[43] The legal form of a Kyoto successor treaty will be addressed in the next section.

Necessary Framework for Mitigation in a Kyoto Successor Treaty—The "Copenhagen Protocol"

A mitigation framework for a Kyoto successor treaty must include several key components. First, a Kyoto successor treaty must include all nations. Second, the reduction in greenhouse gas emissions to eighty percent below 1990 levels by 2050 must be across the board and cannot be based on a nation's per capita emissions.[44] Third, the treaty must take the form of a new legal instrument under the UNFCCC that replaces the Kyoto Protocol rather than an amendment to the Kyoto Protocol or a Meeting of the Parties (CMP) decision.[45] The new legal instrument, the "Copenhagen Protocol," must incorporate Kyoto elements into the new instrument.[46] However, elements of Kyoto that are not functioning properly should be eliminated from the Copenhagen Protocol. Fourth, Annex I nations must establish a fund solely to provide monetary aid to non-Annex I nations to achieve their mitigation commitments. Fifth, the Copenhagen Protocol must establish a comprehensive enforcement mechanism. This paper will focus on the basic framework for the mitigation aspects of the Copenhagen Protocol. The mitigation framework proposed here is not meant to be comprehensive.

An all-inclusive Kyoto successor treaty will give all nations the opportunity to sign on and will tone down any anger or resentment nations could have about being left out of the process. Kyoto critics endorse other approaches such as "bring[ing] together a more limited number of major-emitting and like-minding countries."[47] Others advocate that countries should "make pledges of particular domestic measures."[48] Bringing together a smaller group of the major polluters could potentially work only if it was part of the post-Kyoto mitigation framework. One design for this smaller group "is an agreement among the dozen or so major emitting countries—the United States, China, Europe, Russia, Japan, India, Indonesia, Brazil, Australia, Canada, Mexico, Korea, South Africa, and perhaps a few other major countries—in a regime to limit global GHG emissions."[49] A design of this sort will never work as part of "a parallel regime in a plurilateral approach" because China will never sign onto anything that interferes with the UNFCCC or Kyoto tracks.[50] Any action that smaller groups take with regard to the Copenhagen Protocol must complement rather than replace and official work under the UNFCCC and more specifically, the AWG-KP or the AWG-LCA.

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[42] *Ibid*.
[43] Wuppertal Institute for Climate, Environment and Energy, *supra* note 35, at 21.
[44] Fisher, *supra* note 25, at 229.
[45] Daniel Bodansky, *Legal Form of a New Climate Agreement: Avenues and Options*, available at http://www.pewclimate.org/docUploads/legal-form-of-new-climate-agreement-paper.pdf.
[46] *Ibid*.
[47] KYLE W. DANISH, *The International Regime*, in GLOBAL CLIMATE CHANGE AND U.S. LAW, 31, 54 (Michael B. Gerrard ed., 2008).
[48] *Ibid*.
[49] Jonathan B. Wiener, *Climate Change Policy and Policy Change in China*, 55 UCLA L. REV. 1805, 1823-1824 (2008).
[50] *Ibid*.

Professor Prins argues that "the only way to save the Copenhagen meeting from failure would be to shift away from the top-down approach of the Kyoto framework, and end the quest for tighter emissions targets, closer timetables and more building regulations."[51] Prins' recommendation for "end[ing] the quest for tighter emissions targets [and] closer timetables" in Copenhagen contradicts the entire UNFCCC and Kyoto approach. The science in the IPCC Fourth Assessment report clearly shows that we must act now. Completely revamping our approach less than a year prior to Copenhagen is a recipe for disaster. Xie Zhenhua, the minister and vice-director of China's National Development and Reform Commission (NDRC) has already warned that the Chinese will not shift away from "the top-down approach of the Kyoto framework:" " 'Any attempt to deviate from, breach or re-define the Convention, or to deny the Kyoto Protocol, or to merge the Convention process with the Kyoto Protocol process, will be detrimental, and will ultimately lead to a fruitless Copenhagen Conference.' " With the proper technology transfer and significant monetary aid, though, China may be willing to deny the Kyoto Protocol and merge the AWG-KP and AWG-LCA tracks.

The reduction in greenhouse gas emissions to eighty percent below 1990 levels by 2050 must be across the board.[52, 53] Reduction commitments cannot be based on a nation's per capita emissions. Basing reduction commitments on per capita emissions will actually increase emissions. Professor McCubbin argues for China's cap to be based on "greenhouse gas emissions per unit of GDP."[54] She argues that "this approach would allow China's economy to grow, but it would require its emissions to grow more slowly than if left uncontrolled."[55]

The Kyoto Protocol's first commitment period ends in 2012. The Copenhagen Protocol must cover the time period from 2012 to 2050. The first commitment period for the Copenhagen Protocol should begin in 2012 and go until 2020. This first commitment period will be shorter than the other three commitment periods. The next three commitment periods will run from 2020 to 2030, from 2030 to 2040, and from 2040 to 2050. The year 2030 will serve as the official "midpoint" of the Copenhagen Protocol timetable.

This proposed framework is in keeping with the "A Shared Vision for Long-Term Cooperative Action" (hereinafter "Shared Vision") proposed by the AWG-LCA in documents submitted in advance of the Bonn Climate Change Talks held March 29-April 8, 2009.[56] This Shared Vision contains "A Long-Term Global Goal for Emission Reductions."[57] In paragraph five, the Parties agree that 2050 "is an appropriate time frame for a long-term

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[51] Takashi Kitazume, *Rethinking a Global Post-Kyoto Solution: Initiatives to Counter Climate Change Have to be Ecologically Sustainable and Economically Viable*, JAPAN TIMES (Tokoyo), Feb. 10, 2009, at State and Regional News.

[52] Fisher, *supra* note 25, at 229.

[53] *World Must Sink or Swim Together on Warming*, CANBERRA TIMES (Australia), April 8, 2008, at A11. The *Canberra Times* argues that "both poor and wealthy countries must be bound by these new targets. Certain developing countries, such as China and India, are amongst the world's largest emitters of greenhouse gases. The global targets can only be achieved if all countries reduce their emissions."

[54] Patricia R. McCubbin, *China and Climate Change: Domestic Environmental Needs, Differentiated International Responsibilities, and Rule of Law Weaknesse*s 33, ENERGY & ENVIRONMENTAL LAW & POLICY JOURNAL, Vol. 3, (2008), available at SSRN: http://ssrn.com/abstract=1212562 (article forthcoming in University of Houston's Energy & Environmental Law & Policy Journal).

[55] *Ibid*.

[56] Ad Hoc Working Group on Long-Term Cooperative Action Under the Convention, *Fulfillment of the Bali Action Plan and Components of the Agreed Outcome Note by the Chair part I.*, U.N. Doc. FCCC/AWGLCA/2009/4 (Part II) (March 18, 2009), available at http://unfccc.int/resource/docs/2009/awglca5/eng/04p02.pdf.

[57] *Ibid*.

goal."[58] Proposals by the Parties include stabilization of GHG emissions "of around 450 ppm carbon dioxide equivalent (CO_2 eq) or 350 ppm CO_2 eq;" limiting the global average temperature increase to between 1.5°C and 2°C above pre-industrial levels; and quantification of "GHG emission reductions at a global level," reducing to "50 percent of 1990 levels, or without specifying the base year," "reductions of between 75 and 85 percent (including ranges within these figures) of 1990 levels;" and per capita GHG emission reductions.[59]

During the first commitment period from 2012 to 2020, non-Annex I nations, including China and India, will be allowed to increase their greenhouse gas emissions. After the first commitment period, non-Annex I nations must begin to reduce their greenhouse gas emissions. The Fourth IPCC report indicates that "global greenhouse gas emissions growth needs to stop within the next 10-25 years, followed by a sharp decline."[60] Non-Annex I nations will still be expected to meet the target of an eighty percent reduction in greenhouse gas emissions by 2050. Non-Annex I nations should be allowed to increase their greenhouse gas emissions during the first commitment period to gain time to aggressively put in place energy efficiency programs and new, clean technology. The new fund established under the Copenhagen Protocol will assist non-Annex I nations in achieving these goals. Professor McCubbin agrees that a cap on China's greenhouse gas emissions must be "set *above* current levels in order to allow for growth."[61] Most experts agree that worldwide greenhouse gas emissions should peak by 2020 then must fall in order for emissions to stabilize at 400-450 ppm carbon dioxide equivalent and to cap warming at two degrees Celsius above pre-industrial levels.

The Copenhagen Protocol must take the form of a *new* legal instrument under the UNFCCC regime that incorporates Kyoto elements into the new instrument. The Copenhagen Protocol should retain the following Kyoto elements: an emissions trading scheme (often referred to as "cap-and-trade") and the Clean Development Mechanism (CDM). The Copenhagen Protocol should eliminate Joint Implementation (JI). The Copenhagen Protocol must also incorporate UNFCCC and Kyoto Protocol principles such as common but differentiated responsibilities and equity.

Kyoto's emissions trading scheme should be continued in the Copenhagen Protocol because it functions well and has established a carbon market. Article Seventeen of the Kyoto Protocol sets out the emissions trading scheme. Article Seventeen "allows countries that have emission units to spare—emissions permitted them but not 'used'—to sell this excess capacity to countries that are over their targets."[62] Article Seventeen created a carbon market with carbon being tracked and traded as a new commodity.[63] Replacing the emissions trading scheme with a carbon tax "could congest an already difficult negotiation."[64]

The Copenhagen Protocol must overhaul the CDM system because the CDM has lost credibility in recent years. Ambassador Stuart Eizenstat agrees that "the CDM has not met expectations that it would promote emission reducing investments throughout the developing

[58] *Ibid*. at part I., para. 5.
[59] *Ibid*. at part I., para. 5-6.
[60] Netherlands Environmental Assessment Agency, *Chinese CO2 Emissions in Perspective*, press release, June 22, 2007, available at http://www.pbl.nl/en/news/pressreleases/2007/20070622ChineseCO2emissionsinperspective.html.
[61] McCubbin, *supra* note 53, at 32.
[62] *Emissions Trading*, UNFCCC online document, available at http://unfccc.int/kyoto_protocol/mechanisms/emissions_trading/items/2731.php.
[63] *Ibid*.
[64] *The Rough Guide to Copenhagen's Risks*, ENDS REPORT, March 31, 2009, at 32.

world, and we now have an opportunity to revisit it."[65] The CDM is defined in Article Twelve of the Kyoto Protocol and "allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets."[66] Essentially, developed nations are able to "[lower] their greenhouse gas emissions by financing emission reduction projects in developing countries where investment is cheaper."[67]

CDM overhaul should include several key components. First, the new CDM should mandate CDM project quotas for countries which have historically hosted fewer CDM projects, such as many African nations. As of early March 2009, there were "850 clean development mechanism projects in 49 developing countries but only 23 of those projects [were] in Africa."[68] Second, Copenhagen negotiators must streamline and speed up the CDM project approval process. Third, the new CDM should contain front-loaded time-limited participation incentives to keep the CDM operational despite the economic crisis.

The Copenhagen Protocol should eliminate JI because it allows developed countries to conduct projects in other developed countries and produces a lot of "hot air."[69] Article Six of the Kyoto Protocol sets out the JI mechanism. Article Six "allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO_2, which can be counted towards meeting its Kyoto target."[70] JI is totally ineffective; it is simply a way for developed countries to earn ERUs for less than it would have cost in their own respective countries. The "benefited" developed country is receiving a benefit that it never needed anyway.

Article Three of the UNFCCC sets forth hortatory ("should") guiding principles "for actions by the parties to achieve the objective of the UNFCCC, including common but differentiated responsibilities."[71] The UNFCCC describes common but differentiated responsibilities in terms of developed and developing nations and equity:

The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.[72]

In documents submitted in advance of the Bonn Climate Change Talks, the AWG-LCA particularly focused on the principles of common but differentiated responsibilities and equity in its "Shared Vision." Two topics under this "Shared Vision" complement the UNFCCC principles of common but differentiated responsibilities and equity:

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[65] Stuart Eizenstat, *The U.S. Role in Solving Climate Change: Green Growth Policies Can Enable Leadership Despite the Economic Downturn*, 30 ENERGY L.J. 1, 2009.

[66] *Clean Development Mechanism (CDM)*, UNFCCC online document, available at http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php.

[67] Wambi Michael, *Crisis May Further Undermine Investment in Carbon Trade in African Countries; Environment: Climate Change Does Not Wait for Recessions*, IPS (Latin America), March 5, 2009.

[68] *Ibid*.

[69] "Hot air" refers to the fact that no true abatement has occurred. In the case of JI, there is "hot air" because developed countries are doing projects in other developed countries for less cost than in their own countries.

[70] Joint Implementation (JI), UNFCCC online document, available at http://unfccc.int/kyoto_protocol/mechanisms/joint_implementation/items/1674.php.

[71] Bodansky, *supra* note 44, at 5.

[72] *United Nations Framework Convention on Climate Change*, U.N. Doc. A/AC.237/18 (May 9, 1992), available at http://unfccc.int/essential_background/convention/background/items/1349.php.

(a) Approaches to long-term cooperative action on the basis of equity and in accordance with the provisions and principles of the Convention, in particular the principle of common but differentiated responsibilities and respective capabilities, taking into account social and economic conditions and other relevant factors;

(g) The determination of developing countries to take nationally appropriate mitigation actions (NAMAs) in the context of sustainable development and the determination of developed countries to provide support in the form of technology, finance and capacity-building, all of the above in a measurable, reportable and verifiable manner.[73]

The NAMAs, first proposed in Bali, help link the principles of common but differentiated responsibilities and equity with a more specific mitigation strategy.

The Copenhagen Protocol must take form of a new legal instrument that replaces the Kyoto Protocol rather than 1) "A COP decision addressing further actions under the Convention; 2) "Adoption by the COP of an amendment to the UNFCCC or to an annex, setting forth additional actions and/or commitments by UNFCCC parties;" or 3) "Adoption by the COP of a new legal instrument that…supplements…the Kyoto Protocol."[74] Creating a new legal instrument would enable nations that are not parties to Kyoto to sign the new instrument and bypass Kyoto entirely. Although Chris Spence, the Deputy Director of Reporting Services for the International Institute for Sustainable Development (IISD) has indicated that there is "no clear consensus" on the legal form that a future agreement will take, Professor Bodansky proposes that: "A comprehensive outcome establishing a single integrated climate regime would have several benefits."[75] He logically connects a single integrated climate regime with "adoption of a single new instrument under the Convention (either a Convention amendment or a new protocol), which addressed actions and/or commitments by both Kyoto Protocol parties and Convention parties that are not parties to the Protocol." Because all nations must meet the same emission reduction requirements, there is no need to differentiate these commitments. Non-Annex I parties will be given extra time and resources to achieve their emissions targets. Adding another annex will complicate the situation.

The Copenhagen Protocol must establish a fund solely to assist Annex-I nations in providing monetary aid to non-Annex I nations to help the non-Annex I nations achieve their mitigation commitments.[76] Developing nations will not sign onto the Copenhagen Protocol without significant technology transfer and monetary aid. Providing significant funding to non-Annex I nations will help enable them to meet emission reduction commitments of eighty percent by 2050. This fund should be separate from the CDM.

The Copenhagen Protocol must correct the ineffective Kyoto Protocol compliance system. The Kyoto Protocol compliance system only applies to Annex I nations, and does not apply to all aspects of Kyoto. Kyoto has failed in part because: "Under Article 18 of the Protocol, any compliance procedures entailing binding consequences must be adopted as an amendment to the Protocol."[77] Article Twenty sets out procedural requirements for amending

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[73] Ad Hoc Working Group on Long-Term Cooperative Action Under the Convention, *supra* note 55, at part I., para. 2.

[74] Bodansky, *supra* note 44, at 2.

[75] Chris Spence, *Climate Policy Update—An Overview of the Multilateral Climate Negotiations*, IISD Reporting Services, available at http://www.iisd.ca/climate-l/update/update2.html; Bodansky *supra* note 44, at 7.

[76] Wu Liming and Huan Gongdi, *Top Chinese Negotiator Urges Developed Countries to Commit More in Fighting Climate Change*, XINHUA NEWS SERVICE, March 31, 2009, available at http://news.xinhuanet.com/english/2009-04/01/content_11109345.htm.

[77] Pew Center on Global Climate Change, *COP 11 and COP/MOP 1 Montreal Summary*, available at http://www.pewclimate.org/print/1980.

the Kyoto Protocol.[78] Article Twenty states that parties should try to reach consensus on the proposed amendment, but if consensus is not reached, "the amendment shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting." This means that if a nation decides it does not want to ratify an amendment, it can essentially nullify the entire enforcement process.

The Copenhagen Protocol must contain comprehensive legally binding enforcement mechanisms. The new enforcement mechanisms should apply to both Annex I and non-Annex I nations and should impose penalties for noncompliance in every part of the Copenhagen Protocol including any flexible mechanisms or funds. The new compliance regime could build on the Expert Review Teams and Compliance Committee established under Kyoto by the Marrakesh Accords.[79] The roles of both entities would expand to cover all signatory countries. The Copenhagen Protocol would need to establish new enforcement bodies to monitor aspects not subject to enforcement under the Kyoto Protocol.

The Copenhagen Protocol must detach penalties under the enforcement regime from any amendment process. Penalties must be negotiated and put into the actual original document, not left incomplete for discussion later. Penalties for non-compliance could be linked to each of the four commitment periods with penalties becoming more severe as 2050 approaches. Additional sanctions could include cutting off mitigation assistance funds to developing nations for non-compliance.

China agrees that an enforcement mechanism is a necessary part of the Copenhagen discussions. Su Wei, the Chinese delegation chief to the UN climate change talks in Bonn, said that an " 'effective supervision mechanism' should be set up to monitor the above-mentioned technology transfer and funding."[80]

While a number of potential approaches to a post Kyoto treaty have merit, many fail to address what countries have said they will or will not do. There are some aspects of a Kyoto successor treaty that nations may be willing to compromise on, but a viable solution cannot ignore fundamental views on approaches to the successor treaty. Monetary aid and technology transfer will assist in bringing some nations on board, but any successful Kyoto successor treaty must follow the UNFCCC principles of common but differentiated responsibilities and equity.

If We Build It, They Will Come

In its January 2009 report entitled *A Roadmap for U.S.-China Cooperation on Energy and Climate Change*, the Pew Center on Global Climate Change proposed a global climate change framework for a partnership between the U.S. and China:

> …if human beings hope to avoid the worst consequences of global climate change, the United States and China—respectively the world's largest developed and developing nations, the two largest energy consumers, and the two largest producers of greenhouse gases—have no alternative but to become far more active partners in developing low-carbon economies.
>
> To prevail in such a common effort, both countries will need not only bold leadership and a new set of national policies, but also a path-breaking cooperative agenda that can be sustained over the long run. The advent of a new U.S. presidential administration in Washington, D.C., coupled with a central leadership in Beijing that

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[78] *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, U.N. Doc. FCCC/CP/197/L.7/Add. 1, art. 20.3 (Dec. 10, 1997), available at http://unfccc.int/resource/docs/convkp/kpeng.pdf.

[79] Danish, *supra* note 46 at 51.

[80] Liming, *supra* note 75.

> is increasingly aware of the destructive impact and long-term dangers of climate change, presents an unparalleled opportunity for this new strategic partnership.[81]

The report first recommends that the U.S. and China have a summit between the two leaders as soon as possible after Obama takes office to form a "U.S.-China Partnership on Energy and Climate Change."[82] The partnership is to be directed by two parallel groups. The U.S.-China high-level council will include high-ranking environment, energy, and finance officials from both countries.[83] The second tier of bilateral task forces will include senior officials and independent government experts.[84] Priority areas of collaboration will include: 1) deploying low-emissions coal technologies; 2) improving energy efficiency and conservation; 3) developing an advanced electric grid; 4) promoting renewable energy; and 5) quantifying emissions and financing low-carbon technologies."[85]

The U.S. and China are the two countries best suited to form a partnership and take the lead on curbing greenhouse gas emissions because both countries have a lot to gain, and conversely, a lot to lose. The U.S. and China are inextricably tied together in the global climate change conundrum: "For whether we choose to recognize it or not, these two countries are both crucial in the effort to address climate change. Simply put, if these two countries cannot find ways to bridge the long-standing divide on this issue, there will literally be no solution."[86] It is time for the global game of "chicken" to be over. Unless the U.S. and China can create adequate incentives, "the prospects for an adequate multilateral agreement are dim. The post-Kyoto process does not appear to be developing fast enough among a sufficient number of major emitters to avoid a doubling of atmospheric concentrations of carbon dioxide from preindustrial levels."[87] The U.S. and China must seize this unique opportunity to create this partnership and show the rest of the globe they are serious about global climate change and a Kyoto successor treaty.

The Time Is Now: Implementing The Copenhagen Protocol in The U.S. and China

Since the election of Barack Obama to the U.S. presidency, world leaders and global climate change supporters have adopted a much more optimistic attitude towards a Kyoto successor treaty. Americans feel relieved that Mr. Bush is now out of office and that the U.S. can move forward and fulfill its leadership role in the global climate change debate. Mr. Bush "framed his approach to global warming around two talking points: the uncertainties in forecasts of a dangerously human–heated world and the certainty that economic harm would come from mandatory cuts in emissions of heat-trapping gases."[88] The New York Times observes that President Obama has completely gone in the other direction: "Mr. Obama has taken precisely the opposite track. He spoke late last month of the specter of 'violent conflict, terrible storms, shrinking coastlines' and other perils from unchecked warming, while pressing his vision of prosperity rebuilt around clean cars and pollution-free power from the wind and sun."[89] While Obama seems to be headed in the right direction, he still needs to educate some

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[81] Pew Center on Global Climate Change, *A Roadmap for U.S.-China Cooperation on Energy and Climate Change* at 6 (2009), available at http://www.pewclimate.org/docUploads/US-China-Roadmap-Feb09.pdf.
[82] *Ibid*. at 7.
[83] *Ibid*.
[84] *Ibid*.
[85] *Ibid.* at 7-8.
[86] *Ibid.* at 8.
[87] Michael P. Vandenbergh, *Article: Climate Change: The China Problem*, 71 S. CAL. L. REV. 905, 930 (July, 2008).
[88] Andrew C. Revkin, *Environmental Views, Past and Present Climate: The Legacy of Kyoto*, N.Y. TIMES LATE ED., Feb. 7, 2009, at A12.
[89] *Ibid*.

Americans " 'grappling with uncertain science and a grinding recession that work on long-term energy and climate security cannot be deferred until better times.' "[90] Some of that convincing may need to be directed towards the U.S. Senate.

Under Article II of the U.S. Constitution, President Obama has the power to make treaties, but "two thirds of the Senators present [must] concur."[91] Three U.S. Senate committees currently "all claim jurisdiction on climate change."[92] These committees are the Senate Environment and Public Works Committee, the Senate Energy and Natural Resources Committee, and the Senate Finance Committee.[93] These committees, as well as several committees in the U.S. House of Representatives (House), are currently working on climate change legislation.[94] In the Senate, there is potential for the more pro-environment Environment and Public Works Committee to produce a bill which not be able to garner support in the full Senate.[95] It is doubtful that the Senate will be able to produce a climate change bill this year, which does not bode well for the Senate passing a Kyoto successor treaty.

A U.S. domestic climate change bill could originate in either the House or the Senate, but the Senate must pass a Kyoto successor treaty with a two-thirds vote. The timing this year will probably be such that neither the House nor the Senate will produce a climate change bill before Copenhagen. Even if a Kyoto successor treaty is produced in Copenhagen, there may be further delay before the U.S. will ratify the treaty. The Senate may insist that domestic climate change legislation is in place before signing onto a Kyoto successor treaty.

In his campaign for the American presidency, President Obama promised to "implement an economy-wide cap-and-trade program to reduce greenhouse gas emissions 80% percent by 2050."[96] Since taking office earlier this year, "President Obama has radically shifted the global equation, placing the United States at the forefront of the international climate effort and raising hopes that an effective international accord might be possible."[97] On January 26, 2009, Secretary of State Hillary Clinton announced the appointment of Todd Stern as the Special Envoy for Climate Change.[98] In making the announcement, Clinton emphasized that the new administration is committed to crafting a new global climate change plan for the U.S.:

And that is just a start. As the President has made clear, he is committed to enacting a far-reaching new energy and climate plan. As we take steps at home, we will also vigorously pursue negotiations, those sponsored by the United Nations and those at the sub-global, regional, and bilateral level that can lead to binding international climate agreements. No solution is feasible without all major emitting nations joining together and playing an important part.[99]

Steven Chu, the Secretary of the U.S. Department of Energy, has now confirmed that the U.S. plans on being a leader in Copenhagen: " 'President Obama has made it clear that

[90] *Ibid*.
[91] U.S. CONST. art. II, § 2, cl. 2.
[92] *House Climate Change Bill Seen As Signal To International Talks*, 27 INSIDE U.S. TRADE 17, May 1, 2009.
[93] *Ibid*.
[94] *Ibid*.
[95] *Ibid*.
[96] *Barack Obama and Joe Biden: New Energy for America* (presidential campaign material), available at http://www.barackobama.com/pdf/factsheet_energy_speech_080308.pdf.
[97] Elisabeth Rosenthal, *Obama's Backing Increases Hopes for Climate Pact*, N.Y. TIMES LATE ED. March 1, 2009, at A1.
[98] U.S. Department of State Website, *supra* note 17.
[99] *Ibid*.

the US should act first…Using China as a reason not to act is no longer an option.' "[100] Even with the current economic crisis, the outlook of the new administration towards a Kyoto successor treaty seems to be one of optimism.

At the end of January and within days of President Obama's inauguration, Senator John Kerry and former Vice-President Al Gore began to lobby the Senate on a Kyoto successor treaty. Senator Kerry, former Vice-President Gore, and Mr. Alden Meyer with the Union of Concerned Scientists sat down with Richard Harris of National Public Radio News (NPR News) who spoke with them about a Kyoto successor treaty and what must happen this year for Copenhagen to be a success.[101]

Richard Harris: Massachusetts Democrat John Kerry, who chairs the Senate Foreign Relations Committee, reminded his colleagues the new treaty will be negotiated in December of this year.

Senator John Kerry (Democrat, Massachusetts): That means there is no time to waste. We must learn from the mistakes of Kyoto, and we must make Copenhagen a success.

…

Mr. Gore: Recent statements by Chinese leaders have made it very clear that they are changing, and changing rapidly.

…

Harris: China has been reluctant to make binding promises until the United States does. And since the U.S. wants promises from China up-front, it's a bit of a game of chicken at this point. Meyer says unfortunately, a lot of senators don't realize that developing nations are doing as much as they are.

…

Harris: Yesterday, Al Gore started selling members of the Senate on the need to act and act fast. And while he had a very sympathetic audience at the Foreign Relations Committee, it takes 67 senators to ratify a treaty, and it's clear that there's a lot more convincing to do.[102]

China also seems to be turning a corner, but China's turning the corner will depend on U.S. participation in Copenhagen and the meetings leading up to Copenhagen throughout this year. Even if the U.S. does manage to get China on board, implementation of the Copenhagen Protocol will be difficult in China: "Even if China were to adopt significant and binding GHG emissions, there are serious concerns about how they would be implemented and whether such targets could be effectively achieved."[103] Professor Yang identifies two barriers to the implementation of a binding GHG emissions scheme: "First, China's continued overwhelming focus on economic development objectives, which runs through China's climate programs, raises questions as to whether its policies can promote environmental sustainability. Second, the weakness of China's existing environmental regulatory infrastructure and legal institutions put into doubt its ability to limit GHG emissions effectively."[104] Professor McCubbin echoes many of Professor Yang's concerns:

...this article focuses in particular on three key points, often overlooked in discussions about China's role in addressing climate change, that will be critical to those negotiations:

[100] Clive Cookson & Fiona Harvey, *Chu Aims to Seize Climate Initiative*, FINANCIAL TIMES May 27, 2009, at 5.
[101] National Public Radio News, *Gore Urges Senate to Avoid Kyoto-Type Failure*, Morning Ed. 10:00 AM EST NPR, Jan. 29, 2009.
[102] *Ibid*.
[103] Tseming Yang, *Workshop Paper: The Implementation Challenge of Mitigating China's Greenhouse Gas Emissions*, 20 GEO. INT'L ENVTL. L. REV. 681, 683 (Summer 2008).
[104] *Ibid*.

(1) the synergy between China's domestic environmental goals and the international community's objectives, (2) the need to harmonize environmental protection with China's continued economic growth, and (3) the importance of improving China's rule of law in order to meet the environmental aims.[105]

The Cable News Network (CNN) documentary "Planet in Peril" shows the situation powerfully and vividly. As the documentary team approached the outskirts of the city of Tialinjin, "brown stinking water from local chemical factories was flowing into ditches near the [Heilongjiang] river. We learned quickly that pollution is a touchy subject in China. As we left the river, word of our presence started to get around. So it didn't take long for the police to find us."[106] The police wanted to see the documentary team's passports, find out what they were doing, and question them.[107] When the documentary team knocked on the mine director's office at nearby Dabaoshan mine, he refused to answer any questions.[108]

Despite potential problems implementing the Copenhagen Protocol at the provincial and local levels, the national government in Beijing has shown that it can act swiftly and effectively on environmental matters. The "plastic bag story" is one of the best examples of Beijing's unique ability to quickly effect environmental change. As Thomas Friedman puts it, "One morning in late 2007 China's shopkeepers woke up and found that the State Council had announced that beginning June 1, 2008, all supermarkets, department stores, and shops would be prohibited from giving out free plastic bags, in order to discourage the use of these petroleum-based products. In the future, stores would have to charge customers for them."[109] Friedman asks "What would be so bad? China? Just for one short day?"[110] The U.S. could learn an awful lot by being China "for just one short day."[111]

A binding enforcement mechanism in the Copenhagen Protocol would enable the international community to more effectively "push China for legal reforms."[112] Professor McCubbin suggests using "both the promise of aid and the threat of sanctions to bring those commitments to fruition."[113] New York Times columnist Paul Krugman also thinks that rogue greenhouse gas emitting nations will face serious consequences in the near future: "Sooner than most people think, countries that refuse to limit their greenhouse gas emissions will face sanctions, probably in the form of taxes on their exports."[114]

A Kyoto Successor Treaty and the Economic Crisis

Most commentators argue that a Kyoto successor treaty should not be affected by the current economic crisis. Many argue that the economic crisis may help the "green revolution." Developing countries especially do not want climate change efforts compromised:

Costa Rica, for the G-77/China, said efforts to address climate change should not be compromised by the current financial crisis. She also noted that adaptation and mitigation

[105]McCubbin, *supra* note 53, at 2.
[106] *Planet in Peril* (CNN television broadcast Oct. 23, 2007). The transcript is available at http://transcripts.cnn.com/TRANSCRIPTS/0710/23/se.01.html.
[107] *Ibid.*
[108] *Ibid*. The mine director did say "It's a complicated issue…The government leaders do realize it's a problem, and there have been some environmental issues." Earlier, local residents had admitted that they use the polluted river water to irrigate crops because they have no other choice. When the mine director was asked whether he would eat food irrigated by river water or drink the water, he said "Of course not." The state environmental agency in Beijing (which has oversight) refused to comment.
[109] Friedman, *supra* note 18, at 373.
[110] *Ibid*.
[111] *Ibid*.
[112] McCubbin, *supra* note 53, at 4.
[113] *Ibid*.
[114] Paul Krugman, *U.S. Aboard on Climate, but China Drops Anchors*, DENVER POST May 17, 2009, at 2K.

must be addressed as equal priorities, deep emission cuts should primarily be undertaken domestically by developed countries, and nationally appropriate mitigation actions for developing countries should be considered in the context of sustainable development."[115]

London's *The Independent* argues that the environment and green technology could be the answer to pull us out of this economic crisis: "…the environment ought to be at the centre of attempts to pull us out of this slump. Unemployed labour should be put to work on schemes that help conserve household energy. And if governments invest in renewable energy schemes while resources are relatively cheap, they can use this downturn to lay the foundations for future green growth."[116]

Not acting now on climate change could make the economic situation even worse down the line. The Stern Report, released in October 2006 by the British Chancellor of the Exchequer "estimated that the future adverse consequences of climate change could drain as much as 5% of the global gross domestic product (GDP) in the coming years, whereas immediate, aggressive steps to reduce greenhouse gas emissions would cost only 1% if global GDP."[117]

Conclusion—"We Have Exactly Enough Time—Starting Now."[118]

China and the U.S. must agree to reduce greenhouse gas emissions to eighty percent below 1990 levels by 2050. A Kyoto successor treaty must employ a top-down approach that includes all nations, must contain across the board cuts, and cannot base emissions reductions on per capita emissions. If emissions cuts are based on per capita emissions, China will still be able to increase its emissions and the treaty will be a failure. The largest polluters, China and the U.S., must take a leadership role in the post-Kyoto regime. China and the U.S. must form a partnership as the Pew Center document *A Roadmap for U.S.-China Cooperation on Energy and Climate Change* suggests. China and the U.S. cannot allow their respective alliances and national interests affect their commitments to the emission reduction levels a post-Kyoto treaty must have.

"There is no time to waste. The most risky thing we can do is do nothing," wrote the Union of Concerned Scientists in its May 2008 letter.[119] The question is: if the scientists are so concerned about global climate change, then why are the rest of us not? China and the U.S. are now the top two emitters of greenhouse gases in the world. If China and the U.S. cannot work together to help craft a Kyoto successor treaty, then there is no hope.

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[115] Earth Negotiations Bulletin, *supra* note 36, at 13.
[116] *A Global Deal in Copenhagen Can Still Pull Us Back from the Brink*, The Independent (London), March 14, 2009, at 30.
[117] McCubbin, *supra* note 53, at 11.
[118] Friedman, *supra* note 18, at 412.
[119] Union of Concerned Scientists, *supra* note 29.

China, The United States and Global Warming:
A Planetary Prisoners' Dilemma

Philip S. Golub and Jean-Paul Maréchal[1]

Abstract:
The paper examines some key economic dimensions and the international relations implications of the last question posed in the call for papers: "Given that China and the United States are the largest national sources of gas pollution, albeit with very different capabilities and historical responsibilities, how might they work together to protect the atmospheric commons?"

1. The Trap
The first part of the paper is dedicated to some *structural aspects* – logical and empirical - *of the decision making framework* generated by American and Chinese important levels of GHG emissions.
The logical aspect of the question can be grasped through the notion of "prisoners' dilemma". This notion permits to highlight the fact that both China and the United States are confronted to a contradiction between their short-term and long-term interests.
The empirical aspect of the question is put into evidence by the fact that the environmental Kuznets' curve… does not exist. In other words it is useless to expect that an increase in the GDP per capita of a national economy would lead, above a certain threshold, to an automatic betterment of the quality of the environment.

2. Solving the Dilemma
The second part examines fundamental debates concerning the *burden sharing* (between the US and China) of global warming mitigation. These debates concern both the economic instruments and practical implementation.
Carbon taxation and "cap and trade" pose three kinds of questions, at international and domestic levels. The first deals with the "where equity requirement", i.e. the best way to reduce GHG emissions at the lowest marginal cost. The second deals with the best indicators to define the obligation of each country. The third relates to the domestic level: how to spread the burden between social groups?

3. Forging International Cooperation.
Since shared meanings (in Michael Walzer' sense) need time to change and as the procrastination penalty in the field of global warming is very high, the last part of the paper examines trust-building mechanisms between the US and China, and the larger issue of cooperation under conditions of rising domestic constraints.
Governments seek in crisis circumstances to find short-term solutions to pressing social and economic problems, and to transfer adjustment costs to others. This accentuates rivalry and fragmentation at international level. The intellectual and normative challenge is to imagine new forms of pluralist cooperation leading to convergence around common global agendas that are in the overall human interest.

In an article published in November 2008, "Science: The Coming Century", Martin Rees writes that if the science of climate change is intricate, it is "straightforward compared to the economics and politics" (Rees 2008: 41). Indeed, global warming poses a unique nexus

[1] Philip S. Golub is Senior Lecturer in international relations at Université Paris 8, email: p.golub@wanadoo.fr. Jean-Paul Maréchal is Associate Professor in economics at Université Rennes 2 and researcher at ISMEA (Institute for Applied Mathematics and Economics)., email: marechal.jean-paul@wanadoo.fr.

of economic, political and philosophical challenges — a "perfect moral storm" (Gardiner 2006: 397) — for at least three reasons. First, its causes are globally dispersed and its effects are non-localized. Simply put, driving a car in Paris has no more effect in France than in Hong Kong, and vice versa. Second, the mean lifetime of fossil fuel CO_2 ranging between 30 to 35 thousand years, there is a very long time lag before the natural carbon cycle neutralizes the anthropogenic emission of greenhouse gases (GHG). (Archer 2005: 5) The effects on sea levels of driving a car today will become manifest only in a couple of decades. Consequently, we have to consider the problem of justice both on the intragenerational level (between individuals, nations and social groups today) and on the intergenerational one (between persons, groups etc. living in different periods of time). Last but not least, our "theoretical ineptitude" makes it difficult to solve the problems at hand. As Stephen Gardiner aptly points out, "we are extremely ill-equipped to deal with many problems characteristic of the long-term future. Even our best theories face basic and often severe difficulties addressing basic issues such as scientific uncertainty, intergenerational equity, contingent persons, nonhuman animals and nature". (Gardiner 2006: 407)

The facts on which our judgments should be based are well known and well established. Expressed as a global average, surface temperatures have increased by more than 0.70°C over the past century. The rate of temperature change has also accelerated. During the last 50 years the rate of increase was 0.13°C per decade, or twice what had been observed during the previous century, and has accelerated over the past two decades. (OECD 2008: 141-143) The "linear" consequences of these temperature changes include the decline in snow pack and ice cap coverage, the retreat of glaciers, increasingly frequent extreme wet and dry weather events, the proliferation of pathogenic agents and so on. "Non-linear" consequences include, for instance, the disturbance of deep-ocean circulation or abrupt collapses of ecosystems. The third IPCC report (2001) leaves no doubt about the causes of these modifications: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities". In fact, it is caused by the emissions of gases such as carbon dioxide and methane gases, to cite the most important ones, which are included in the "GHG" category. Carbon dioxide concentration, which has risen 20 parts per million (ppm) during the last 8,000 years, rose from 280 to 379 ppm during the twentieth century. Atmospheric carbon dioxide and methane concentrations are now higher than at any time during the last 650,000 years.

These transformations threaten the human prospect. In the absence of decisions today, the effects sketched above will at the very least inhibit human development and might in fact generate truly catastrophic systemic outcomes in future. By upsetting the balance of the ecosystem, anthropogenic interference with the climate[2] threatens the "mother of all public goods". (Nordhaus 2008: 62) Yet, since there is no simple coincidence between the descriptive and the normative, we face major difficulties in translating knowledge into an effective global agenda. Having a grip on the facts does not tell us what should be done. James Garvey summarizes the complexity of the situation when he writes: "The spatial and temporal smearing of actions and agency can be deeply confusing, because sometimes moral responsibility depends conceptually on another sort of responsibility: causal responsibility… We lack both the wisdom and the theory to cope with [global warming]. It's possible… that our theoretical failure can lead to a moral failure, a kind of deception in which we focus on one part of the problem and not others. The complexity can be an excuse, a problematic excuse, for doing nothing at all". (Garvey 2008: 61) Indeed, the broad scientific consensus

[2] To borrow the expression of Article 2 of the UN Framework Convention on Climate Change of 1992 (UNFCCC).

over global warming has not been matched by a shared commitment at the political level to find solutions founded on the universal human interest.

The universal dimension of the crisis, a word whose etymology implies that we are facing a historical moment of *decision*, requires that we pay careful attention to the different issues raised by climate change. The aim of this article is to contribute to the theoretical debate by focusing on the issue of distributional justice among states and social classes. Nation states have varying capabilities and different historical responsibilities in the process of global warming, a reality that derives from their historical pattern of insertion at the centre or periphery of the global political economy, with implications regarding burden sharing. At the same time, given the rise of a large class of consumers in "emerging countries", a serious appraisal must imperatively distinguish between social classes. The purpose of new theorising is to find ways to overcome the contradiction between global human needs and the presently reality of the segmentation of the international system into discreet national units. To discuss these issues we have chosen to take the cases of the United States and China, the two largest emitters the actions or non-actions of which will largely determine global outcomes. The question is how trust-building mechanisms could be developed that would lead to effective cooperation allowing states to break out of the prisoners' dilemma they otherwise face, and move forward towards a global project of protection of the atmospheric commons.

The first part of this paper is devoted to structural aspects of the decision-making framework generated by American and Chinese GHG emissions. The second part examines fundamental debates concerning burden sharing between the US and China in global warming mitigation. The third deals with the intellectual and normative challenge to imagine new forms of ordered pluralist cooperation leading to convergence around common agendas that are in the overall human interest.

I. The Trap

There is a significant difference between knowing that something should be done and knowing what must be done. In the case of global warming, this difficulty is not only linked to technological challenges that are real and perhaps not solvable, but also to the problems raised by existing decision-making frameworks. There is a manifest contradiction between the understanding that survival in the long run depends on stopping the present course of climate change and the utility maximising logic of *homo economicus*. The available scientific data leads to the inescapable conclusion that there is an overwhelming common interest to act today. Yet, at the same time, aiming to maximize short-term benefits, individual agents have an interest in continuing voracious consumption of fossil fuels and other natural resources. The logic of *homo economicus*, leads all actors – states, firms or individual citizens, rich and poor people alike – to being unreasonable at the deepest level of reason. Economists call this a "prisoner's dilemma" (PD). In the case of global warming, this dilemma is made particularly acute by three specificities: first, it concerns a "common resource", second it is both intra and intergenerational, and, third, it involves different categories of nation-states with different historical responsibilities in global warming, including newly industrialised countries such as China.

A. Public Goods

The common resource endangered by global warming is the carbon-absorbing properties of the planet, properties that are sometimes called "carbon sinks". In what way are these carbon sinks a common resource?

Goods can be classified according two attributes: whether they are excludable (people can be excluded from consuming them) and whether they are rival (one person's consumption of a considered good reduces the amount available to other consumers). Private goods (cars, oranges…) are both excludable and rival. Public goods, on the other hand, are goods that are non-excludable (nobody can be excluded from consuming them) and non-rival (the consumption of one unit of such a good does not diminish another agent's possibility to consume it). Some public goods such as sunshine are produced by nature and virtually imperishable (at least on a human time scale). Others are man made, for instance national defence or lighthouses. If private goods can be efficiently produced and consumed on a competitive market, this is not the case for public goods. Because of the lack of financial incentives to produce them or to pay for their consumption (a free-rider problem) they must be provided by government and paid for with taxes.

There is a large spectrum of goods between purely private and purely public goods. These in-between cases - sometimes called "impure" public goods (Stiglitz 1999) - belong either to the category of "club goods" if they are exclusive but non-rival (coded TV broadcast…) or to the category of "common resources" (or simply "commons") if they are non-exclusive but rival (fish stocks...). The climate can be considered as a pure natural public good or, to be more precise, it was a pure natural global public good prior to the ability of human beings to modify it. Since the end of the eighteenth century, when humanity became a kind of geophysical force (Vernadsky) and the planet entered in a new age that Will Steffen, Paul Crutzen and John McNeill call the "Anthropocene" (Steffen, Crutzen, McNeill 2007), the earth's climate has gradually became a global public good that has, in part, to be created by human beings. Of course, what has to be created is not the earth climate *in se* but earth climate stability. (Traxler 2002: 120) Put differently, climate stability is no longer a "pure natural public good", nor a "pure artificial public good". It is partially both. It is a "global common" or, to be more precise, "carbon sinks" are global common resources. The rise of earth temperatures - that can be defined as a "public bad" (Samuelson & Nordhaus 1985: 713) - is the result of an overuse by some economic agents (states, producers, consumers…) of the carbon absorbing capacities of the planet.

Left to market mechanisms alone, common resources suffer from overuse. A consumer can freely deplete the available amount of commons. This is what Garrett Hardin in a famous article called the "Tragedy of the Commons" (Hardin 1968). Thus, it can be said that the carbon-absorbing properties of the planet is a common resource and that GHG emissions are a form of appropriation of this common resource. The overuse of carbon sinks can be analysed as a possible payoff of a prisoners' dilemma. The prisoners' dilemma generated by global warming is both intra and intergenerational.

B. An Intra and Intergenerational Prisoners' Dilemma

The intragenerational aspect of the dilemma can be expressed the following way:

"(PD1) It is *collectively rational* to cooperate and restrict overall pollution: each agent prefers the outcome produced by everyone restricting their individual pollution over the outcome produced by no one doing so.

(PD2) It is *individually rational* not to restrict one's own pollution: when each agent has the power to decide whether or not she will restrict her pollution, each (rationally) prefers not to do so, whatever the others do". (Gardiner 2006: 400)

This is a good example of the traditional prisoners' dilemma. In the real world it could be resolved when the parties involved benefit from a wider context of interaction, that is to say when reciprocity or mutually beneficial decisions play an important role. Trade and security are good examples of such a situation. That is why Joseph Stiglitz has proposed to use trade sanctions as a mean of enforcing the U.S.' participation in the Kyoto Protocol. In 2006, Stiglitz wrote: "Fortunately we have an international trade framework that can be used to force states that inflict harm to others to behave in a better fashion. Except in certain limited situations (like agriculture) the WTO [World Trade Organization] does not allow subsidies — obviously, if some country subsidizes its firms, the playing field is not level… Not paying the cost of damage to the environment is a subsidy, just as not paying the full costs of worker would be. In most of the developed countries of the world today, firms are paying the cost of pollution to the global environment, in the form of taxes imposed on coal, oil, and gas. But American firms are being subsidized — and massively so. There is a simple remedy: others should prohibit the importation of American goods produced using energy intensive technologies, or, at least impose a high tax on them, to offset the subsidy that those goods currently are receiving". (Stiglitz 2006: 2)

A slightly different line of reasoning leads to very similar conclusions. Game theory teaches us that to progress from rivalry to cooperation there is no need for friendship (fortunately: if there were, we should consider moving at once to another planet!) but only interaction taking place over time. (Axelrod 1984) To put it more precisely, sustainable relations between players may generate cooperation. Who could deny that negotiations on climate control are an example of this kind of situation? But there is always the possibility of tit for tat: one player failing to attend might push others into retaliating by staying away. This outcome would, in the case of climate negotiations, be a recipe for disaster.

A disaster could also result from the intergenerational dimension of the prisoners' dilemma. The risk linked to this temporal characteristic appears clearly when we consider a "pure" version of the intergenerational problem, that is to say a case where different generations do not overlap. This "Pure Intergenerational Problem" (PIP) can be expressed as follows:

"(PIP1) It is *collectively rational* for most generations to cooperate, (almost) every generation prefers the outcome produced by everyone restricting pollution over the outcome produced by everyone over polluting.

(PIP2) It is *individually rational* for all generations not to cooperate: when each generation has the power to decide whether or not it will over pollute, each generation (rationally) prefers to over pollute, whatever the others do". (Gardiner 2006: 404)

This second trap (PIP) is worse than the first (PD).

PIP1 is worse than PD1 because the first generation is not taken into account in the logical process. Thus, the first generation has no incentive to act and this inaction has a domino effect on subsequent generations, an effect that undermines the possibility of a collective project of compliance. PIP2 is worse than PD2 because, since the different generations do not coexist, they are unable to influence each other's behaviour through the building of institutions setting binding norms.

PIP is thus more difficult to resolve than the PD "because the standard solution to the Prisoner's Dilemma are unavailable: one cannot appeal to a wider context of mutually beneficial interaction, nor to the usual notion of reciprocity". (Gardiner 2006: 405)

C. The Challenge of Emerging Countries

The dilemma has been sharpened during the last few decades by the impressive economic growth of some newly industrialized or re-industralizing countries. China is the perfect example of this new situation.

Some figures give a very precise idea of the problems that are before us.

In 1970, total greenhouse gas emissions were 23.9 $GtCO_2eq$. The share of the "BRIC countries" (Brazil, Russia, India, China) was 5.9 (i.e. 24.6%) and the share of the OECD counties was 13.7 (i.e. 57.3%). In 2005, total greenhouse gas emissions were 46.9 $GtCO_2eq$. The share of the BRIC countries was 16.1 (i.e. 34.3%) and the share of the OECD countries was 18.7 (i.e. 39.8%). If no new policy actions are taken, in other words if we follow a business as usual scenario, global greenhouse gas emissions are projected to reach 71.4

$GtCO_2eq$ in 2050. The share of the BRIC countries will reach 26.2 (i.e. 36.6%), 23.5 (i.e. 32.9%) for the OECD countries (see Table 1).

Table 1

Emissions of all anthropogenic gases. Baseline (figures in $GtCO_2eq$)			
Group	**1970**	**2005**	**2050**
OECD	13.7	18.7	23.5
BRIC	5.9	16.1	26.2
ROW	4.3	12.1	21.7
Total baseline	23.9	46.9	71.4

Source : OECD (2008), *OECD Environmental Outlook to 2030*, Paris: OECD, p. 25

In 1980, Chinese emissions of CO_2 were about 1.5 billion tons, the emission per capita being 1.5 ton. That same year, the American figures were respectively 4.8 billion and 21. In 1990 these figures were 2.3 billion and 2 for China against 4.8 billion and 20 for the United States. In 2005 they were more than 5 billion and 4 for China against nearly 6 billion and 20 for the United States. In 2006, the trends curves crossed (see Table 2). According to a report published by the Netherlands Environmental Assessment Agency in 2008, overall Chinese emissions in 2006 were 7% above the US emissions, 14% above in 2007. (Rosenthal 2008)

Forecasts by the International Energy Agency (IEA) indicate that the increase in China's emissions of CO_2 between now and 2030 — 4 additional gigatons (Gt) — would by itself constitute 40% of all additional emissions by all the world's countries and nearly double those of the old industrialized countries. (IEA 2006: 188)

Such a situation raises a very difficult ethical question. China's right, as well as the right of all other "emerging" countries to economic growth and development cannot be put into question. But how can this entirely legitimate right to economic development be guaranteed without nullifying international efforts to limit GHG emissions? What is more, the effects caused by the size and populations of these countries make it impossible for us to argue solely in relative terms. The fact that each American emits on average 4.3 times more CO_2 per annum than a Chinese person cannot in any way lead us to conclude that, in the interest of "justice", no measures for controlling Chinese emissions should be taken so long as Chinese individual emissions lag behind American ones. Indeed, if individual emissions in China reached levels comparable to those in America, one can easily imagine the state that the world climate would be in.

Table 2

Global* and per capita US and Chinese CO_2 emission between 1980 and 2006**						
		1980	1990	2000	2005	2006
United States	Global emission	4,788	5,028	5,860	5,994	5,902
	Emission per capita	21.0	20.1	20.8	20.3	19.8
China	Global emission	1,460	2,293	2,966	5,429	6,017
	Emission per capita	1.5	2.0	2.3	4.1	4.6
US emission per capita / Chinese emission per capita		14.0	10.0	9.0	4.9	4.3

*** Expressed in million metric tons of carbon dioxide. ** Expressed in metric tons of carbon dioxide.**
Source: website of the Energy Information Administration (EIA). Official Energy Statistics from the U.S. Government

Yet another element makes the situation even more complex: the countries which have (on average) the biggest ecological footprint have also the highest HDI (Human Development Index). And those which have the highest HDI have also (always on average) the highest GDP per capita. (Table 3)

Table 3

Human Development Index	**Number of countries**	**GDP per capita** (PP US$) 2005	**Life expectancy at birth** (years) 2005	**Combined gross enrolment ratio for primary, secondary and tertiary education** (%) 2005	**CO_2 emissions** (Mt CO_2) 2004	**Share of world total*** (%) 2004	**CO_2 emissions per capita** (t CO_2) 2004
High human development 1 ≥ HDI ≥ 0.8	70	23,986	76.2	88.4	16,616	57	10.1
Medium human development 0.8 > HDI ≥ 0.5	85	4,876	67.5	65.3	10,215	35	2.5
Low human development 0.5 > HDI ≥ 0	22	1,112	48.5	45.8	162	1	0.3
World	177	9,543	68.1	67.8	28,983	100*	4.5

***The world total includes carbon dioxide emissions not included in national totals. These emissions amount to approximately 5% of the world total.**

Source: UNDP (2007), *Human Development Report 2007/2008*, p. 69, 232.

Similar comparisons can be made between the United States and China (Table 4).

Table 4

	HDI	**GDP per capita** (PPP US$) 2005	**Life expectancy at birth** (year) 2005	**Combined gross enrolment ratio for primary, secondary and tertiary education** (%) 2005	**CO_2 emissions** (Mt CO_2) 2004	**Share of world total** (%) 2004	**CO_2 emissions per capita** (t CO_2) 2004
United States	0.951	41,890	77.9	93.3	6.046	20.9	20.6
China	0.777	6,757	72,5	69.1	5.007	17.3	3.8

Source: UNDP (2007), *Human Development Report 2007/2008*, p. 69, 232.

Jean Gadrey has highlighted a strong linear correlation between CO_2 emissions per capita and GDP per capita. Up to 13,000 US dollars per capita, when GDP per capita increases by 3,000 dollars, GHG emissions increase by 1 ton. After 13,000 dollars (only 36 countries in the world, out of 177 ranked by the UNDP), this relation weakens. (Gadrey 2008: 70) To get a simple idea of the margin of progress that can be achieved by the United States, it is useful to have in mind examples such as Japan, which has an HDI of 0.953 and a CO_2 emission per capita of 9.9 tons or France where these two figures are respectively 0.952 and 6.

Notwithstanding the problems discussed above, the target humanity has to reach is clear. If we want to avoid what the OECD calls "dangerous" climate change, the rise of the earth's temperature must not exceed 2°C during this century. Above this threshold, the risk of "large-scale human development setbacks and irreversible ecological catastrophes will increase sharply". (UNDP 2007: 7) However, if we want to limit the temperature increase to 2°C above the pre-industrial level, the GHG concentration must not exceed 450 ppm (as we noted above, this concentration has risen from 280 to 379 over the past 100 years). At 450 ppm the probability to stay beneath 2°C is 50%. At 550 ppm this figures shrinks to 20%. To fulfil the objective, the carbon budget for the whole twenty first century must be limited to 1,456 $GtCO_2$, that is to say 14.5 $GtCO_2$ per year. (UNDP 2007: 46) This figure must be compared to our present annual emissions: 28.9 $GtCO_2$! Table 3.)

A number of scenarios have been suggested. The UNDP has identified a pathway to keep the planet under the 2°C threshold. World emissions, after a peak around 2020, would have to decline by 50% by 2050 (from a 1990 base-year) and fall toward zero in net terms by the end of the century. Of course, the burden of such a mitigation strategy must be equitably shared between countries of different development levels. That is why the UNDP distinguishes two groups of counties: industrialized and developing. The first would have to target an emissions peak around 2012, then a 30% cut by 2020 and 80% by 2050. In the second group there would be of course large variations. Major emitters would maintain a trajectory of rising emissions to 2020, peaking at around 80% above current levels, with cuts of 20% as compared to 1990 levels by 2050. (UNDP 2007: 48) These goals are very ambitious and are based on the assumption that there is a universal obligation to avoid negative outcomes. They require imagining "efficient policies", that is to say policies that permit to reach these objectives (the 2°C threshold needn't be justified here[3]) at the lowest possible costs. This question is however inextricably linked to the question of the burden sharing rules.

II. Burden Sharing Rules

Climate stability being a common resource, collective action is needed to preserve or, in a certain sense, to create it. Reduction and adaptation measures are thus required. Reduction (or "abatement" or "mitigation") means the curbing of GHG emissions and adaptation means a set of actions designed to prepare humanity to meet the challenges of the rise of the temperatures that is, whatever is decided, underway. If the ecological necessity to act is obvious, this requirement is as we have seen above linked to the aim of improving human development. In other words, the new climate regime that has to be conceived and implemented must place the right to development at its core. Collective choices and commitments must therefore be taken at the world level.

[3] As it seems to exist a consensus (or at least an « near-consensus ») on this figure and on the pathway of GHG emissions reduction the world has to follow, we will not discuss here what William Nordhaus for instance call the « when efficiency requirement », that is to say the level of the rate of social time preference that must be applied to the cost-benefit analysis. (Nordhaus 2008) The likelihood of a "dangerous" climate change if the rise of temperature should exceed 2°C seems great enough to justify action.

The UNFCCC aptly summarizes some of the major challenges that are (still) before us when it underlines that "the global nature of climate change call for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated capabilities and their social and economic conditions". The problem to solve is thus a question of distributive justice concerning the use of carbon sinks or, to put it differently, a problem of sharing the world's carbon budget in a way that will avoid an increase of temperature superior to 2°C in the next 100 years. As James Garvey underlines it: "The carbon sinks of our world are a finite resource which has been shared out unequally. Justice demands that we redress the balance". (Garvey 2008: 76)

A. The "Relevant Agents" Question

In the climate regime to come it will thus be necessary to define an acceptable regime of burden sharing among economic agents. But, who are the relevant agents? To put it differently: "Who is obligated to act and to aid?" (Harris 2008: 482) Traditionally, the answer has been "the nation state". In the debate on burden sharing rules, arguments are frequently based on aggregate emissions per state and emission per capita in a given state. All comparisons between states or between individuals take nation-states as the unit and building block of the reasoning. This state-centric approach has a perverse effect since it masks emissions differentials within states among social classes. As Paul Harris argues, many of the solutions to climate change will, of course, have to involve states. "But this reality needs not absolve capable *individuals* from explicit responsibility and obligation, especially when states are not doing nearly enough". (Harris 2008: 483) He rightly asks: "Why should a poor person in, say, Germany be lumped with the wealthy of Germany to aid both the poor *and* the rich in China or other developing countries who suffer from the effects of climate change, especially when the latter pollute far more?" (Harris 2008: 484) The question is not simply theoretical, the Indian and Chinese middle classes being more numerous than the German population.

Any answer must thus address both levels. The state-centred approach must lead to an international climate justice framework with enforced national obligations. The social class or citizen centred answer requires a cosmopolitan or rather global climate justice framework with individual obligations.

B. International Climate Justice

The principle of states' obligations is the foundation of the international climate justice approach. But how should we define the "obligations" of any particular state? At least two criteria can be taken into consideration: the historical responsibilities of the state considered and its present (economic, technological…) capacities to contribute to its mitigation.

Concerning the first point, is it useful to stress that some states have contributed far more than others to the present rises of earth temperatures? In fact, the disparities in current levels of GHG emissions reflect the disparities in cumulative emissions since the industrial revolution. The United States, for instance, which is the first per capita emitter of the planet and until 2006 was the first emitting country, is responsible for almost 30% of cumulative CO_2 emissions between 1850 and 2002. The European Union ranks second with 26.5% and Russia third with 8.1%. From 1850 till now, the "developed" world has been responsible for 76% of CO_2 emissions, a figure that means that the responsibility of the "developing" world is limited to 24%. (Garvey 2008: 70) These figures clearly show that some countries have overused the carbon sinks of the Earth. Second, it is also obvious that the industrialized states have greater financial and technological capacities to develop climate friendly technologies or at least more energy efficient technologies.

Burden sharing principles must thus be adopted. But, what makes such a decision difficult to take is that there are different kinds of rules that rely on different moral justifications. Martino Traxler, for instance, proposes an interesting typology that distinguishes between "just" and "fair" principles. Just principles are "backward looking" "historical rectificatory principles" that are "intended to restore an acceptable moral order that past actions had disturbed". Examples of "just" proposals could be: 1. to pay or contribute in proportion to the *benefits* received from the total historical emissions of GHGs; 2. to pay in proportion to the total historical emissions of GHGs; 3. to pay in proportion to responsibility, the responsibility being for instance limited to emissions after a given year of reference, for example 1990. (As a matter of fact, in the field of pollution, nobody can be held responsible for a damage caused at a period when science had not evidenced such damage. That is why the year of the publication of the first IPCC can be considered an acceptable starting point). Fair principles are "forward looking". They "seek to maintain matters at least as morally acceptable as they are found to be at present in the future". An example of a "fair" proposal is to pay on an equal per capita basis.[4] (Traxler 2002: 117-131) In this perspective, the Kyoto Protocol is both unjust (because some developing countries like China are in the Annexe 2 even though they will soon contribute to global warming far more than many developed countries) and unfair in the sense that these developing countries are not bound to emissions reduction.

Paul Baer, Tom Athanasious, Sivan Kartha and Eric Kemp-Benedict - authors of *The Greenhouse Development Rights Framework* - propose a "Responsibility Capacity Index" (RCI) to calculate national climate obligations. First, they fix a "development threshold", that is to say a level income (7,500 dollars per capita and per year, in purchasing power parity (PPP) at which people achieve acceptable levels of the Millennium Development Goals indicators. On this basis, a nation's capacity is the sum of all individual incomes above the threshold. Its responsibility is likewise defined as cumulative emissions since 1990, excluding emissions that correspond to consumption below the development threshold. These measures can be combined in the "Responsibility Capacity Index". (Baer *et al.* 2008)
With a RCI = aR + bC (with a = b = 0.5) we obtain the following figures (Table 5) :

Table 5

Greenhouse Development Rights Framework for United States and China							
	2010					2020	2030
	Population (% of global)	GDP per capita ($ US PPP)	Capacity (% of global)	Responsibility (% of global)	RCI (% of global)	RCI (% of global)	RCI (% of global)
United States	4.5	45,640	29.7	36.4	33.1	29.1	25.5
China	19.7	5,899	5.8	5.2	5.5	10.4	15.2
World	100	9,929	100	100	100	100	100

Source: from Baer *et al*. (2008), *The Greenhouse Development Right Framework*, Heinrich Böll Foundation, Christian Aid, Ecoequity and the Stockholm Environment Institute, p. 55.

[4] It is not useless to note that in 2004 the CO_2 world emissions per capita is 4.5 tons. A figure to compare to the Chinese figure: 3.8 tons and to the American one: 20.6 tons. These figures are obtained with a world total emission of almost 29 gigatons. With the annual budget of 14.5 gigatons cited above, these figures should (with the same population) be reduced by 50%! We understand why Chinese authorities prefer "intensity targets" (carbon intensity of economic growth, energy intensity of the economy…) to "absolute targets". For a critique of a contribution on equal per capita basis, see Traxler (2002: 124 -125).

It must be noted that because the measure of capacity excludes the income of poor people, a rich country's capacity will be larger in percentage terms than its share of global income, and a poor country's capacity will be smaller. In the same way, a wealthy country's responsibility will be larger than its share of cumulative emissions because fewer of its historical emissions will be excluded. If we assume that the total cost of the global climate program is 1% of gross world product, or about 1 trillion dollars in 2020, we obtain the following estimates of obligation to pay (for mitigation and adaptation) (Table 6[5]). (If one believes that the cost will be 2%, then one should multiply by 2 the last two columns.)

Table 6

National obligations to pay					
	National income (billion $)	National capacity (billion $)	National capacity (% GDP)	National obligation (billion $)	National obligation (% GDP)
United States	18,177	15,661	86.2%	275	1.51%
China	13,439	5,932	44.1%	98	0.73%
World	94,405	59,388	62.9%	944	1.00%

Source: from Baer *et al.* (2008), *The Greenhouse Development Right Framework*, Heinrich Böll Foundation, Christian Aid, Ecoequity and the Stockholm Environment Institute, p. 58.

Even if these figures seem huge, they must be considered in a perspective of economic growth. As Christian Azar and Stephen Schneider demonstrate, the abatement cost of global warming would be overtaken after a few years of income growth. "If the cost by the year 2100 is as high as 6% of global GDP and income growth is 2% per year, then the delay time is 3 years, whereas as the delay time is only 1 year if income grows by 3% per year and the abatement cost is 3% of GDP." (Azar and Schneider 2002: 77) If you rank countries according their average obligation per person above the development threshold, it appears that 17 of the top 40 countries are not countries included in the Annex 1 of the Kyoto protocol. (Baer *et al.* 2008: 62) But states are not the only relevant actors obligated to act. What about affluent people, whatever their nationality? Taking this question into consideration leads to the concept of cosmopolitan climate justice.

C. Cosmopolitan Climate Justice

As Paul Harris argues, the cosmopolitan conception of justice points to individuals as global citizens of one world. "A cosmopolitan approach places rights *and* obligations at the individual level, discounting the importance of national boundaries". (Harris 2008: 486) In such a perspective, national boundaries are not considered as a morally distinctive feature for the elaboration of burden sharing rules. The cosmopolitan conception of justice can thus be seen as an application, at the international level, of John Rawls' veil of ignorance. As Charles Beitz puts it: "For purpose of moral choice, we must… regard the world from the perspective of an original position from which matters of national citizenship are excluded by an extended veil of ignorance". (Beitz 1979: 176) But, why should such a shift from international to cosmopolitan justice be considered so important?

The answer is quite simple: in "emerging" countries a growing number of people enjoy a middle-class lifestyle in terms of consumption patterns. (Myers & Kent 2004) The first methodological step to grasp the importance of this new class of consumers is, in order to compare national economies on a robust basis, to express their GNP (gross national product) or GNI (gross national income) not in conventional or international-exchange

[5] Explanation : the figure 275 billion dollars for the United States (column 5) is obtained the following way: 944.05 x 0.291 (from Table 5 column 7) = 274,7. (944.05 is 1% of world GDP)

dollars but in "purchasing power parity" (PPP). Using PPP provides an indicator of wellbeing that is free of exchange rates distortions. This leads to sometimes substantial modifications in country rankings. (Table 7). (In 2007, expressed in current dollars, US GDP was $13,886 billion and China GDP was $31,121 billion. The indications of Table 7 are thus still, not to say more than ever, valid.)

Table 7

Two of the world's largest economies in 2002				
	$, billions	Rank	PPP $, billions	Rank
United States	10,138	1	10,138	1
China	1,237	6	5,732	2
World	32,253		47,426	

Source: from Myers & Kent (2004), *The New Consumers. The Influence of Affluence on the Environment*, Washington, Covelo, London: Island Press, p. 9.

The "new consumers" can be defined as "people within an average four-member households who possess purchasing power of at least PPP$10,000 per year, or at least PPP$2,500 per person". (Myers & Kent 2004: 8) These new consumers being more and more numerous, a new category of nations has progressively emerged that can be called: the "new consumer-countries". If we limit this group to the countries that have had vigorous economic growth in recent years and a population of at least 20 million people, we obtain a set of 20 countries, headed by China (Table 8). This is unsurprising since between 1978 and 2003, the country has multiplied its GNP by almost 7 and its real income per capita by almost 5. (Maddison 2007: 69) To limit ourselves to one example (for a detailed presentation of the situation, see Huchet & Maréchal 2007), the Chinese car fleet rose from 1.6 million in 1990 (152 million in the United States) to 8 million in 2000 (175 million in the United States, this figure including SUVs), and was expected (in 2004 by Myers & Kent) to exceed 40 million by 2010, that is to say to equal the German fleet. In fact, in 2007, there were 53 million cars on the Chinese roads! In short, China's "ecological footprint" is rising rapidly. Both the United States and China have now an ecological deficit. (Myers & Kent 2004: 60) Whatever the economic instrument chosen in the next years (tradable emission permits or carbon tax) negotiations are going to be difficult and potentially conflict ridden between "developed" and "developing" countries.

Table 8

The New Chinese and Indian Consumers in 2000					
	Population (millions)	Per-capita GNI ($)	Per-capita GNI (PPP$)	New consumers (millions and % of population)	New consumers' purchasing power (PPP$ billions and % of national total)
China	1262	840	3920	303 (24)	1267 (52)
India	1016	450	2340	132 (13)	609 (39)
Totals of the 20 counties ranked	3632	xx	xx	1059 (29)	6305 (67)

Source: from Myers & Kent (2004), *The New Consumers. The Influence of Affluence on the Environment*, Washington, Covelo, London: Island Press, p. 17.

III. Ordered Pluralist Cooperation

Because of its global scope, the first crisis of its kind in recorded history, global warming poses an acute practical and normative challenge for political philosophy in general and international relations theory in particular. It follows from what has been said that the normatively best approach to solving global warming would be based on a holistic assumption of species and eco-systemic unity, or universal interdependence transcending national and cultural distinctions. This in turn implies the inalienable right of all individuals, present and future, to a "good life", that is a life worth living "with and for others under just institutions". (Ricœur 1990: 202) In a cosmopolitan setting, the distributional issues raised by the need to offset global warming would translate as a problem of social justice among individuals and social classes at the global level rather than simply between nation states. This in turn assumes the need for empowered institutions of global governance, the purpose of which would be to define and implement universal public policies designed to secure inter and intra generational equity. In the pursuit of this normative goal, theory should be geared towards generating a cosmopolitan ethos and shared inter-subjective meanings regarding the human prospect that are based on solidarity.

The difficulties of implementation of such a cosmopolitan perspective are however enormous. It presupposes the passage from the modern or Westphalian inter-national system, which is segmented into sovereign national territorial units, to a post-modern configuration of post-nationality. Yet, the imagined communities (Anderson 1991) we live in and have constructed since the rise of the modern nation state are based on ontological assumptions about identity, belonging and obligations that cannot be simply swept away by new scientific facts (this is another way of saying what we affirmed earlier regarding descriptive and normative judgments). National, religious and indeed racial segmentation remain stubborn if often unfortunate social facts. Despite deepened transnational linkages at various levels, we are still very far from the post-international and post-national politics envisioned by some political theorists in the aftermath of the Cold War (Rosenau 1992; Habermas 1996). Even if we assume that a shared understanding is indeed gradually emerging that the collective human fate is inescapably bound to finding global answers to transnational problems, the abstract understanding of shared humanity (species being, in Marx' formulation[6]) does not automatically translate into a cosmopolitan ethos since it runs counter to daily experience of difference, otherness and self-interest (however flawed these can be shown to be). Likewise, even if we are able to rid ourselves, individually and collectively, of philosophies of radical selfishness (*homo economicus*) this does not mean that they will spontaneously give way to empathy towards "strangers", much less universal altruism. Moreover, while the statement "we are all likely to die or at least to suffer extremely deleterious consequences if we don't share the burden of global warming" is certainly accurate, it does not tell us how in fact various nations and social classes should share it, or who will define the terms of the settlement. Lastly, even assuming that global institutions can be created to find ways out of our present collective predicament, how to we ensure that they will be just?

A. Partial Cosmopolitanism

These are extremely difficult problems to resolve. Perhaps the best way out of contradiction is to reject options that are either undesirable or unattainable. The first undesirable outcome would be a sharpening of international segmentation through an exacerbation of struggles over scare resources, an outcome predicted by realist and neo-realist international relations theory. Still dominant in the contemporary literature, neo-realism postulates that nation-states

[6] Indeed, one can argue that global warming confronts individuals to the existential reality of species-being, in the sense given to that concept by Marx. See Karl Marx and Friedrich Engels, *Collected Works*, Vol. 3, New York: International Publishers, 1973.

are functionally undifferentiated self-seeking units that are conditioned by structural anarchy to maximise their power and minimise their insecurity, to the exclusion of all else. Under conditions of eco-systemic crisis, this Hobbesian assumption, which has been subjected to powerful critique,[7] implies a sharpening of interstate conflict. Said otherwise, realism and neo-realism have to be rejected outright if there is any hope of solving the greatest challenge humanity has as yet faced. However, as Richard Falk has rightly pointed out, we also have to exclude a number of "post-Westphalian scenarios" as either undesirable or unattainable or both, among them the notion of a self-regulating global market system, the limits of which are now plainly apparent, or the idea of a world government. (Falk 2004) If it were possible, which it is not, world government would erase pluralism and is not synonymous with democratic global governance. A world Leviathan would more likely reproduce at global level, under highly coercive circumstances, the social inequalities that presently exist within national boundaries, than establish global justice.

Having rejected *a priori* both interstate anarchy and these two post-Westphalian scenarios, what options are we left with? Falk points to a solution when he calls for the "gradual emergence of an accountable global polity" (Falk 2004: 9) To be legitimate, that global polity would be inclusive, democratic, pluralistic and founded on human solidarity. In a similar vein, Mireille Delmas-Marty has suggested that the alternative to the chaos of interstate rivalry or to hegemonic rule by a single world state or a world empire would be for the international system to move incrementally towards "ordered pluralist cooperation". (Delmas-Marty 2006) The concept of ordered pluralist cooperation implies the gradual convergence of actor agendas around common goals across different issue areas. Rather than erasing pluralism, it would seek to identify areas of convergence that allow for cooperative action in a pluralistic setting, successful cooperation in any one area generating trust and opening the possibility for advances in other areas. In contrast to hegemonic regimes, the rules and disciplines of which are set by a dominant power, ordered pluralism would not be based on hierarchy but on the mutual needs of various actors with different capabilities (the European Union being at political level a good heuristic example of a non-hegemonic ordered plural system). In other words, we should eschew attempting to achieve an unattainable *complete* cosmopolitan order but rather imagine the frameworks that would allow movement towards convergence, that is a partial cosmopolitanism that does not erase plural traditions and identities. (Appiah 2007) We can apply these concepts to the question of global warming by identifying areas of congruence between national and universal interests. In the case under study, there is a real opportunity for the United States and China to set goals that meet mutual needs, and by extension to secure the global atmospheric commons.

A very good concrete example of possible cooperation and convergence around common goals is the proposal made by recently by Hu Angang, a senior figure of the Chinese Academy of Sciences, for a fair global settlement, taking into account "average greenhouse-gas emissions per capita, total greenhouse-gas emissions, [and] historical and current responsibilities". (Hu Angang, 2009) In Hu's proposal, the Human Development Index (HDI) of countries would serve as the metric of burden sharing rather than GDP. Thus, various categories of countries – High (above 0.8), Medium High (between 0.65 and 0.8), Medium Low (between 0.5 and 0.65), and Low HDI (under 0.5) – would contribute differentially to the reduction of emissions. If all the largest polluters, which include both High HDI (the "developed countries") and Medium High HDI countries (such as China, HDI = 0.777) will be required to make major efforts to cutback emissions, the High HDI countries, which owe their present position of wealth and power to their historical position at the core of the

[7] See for instance Richard Ashley's and Robert Cox' critiques *in* Robert Keohane (ed), *Neorealism and its Critics*, New York: Columbia University Press, 1986.

hierarchical late modern world system, would be called upon to make the greatest unconditional efforts not only in terms of emissions reduction but also in terms of providing financial and/or technological assistance to the other groups of countries. This would help to significantly mitigate climate warming while correcting the patterns of international inequality set in the nineteenth century and that still shape the world today. Medium Low HDI countries would "benefit from low-interest loans from international financial organizations and low-cost technological assistance". Obligations of various countries would of course evolve according to their shifting position in the Human Development Index. Thus Medium High HDI countries would become unconditional reducers once they have reached High HDI status. The global effort would be enforced by a United Nations agency established to that effect and which would set binding targets for all countries.

B. Convergence Around Norms

Global distributive justice would have to be complemented by fair social bargains at national level. At the national level distributive justice in burden sharing would be accomplished through redistributive policies such as progressive tax policies, incentives to invest in green technologies, punishing disincentives for polluters, etc. In other words, the global bargain would have to be sustained by domestic social democratic bargains based on a fair distribution of resource consumption among social classes and a reorientation of patterns of consumption to make that possible. A few years ago, proposals of this type would have appeared hopelessly unrealistic since *homo economicus* was triumphant and the most powerful state in the international system had abandoned cooperation and international law and adopted policies of unilateral power maximisation policies. Today however, a new and far more hopeful political configuration in the United States makes it possible to move forward once again and to break out of the prisoners dilemma discussed in this article. In spite of persisting competitive pressures, domestic and international, it is no longer impossible to imagine convergence around shared understandings and norms. In that sense, the present generation of world leaders have an immense historic responsibility since they will define whether survival oriented outcomes will prevail or not. The responsibility is however not theirs alone. There is a need to overcome the "theoretical ineptitude" discussed at the outset. A concerted theoretical effort is required to generate the intellectual and political conditions to make optimal outcomes possible. Theory is reflexive rather than positive in the sense that the thinking subject is not separate from the object of thought but plays a determining role in the constitution of the "real". Along with historical actors, theorists have the responsibility to help construct the cosmopolitan ethos that will underpin a world order based on pluralist cooperation rather than rivalry.

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Emerging Opportunities for Responding to Climate Change in The Obama Administration: Why China Should Propel Developing Countries Towards Global Carbon Reduction Cooperation

Richard Ingwe[1] S. P. I. Agi[2], and James Okoro[3]

Abstract

The use of diplomatic brinkmanship by the USA and her more recent uncooperativeness with global response to the climate crisis (Kyoto Protocol) under the presidencies of George W. Bush and Bill J. Clinton has led to fears in quarters that China, a rapidly industrialising country might opt to become uncooperative in the global climate change efforts. We use suitable conceptual frameworks of international relations to review the US' previous conduct in international relations during the "cold war" among others to analyse recent issues pertaining to global carbon reduction under the Kyoto Protocol. We argue that China's rising profile in economic, political and social spheres especially the way it offers loans on softer terms compared to the Western Consensus model, her ratification of the Kyoto are among the several indications that her relationship with the USA and other nations in carbon reduction portend good relationship in future. We argue also that Presient Obama's promise of acknowledging the reality of climate (change) science and to lead other nations in responding to the crises seem to be getting fulfilled based on recent evidences. We conclude that the future for global cooperation between the USA and China, on one hand, and between USA and the rest of the world, on the other, present grounds for optimism that global carbon reduction would proceed more peacefully and profitably than it was hitherto.

Background

The world faces a multiplicity of challenges. Widespread and prolonged poverty afflicting a large proportion of the world's population especially in the developing world since previous decades had frayed nerves leading to numerous conflicts and wars. Ideological differences had in the 1960s brought the world to the brink of a nuclear holocaust when the defunct USSR and USA threatened to go to war which could have culminated in the deployment of nuclear weapons. In August 7, 1998, terrorist networks had emerged and instrumented bombings of US missions simultaneously in Nairobi (Kenya) and Tanzania killing hundreds of people and destroying precious property compelling the US to retaliate with Tomahawk cruise missile attacks on al-Qaeda bases in eastern Afghanistan, followed by unilateral and later multilateral sanctions by the US and UN security council resolutions 1267 and 1333 aimed at subduing the Taliban leadership to surrender and trial.

The 9/11 and 11/11, 2001 bombings of the twin towers of the World Trade in centre New York and the Pentagon in Washington, D.C Killing over 2000 people in the former represents the escalation of terrorism. The US response packaged as "Operation Enduring Freedom" on Afghanistan was expanded to cover Iraq leading to a bitter experience for both Americans and Iraqis. Although the Taliban regime fell on 13 November 2001, the US offensive on Iraq persists and formed one of the central issues of the US presidential campaign in 2008 (Maley in McLean and McMillan 2003:9-10). These existing widespread conflicts will be exacerbated with increasing warming of the world, abrupt and dangerous

[1] Senior Scholar, Centre for Research and Action on Developing Locales, Regions and the Environment (CRADLE), Calabar, Nigeria. Telephone: (+234)8051740656; Email: cradle.africa@gmail.com and ingwe.richard@gmail.com

[2] Reader, Department of Political Science, University of Calabar, Calabar, Nigeria

[3] Senior Lecturer, Department of Political Science and Institute of Public Policy and Administration (IPPA) University of Calabar, Calabar, Nigeria

changes in climate and the environment. Among the several widespread and serious consequences associated with global warming a few deserve our present attention: the indifference and irresponsibility of governments towards it and its potential to perpetuate conflict among nations leading to the legacy of conflicts/wars characterizing recent history. Official acknowledgement of global warming/climate change Despite the report of global warming in 1896 (i.e. 113 years ago) by Svante Arrhenius, whose work was preceded by another colleague (Joseph Fourier in 1827 (182 years ago), official acknowledgment of the destructive phenomenon was disregarded by politicians until recently when reports by Intergovernmental Panel on Climate Change (IPCC) became more alarming. It was only in a few counties such as the European Union and a few others that carbon reduction programmes including sustainable (renewable and efficient) energy programmes were implemented (Droege 2008: 1-14). The UN Secretary-General, Ban Ki-moon acknowledged the threats posed by climate change and energy crisis to global security and peace. This is especially true for regions which have a rather longer experience of conflicts and where relationship with neighbours had collapsed and are not aware of the accumulative effects of global warming and its consequences (Ki-moon, 2007: xvi).

Irrespective of the UN's acknowledgment of the problem, it has been difficult to muster the political will of global leaders to tackle the problem. This point was clearly made by former UN Secretary-General Kofi Anan who stated the world lacks leadership in the environment (including climate) sector (cited by Ingwe 2008). Another dimension of the poor political leadership worldwide is the tendency of some countries to resort to previous historical disappointments, directly or indirectly, with their peers or counterparts in the development process to forge national policy strategies that do not strive towards achieving optimum results in terms of mitigating and adapting to climate change to the global benefit by aiming to drastically reduce their green house gas (GHG) emission. This has been the case in the global climate change response behaviour of the European Union (EU), on the one hand, and the USA and between the rest of the world (nations of the advanced North which have joined/endorsed the global mechanism (the Kyoto Protocol) for tackling global warming and the USA, on the other.

This article examines differences in the nature of response to global warming taken by China, a rapidly industrializing developing country, as a result of her perception and consideration of the attitude of the USA towards the global climate change/carbon emission reduction. This undertaking is justified for several reasons. Under the context of the failure of the advanced industrialized countries to fulfill their promise to deliver aid (except the Scandinavian/Nordic nations) and the increasing manifestation of climate change impacts On Africa (such as the flooding of about 20 Africa countries in 2007 alone) global response to the crises is urgent and imperative in the wake of the complication o the continent's problems. It is apposite to examine the response to climate change) by countries which are the greatest emitters of Green House Gases (GHG). The USA and China fit the case study approach due to their representativeness of the advanced and developing worlds in a rapidly changing world. The Intergovernmental Panel on Climate Change (IPCC) has stated the unequivocality of the contribution of anthropogenic forcing as the cause of global warming: revealing that earth surface temperature increase since 1800 but more rapidly between 1970s and the present (about 1.7^{O}F) (www.epa.gov.250inafrica:12).

The Problem

As elaborated later, the global effort to reduce carbon emission initiated in 1997 in Kyoto (Japan) involved 38 industrialized countries which committed themselves towards achieving a target of eight percent GHG emission reduction by 2012 compared with their 1990 levels (European Commission 2009:18). Although developing countries were expected to cooperate in the emissions reduction effort, there is a gap in information and knowledge of their contribution to the programme. The case of China deserves careful analysis for several reasons among which deserve mention here. China possesses a large proportion of the global population, has been experiencing high rhythms of economic growth due to rapid industrialization and technological development and has more recently attained a globally enviable position of a national economy that was capable of lending the USA funds required for prosecuting the stimulus (financial) package designed for resuscitating the economy after the global financial meltdown and the economic recession within the last part of 2008 until the present. Ruefully, report on global effort to address global warming still concentrate discriminatively on the advanced countries of the North irrespective of recent advocacy for the restructuring of the global economic and political order which led to the expansion of the G8 nations to create the new G20 nations by including other countries which are experiencing promising signs of contributing to revamping the global economy and reducing its vulnerability to the financial and economic crises which recently devastated the USA and several other G8 economics. Despite China's rising political and economic status response to climate change is poorly understood.

Purpose

The purpose of this paper is to highlight the potential role which China-a rapidly industrializing and economically rising economy-to the global efforts to reduce GHG emissions.

The specific objectives are: To show the evolution of the current effort to address global warming through the mechanism of the Kyoto Protocol;

To describe the role that the USA played in the global effort to reduce GHG emission;

To highlight the opportunities presented by the new Obama administration of the USA for promoting a more acceptable framework for accelerated reduction of GHG emission.

To show how China and the rest of the world should adjust their paradigms of international relations to fit the new thinking and actions in Washington D.C as a better way of achieving sustainable development.

In the remainder of the paper, we describe the problem of global warming (climate change) in the second section to provide a basis for understanding the arguments. We follow this up by presenting relevant theory in the nexus of international relations aiming to resolve problems that concern several nations. These include: catastrophe theory, which sets the tone for understanding the context of widespread catastrophic consequences that scientists predict will come with the ongoing and increasing global warming. Brinkmanship theory has characterized previous crises involving the USA and its counterparts and its legacy might be determining the recent strategy of the US response to the Kyoto protocol. We introduce the theory of neoliberalism due to its variable connotations as used by the advanced countries and the contrasting view of the developing world. Moreover, the response of nations to global warming or carbon reduction is determined by their economic circumstances and the consideration of the economic benefits perceived to derived from specific political action(s). Neoliberalism captures these political and economic dimensions. We present global response to global warming in form of the Kyoto Protocol, and the attitude of the USA towards it ratification/enforcement and the distinctive achievements of the European Union under its framework in section three. In section four, we show the opportunities presented the new

Obama administration for leveraging the global effort to reduce GHG emissions. Here too, we review the actions taken by the Obama administration towards fulfilling his promise to accept climate science and lead the global campaign to reduce GHG emission.

In section five, we review recent changes in the Chinese economy, industry, and position regarding the approach of the US and the advanced nations to global GHG emission reduction. Based on the paradigmatic shifts in the international relations style of the Obama administration, we conclude the paper by urging China and other nations to place global interest as equal pedestal as country by more honestly.

Climate Change: The Consequence of Global Warming.

This phenomenon refers to steady and accumulated build up of six major (greenhouse) gases GHG dominated by carbon dioxide (CO2) in the atmosphere over a long period has led to entrapment of solar radiation resulting from the formation of a kind of ceiling by the GHGs over the upper atmosphere thereby heating up the earth surface due to prolonged prevention of solar radiation from being reflected back into space. Its consequences over the years include the alteration of climate and weather events: their physical behaviour, dynamics of rainfall, temperature etc) and by extension environmental characteristics. It also involves changes in the mixture of atmospheric gas composition and earth surface temperature has fluctuated over the years. The consequence were initially considered uncertain but more recent findings from more reliable scientific studies show that they would involve widespread catastrophe including deforestation, desertification, poleward extension of vegetation and animal population, increases in sea levels and declining precipitation scientific evidence shows that CO2 emission from fossil fuel burning contributes 80% of worldwide GHG emissions (Matthes 2006:293, Humphrey in Mclean and McMillan 2003: 225).

Although a consensus is yet to be reached, it is widely known that limiting global mean temperature increase resulting from global warming to two degrees Celsius above pre-industrial levels is mostly considered to be a reasonable point beyond which widespread catastrophic consequences of global warming on human society and natural system will occur (the European Council (no date) in Matthes 2006:295). A tolerable level of further global warming is put at $1.4^{O}C$ since the 19th century. Therefore, a mean long term global warming rate of $0.2^{O}C$ per decade, not more, is considered safe and must not be compromised (WGBU 2003 and 2004 in Matthes 2006:295). Based on various global warming reduction parameters (climate windows) and various alternatives for GHG emission reductions strategies, it was proposed that a climate policy targeting stabilization of GHG concentrations at 440 parts per million (ppm) to 450ppm (equivalent to stabilization of CO2 concentrations at 350 to 400ppm represents an ambitious climate policy (Meinshavsen 2005). This proposal represents a GHG emissions reduction by about 50% by 2050 compared to 1990 levels (Matthes 2006:296). The intergovernmental panel on climate change (IPCC) has demonstrated that human activity mainly fossil fuel use is incontrovertibly responsible for increasing GHG emission leading to global warming/climate change. Using the GHG emission; profile of the past century, there is likely to be an average global temperature increase of between 2 and $4.5^{O}C$ by the year 2100 compared to 1990 levels (IPCC 2007, 2001 in Byrne 2008:27). Scholars have engaged in frightening number game projecting the scale of consequences that will arise from climate change in future. As many as 200 million people could be displaced by monsoon systems, rainfall regimes, severe droughts, flooding when climate change reaches an advanced stage in about 2050 (Myers 2005 in Oli 2008).

Another popular study reveals that while most coastal and low lying parts of the world would suffer widespread damage and economic losses, Africa is the most vulnerable of all regions of the world. It recommends a GHG emissions reduction at least 80% by all countries to avoid the catastrophe (Stern 2006).

Catastrophe Theory Presents a Good Framework for Understanding Climate Change

The manner in which US Governments under President George W. Bush and to some extent Bill Clinton failed to cooperate with the global movement to respond to climate change and the predictions of doom and worsening impacts of the environmental crisis. The theory offers a suitable way of systematically classifying abrupt disruptions in conditions of stability thereby enthroning chaos. The theory has been employed for analyzing a wide variety of phenomena studied by both physical and social scientists from the freezing of a liquid to the disintegration of an empire that was hitherto a formidable socio-political entity, or violent action of inmates of a prison or the bending and breakage of solid objects such as a metal. Although its use engendered controversy by the mid 1970s, it enjoyed popularity in the social sciences in the early 1970s through its employment Christopher Zeeman and colleagues, after its creation around the mid 1960s. The popularity of the theory among non-mathematicians has been attributed to two major reasons First, it produces more easily comprehensible general ideas of spatial intuition derived from more appropriate qualitative methods contrasted to quantitative approaches used by mathematicians to analyse surfaces and topology. Secondly, the theory is amenable to use for explaining in a discriminatory way only circumstances that have deviated or changed radically in a discontinuous way from an original initial conditions that were considered to pose problems for easy explanation using available scientific methods that are based on Newtonian paradigm and characteristic and peculiar to social and political events. Despite the popularity it enjoyed in political science scholarship within the decade (1965-1975) and perhaps until the present, the catastrophe theory is yet to attain a more respectable status in the discipline. Its use has been adjudged to be more successful as a heuristic instrument than for detailed studies. However, its popularity is beneath the level achieved by its counterparts e.g. game theory, its rather transient popularity within a decade has been likened to chaos theory its other counterpart (Jones in McLean and McMillan 2003:66-7). The suitability of catastrophe theory to the analysis of climate is in the way global warming has already been acknowledged to be characterized by abruptness, suddenness and danger.

The way its impacts trigger various consequences that by themselves lead to disruptions in several sectors such mass migration of people in search of more livable environments compared to their original usual places of habitation and work make it suitable for analyzing predictions about widespread catastrophic events such as extreme weather events (flooding, drought, storms and so forth (Helmuth et al. 2007, Meyers, 2005, Stern 2006 etc). Climate change in its own right triggers catastrophic events in the physical environmental subsystems (atmosphere, hydrosphere, and lithosphere) and also catalyses catastrophic decisions within the social (human) and political systems a matter we turn to presently.

The legacy of “Cold War” brinkmanship: According to Geoffrey R. D. Underhill, the term brinkmanship refers to the tendency of the superpowers during the “Cold War” era to deliberately cause a crisis associated with accelerating a “potential nuclear holocaust”. This habitual tendency smacking of “going to the brink” (of civil action) was aimed by either of the two superpowers to stampede its rival to concede on the issue of military supremacy. Some examples include; the 1961 crisis over Berlin-the former and current capital city of the United German Federal Republic and the Cuban Missile crisis of 1962 i.e. only one year after the former (1961) crisis. It involved USSR’s installation of nuclear weapons in Cuba, near Florida, US and US demand that the Russians clear-up the offensive threats. Theses crises have been documented elsewhere and do not bear repetition here due to the need to concentrate on our present task and title/issue (see Peter Byrd in McLean and McMillan 2003:129-131 for detailed account of the Cuban Missile crisis). Brinkmanship also describes other political “gamesmanship” actions that are of high stakes which are capable of affecting international politics and relations among sovereign states (Underhill in McLean and McMillan 2003:53).

The theory/concept is relevant in this article due to the way it captures the way US Governments under presidents George W. Bush and Bill J. Clinton a topic described elsewhere in this paper. The way the problem of global warming has become inextricably interrelated to the financial crises and the economic recession of the late 2008 up to the present beckons for other theoretical and conceptual frameworks that capture these twin crises.

The Relevance of Brinkmanship of The Cuban Missile Crisis (CMC)

The CMC was regarded as a paradigm case in "crisis management" in the West because it represented a novel deployment of diplomatic tactics by the US to resolve the crisis which was inexorably heading towards a painful nuclear war between the defunct USSR and USA with Cuba and the rest of the world bearing enormous brunt. Its high points include the way the US fine diplomatic action (or response) to the adamancy and belligerence of the Russian leader: Nikita Krushcher over withdrawing nuclear weapons installed in Cuba yielded beneficial results. The potency of the US action was credited to the use of brinkmanship (the threat of war) to cause the opponent to acquiesce and also the inclusion of an allowance of a last resort for the opponent to prevent the escalation of disagreement of a very serious kind (Underhill in McLean and McMillan 2003:53). The theory of brinkmanship might have been a legacy that appealed to President George W. Bush and his supporters but is inappropriate as a strategy to apply to the problem o global warming which is irreversible in a world that has attained a relatively higher degree of awareness deriving from advanced scientific and technological methods of producing and disseminating/communicating information of the type used by Barack Obama in prosecuting/managing his presidential campaign.

Neoliberalism, Postneoliberalism and Climate Change

The recent global financial crises of the last quarter of 2008 which rapidly degenerated into a global economic recession has raised to high pedestal the theory of neoliberalism. There is increasing interest in the potency and value of the theory which is being held responsible for the crises. The following account will demonstrate the globalization of the theory, through its application in various senses/meanings in both the advanced and developing worlds. The way the theory covers both advanced and developing worlds makes it suitable for analyzing the way China has responded to the USA's approach towards managing the global warming problem.

Andrew Hurrel and Laura Gomez-Mera have provided a comprehensive definition of the term by highlighting its different meanings. The term has been applied in the field of academic international relations as a theoretical approach developed to analyse institutions thus earning it other names: neoliberal institutionalism or regime theory. Created in the mid 1990s, this strand of the term was developed as a response to the non-realist paradigm involving the demonstration of the possibility of realizing the goals of international cooperation based on the principles of non-realism. In pursuing this goal, the cooperating states are considered to be rational, unitary actors interested in maximizing their utility within a rather anarchic international system. The neoliberal institutions are regarded as effective mechanism for facilitating cooperation among the states involved through deliberate reduction of uncertainty, articulation of issues of common interest to the cooperating states, monitoring the conduct of the states and promoting appreciation of the benefits of reputation among the parties involved. Under the context of the absence of a sovereign authority in the international arena, a problematic situation that causes frequent conflicts among states, cheating and defection among states, the foregoing measures are regarded to be capable of providing solutions.

Theorists of Neorealism have challenged the arguments of the Neoliberals/institutionalists by emphasizing the gains of relative gains as superior to those derivable from the absolute gains. The Neorealists argue that powerful states create institutions that they customize to pursue interests/goals of their own states while relegating issues that concern other states to the background and treating them as impediments.

The second meaning of neoliberalism refers to a set of policies related to market-liberal economic system. There are two meanings of the term under this family; corresponding to the perceptions of the advanced countries and developing countries. In the advanced countries, neoliberalism is associated with Thatcherism (after the economic and political strategies applied by former British Prime Minister: Margaret Thatcher). It emerged as a challenge to Keynesianism, an economic policy approach associated with the economist John Maynard Keynes.

Neoliberalism is used in developing countries to challenge the infamous national development strategies of import substitution industrialization applied intensively from 1945 to the early 1980s. Here the term is commonly tied to the Washington Consensus characterized by implementation of privatization and deregulation, liberalization of trade and financial mechanisms, curbing of the role of states in national economic processes and institutions, emphasis on foreign direct investment. Additionally, the term refers to the structural adjustment programmes (SAP) that were notoriously implemented by international governmental organizations such as the international Monetary Fund (IMF) and the World Bank. Some (including anti-globalization movements) have used neoliberalism to describe the globalization of capitalism representing an economic ideology advocated by the advanced countries. Although the various meanings of neoliberalism are related, its economic meanings are perceived to have remained rather imprecise and general (Hurrel and Gomez-Mera in McLean and McMillan 2003:368). Postneoliberalism has most recently emerged as a challenge to the economic impasse presented by the financial and economic crises devastating the global economy. Scholars and activists contributed 15 articles examining various facets of postneoliberalism: its analytical value, promises to bailout crisis ridden economics, bifurcations, relationship/differences with capitalism, counter hegemonic potential, value to biodiversity, food security and women peasants and its legacies in different countries/continents (development dialogue Melber 2009:212 pp +4).

Global Responses to Climate Change

The United Nations Framework convention on climate change (UNFCCC) represents the most serious global response to the problem of global warming because of the measures it has created to manage the debacle. The convention was adopted in 1992 at the Earth Summit held in Rio de Janeiro (Brazil). Its principal objective is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-made) interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (Detailed information is available at the UNFCCC Secretariat website at: http://www.unfccc.int/resources/docs/conveng/pdfcitedinUNDP,UNEP,WorldBank&WRI2003:240).

The Kyoto Protocol

This refers to a protocol established in a Japanese city called Kyoto in 1997 by the third session of the conference of parties (COP-3) including 38 industrialized countries to the

UNFCCC. It stipulated that when ratified by 55 countries would represent the commitment of advanced countries to reducing their collective emissions of six key green house gases CO2, CH4, and so forth by 5.2% on average by 2012. The emissions reduction was expected to be at least five percent lower than 1990 levels by a deadline which initially ranged from 2008 to 2012 compared to the emissions levels that would be expected to be achieved 2010 devoid of applying emissions control devices. The target emission of the protocol was equivalent to a 30 percent cut. It represents an agreement to reduce emissions and to promote adaptation to future climate change impacts by both developed and developing countries, their reporting of information on their national climate change programme and inventories; promotion of technology transfer; scientific and public research cooperation and promotion of public awareness raising, education and training programmes. To cause it to come into force, ratification by 55 parties to the convention representing parties that contribute 55 percent of CO2 emissions in 1990 by Annex 1 parties (describing industrialized nations) was required. The ratification of the Protocol by 94 countries represented only 37 percent of the Annex/countries emissions was attained by September 2002. See further information in a Guide to the climate change convention process, available online at http://www.unfccc.int/resources/process/guildeprocess-p.pdf<UNDP,UNEP,WorldBank&WRI2003:240). In February 2005, the Protocol came into force following its ratification by Russia and other countries. The 5.2% average emissions reduction was far below the 60% target recommended by scientists of climate as a means of avoiding further dangerous global warming which they have severally warned would lead to widespread catastrophic consequences for the earth's climate and environmental systems (land, water and atmosphere).

US Contrivance of Intransigencies and Frustration of the Kyoto Protocol Ratification

The USA is a major driver of carbon emission in the world (with a total CO_2) emissions in 1999 of 5,584.8 million metric tonnes (24.1% of global total) representing 15.2 percent change since 1990 and per capita of 19.9 metric tones per person in 1999 representing 4.7 percent change since 1990 levels. These were the highest carbon emissions worldwide. For China, the total CO_2 emission in 1999 was 3,015.3 (29.6 percent change since 1990) while the per capita CO2 emission was only 2.5 (i.e. 16.6 per cent change since 1990) (UNDP, UNEP, World Bank and WRI 2003:258-9). Only one year later, the total CO2 emission of the US rose to 5,762.1 million metric tonnes representing 24.11% and 17.9 percent change since 1990 China's CO2 emission in 2000 was a total of 3,473.6 million metric tonnes i.e. 39.3% change since 1990 while her per capita CO_2 emission was 2.7 tonnes per person in 2000 (i.e. 26.2% change since 1990 (UNDP, UNEP, World Bank and WRI 2005:204-5). Contrary to expectations of the USA to lead global response to reduce carbon emissions that it contributes enormously to, US Governments under Presidents George W. Bush and Bill Clinton failed to cooperate with global efforts aimed at tackling the world's greatest threat.

The way the US posed impediments to the global efforts to reduce carbon emission could be better understood by reviewing, albeit briefly, the crucial intergovernmental meetings that have been organised to mobilize support towards transforming the Kyoto Protocol into a ratified treaty thereby empowering it with legal instruments to command or effect enforcement. An account of global warming given by Mathew Humphery provides a foundation for doing this. The first intergovernmental meeting held in the Hague in November 2000 ended in disarray following the European Union's (EU) disagreement with the USA especially over the insistence of Americans that forests and vegetation must be included in the list of "Carbon sinks" and should be used in measuring the level of their emission of carbon through fossil fuel use or burning. Owing to the uncertainty, transiency and instability of the carbon storage capacity of vegetation, the EU feared that the use of vegetation as carbon sink in the agreement would create loopholes that the Americans would exploit to cheat. On his inauguration, President George W. Bush promptly caused the unilateral withdrawal of the US from the Protocol claiming that it had the capability of severely damaging its economy. The US failure to cooperate with others in this and similar carbon reduction efforts represents one of the most serious impediments to sustainable development of the world-considering that the US emits the largest quantity of CO_2 worldwide.

The second intergovernmental meeting on climate change held in Bonn (Germany) in July 2001 assembled 186 countries created a treaty out of the Protocol. Unfortunately, this was achieved only when unnecessarily huge concessions were granted to Canada (the US North American neighbour aiming perhaps to break the gang-up in the region), Australia, Japan and Russia regarding the acceptance of forests as "carbon sinks" and the instrument for enforce any agreement reached. These concessions are perceived to represent drastic reduction of the effective size of the initial emission reduction proposed at 5.2 percent on the 1990 levels to as low as between 1.8 and 3 percent (Humphrey in McLean and McMillan 2003:225-6).

More recently, in late 2008, another intergovernmental meeting on climate change held in the Indonesian city of Bali. It has been credited with achieving a roadmap for pursuing the goals of global carbon reduction.

Sadly, the Bali climate change meeting missed the participation, directly or indirectly of Barack Obama, who at the time was still campaigning for the US President but had announced that his administration would acknowledge the climate change problem, scientific evidence and also tackle it seriously. Therefore, the efforts of the Obama administration to dissociate from climate change science denial as a means of cheating, frustrating global climate change mitigation and adaptation efforts deserve attention here. Before undertaking that, it is apposite to examine the achievement of the EU in the area of carbon reduction based on the Kyoto Protocol as mechanism. The obstinacy of US Governments, especially under President George W. Bush, in applying brinkmanship while ignoring the global effort in the Kyoto compelled "civil action to shrink the carbon footprint in the US (Byrne et al 2008:27-53). It is apposite to consider the distinctive contributions of the European Union towards global carbon reduction.

What Has The European Union (EU) Achieved in The Kyoto Protocol?

A recent heartwarming report that "Brussels draws closer to Kyoto" explains that the EU has almost achieved its targets regarding the fulfillment of its greenhouse gas emission reduction obligations as stipulated in the mechanism or agreement. Citing the European Environment Agency (EEA), recent reports show that the EU's GHG emissions declined by 0.3% between 2005 and 2006 to a level (of) 7.7% below the 1990 level. Two reasons were given to account for the cheering record. First, certain chemical factories had recorded declining production. Second, the mild weather experienced in 2006 led to reduced use of heating fuel. Despite increases in major emission in Finland and Denmark as a consequence of rising coal consumption, the EU-15 at a regional level deserve commendation for leading the global quest for carbon (emission) reduction. The 12 new EU member states were reportedly poor carbon emission reduction performers. Whether the heartwarming reports from parts of the EU will be sustained in the future is yet to be seen (European Commission/research*eu 2008:18 citing http://reports.eea.europa.eu).

The Distinctive Opportunities of The Obama Administration for Global Carbon (GHG) Reduction

Despite the enormous dust raised by the global financial meltdown and economic recession which occurred in quick succession within the last part of 2008 in the USA and the way these crises beclouded the campaign and inauguration of President Barack Obama of USA the sterling credentials, qualities and commitment of the new administration towards carbon reduction remain clear and discernible. Irrespective of the enormity of these financial and economic crises and their capacity to dampen a revolutionary spirit, the firmness and commitment of President Obama to carbon reduction remains indefatigable. Owing to the fact that opportunities have everywhere and every time proven to be sublime, difficult to perceive and exploit, there is need for greater and elaboration and here to make them visible.

Perhaps the most promising opportunity of President Obama in global carbon reduction might be credited to his pedigree, association and paradigms and worldview. Obama's pedigree in carbon reduction campaign dates back to his anonymous days when he was either a quieter Illinois Senator, community mobiliser, editor of the prestigious Harvard Law Review (Journal) or voracious researcher when he took interest in climate change science and campaign. This has been documented and does not bear repetition here. Obama's association with climate change science/campaign is well illustrated with the roles played by world renowned climate change campaigners. Perhaps the most noteworthy was Obama's introduction by the sustainable development/climate change Nobel Laureate and creator/narrator of the environmentally friendliest film: ***The Inconvenient Truth:*** Al Gore (former Vice-President of the USA during the Clinton regime) as the presidential candidate of the Democratic Party in ………. 2008.

What is most valuable about Obama's paradigms generally is their radicality, novelty in the political arena, and their deep intellectual foundation. The political arena in most of the world has been entrapped/imprisoned in conservatism, status quo thinking, policy and action. Yet Obama has differed. Obama's development and energy production and use paradigm is that the USA and the world requires renewable and efficient energy resources to achieve greater sustainable development. He has argued that sustainable energy and environmental programmes promise more jobs for Americans and has invested impressively in the green technologies on inauguration only in January 2009.

Obama's worldview is harmony and peaceful coexistence between USA and other counties of the world. To Cuba one of the US longest political foes, to Iran, to Korea and several other nations, President Obama has offered and is pursuing international cooperation and relations as equal partners.

To the climate change group of nations generally and especially those which have ratified the Kyoto Protocol, President Obama offered to acknowledge the scientific evidence available and lead in the global campaign to drastically reduce carbon emissions as a means of achieving sustainable development. Obama's worldview in this regard was succinctly captured in his inauguration speech thus:

"The world will remember a person not on the basis of the damage/harm done…. But on the edifices she built…

The Impressive Actions of Obama Administration on Carbon Reduction

Development scholars are declaring that "the colour of stimulus goes green" (Robbins et al 2009). Robbins and colleagues (2009) reveal that governments across the globe have allocated over USD43billion in fiscal stimulus focusing on key climate change reduction investment themes with the USA and China in the lead worldwide. While the USA invested $973.0, i.e. US$186.0 (USEESA) and US$787.0 for USARRA, China invested: $586.1 (Robbins, Clover, and Singh 2009).

Perhaps more heart warming is the US' recent joining of the membership of the International Renewable Energy Agency (IRENA). Despite IRENA's recency, the global environmental sustainability community, including civil society and non-government organizations are praising the Obama administration for its climate friendly programmes and policies. For example, in a press release, the World Wind Energy Association recently praised the recent policies of President Obama as a good response to climate change (World Wind Energy Association, 2009). For example, Volker Thomsen, Chair WWEC2008 Board Member World Wind Energy Association and a member of: the World Council for Renewable Energy (WCRE), Eurosolar in Germany, and Co- founder WWEI World Wind Energy Institute Denmark, revealed happily that most recently the USA together with Australia joined the membership of the International Renewable Energy Agency (IRENA), whose membership as in June 2009, is nearly 100 countries (http://volkerthomsen.com/irena-the-international-renewable-energy-agency/, personal communication via email to WWEA network, 13 June 2009). The flourishing IRENA generally and the joining of its membership by the US is being commended by the sustainable development and energy community worldwide. Additionally, Steve Bouchard recently reports good news that the US House of Representatives has just passed a landmark bill that was designed to propel the nation toward a clean energy future.

The debate moves on to the Senate where opponents of the clean energy proposal are expected to pose obstacles to the bill's passage. However, clean energy advocates, whose momentum has been raised are resolute and promise to mount pressure in order to re-enact the recent success recorded in the lower federal legislature in the US Senate. Today, we have something to celebrate. Bouchard notes: "For the first time in decades, we have taken bold action to help solve the climate crisis" (Personal communication to the World Wind Energy Association, WWEA, networkers, 27 June 2009).

China is a signatory to the Kyoto Protocol. Her CO_2 (International Dollars) of GDP declined from 1,523 metric tonnes in 1990 to 949 metric tonnes in 1996 (UNDP, UNEP, World Bank and WRI 2001:282) while the CO2 emissions in 1999 was 3051.1 and 25.6 percent change since 1990. the increasing GHG emission results from rapid industrialization/economic activity in the world's most populous country with over 1.2 billion in 2002 (UNDP, UNEP, World Bank and WRI, 2003: 278, 258).

China's Response to Climate Change and US Strategies

The analysis of China's attitude to global climate change and her evaluation/assessment of the role played by the USA must be based on specific premises. It is important to accord China the status of a leading country in the developing world-a status which she gained several years ago when her economic growth rate shot up beyond the expectations of the world-especially the industrialized/advanced countries which foisted development models based on the Washington Consensus on the developing world based solely on their own economics histories and development experiences. More recently, China's global leadership role rose higher when it become a lender to the US and donor to Africa based on terms of friendship without the rather stringent conditions that contradicts the insistence of the Bretton Woods institutions and International Financial Institutions (IFIs) on the notorious "debt sustainability framework" describing stringently formulated documents and conditions. In this regard, china is commanding greater respect and following. This is important for the expectation of developing countries to join the global carbon reduction efforts. Additionally, China has been a candidate for a position in the membership of the UN Security Council for quite some time. Therefore, China's response to the global climate change and the role/attitude of the US to the campaign will certainly influence most developing countries especially those which have benefited from more favourable development assistance and expect same from the new economic and political force represented by China (Bayer 2009: 99).

It deserves statement that while China's economic and political might is not the main issue in assessing her response to climate change but it provides the foundation for their international relations policies and strategies.

The foregoing position is likely to be true also of 12 other "sustainable growth" countries which together with China have emerged as achieving economic growth rates of seven percent or higher within the past 25 years. They include: Botswana, Brazil, (China), Hong Kong, Indonesia, Japan, Korea, Malaysia, Malta, Oman, Singapore, Taiwan and Thailand. China's achievement of the rapid economic growth rate has been credited to the decision of her leader (Teng Hsiao Ping), after visiting to learn from the glamorous financial centres of Malaysia and Hong Kong in 1979, to avoid the strategy of undertaking the "great leap forward". On the contrary, he preferred to take the approach of "gradualism" while retaining existing communist institutions but reformed them by injecting into them appropriate doses of market structures and processes (Spence 2008 in Bayer 2009: 91).

The Global Carbon Reduction Effort Requires Respectable Fresh Ideas in China and Sustainable Growth Countries

By achieving impressively high economic growth rate (7%+) by applying strategies different from the neoliberalism prescribed insistently by the proponents of the Washington Consensus, China and its peers clearly demonstrated their originality and potency of their thinking in terms of achieving their economic and social development objectives. This point was acknowledged in "The Growth Report" written by academics, World Bank staff, UN officials and similar professionals when they stated that the era is over when the Washington Consensus was regarded as the most potent and effective route to national development. They report that the achievement of the sustainable growth countries was the result of the application of local resources/contributions, non-conventional strategies, regard for lessons learnt from practical experience of implementation of new ideas considered as promising by endogenous/indigenous planners and citizen participation in the process of fashioning appropriate strategies that befit local circumstances. This contradicts the insistence of the Washington Consensus on the existence of a "grand scheme" for pursuing development in the global South (Rodrik 2008 in Bayer 2009:92).

China's Leading Investment in Green Technologies

Very recent evidence shows that China is one of the leading investors in green technologies (including renewable and efficient energy sources and environmentally sustainable programmes). Only the USA has invested more money into green technologies than China has recently.

China Needs Not/Will Not be Hostile to the USA at this Time

Several factors justify our optimism and suggestion that China's response to the global climate change campaign will remain responsible, ignore disappointments exhibited by any country (be it the USA or others). Apart from her present rising economic and political profile, China has charted a refreshingly impressive diplomatic style involving her proposition of friendship rather than the typical model of diplomacy that is prone to brinkmanship.

China's recent tremendous investment in green technologies demonstrates her appreciation of the problem of climate change and the urgency and imperativeness of carbon reducing development approaches.

The USA under the Obama administration is vigorously implementing a new international relationship model (on equal basis) with Iran, Cuba and wooing the cooperation of countries belligerently, pursuing nuclear proliferation programmes which President Obama is discouraging with persuasive commitment.

EU-15's impressive achievement of its Kyoto Protocol targets provides a lesson which China ought to emulate rather than look up to any disappointments from the USA and/or other countries.

China must be aware of the enormity of the adversity that would befall her huge population (The world's most populous country) whose 1.22 billion people in 2002 was projected to rise to 1.5 billion in 2025 (UNDP, UWEP, World Bank and WRI 2003:278). In the event of escalation of climate change impacts, there is no other country that would suffer as many casualties as Chinese within and outside China.

Conclusion

Although the global climate change/carbon reduction strategies under the mechanism of the Kyoto Protocol (evolved in 1997) suffered a setback through the withdrawal of the US administration of President George W. Bush, recent phenomena portend favourable international cooperation/relations. Almost coincidentally, two major impediments to the Kyoto were neutralised within the short period between August 2008 to November 2008. First, the collapse of the US real estate, and financial institutions and rapid recession of the economy and its reverberation worldwide has been unanimously interpreted as the collapse of the "neoliberalism" (Washington Consensus) which has had a long history of about 30 years and engendered faulty economic development thinking and strategies. The emerging postneoliberalism involves popular endorsement of increasing investment in green technologies which represent carbon reduction measures. This has provided a point of agreement among a growing number of countries led by the USA, China and a host of others.

Secondly, the election of Barack Obama in November 2008 and his policies since inauguration in January 2009 seems to be indicating an end of the 47-year era of employment of diplomatic brinkmanship by US Governments. Evidence of reversals of USA's diplomatic extremism with Cuba, Iraq, Iran and so forth seems to be mounting.

Specifically, Obama administration is fulfilling his promise to acknowledge climate change science and lead the global campaign to reduce carbon emission.

The recent changes have enthroned a new slate for carbon reduction by fresh resources from the USA and China to complement the achievements recorded by the EU under the Kyoto Protocol.

It must be acknowledged that global awareness raising of global warming has been the responsibility of civil society and non-government organizations, these range from international government organizations supported ones such as the IPCC the World Council for Renewable Energy (WCRE), World Wind Energy Association, WWEA etc, to national ones like "the Royal Society", and so forth.

Recommendations

We recommend that President Obama's leadership of the global carbon reduction effort should be realized by pushing for the upward revision of the target of carbon reduction (which was reduced drastically from 5.2% to between 1.8 to 3 percent as a bait to get the ratification of the Kyoto Protocol by Canada, Australia and so forth) after ratifying the Kyoto Protocol. That would be the best fulfillment of the global leadership promised by Obama under the context and history of unnecessary compromises that hurt the carbon reduction effort.

Considering the excellent track record of environmental and energy NGOs in mobilizing global and national response to the climate environmental change crisis, the role of ENGOs in catalyzing increasing appreciation of the enormity of the crisis to US Government functionaries and civil society cannot be overemphasized.

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EU-China Relations on Climate Change Policies and The Role of Bilateral Cooperation for a Global Climate Change Regime

Astrid Carrapatoso[1]

Abstract

What must the European Union do to make China commit to binding regulations on greenhouse gases? China has been one of the major veto players with regard to binding rules on carbon emissions in context of the Kyoto Protocol and the negotiations of a Post-Kyoto arrangement. And yet, China is one of the largest polluters in this respect. Because of its economic growth rates, emissions are likely to rise in the future. It is therefore necessary to find viable solutions that encourage China to limit and finally reduce greenhouse gas emissions. In contrast, the EU has internationally showed leadership in climate change policy. The EU is often considered as a normative power, i.e. having the ideational power to define what can be perceived 'normal' on the international level.

The question is whether the bilateral cooperation between the EU and China on climate issues can help to (a) promote norms and values and generate an increased awareness of climate change both on the political and societal level, (b) establish comprehensive environmental policy frameworks on a bilateral basis with a positive impact on national policy making and (c) positively influence environmental policy making on the international level such as the Post-Kyoto negotiations on climate change.

This paper seeks to set a research agenda for the exploration of the EU's normative power with regard to climate change policy in China. As the main research objective will be to find out about the acceptance and adaptation of norms related to climate change, the concept of normative power and the discussion on norm diffusion and norm localization will be central to this analysis. Furthermore, this study will be embedded in the debate on 'new bilateralism', thus concentrating on new actors, agendas and instruments in bilateral relations.

Introduction

To institutionalize and enhance their cooperation on climate change issues, the European Union (EU) and China agreed on a partnership agreement in 2005, which sets out key objectives for further efforts to jointly address the issue of climate change. This declaration was translated into a Rolling Action Plan (RWP) in 2006. Since then, the EU and China regularly launched bilateral consultations and summits to further develop joint projects such as, for example, the COACH project (Cooperation Action with CCS China-EU). The joint declaration is meant to "fully complement the UN Framework Convention on Climate Change and the Kyoto Protocol. It will strengthen cooperation and dialogue on climate change including clean energy, and will promote sustainable development" (EC 2009). This comment raises three questions that will guide this research: (a) Will this cooperation merely include technical issues or does it have the potential to promote the norm of sustainable development and climate change being part of it? (b) Will such a bilateral cooperation be successful in establishing sound environmental policy frameworks on a national basis? (c) Will bilateral cooperation on climate change such as the one between the EU and China help or hinder the development of a global climate change regime after the Kyoto Protocol will have expired? These questions will become crucial in the light of the upcoming negotiations of the UN Framework Convention on Climate Change (UNFCCC) in Copenhagen in December 2009. Here, member states will decide on the future directions of global climate change policy making and the integration of China into such an agreement and China's

[1] Assistant Professor, Albert-Ludwigs-University Freiburg, email: astrid.carrapatoso@politik.uni-freiburg.de.

acceptance on quantitative emission goals will be decisive. At the UNFCCC conference in Bali in 2007, China for the first time agreed on discussing these issues in context of a Post-Kyoto-Protocol. Whether this leads into a binding commitment will not only depend on China's willingness to do so but also on the industrialized nations' assistance in developing and implementing climate change policies in China and in giving the right incentives for China to also independently set up policies to address problems causing and caused by climate change. Both the EU and the U.S. will play an important role in this respect.

The objective of this research project is to explore the sources of EU and Chinese climate change policy making and the role and function of EU-China relations on climate change policy for international relations. To find out about the sources will help to map existing or potential cooperation between European and Chinese actors. Based on the assumption that official cooperation frameworks such as the above mentioned joint declaration are not only implemented through political actors but also through business and civil society actors, one research goal of this project is to find out about both political and societal actors involved in this cooperation. Furthermore, this analysis wants to illustrate EU-China cooperation on different levels, i.e. projects on the political, business and civil society level to explore the nature and key aspects of EU-China bilateral relations.

The analysis will be embedded in the debate on 'new bilateralism' (Kiatpongsan 2008), 'bilateral inter-regionalism' (Ponjaert 2008) or 'quasi-interregionalism' (Hänggi 2006) and blended with insights gained from foreign policy analysis (Hudson 2005; Goldstein/Keohane 1993; Boekle/Rittberger/Wagner 1999; Risse 2000). New bilateralism focuses on new actors beyond government-to-government relations, new agendas also emphasizing issue linkages such as trade and environment or sustainable development and new instruments that include 'multiple issue-specific alliances', which means that bilateral agreements focus on specific policy areas (Kiatpongsan 2008; Smith/Tsatsas 2002). The study of EU-China relations on climate change policy therefore seeks to explore both the political and societal actors involved in climate change policy making, their objectives and motivations, the climate change agenda, the instruments to be used, including strategic dialogues, summits, track-two-diplomacy and policy networks and the effect of these bilateral relations on the international system. Furthermore, as this study deals with the promotion and establishment of the norm of sustainable development in context of climate change, this analysis will be guided by the literature on the EU as a normative power and the aspect of norm localization (Manners 2002; Acharya 2004). Here, the question refers to the ideational power of the EU "to shape conceptions of 'normal' in international relations" (Manners 2002: 239), i.e. to promote its ideas on climate change policies in a multilateral and bilateral context. Acharya reflects this process from the perspective of the norm-taker, which means that he asks about the process of adapting external norms and ideas "to meet local practices" (Acharya 2004: 251). The question is on which levels such norms are promoted and localized. The analysis of both the political and societal level is therefore necessary.

Methodologically, the analysis of EU-China relations on climate change issues consists of two parts. First, a theoretical discussion of 'new bilateralism', 'interregionalism' in addition to Europe as a normative power and norm localization will lead to an analytical framework for the exploration of environmental foreign policy making in context of bilateral inter-regional relations. Constructing an analytical framework out of these concepts and theories is challenging on several counts:

(a) the major focus of the 'new bilateralism' and 'interregionalism' debate has been on trade and economic issues and has not been applied to environmental issues yet,
(b) considering the EU as a normative power leads us to constructivist foreign policy theory, which deals with norms, values and belief systems. This not only bears

definitional problems but requires profound cultural knowledge; moreover, the security agenda still dominates foreign policy analysis so that an analysis of environmental foreign policy making needs a clarification of environmental norms,
(c) the concept of the EU as a normative power is highly contested and needs further clarification with regard to environmental issues.
(d) foreign policy analysis of both international and bilateral environmental cooperation is close to non-existent so that only few academic writings can serve as reference points.

The major objective of the theoretical part will thus be to work out the main characteristics of ‘new bilateralism’ such as actors, agendas and instruments (e.g. Kiatpongsan 2008), the sources of climate change policy making, the functions of interregional relations such as agenda-setting or identity-building (e.g. Rüland 2001), and the role of norms as part of the constructivist agenda (e.g. Risse 2000; Sedelmaier 2004), including the EU’s role as a normative power (e.g. Manners 2002) and the perception of this role or reaction by China.

The theoretical part will be followed by an empirical analysis of EU-China relations with regard to climate change policy. The analysis will be done in three stages:

(a) On a sub-systemic level, the sources of the EU’s and China’s climate change policy behaviour will be identified. This is crucial to explain the two parties’ motivations for bilateral cooperation in environmental issues. Here, the focus lies in domestic and societal aspects of climate change policy making.
(b) On a systemic level, the EU and China will be considered as the primary actors in bilateral relations and their interaction on the bilateral level will be explored.
(c) The analysis will then continue to link the sub-systemic with the systemic level, thus highlighting the role of societal actors including business in the implementation of policies decided on at the systemic level.
(d) In a final step, the interplay between bilateral cooperation and the international system will be analyzed. The challenge is here to work out causalities between the bilateral and multilateral level.

The research will follow a discourse analytical design. To begin with the research process, I will explore the relevant discourses regarding EU-China cooperation on climate change. The discourses will be identified on both the sub-systemic and systemic level, i.e. discourses on the business and civil society level as well as on the level of EU-China political relations. The analysis will be based on a document analysis and qualitative interviews. The study of EU-China relations with regard to climate change will be based on the analysis of primary and secondary sources, i.e. academic literature to be found in university libraries and the internet, legal documents, official (government) websites and press releases (such as http://europa.eu), media releases (official newspapers), websites from societal actors such as environmental non-governmental organizations or foundations (e.g. Asia-Europe Foundation), websites and documents from business, documentation of strategic dialogues and summits (including the Asia-Europe Meeting, ASEM), documentation of the work of policy and scientific networks (e.g. Green Diplomacy Network). This document analysis will be complemented by qualitative interviews – narrative and expert interviews -, which are based on a semi-structured questionnaire to allow for greater flexibility in more or less informal interview situations. The selection of interviewees will be based on a network approach.

The methodological tools will be complemented by the method of process tracing. This helps to understand the causal relationships between different variables over time. The analysis starts with the establishment of the EU-China Strategic Partnership in 2005 and follows the current negotiations on a Post-Kyoto Arrangement until a final agreement is decided on in Copenhagen 2009. To remain flexible, the period to be analysed might be expanded.

As the research project is in its early stages, this paper is meant to explore the theoretical dimension of this research agenda and give a first broad overview of the empirical part. I will focus on the concepts of new bilateralism and norm localization as a possible analytical framework for the outlined research project. I will then continue to outline existing cooperation between the EU and China on climate change policies, identify incentives for China to strengthen and deepen cooperation with the EU in this respect and to describe instruments that are or might be important in this cooperation. Possible actors that could act as norm promoters and norm takers will be worked out.

New Bilateralism – What Is The Concept About?

The concept of new bilateralism was introduced in the 1980s (e.g. Haggard/Cheng 1989) and has since been discussed under the terms of inter-regionalism (e.g. Rüland 2001) or quasi-interregionalism (e.g. Hänggi 2006). Scholars became interested in the changing nature of international relations and the emergence of new forms of bilateral cooperation instead of relying merely on multilateral structures. This observation could specifically be made in the area of trade and finance. A well-known phenomenon is the boom of bilateral and inter- or cross-regional free trade agreements in the Asia-Pacific region since the end of the 1990s (e.g. Dent 2006). Ravenhill (2003) sees new bilateralism as a reaction to the failure of existing international and regional institutions and the positive effects that could be established through new forms of bilateralism. The main research question is why states actively pursue these new forms of bilateral cooperation despite the advantages of multilateralism that are widely accepted by policy makers. The related question refers to the short-term and long-term impacts of new bilateralism for the international system.

The main characteristics of new bilateralism can also be derived from the literature on new regionalism. Rüland (2001) identifies four key features of new regionalism:

- more diffuse membership,
- growing agenda complexity,
- development of its own organizational infrastructure,
- emergence of new independent actors.

Kiatpongsan (2008) translates these features into new bilateralism by concentrating on new actors, agendas and instruments. On a government-to-government basis, new actors particularly come in on the level of track-two diplomacy. Here, corresponding officials, academics or experts become important players. Furthermore, business and civil society actors regularly participate in this kind of interaction (ibid.: 23). The traditional agendas of bilateral relations – economy, security, development – are conceptually modified. With regard to the economy, for instance, more sensitive issues such as the environment or agriculture are addressed in bilateral agreements (e.g. Fritz Carrapatoso 2007). The security agenda now follows a more comprehensive understanding of the security concept, thus integrating non-conventional security issues including topics such as, for example, the environment (ibid.: 27; see also Buzan/Weaver/de Wilde 1998; WBGU 2008; Diehl/Gleditsch 2001). The development agenda has shifted away from the traditional aid pattern and is now strongly based on issue-linkages. This means that development objectives are now linked to, for example, trade or security policies (ibid.: 32).

States or regions decide to establish bilateral relations in addition to multilateral efforts for many reasons. Smith and Tsatsas (2002:3-9) highlight the following factors determining bilateral relations:

- Geographical, historical, religious, cultural and trade factors influence the scope and depth of bilateral relations.
- Pragmatism is a key factor, i.e. choosing partners with compatible interests to achieve shared objectives.
- Existing personal ties and regular contact between political actors facilitate cooperation.
- Good personal relations are decisive for the effectiveness of bilateral relations.
- Coalition-building is influenced by the existence of traditional alliances and geographical proximity.

Bilateral relations have always been in the logic of EU policy-making. They have played a vital role in EU decision-making and are therefore important not only within the EU but also in its external relations. However, Smith and Tsatsas see "a danger in over-emphasizing bilateral initiatives. They may be vital for effective policy-making, but achieving desired policy outcomes remains the key aim" (ibid.: xiii). In addition to creating and implementing effective policies, bilateral cooperation frameworks bear the potential to promote norms, motivate social learning and thus can help to bring about a paradigm shift in a country's policy making. Whether an organisation like the EU can act as a normative power depends on two factors: First, the development of a norm such as sustainable development needs a strong societal basis for two reasons. On the one hand, such a norm is considered a legitimate basis for policy-making when it is accepted by a wide range of societal and political actors. On the other hand, norms are promoted on both a political and societal level. To avoid contradictory policies and activities, a strong consensus on a norm is important. Second, the cooperating country must be willing to adopt such a norm. This is the basis for identifying common interests and effective policy-making. The acceptance and adoption of external norms does not only have to be by merely imitating but can also happen through the process of norm localization. This provides a norm like sustainable development with more legitimacy in the cooperating country and sets a long-term basis for future policy-making. The main characteristics of the concepts of normative power and norm localization will be discussed in the following section.

Normative Power Europe – How Norms are Spread and Localized

With his article "Normative Power Europe: A Contradiction in Terms?", Ian Manners (2002) started a lively debate on the potential of the European Union to shape ideas and norms both within and outside Europe. In the tradition of Europe as a civilian power (Maull 1990), Europe's power is not seen in the realm of military action. Rather, Europe is considered to have the ideational power "to shape conceptions of 'normal' in international relations" (Manners 2002: 239). The EU has a strong normative basis which guides EU policies and external relations. Manners identifies five core norms and four minor, although far more contested, norms. The first ones include peace, liberty, democracy, rule of law and human rights. The minor norms refer to social solidarity, anti-discrimination, sustainable development and good governance (Manners 2002: 242). He continues in his argumentation by emphasizing the necessity not only to accept but to diffuse these norms in order to speak of a normative power. There are six factors shaping the process of norm diffusion: contagion, information, procedures, transference, overt diffusion and cultural filter (Manners 2002: 244-245). Contagion refers to unintentional diffusion, meaning that the EU acts as an example of successful regional integration. The aspect of information centres upon strategic communications, while procedures mean the institutionalization of a relationship with a third party. Transference highlights the diffusion taking place when the EU practices its politics, e.g. through the exchange of goods. Overt diffusion emphasizes the role of the EU through its physical presence in a third country. Finally, norm diffusion is shaped by a cultural filter, which is based on the "interplay between the construction of knowledge and the creation of social and political identity" (Manners 2002: 245). The aspect of a cultural filter becomes crucial in the literature on norm localization rather than norm diffusion. While norm diffusion seen from a constructivist perspective of socialization is considered as a result of adaptive behaviour, i.e. that "local practices are made consistent with an external idea", localization "describes a process in which external ideas are simultaneously adapted to meet local practices" (Acharya 2004: 251). Acharya argues in favour of "a dynamic explanation of norm diffusion that describes how local agents reconstruct foreign norms to ensure the norms fit with the agents' cognitive priors and identities" (ibid.: 239). Norm localization emphasizes the role of domestic actors in determining the "reception of new global norms", thus focusing on political, organizational and cultural variables in the specific country or region (ibid.: 243). Localization shows three characteristics: framing, grafting and congruence of ideas. Framing refers to the creation of issues, particularly through language. Grafting is understood as associating new norms with pre-existing norms. In a final step, through re-interpretation and re-representation of foreign norms, these norms are made congruent with prior local norms. Congruence-building is done by so-called "norm takers" (ibid.: 244). In sum, Acharya defines localization "as the active construction (through discourse, framing, grafting, and cultural selection) of foreign ideas by local actors, which results in the former developing significant congruence with local beliefs and practices" (ibid.: 245). Why foreign ideas are adjusted can be traced back to three factors: strengthening of existing institutions, rational exclusion of elements of new ideas to preserve the existing social order, enhance the profile and prestige of local actors and beliefs (ibid.: 246). The willingness or necessity to localize these foreign ideas can be found in the questioning of existing rules in context of a major crisis, systemic change, domestic political change in the norm taker or because of an international or regional demonstration effect (ibid.: 247). There are some conditions why localization is pursued and some advantages attributed to this process. First, the localization of foreign norms can improve legitimacy and authority of local actors without challenging existing social identities. Second, the strength of pre-existing local norms will become visible. Third, there must be local actors who are both credible and powerful in terms of shaping the discourse. Finally, the norm-takers have to have a strong sense of identity, i.e. they are aware of existing values and their uniqueness. (ibid.: 248-249)

The understanding for the process of norm localization becomes crucial when it comes to the question of how to promote European norms in third countries to facilitate cooperation. Past and current relations of the EU and member states to China show that Chinese self-perception and values are key to their commitment in the area of, for instance, climate change. In addition to taking the Chinese cultural and historical background into account, the normative role of the EU in climate change issues highly depends on its own developments in this respect (Scheipers/Sicurelli 2007:448). An ambitious climate change policy will not only enforce the EU's leadership in climate protection but being the global best practice case will increase its credibility.

The EU's identity-building with regard to climate change was influenced by the opposing position of the U.S. under the Bush Administration. The more the U.S. opposed the Kyoto Protocol the more unified the EU got and the more ambitious its policies were formulated. It further strengthened its self-perception as the leading power in climate issues. (Scheipers/Sicurelli 2007: 445-446). The EU thus became an attractive partner in the worldwide promotion of technology transfer, the exchange of know-how and the enhancement of global and regional and national strategies for mitigation and adaptation measures. Leading by example can thus be considered as the strongest power of the EU to integrate other countries into multilateral efforts to mitigate and adapt to climate change. This means the EU's major strengths lie in its contribution to norm-spreading and institution-building by using appropriate instruments such as multilateralism, diplomacy, precaution and the establishment of binding rules through international law-making (Scheipers/Sicurelli 2007: 451-452).

Constructing norms and promoting them does not take place in a vacuum and norms are not "a given". From a European perspective, the norms shaping EU policies come from civil society and political elites (Manners 2002: 251). These norms are then mostly delivered through transnational and supranational organizations. Business as well has become decisive in promoting norms through their activities and cooperation with businesses in other countries. It is therefore likely that the process of norm localization takes place on three levels: civil society, business and political elites. The question is not only to what extent these norms are promoted through transnational or bilateral co-operations but also through which actors and networks this is done. We should therefore ask who acts as a norm promoter from a European perspective and who are the norm-takers or norm-localizers in China. This means we have to, first, ask about the sources of norm creation on the European level and, second, to identify the counterparts for norm localization in China. Finally, we can ask about the relevance of these forms of cooperation in (a) promoting norms on sustainable development and climate change in China and (b) the contribution of this alternative ways to multilateralism in enhancing the global climate change regime.

In the following section, I will discuss the role of the EU as a norm promoter by outlining the key aspects of its climate change policy. By showing leadership in climate change policies and instruments, the EU has a best practice case as a solid basis for promoting the norm of sustainable development. This will be followed by a brief introduction into China's environmental problems as a trigger for an intensified cooperation with foreign partners. In a subsequent step, I will outline the major cooperation frameworks between China and the EU on the systemic level and continue with some examples of other institutional cooperation such as between China and the European Environment Agency (EEA) and the European Investment Bank (EIB). A first overview will be given on cooperation on the sub-systemic level. In the research project, cooperation between business actors and civil society actors will be analysed. In this paper, the focus will however be on civil society.

Showing Leadership: The EU Policy on Climate Change

In 2008, the European Parliament and Council agreed on a "Climate Action and Renewable Energy Package", which was drafted by the European Commission. In this package, the member states re-emphasized their commitment to the mitigation of and the adaptation to climate change. The following goals were set out (European Commission 2009, 2009a, 2009b):

- Cutting emissions to at least 20 per cent by 2020 compared to levels in 1990; member states agreed to reduce emissions to 30 per cent if other developed countries agreed on comparable reductions in a Post-Kyoto agreement. The instrument to be used is the Emission Trading System (ETS). This instrument, which is in effect since 2005, has to be strengthened. It is "the largest multi-country, multi-sector Greenhouse Gas Emission Trading System world-wide" (European Commission 2009c).

- Cutting emissions of sectors excluded from the ETS (transport, agriculture, waste and households) to 10 per cent compared to the level in 2005 by 2020. This has to be done through binding national targets. With regard to transport, the aviation sector will be integrated into the ETS from 2012 onwards. Furthermore, CO2 emissions from new cars have to be reduced to an average of 130g per km.
- Increasing energy use of renewable energy to 20 per cent by 2020. Having a 10 per cent share for sustainably produced biofuels and other renewable fuels in transport.
- Cutting energy consumption to 20 per cent by 2020 through improving energy efficiency.
- Promoting the development and safe use of Carbon Capture and Storage (CCS) technology.
- Increasing research and development in environment, energy and transport to further enhance and promote clean technologies and to widen the understanding of climate change and its impacts.
- Reducing air pollution and health costs.
- Increasing employment through the support and development of eco-industries.

The EU is a strong promoter of the norm of sustainable development, which becomes visible in its efforts to tackle climate change. The EU has developed a leading position in the global climate change regime and acts as a best-practice example with regard to its emission trading system and the development of new technologies. The ambitious goals with regard to CO2 emissions and the integration of further economic sectors into the ETS are promoted on an international level. Nevertheless, in order to remain competitive on the global market, the EU requires other developed countries to show similar efforts and wants developing countries like China to agree on binding rules with regard to emission reductions. To underline the EU's own commitment to global climate protection, it would further increase its own emission targets.

The EU has shown that climate protection can be economically beneficial through the development of new industries and the creation of new jobs in addition to the implementation of a successful emission trading scheme, which has not created significant economic downturns. Furthermore, the EU enlargement process has illustrated that economic development and environmental protection can be integrated. European environmental standards had to be adopted and implemented by the new member states. To meet future challenges in innovation, the EU opted for both push- and pull-strategies. The pull-strategies include the development of a market value for greenhouse gases and the phasing out of environmentally harmful subsidies. Moreover, the development and implementation of market-based instruments should be facilitated. The push-strategies are composed of an increase in financial support for innovative research and the establishment of public-private-partnerships, especially to foster international cooperation (European Commission 2005).

Speaking in Manners' terms: the EU promotes its norms through contagion, which means that the EU acts as a successful example for the development of a sound climate change policy that integrates economic and environmental policies to fight global warming. The EU is however criticized for not fully using its potential through complex internal negotiations (Gupta/Ringius 2001). Nevertheless, many countries consider the EU as a best practice case. This picture is further promoted by the EU itself through international cooperation, which the example of the EU-China relations on climate change shows. To strengthen cooperation with a country like China, the EU seeks to give economic incentives, to improve information exchange and communication structures, but a successful cooperation also depends on China's willingness to seriously participate in this. Such willingness is further pushed through external factors like serious environmental degradation in China. This reality has been accepted by the Chinese government, which facilitates international cooperation in this respect and also increases the likeliness of the Chinese government and society to adopt and localize the norm of sustainable development. The next section will briefly outline China's most urgent environmental problems, which are also all related to global warming.

Environmental Problems in China: A Catalyst for Cooperation?

Environmental problems in China are manifold and now bear the potential for social unrest on a national level and diplomatic conflicts on an international level. In addition to (unequal) economic growth and a huge population, the lack of political transparency and the inequalities in the enforcement of environmental policies put further stress on the Chinese environment (Edmonds 2008: 271, 295). The major environmental challenges that could be identified for China are deforestation, water scarcity, desertification, flooding, soil erosion, glacial retreat, population growth and pollution (Economy 2005: 204-205; Edmonds 2008: 271). All these problems are and will be intensified by climate change, which the IPCC report clearly illustrated with regard to China (IPCC 2007). In 2008, the Chinese government reacted to climate change issues and recently published its „White Paper: China's policies and actions on climate change" (Chinese Central Government 2009), in which they point out the situation and impacts, develop strategies and objectives for addressing climate change and laid out policies and actions decelerate and adapt to climate change. The government also emphasizes the importance of enhancing public awareness and the necessity to cooperate internationally.

The urgency of China's environmental problems including those caused and intensified by climate change was underlined by a World Bank report in 2007. In this report, the World Bank states that even though economic development has positively impacted on the environment in terms of technology improvements, a changing industrial structure in terms of energy efficiency and pollution control and general pollution control policies, the environmental problems are pressing and cause a lot of costs. Increasing health problems, crop and material damage through air and water pollution, deterioration of the water problem would cost the Chinese government billions of dollars per year (World Bank 2007). China is therefore interested in cooperation with both international institutions and other countries to tackle its environmental problems. China has received strong assistance from the World Bank, the Asian Development Bank (ADB), the Global Environmental Facility (GEF) and Japan. They helped China in developing and implementing environmental protection work such as monitoring systems, developing a legal system and analyzing energy alternatives (Economy 2005: 209-210). Nevertheless, economic growth should not be compromised for the sake of environmental protection. The best case scenario would therefore be to combine continuing growth, democracy and environmental protection. The reality however shows a different picture. This has once again become clear in the ongoing negotiation process of the Post-Kyoto-Protocol. To assure China's participation in a global climate change regime, not only financial and economic incentives given by other countries and international institutions to help China develop a "greener" economic structure are essential. Moreover, a fundamental change in values is required (Economy 2005: 213). It is therefore necessary that the major industrialized and polluting countries lead by example and actively contribute to the design of "China's environmental future" (Economy 2005: 214).

Here, the cooperation with the EU can become crucial. First, the EU has a strong history in environmental protection and has developed expertise in instruments to combat climate change. Second, the EU can act as a norm promoter with regard to sustainable development and help to raise public awareness in China about environmental and climate issues. Third, the EU has various possibilities to promote these norms – either through its official ways or through its member states. Finally, many actors including civil society and business are and can be involved in fostering environmental and climate protection. Through their work on the ground, it can be assumed that their assessment of potential cooperation frameworks is more realistic and based on practical experience.

'New Bilateralism' to Fight Global Warming? The EU-China Relations on Climate Change

Norm diffusion is facilitated through the establishment of strategic communications and the institutionalization of bilateral relations, which then further supports this diffusion process through concrete actions, i.e. transference. As I do not assume that the Chinese government and society simply imitates and adopts the norm of sustainable development as stated by the literature on norm diffusion, I argue that these are also the processes that trigger the process of norm localization as interaction is a prerequisite for this.

A starting point for the analysis of EU-China relations on climate change is the "EU and China Partnership on Climate Change", which was established between the two parties in September 2005 (European Commission 2005a). In the "Joint Declaration on Climate Change between China and the European Union", the EU and China set the agenda for future cooperation on climate issues. Both parties seek to strengthen cooperation on climate change policies through dialogue, practical co-operation in the fields of development, deployment and transfer of clean technologies and the Clean Development Mechanism (CDM). Furthermore, more cooperation is sought on research and analysis on the consequences of climate change in addition to enhanced cooperation on capacity building and strengthening of institutions through, e.g. raising public awareness and environmental education and training. In parallel, the two parties agreed on "The China-EU Action Plan on Clean Coal" and "The China-EU Action Plan on Industrial Co-operation on Energy Efficiency and Renewable Energies". The EU-China Rolling Work Plan (RWP) on Climate Change, which the two parties agreed on in October 2006, serves as the major reference document in which they set the agenda for further cooperation. The following forms of cooperation have been decided on (European Commission 2006):

- EU-China summit: ensuring high-level political follow-up and where necessary provide further guidance.
- Bilateral Consultation Mechanism: ensuring contacts at working level, involving representatives from the Chinese Ministries concerned and the EU Troika (current and future EU Presidency and Commission) to provide broader political coordination and guidance for the implementation of the Partnership and strengthen their dialogue on climate change policies and exchange views on key issues in the climate change negotiations. This Mechanism shall meet at least once and where necessary twice every year.
- Direct cooperation between the EU environment counsellors group and relevant Chinese ministries: the EU environment counsellors group will ensure coordination between EU Member States and day to day follow-up of the Partnership.

In this document, the importance of bilateral sectoral cooperation under specifically framed bilateral mechanisms was highlighted. I could be assumed that a broader cooperation including the integration of not only political actors but also business and societal actors was aspired to gather experts in their fields in order to establish effective cooperation in specific areas. This was further emphasized through the recognition of priority areas (PA) in which practical cooperation becomes crucial (European Commission 2006):

- Energy efficiency and energy conservation;
- New and renewable energy;
- Clean coal technologies and carbon dioxide capture and storage for near-zero emissions power generation
- Methane recovery and use
- Hydrogen energy and fuel cells
- Power generation, transmission and distribution
- Clean Development Mechanism and other market-based instruments such as Emissions Trading Schemes
- Impacts of and adaptation to climate change
- Capacity building, strengthening institutions and raising public awareness.

Based on this work plan, the following joint projects are currently listed on the European Commission’s website (European Commission 2009):

- EU-China CDM Facilitation Project to strengthen the Clean Development Mechanism (CDM) as a central pillar of sustainable development in China. The establishment and improvement of China’s policy and regulatory frameworks in addition to quality management of the CDM process will be the key areas of cooperation.
- Carbon Capture and Storage (“Zero-Emission” Demonstration Plant) to promote “practical cooperation on the development, deployment and transfer of clean fossil fuels technologies, to improve energy efficiency and to achieve a low carbon economy”. There are currently two feasibility studies on CCS (Carbon Dioxide Capture and Storage) in process. First, the Near Zero Emission Coal (NZEC) project and the COACH project (Cooperation Action with CCS China-EU)[2]. These projects are supported by the STRACO2-project (Support to Regulatory Activities for Carbon Capture and Storage). The activities will be continued in a phase two and three, which will, first, specifically focus on site-specific design and feasibility studies, and, second, focus on the construction and operation of a demonstration plant with CCS technology.
- The EU-China Energy and Environment Programme (EEP) seeks to promote sustainable energy use and thus to improve the environmental and health conditions in China.
- There are regular meetings under the Bilateral Consultation Mechanisms, the EU-China NZEC Steering Committee, annual summits, official visits, study visits, joint workshops and expositions.

Under the umbrella of the European Environment Agency (EEA), several smaller projects have been pursued such as the China (Kunming) Environmental Protection and Renewable Energy Exposition, the China Europa 2009 or the China Carbon Trade Summit 2009[3]. This trade summit is an interesting institution as it seeks to serve as a networking arena for senior executives, tradesmen and environment and technique expert to discuss issues relevant for carbon industry. China has become an important player in the CDM market, now covering 51 per cent of the global CDM trading market. China is therefore an

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[2] For further information on these programmes see NZEC, http://www.nzec.info and COACH, http://www.co2-coach.com (07.06.2009).

[3] For further information on these events see China (Kunming) Environmental Protection and Renewable Energy Exposition, http://technologies.ew.eea.europa.eu/Events/eve204704; China Europa 2009, http://www.eea.europa.eu/events/china-europa or the China Carbon Trade Summit 2009, http://ccts.cbichina.com/english.html (07.06.2009).

attractive partner for foreign investment to reduce carbon emissions. This is a good example to illustrate business interest climate change policy.

At the 10th China-EU Summit in 2007, political leaders decided on the establishment of a China-EU Clean Energy Centre. The objective is to strengthen cooperation on energy efficiency and on exploring new clean technologies[2]. The commitment to combat climate change through joint projects was reaffirmed at the 11th EU-China Summit in 2009. In context of the summit in 2007, the European Investment Bank (EIB) considered to offer China a EUR 500 million framework loan, the China Climate Change Framework Loan (CCCFL) to invest in projects combating climate change (Presidency of the European Union 2007). This loan now provides China with a total of EUR 220 million that will assist the Chinese government in investing in projects helping to mitigate climate change. The funding of projects includes forestation programmes, the construction of wind farms and energy efficiency and pollution reduction. These projects shall all be registered under the Clean Development Mechanism (European Union 2009d).

The general and by far not exhaustive illustration of EU-China cooperation on climate change shows that the emphasis is put on the transfer of technology and know-how through joint research projects, practical cooperation and investment programmes. The political framework is set and developed through regular dialogue and bilateral consultation mechanisms and high-level summits, which further emphasize both parties' commitment to this process. The projects also meet strong business interests such as in the carbon market, clean energy technology and renewable energies. The EU thus integrates China into the global combat of climate change through financial and economic incentives, which are in the end beneficial to both sides. The question remains whether this rather technical and economic cooperation also leads to a re-thinking about the relationship between economic development and environmental protection, i.e. following the path of sustainable development rather than treating the economic and ecological sphere separately. This leads us back to the initial question of the EU as normative power acting through various channels on the systemic and sub-systemic level. So far, I have briefly outlined cooperation that primarily takes place on the systemic level between the EU and China. The illustration of the EEA's activities emphasized the role of business in promoting climate protection measures. In addition to the political and business level of cooperation, there is also civil society cooperation on climate change issues. Under the framework of new bilateralism, the research agenda of this project is to analyze the diverse actors, agendas and instruments. In the following section, I will give a first overview of some civil society cooperation frameworks.

Civil Society: Actors, Agendas and Instruments

A first entrance point for the exploration of EU-China civil society relations is the EU-China Civil Society Forum. As stated on the forum's website, the main objective is „to foster the development of relations between the EU, its members and China and to ensure that their relations promote social justice, contribute to the protection of the environment and strengthen human rights" (EU-China Civil Society Forum 2009). To achieve this goal, the forum wants to enable informed public debate, assist political institutions within the EU and its member states in building relations to China based on principals like social and ecological justice and human rights, ensure the maintenance of labour and environmental standards in business activities and to increase cooperation between and among civil society groups in the context of EU-China relations. This network is run by civil society organizations from Germany, Austria, France and Belgium. Cooperation partners in China differ depending on the topic. With regard to the environment, the following organizations are listed:

- Center for Biodiversity and Indigenous Knowledge (Kunming, China)

- CANGO-China Association for NGO Cooperation (Beijing, China)
- Roots&Shoots (Beijing, China)
- Green Watershed (Kunming, China)
- Green Stone (Nanjing, China)
- Animal Asia Foundation (Hong Kong, China)
- The Green Volunteer League of Chongqing (Chongqing, China)
- Green Earth Volunteers (Beijing, China)
- Xinjiang Conservation Fund (Beijing, China)
- Moving Mountains (Beijing, China)

If we take a closer look at the Chinese organizations listed, the most interesting one with regard to the networking aspect is CANGO. The aim of CANGO is to provide a platform for the exchange of information and experience for Chinese NGOs working on poverty alleviation, environmental protection and social development. CANGO also seeks to "broaden corporative channels between CANGO and government, business, and research institutes" and also acts "as an intermediary agency and partners with foreign NGOs, bilateral and multilateral organizations and Chinese NGOs to enhance fundraising, provision of technical support and capacity building of grassroots NGOs in China" (CANGO 2009). In addition to various European-based organizations and institutes (and other international and foreign organizations and institutions), the European Commission is part of the partners and donors of CANGO, which means that there is a close affiliation from the EU to this network.

The agendas of these civil society organizations and networks are diverse. Their role is to promote a better understanding for environmental issues including environmental protection, conservation and climate change. They are diverse in their constitution and missions but they share similar goals, namely to protect the environment on a local, national and global level. As most of the NGO umbrella organizations, CANGO has the potential to support exchange of the various existing environmental NGOs in China and link them with foreign NGOs and transnational networks in addition to providing them access to government and business actors to strengthen their lobbying capacities. A crucial role of NGOs is also public information and education. A wider network can assist them in professionalizing in public relations and information management. NGOs and other civil society groups can therefore act as norm takers as they are rooted in their society and are accustomed with its values and ideas so that external norms can be localized. To what extent this can happen and what the EU can contribute in this respect has to be further analyzed on the basis of personal interviews.

Conclusion

EU-China relations can significantly contribute to a strengthening of the global climate change regime beyond international negotiations under the UNFCCC. As it is difficult to integrate a country like China into an international agreement with binding regulations on emission reductions, the EU as a best practice example for the integration of economic and environmental policies with regard to climate change can act as a normative power. This means, the EU can first show leadership in the field of climate change policy and illustrate how significant emission reductions are possible without challenging high economic performance. Second, the EU can assist China in developing and deploying new clean technologies and help to direct its economic growth in a sustainable way. And, third, by promoting its norm of sustainable development (and climate protection being part of it) through the its activities and the institutionalization of EU-Chinese relations, the EU can help in raising awareness for climate change issues and to show ways in dealing with this problem. The potential for a paradigm shift in Chinese policies and thinking increases the more interaction there is between European and Chinese actors on a political, business and civil society level. It is however more probable that the Chinese government and society localize the norm of sustainable development than merely imitating and adopting European norms without embedding them into local traditions. If a norm is localized, it will be more accepted within politics and society. It is therefore not only more enduring but also more likely to bring about a cognitive shift. If this happens, China's participation in multilateral negotiations on climate change policy will positively alter, which will be beneficial for the promotion of a global climate change regime. That such bilateral cooperation has the potential to act in the way of norm diffusion or norm localization and to act as a catalyst for further commitment on the multilateral level could already have been observed during the pre-negotiations in Bali 2007, when China accepted to talk about quantitative reduction goals in upcoming negotiations. Copenhagen 2009 will show how strong this commitment finally is and which are the influential factors in getting a turning point in global climate change policy-making.

The role of "new bilateralism" for the strengthening of a global climate change regime in addition to the questions of how Europe can act as a normative power and to what extent the norm of sustainable development in the context of climate change is localized in China on the political, business and civil society level will be further analyzed in this research project.

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Reverse Positions: Can China be The Winner in Sino-EU's Post-Kyoto Negotiations of Combating Climate Change?

Yu Qiao[1]

Introduction

This study examines the Sino-EU's post-Kyoto negotiations for combating climate change from 2007 to 2008, and answers the question why the EU could not lead China to adopt the post-Kyoto quantitative reduction targets on greenhouse gases by exploring the characteristics of China's climate negotiation strategy.

This study argues that until the end of 2008, the reason that the "tug of war" between China and the EU did not result in any new perspectives or feasible outcomes is due to China's reluctance of adopting the post-Kyoto quantitative reduction target and the EU's lack of leadership. Both China and the EU wanted to gain as much as possible from the other side through minimal effort.

This study also argues that since the beginning of 2007, in the Sino-EU's post-Kyoto negotiations, the Chinese government reversed its passive position gradually and reached its objectives, which were to refuse binding quantitative objectives, keep a responsible stakeholder image, and gain international support, which included funding and technology transfers, by using its advance and retreat strategy. On the other hand, the EU's role in the negotiations has switched gradually from leading to waiting and seeing.

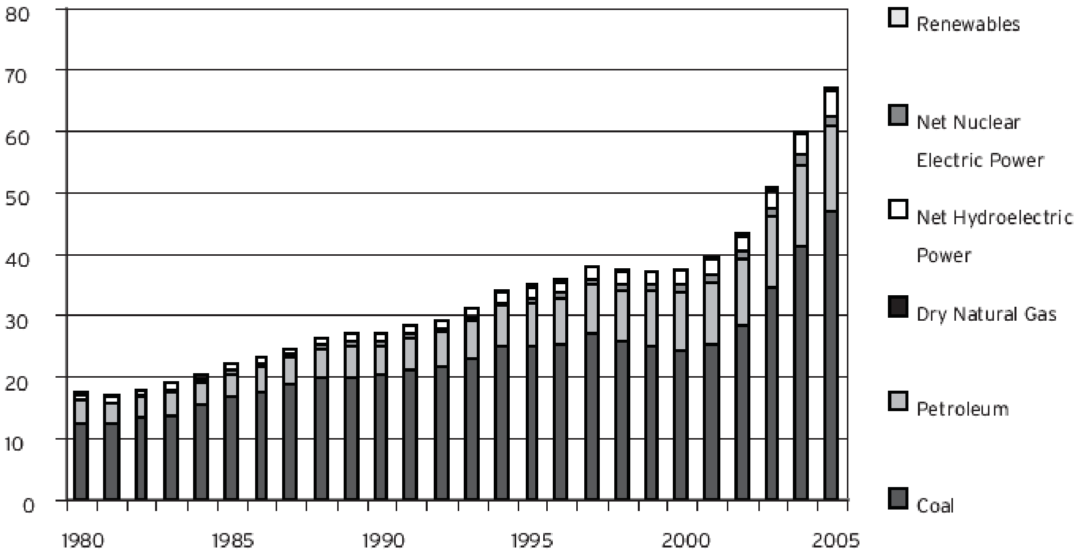
Chapter I of this study introduces how China has been involved in the post-Kyoto negotiations. Chapters II, III, IV analyze China's advance and retreat negotiation strategy. The last chapter concludes this study.

1. China's involvement in post-Kyoto climate change negotiations

1.1 Rising emissions and China's position in the 1980s and 1990s

China is the largest emitter in the world of greenhouse gases after the United States. China's booming industry and its corresponding burst in energy consumption and rapid urbanization are largely responsible for its rapidly climbing greenhouse gas emissions.

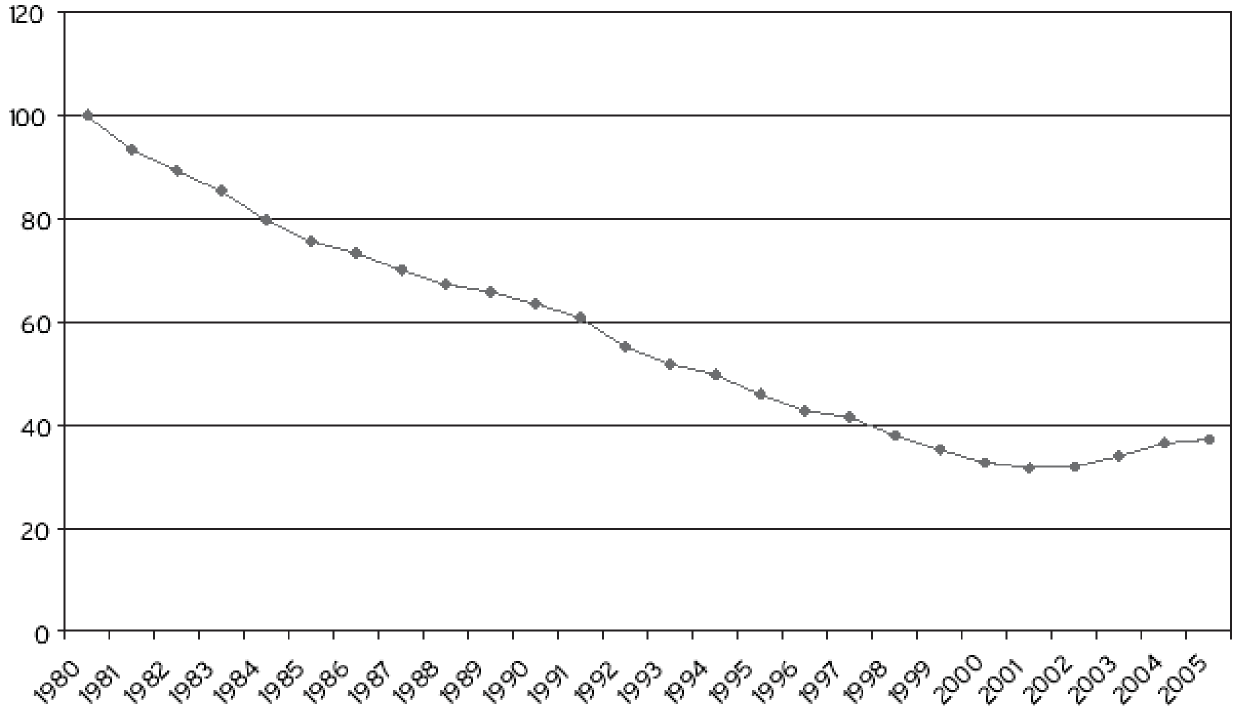
Figure 1: China's Energy consumption by source (Quadrillion Btu)



Source: Energy Information Administration, 2007

[1] University of Tsukuba, email: Benben0356_cn@hotmail.com

Figure 2: Energy (1000 BTU) per unit of GDP, (1980=100)



Source: Energy Information Administration World Energy Outlook

Since the beginning of international negotiations on climate change in the 1980s, China has consistently emphasized that developed nations must be held responsible for past greenhouse gas emissions. When the Kyoto Protocol was negotiated in 1997, China officially stated that it would not consider limiting greenhouse gas emissions until it reached a "medium level of development" which would be reached around the middle of the twenty-first century.

Years have gone by; the Chinese government has been more flexible in participating in international efforts to mitigate climate change. This flexibility has included participating in the Kyoto Protocol's Clean Development Mechanism, and cooperating on the technological development of renewable energies, as well as on carbon capture and storage. Beijing saw climate change negotiations as an integral part of its foreign policy, and a terrain on which it, and other developing countries, would need to protect development rights and opportunities.

After the Kyoto Protocol was negotiated in 1997, the Chinese government shifted responsibility for climate change policy from the China Meteorological Administration (CMA), which was given the responsibility of advising the government on policy options since the 1980s, to the more powerful National Development and Reform Commission. The move indicated a shift in perspective: for China, climate change had become predominantly a development issue.

1.2. The EU Prepared for the Post-Kyoto Negotiations

The EU is a world leader in combating climate change. It is setting an example with tough objectives on cutting energy use and emissions within the EU.

The EU believes that the present commitments under the Kyoto Protocol to the United Nations Framework Convention on Climate Change are only the first step in addressing the climate change threat, and that the necessary cuts in global emissions can be achieved only if all countries contribute their fair share according to their responsibilities and capacity.[2] Therefore, the EU is leading the world in preparing post-Kyoto negotiations that are under way to conclude a global agreement at the UN climate change conference in Copenhagen for the period after 2012.“To keep global warming to tolerable levels we need an ambitious new international agreement to cut greenhouse gas emissions, and we need to reach it urgently so there will be no gap when the Kyoto targets expire in 2012.”[3]

After the withdrawal of the U.S. from the Kyoto Protocol, the EU realized that without the effort of developing and emerging countries, it would be extremely difficult to combat climate change. Therefore, the EU called for developing countries to join the industrialized countries to reduce greenhouse gas emissions. As the biggest developing country in the world, China’s action and effort to reduce greenhouse gases was necessary for the EU. The EU then set up its next objective which was involving China in the post-Kyoto negotiations.

1.3. China Becomes Involved in Post-Kyoto Climate Change Negotiations

With a view to modernizing Sino-EU bilateral relations, under the leadership of the EU’s ambitious plan of combating climate change, China became involved in the Sino-EU post-Kyoto climate change negotiations.

Agreeing on the growing importance of Sino-EU relations, in September 2005, both sides highlighted the need to move towards early negotiations on a new Sino-EU framework agreement to reflect the full breadth and depth of the strategic partnership between China and the EU. British Prime Minister and acting President of the Council of the EU, Tony Blair, said, “[…] the strategic partnership between China and the European Union is of immense importance, not just in terms of trade and the economy, but also in terms of our cooperation in all the major political issues the world faces” when he attended the 8th EU-China summit in Beijing with Chinese President Hu Jintao.[4]

After several presidential- and ministerial-level meetings, in October 2006, the Commission adopted a communication “China: Closer partners, growing responsibilities”. This document covers all fields of bilateral relations. In terms of energy and climate change, it encourages Beijing to be a responsible energy partner, stresses in particular the importance of the EU’s encouraging China to reduce the growth of its energy demand, increase its energy efficiency, use renewable energy and clean technology. Moreover, this document claims that both parties must also enhance their cooperation to meet their shares responsibilities under the Kyoto Protocol.[5] In the beginning of 2007 the EU sent a group to persuade China to cooperate more.

China then became involved into the actions of fighting climate change with cooperation of the EU in a positive way.

2. Showing Her Good Intentions

2.1. Devotion inside the EU Increases Quickly

Inside the EU, combating climate change was taken very seriously. In the first half of 2007 Germany was in charge of the Council’s Presidency. The energy/climate problem was the “most important subject” on the Council’s environmental agenda.

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[2]Europa-the European Union on-line, (2009).*The EU’s contribution to shaping the future global climate change regime*. Web site: http://ec.europa.eu/environment/climat/future_action.htm

[3]Agence Europe. (2006, December). Leading role of EU in fight against climate change is more necessary than ever, *Bulletin Quotidien Europe No.9331*, 9.

[4]Agence Europe. (2005, September). Signing of several agreements at EU-China Summit demonstrates desire to boost strategic partnership, *Bulletin Quotidien Europe No.9020,* 4.

[5]Agence Europe. (2006, October). Commission adopts new strategy to modernize EU’s economic and political relations with Beijing, *Bulletin Quotidien Europe No.9293,* 7.

In February, the European Parliament also sent a strong message to the EU. It was: in order to reach the international target subscribed to by the EU- to reduce the average rise in global temperature to 2°C compared to the pre-industrial era- a minimum 30% reduction of greenhouse gas emissions was needed in industrialized countries in the run-up to 2020 to reach 80% reduction by 2050. And the EU must not imagine that international talks on the post-2012 period could fail or aim at a unilateral reduction in emissions targets.[6]

After the German Council's Presidency made an integrated energy and climate strategy an absolute priority in the fight against climate change, in Brussels on 9 March, the heads of state of the 27 EU member states agreed to a unilateral, binding 20% reduction in EU emissions.[7] Pointing out the need to take immediate action to limit the increase in the average temperature of the surface of the planet, the EU expressed the need for effort from both developed and developing countries.

2.2. The EU's Challenge of Persuading Beijing

As a developing country ratifying the Kyoto Protocol, China did not undertake to make any quantified reduction in its emissions. The European Commission reiterated the importance of the fight against climate change by saying in press that "Energy security and climate change are priorities for the EU in 2007. Neither can be effectively addressed without China".[8] Therefore, persuading Beijing to join the efforts of the developed countries in the framework of a global binding agreement was a massive challenge for the Union.

In January 2007, negotiations on a new Sino-EU partnership and cooperation framework agreement had officially begun. External Relations Commissioner Benita Ferrero-Waldner and Chinese Foreign Minister Li Zhaoxing held a first round of talks. During these talks, Ms Ferrero-Waldner tried to persuade Beijing to improve energy efficiency and reduce Chinese greenhouse gas emissions.[9] The Union's goal was quite clear. It wished to win Beijing over to its cause to combat climate change. This challenge was at the heart of European foreign policy.

Calling for urgent action to reduce gas emissions, at the end of March 2007, industry and enterprise commissioner Günter Verheugen went to China to discuss the bilateral economy and energy cooperation issues. The question of energy efficiency was also a key focus of the talks, as the Union sought to propose to its partner that it shared its experience in this field.[10]

In the beginning of April, Stavros Dimas, European Commissioner for the Environment, stressed that if the group of industrialized countries was to aim for a reduction of 30% in its greenhouse gas emissions by 2020, the developing countries should also make efforts… the emerging countries must agree on binding reduction objectives.[11]

As an emerging economy, facing increasing pressure from the EU and the worsening climate situation, China realized the necessity of reducing greenhouse gases and the importance of joining the binding reduction objectives. However, fearing that any effort in

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[6] Agence Europe. (2007, February). EU must pledge to reduce emissions by at least 30% by 2020 to reach 60-80% reduction in 2050- parliament says there is no other choice, *Bulletin Quotidien Europe, No.9367*,13 .

[7] Agence Europe. (2007, March). EU27 agree binding targets for both greenhouse gas emissions and renewable energy by 2020- victory for EU credibility, *Bulletin Quotidien Europe No.9383*, 4.

[8] Agence Europe. (2007, January). Wednesday's Peking Launch of negotiations on new partnership and cooperation agreement, *Bulletin Quotidien Europe No.9344*, 4.

[9] Agence Europe. (2007, January). First session of talks in Beijing on future partnership and cooperation framework agreement, *Bulletin Quotidien Europe No.9346*, 11.

[10] Agence Europe. (2007, March). Economic cooperation on agenda for industry commissioner Günter Verheugen's visit to Beijing, *Bulletin Quotidien Europe No.9398*, 6.

[11] Agence Europe. (2007, April). European Union hopes that report expected from international scientists on impact of global warming will translate to resolute political decisions, *Bulletin Quotidien Europe No.9399*, 11.

this direction would hinder its economic growth, and with its lack of funds and technology, China was pushed to make a choice.

2.3 Beijing Shows Her Intensions of Taking Global Warming Seriously

Wary of maintaining the dynamism and sustainability of the Chinese economy which was a huge consumer of hydrocarbons, the Beijing authorities were reluctant to adopt binding objectives on limiting emissions. Facing the EU's pressure, China had made her choice, which was earning time by showing her intensions of taking global warming seriously, while making limited actual effort.

In January, when the External Relations Commissioner Benita Ferrero-Waldner visited China, she was pleased to point out that China is "taking global warming seriously". As Beijing kept showing her difficulties in joining the binding reduction objectives, Ms Waldner said, "[…] for the moment, we are not going that far. We understand China regards herself as a developing country". [12] Beijing sent the Europeans back home, and with good intentions earned time to develop and prepare for the bigger pressure, which came several months later.

The climate negotiation at this stage was part of the negotiations of redefining China and EU bilateral relations, which meant that the negotiations were influenced by other political economy negotiations, making it difficult sometimes for the EU to exercise its leadership effectively.

In the EU/China ministerial meeting in Hamburg, the head of German diplomacy and acting president of the Council, Frank-Walter Steinmeier and the Commissioner for External Relations, Benital Ferrero-Waldner, called on China to continue to open up its markets, and expressed their wish for China to adopt the post-Kyoto quantitative reduction targets on greenhouse gases.

The Chinese said they shared the European's priorities on climate change and the environment, but they argued for a fair balance between environmental considerations and development demands. The Chinese minister for foreign affairs stressed: "[…] the current status of climate change is not the doing of the developing countries". He continued to point out that his country had set itself targets on controlling growth in greenhouse gas emissions and reducing energy consumption per capita by 20% between 2006 and 2010. The minister added: "We need to take note of what China has achieved. Naturally, we want to have an exchange of views on how we can do better".[13]

However, the EU needed China to open up its markets to reduce trade deficits, which was estimated to have risen to €130bn in 2006. And since the EU wanted her demands in trade to be fulfilled, it could not push Beijing too much in the climate domain. China's attitude towards the climate negotiations therefore was considered to be on the right track. Diplomats in Hamburg had to accept that they had failed to convince the Chinese authorities of joining them in a commitment to reduce CO_2 emissions by 30% as part of the post-Kyoto international agreement.[14]

3. Asking for Funding and Technology from the EU

China saw the climate change negotiations not only as a way to protect the environment, but also as a good way to gain funding and technology to prepare for future reduction and to

[12] Agence Europe. (2007, January). Benita Ferrero-Waldner hopes to win Beijing over to European cause on Climate, but gently, *Bulletin Quotidien Europe No.9347*, 11.

[13] Agence Europe. (2007, May). Union calls for opening up of Chinese markets but fails to convince Beijing to participle in joint climate change efforts, *Bulletin Quotidien Europe No.9434*, 6.

[14] Agence Europe. (2007, May). Union calls for opening up of Chinese markets but fails to convince Beijing to participle in joint climate change efforts, *Bulletin Quotidien Europe No.9434*, 6.

catch up with the industrialized countries.[15] To reach this goal, Beijing again used its advance and retreat strategy: first it refused the EU's requirements by highlighting and upholding the "common but differentiated responsibility". Then China retreated by showing the EU its domestic reduction target to let the EU understand its will of protecting the environment and the difficulty of lacking funds and technology.

By using this strategy, Beijing not only conveyed its message well, but also handed her own funding and technology problems to the EU successfully. Beijing turned on the pressure that came from the EU back to the EU to get its help, and if Beijing's requests were refused, then it would be a good excuse to avoid taking responsibility for not signing the binding target which was the EU's requirement. In this way, China could maintain a positive image internationally. Therefore, the problem was kicked into the EU's field.

3.1. The "Common but Differentiated Responsibility" Principle

Launching the widest possible negotiation process in Bali in order to strike agreement in 2009 on a global post-Kyoto system for combating climate change had been the main thrust of the highly ambitious negotiation mandate in October 2007. The mandate wanted binding commitments from all industrialized countries that they would cut their greenhouse gas emissions by around 30% by 2020 on the 1990 figures; a contribution from emerging economies and developing countries that was adapted to match their responsibilities and capacities. The EU was strongly committed to leading the post-Kyoto negotiations and to leading the climate change battle.[16]

Preparing for the upcoming Bali conference, the EU expressed the urgent need of turning words into actions and of finding an over-arching, international and binding solution, hoping to convince not only the U.S., but also the emerging countries to find a binding solution to the climate problem.[17]

On the other hand, China saw this kind of forum as a very good chance to let her voice be heard, to let her difficulties be understood, to have other emerging countries share the same view, and if possible to change her passive position in the climate negotiations. Beijing then decided to use its advance and retreat strategy again to win the EU's support of funding and technology.

Speaking for China, Ronglai Zhong from China's representation office to the EU said common but differentiated responsibilities had to be decided at the global level, which would introduce a universal mechanism for the transfer of clean energy that adding to the Millennium Development goals climate targets for sustainable development policies. Trying to sound more cooperative, Mr. Zhong then stressed that China had already been hugely successful in combating climate change and pledged to continue restructuring its economy in order to promote green technology and cut CO2 emissions. He then tried to impress the other countries by saying that his country would reach the 10% target for renewable energy in 2012 and 16% in 2020.[18]

Soon the strategy proved to be working; Beijing had its voice heard in respect of the common but differentiated principle. Later, the European Parliament's temporary committee on climate change outlined a wish-list of ingredients to ensure success at the Bali conference.

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[15] 王金南, (2008, 12, 19).“后京都时代”中国的谈判压力与策略，*第一财经日报*，p.12。

[16] Agence Europe. (2007, October). Council fine-tuned EU negotiating mandate for Bali climate change conference- commission's climate package to be unveiled on 23 January 2008, *Bulletin Quotidien Europe No.9535*, 9.

[17] Agence Europe. (2007, October). Temporary Committee prepares for UN conference in Bali, *Bulletin Quotidien Europe No.9518*, 12.

[18] Agence Europe. (2007, October). Temporary Committee prepares for UN conference in Bali, *Bulletin Quotidien Europe No.9518*, 12.

In the ingredients, the EU asked for effort from emerging economies through making fair and proportionate targets.[19] In defending its firm position given by the adoption of the ingredients, the EU Environmental Commissioner Stavros Dimas said developing countries had to be helped to play their role, and he added that new funding sources had to be found for the negotiation process.[20]

As time passed, the EU noticed that by leading China to join the climate change battle it needed to win the negotiations, and to win the negotiations, it needed to understand China's position first. After outlining its own position in the Bali conference, the EU sent a delegation to China to understand hers.

3.2. Negotiations for Funding and Technology

In the hope of promoting a consensus between industrialized and developing countries on the modalities for a post-Kyoto agreement, in the beginning of November 2008, Guido Sacconi, the chairman of the parliamentary temporary committee, and his delegation visited Beijing. At the meeting, Sacconi pointed out that "As the most populous country in the world and a fast growing economy, China certainly has an important role to play".[21] Karl-Heinz Florenz, the temporary committee reporter added: "Establishing a new international climate change regime after the expiry of the Kyoto Protocol in 2012 will only be possible if countries like China or India are part of such an agreement… We would like to learn more about what China is doing in the area of climate change and to better understand the Chinese position" on this issue.[22]

Beijing had sensed the EU's willingness to help developing countries with funds and technology since the end of October 2007, and decided to make good use of its willingness. Therefore, the Chinese delegation expressed that Beijing was very committed in the fight against climate change and ready to engage in the area of emissions reductions, and energy-efficiency. At the same time, the Chinese acknowledged the importance of cooperating with industrialized countries on technology transfer, as well as the need for financial assistance in this field.[23]

Beijing's efforts in showing their intention of reducing greenhouse gas emissions and convincing the EU to provide funds and technology brought rewards. The EU was happy to learn that "the Chinese authorities are adopting and implementing legislation to successfully start the fight against climate change". And Karl-Heinz Florenz said that he was convinced that China would be a close and key partner of the EU in the negotiations for a post-2012 agreement.[24] Soon the EU claimed that industrialized countries had a moral obligation to help developing countries. In Strasbourg on 15 November, the EU set out its position, which it would recommend for the EU's strategy at the upcoming Bali conference. According to this position, the EU planned to find instruments, financial and other, for clean development and

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[19] Agence Europe. (2007, October). EP's Climate Change Committee outlines wish-list for successful EU contribution to UN climate conference in Bali, *Bulletin Quotidien Europe No.9533*, 10.

[20] Agence Europe. (2007, October). Council fine-tuned EU negotiating mandate for Bali climate change conference- Commission's climate package to be unveiled on 23 January 2008, *Bulletin Quotidien Europe No.9535*, 9.

[21] Agence Europe. (2007, November). European Parliament Delegation visits China on preparatory mission for Bali conference on post-2012, *Bulletin Quotidien Europe No.9536*, 15.

[22] Ditto.

[23] Agence Europe. (2007, November). EP Temporary Committee says China is prepared to cooperate with rich countries but unconvinced about need for quantitative objectives for emerging countries, *Bulletin Quotidien Europe No.9541*, 11.

[24] Ditto.

technology transfer and deployment, including further development of the Clean Development Mechanism for developing countries.[25]

At the end of November 2007, the tenth China-EU Summit was held in Beijing, and premier Wen Jiabao of China attended the meeting with the President of the European Council, Prime Minister Jose Socrates of the Portuguese Republic, and the President of the European Commission, Mr. Jose Manuel Barrose. [26]

The two sides reiterated, in accordance with their common but differentiated responsibilities and respective capabilities, the need for developed countries to continue to take the lead in reducing greenhouse gas emissions beyond 2012 and to assist developing countries in enhancing their contributions to addressing climate change. Leaders emphasized the importance of a post-2012 agreement to help within the context of the UNFCCC and the Kyoto Protocol to make clean technologies accessible and affordable to developing countries by technology transfer, deployment, and dissemination as well as the importance of strengthening the global carbon market and intensifying cooperation on adaptation to the increasing adverse impacts of climate change. Leaders witnessed the signing of a 500 million euro framework loan to the People's Republic of China from the European Investment Bank to support projects that contribute to combating climate change.[27]

Beijing's advance and retreat strategy worked again. Predicting that the EU needed to exercise leadership in the negotiations and was willing to convince developing countries by providing funds and technology, Chinese authorities took the opportunity and pushed the EU like a boat downstream. Not only gaining the understanding of her insistence of respecting the Kyoto Protocol framework and the common but differentiated principle, China also won some limited investment and a promise of technology transfer even before the negotiations of Bali conference. This joint statement also influenced the EU's view of helping developing countries in negotiations at the Bali conference. Beijing therefore became an example of emerging countries facing similar pressure from the EU.

On the other hand, the EU was trying to lead the whole world to fight the climate change battle in a bad situation. In the Bali conference negotiations, the United States, the only industrialized country not yet to ratify the 10-year-old Kyoto Protocol, was still refusing to hear of any specific objectives for the reduction of its greenhouse gas emissions. The large emerging countries such as India and China, for their part, continued to take the view that it was up to the industrialized countries to lead by example, if they wanted the less industrialized countries to commit in turn. Facing this difficult situation, on 12 December, Ban Ki-Moon, the Secretary-General of the United Nations, urged the ministers to obtain a "breakthrough", unless they wanted to be deficient in their duties. "The fate of the future generations depends on this", he warned.[28]The EU therefore pleaded for the industrialized countries to take the measures necessary to gain the confidence of the developing countries. Stavros Dimas, European Commissioner for the Environment, pointing out the importance of efforts of developing countries stated "[…] the developed countries have both a moral obligation and the resources required to take the lead in reduction efforts." A member of the delegation to Bali, Alejo Vidal Quadras said that "[…] the developing countries fear that

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[25] Agence Europe. (2007, November). EU negotiating mandate for Bali should focus on halving global emissions by 2050- industrialized countries have moral obligation to help developing countries, *Bulletin Quotidien Europe No.9545*, 11.

[26] *Full Text of Joint Statement of the 10th China-EU Summit. (2007*, December). From People's Daily Online Retrieved December 4, 2007, Web site: http://english.peopledaily.com.cn/90001/90776/90883/6314110.html

[27] *Full Text of Joint Statement of the 10th China-EU Summit. (2007*, December). From People's Daily Online Retrieved December 4, 2007, Web site: http://english.peopledaily.com.cn/90001/90776/90883/6314110.html

[28]Agence Europe. (2007, December). EU urges industrialized countries to set example to gain confidence of emerging countries and ensure that Bali can launch negotiations on post-2012, *Bulletin Quotidien Europe No.9563*, 12.

behind the rhetoric on climate change, a protectionist agenda is hidden, which put the brakes on the Bali negotiations … it is time to recognize the provisions taken by China, India and other emerging economies".[29]

The EU's reaction to these reluctant developing countries did not convince these countries completely at this stage. The EU's effort in trying to understand and help without any requirement of emission reduction targets was probably considered as a signal of weakness which led to an unpredicted bargaining situation the EU did not want to see.

4. Leading Developing Countries Fight with the Developed Countries

After the EU partly satisfied Beijing's requirements of funding and technology transfer, they kicked the problem back into China's field. Instead of adopting the post-Kyoto quantitative reduction target, Beijing chose to satisfy the EU by making a great effort to reduce greenhouse gas emissions, and by showing itself in the image of a responsible partner in the world.

China saw the climate change negotiations as a good opportunity to build this responsible image internationally. Although Beijing was reluctant to adopt the post-Kyoto quantitative reduction targets on greenhouse gases, it still wanted to show the world that Chinese authority was taking climate change seriously, and it truly did all it could to commit to decreasing emissions, even if it could not do as well the EU wanted.

Therefore, China united the other developing countries, especially other emerging countries, in holding the same position in the negotiations and to fighting with the developed countries, especially the EU.

In this stage, Beijing also used its advance and retreat strategy. It kept asking for funds and technology transfer from the EU and finally united the other developing countries to put pressure on the EU. On the other hand, China also comforted the EU by showing indications of its readiness to adopt domestic emission reduction policies in an international agreement.[30]

4.1. Beijing's Reaction to the EU's Help

China was stimulated by the EU's help and worked hard to keep on the gravy train. Since the EU had kicked the problem back into China's field and kept requiring the adoption of quantitative reduction targets, China had to show the world that instead of adopting the binding target, her way of reducing greenhouse gas emissions was also effective. In its efforts to respond to global climate change, National Development and Reform Commission's Xie Zhenhua said "as a responsible government, the Chinese government will definitely take effective measures and is always ready to cooperate with all countries across the world".[31]

In March 2008, Beijing started checking provincial-level governments' performances in conserving energy and re*d*ucing pollutant emissions, and the results, to be taken as a major index for administration evaluation, would be publicized in May or June. About 1000 key enterprises were also put under the scrutiny, whose performances would be examined by provincial-level governments. Those who miss the annual goals in energy conservation and emission reduction, either governments or enterprises, would be required to make explanations and take measures for improvement within a set time. They would also be denied any honor or award, and the approval of new high energy-consuming projects in the province or of the enterprise would be suspended, said Xie Zhenhua, Vice Minister in charge

[29] Ditto.

[30] Agence Europe. (2008, April). Barroso and Wen introduce first session in productive economic and trade dialogue mechanism, *Bulletin Quotidien Europe No.9651*, 17.

[31] *Green governance ranking to come in months*. (2008, March,11). From China Daily Web site: http://www.chinadaily.com.cn/china/2008-03/11/content_6527482.htm

of the NDRC, at a press conference held on the sidelines of the ongoing parliament annual session.[32]

The central government was confident in reaching its goal which was to cut China's total energy consumption by about 20% and the emission of major pollutants by 10% by the year 2010, Premier Wen Jiabao announced in his government work report in the beginning of March. And China reported, historically, a drop of both sulfur dioxide emission and COD in 2007.[33] Beijing also comforted the EU by showing indications of its readiness to its domestic emission reduction policies in an international agreement.[34]

At the same time, Beijing was also taking every opportunity to get more help from developed countries. In the meeting of the Group of 20 on climate change in March 2008, Xie Zhenhua, Vice Chairman of the China NDRC, called on developed nations to allocate, in accordance with a U.N. treaty, some of their official development assistance to set up a fund facilitating the distribution of high-end technologies, indicating that developing nations should enjoy free or low-cost access to those environment-friendly technologies.[35]

4.2. China Leads Developing Countries and Builds Responsible Image

As an implementation of the roadmap created at the Bali conference continued, the gap of negotiation positions between developing and developed countries became clearer and clearer. As wealthy nations urged the developing world to cut carbon dioxide emissions by absolute values, developing countries which were worried about shackling their economic growth, and therefore, called on the developed countries to bear more obligations in global anti-climate change efforts. After China and the EU issued their joint statement at the end of November 2007, other developing countries faced similar difficulties of reducing greenhouse gases emissions and the same pressure from developed countries saw China as a model and fell into step.

In the beginning of February 2008, the European Parliament temporary committee on climate change visited India and found that India had a similar negotiating position as China, who was becoming more aware of the problem of global warming, interested in technology transfer and not ready to accept binding greenhouse gas reduction targets as part of a global system to combat global warming beyond 2012.[36] Another emerging economy Brazil, pointed out that it was not obliged to reduce its emissions, yet it already had over 106 projects for the Clean Development Mechanism, equivalent to 10% of the global total.[37]

During the negotiations with the EU and other developed countries, Beijing also tried to build funds and technology transfer to benefit other developing countries, which no doubt put its leadership on a firm footing in the developing countries. In the G20 meeting in 2008 China supported the proposal of establishing the Multilateral Technology Access Fund, which could bring more technologies into the box of "public goods".[38] In July 2008, Chinese President Hu Jintao put forward a three-point proposal for the world's major economies on

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[32] Ditto.

[33] *Green governance ranking to come in months*. (2008, March,11). From China Daily Web site: http://www.chinadaily.com.cn/china/2008-03/11/content_6527482.htm

[34] Agence Europe. (2008, April). Barroso and Wen introduce first session in productive economic and trade dialogue mechanism, *Bulletin Quotidien Europe No.9651*, 17.

[35] *G20 climate-change meeting concludes without agreement.(*2008,March,17). From China Daily Web site:http://www.chinadaily.com.cn/world/2008-03/17/content_6542319.htm.

[36] Agence Europe. (2008, February). India interested in technology transfer, but not ready for post-2012 binding targets, *Bulletin Quotidien Europe No.9596*, 9.

[37] Carlos Tautz, (2007). *Climate Change: Brazil Has No National Policy.* From Inter Press Service news Agency. Web site: http://ipsnews.net/news.asp?idnews=36555

[38] *G20 climate-change meeting concludes without agreement.(*2008,March,17). From China Daily Web site:http://www.chinadaily.com.cn/world/2008-03/17/content_6542319.htm.

the fight against climate change in the meeting with leaders from Australia, Brazil, India, Indonesia, Mexico, South Africa, South Korea and the Group of G8 at the Hokkaido Toyako Summit, Japan. Hu Jintao pointed out that "[…] We should work to improve the Global Environment Facility and other existing financing mechanisms and promptly implement the projects under the Adaptation Fund to provide new and additional financial support for developing countries as they endeavor to adapt to climate change". The President also urged the international community to establish effective technology transfer and dissemination mechanisms and realize technology sharing to ensure that developing countries can get affordable technologies that are both climate-friendly and environment-friendly.[39] In October 2008, China called for the establishment of a commission for technology and its transfer.[40] On the 23rd to the 24th in October 2008, the Asia-Europe Meeting was held in Beijing. The summit devoted a chapter to the "Declaration of Beijing on sustainable development" to climate change and energy security. In their declaration, the leaders of the ASEM stated that the developed countries should continue to show strong leadership and to take appropriate national commitments to combat climate change, with quantified objectives for the limitation and reduction of emissions. These countries should also provide financial support and transfers of technology for the developing countries.[41]

China's effort of benefiting itself and other developing countries was welcomed by most of the developing countries, especially the emerging economies. In the Poznan conference, China played an increasingly leading role among developing countries. By facing the pressure of developed countries, especially the EU, Beijing united members of the Group of 77 developing countries and put forward proposals that funding from developed countries should equate to 1% of their GDP. "As China is playing a leading role in combating climate change, it is eager to be understood by the international community", said Wu Changhua, director of the environmental organization in greater China for the climate group. For the first time, the Chinese delegation held a night event at the conference to showcase its efforts in countering climate change.[42] In the conference, China also raised a number of proposals in mitigation, adaptation and technology transfer, a move that demonstrated China's support for and involvement in international cooperation in tackling climate change.[43]

Beijing's efforts in becoming understood created the desired effect. Although China still refused the quantitative reduction targets, its efforts of reducing greenhouse gases was recognized by both developing countries and developed countries. The UN General Secretary, Ban Ki-Moon, said that China had been playing a positive and constructive role in the Poznan talks and had worked out a national climate strategy to address the problem on its own, thereby setting an example for other countries to follow.[44] Former US Vice President, an environmentalist who shared the 2007 Nobel Peace Prize for his efforts to draw attention to global warming, AL Gore gave a speech in the conference, and he pointed out that "China, once seen as a looming obstacle to world efforts to reduce CO2 emissions, has itself a green stimulus of 600 billion dollars over the next two years… Chinese leaders are mobilizing a national effort to introduce CO2 reduction initiatives, and have already begun the largest tree-

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[39] *Hu calls on major economies to combat climate change*. (2008,July,09). From China Daily Web site*:* http://www.chinadaily.com.cn/china/2008-07/09/content_6832095.htm

[40] *Fighting climate change. (*2008, October, 07). From China Daily Web site: http://www.chinadaily.com.cn/cndy/2008-10/07/content_7081590.htm

[41] Agence Europe. (2008, October). European and Asian leaders commit to work together determinedly at UN conference in Poznan, *Bulletin Quotidien Europe No.9770,* 11.

[42] Sun Xiaohua. (2008, December, 02)). *Country has 'key role' on climate*, From China Daily. Web site: http://www.chinadaily.com.cn/cndy/2008-12/02/content_7258538.htm

[43] *Ban: China an example in fighting climate change*.(2008,December,11). From China Daily Web site: http://www.chinadaily.com.cn/china/2008-12/11/content_7294210.htm

[44] *Ditto.*

planting program the world has ever seen." [45] Not only Gore, but also US Senator John Kerry, widely viewed as the representative of President-elect Barack Obama, praised China's achievements in addressing climate change on its own.[46]

4.3. The EU's Lack of Leadership

On the other hand, the EU lost its leadership little by little in the negotiations; it could not suggest an ambitious reduction plan in the Poznan conference, and could not fulfill China's and other developing countries' requirements of funding and technology transfer. Therefore, the EU could not rally China to adopt the post-Kyoto quantitative reduction targets on greenhouse gases.

Knowing that the EU27 could not convince developing countries to commit to targeted objectives post-2012 in the G8 Summit in 2008,[47] the French Presidency of the Council called for reaching an internal political agreement on the climate/energy package in time to allow the EU to defend an ambitious and credible stance at the UN climate conference in Poznan. President-in-office of the Environment and Energy Council Jean-Louis Borloo stressed: "The aim of the EU is to achieve a 30% reduction of greenhouse gas emissions in the event of international agreement." The Presidency's intensions were for rallying China and India to the cause before Poznan Conference. Mr. Borloo said: "[…] rallying China to a global ETS (emission trading scheme) should not be too difficult".[48]

In August, the French Presidency of the Council hoped that there would be sufficient progress to convince emerging and developing countries that developed countries were firmly committed to accepting the lion's share of the ambitious post-2012 regime.[49] However, any hope of collective efforts was extinguished. After the financial crisis hit the world, several member states became reluctant. In October, Italian Prime Minister Silvio Berlusconi suggested the EU to 'pause for thought' in its talks on the energy and climate package,[50] which triggered a discussion in the EU. In the end, a majority of the member states considered the EU would lose credibility, and chose to reach agreement of burden sharing. Finally, in December, although the EP Temporary Committee on Climate change set a target of a 25-40% reduction in emissions by 2020,[51] the EU could only reach an agreement of 20% reduction of CO2 emissions in the adoption of the climate/energy package.[52]

In the Poznan conference, instead of being a positive climate negotiations pusher, the EU's performance was retrogressive. Italian Prime Minister Silvio Berlusconi launched an attack in public. He thought that considering the financial crisis, the discussion of reducing greenhouse gas emissions was absurd. In addition, the EU became very harsh to developing countries, in terms of providing funds; it complained that the EU members were not automatic teller machines; in terms of technology transfer, the EU complained about intellectual property rights, in terms of reducing emissions, it asked emerging countries to use

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[45] *Gore praises China's contribution to fighting climate change. (*2008). From China Daily. Web site: http://www.chinadaily.com.cn/china/2008-12/13/content_7300887.htm

[46] Ditto.

[47] Agence Europe. (2008, October). European and Asian leaders commit to work together determinedly at UN conference in Poznan, *Bulletin Quotidien Europe No.9770*, 11.

[48] Agence Europe. (2008, July). French EU Presidency calls on Parliament to promote "political and popular" agreement on climate/energy package before talks in Poznan, *Bulletin Quotidien Europe No.9706*, 12.

[49] Agence Europe. (2008, August). International community meets in ACCRA to take forward talks on post-2012 agreement, *Bulletin Quotidien Europe No.9725*, 3.

[50] Agence Europe. (2008, October). Silvio Berlusconi to suggest a 'pause for thought' on energy and climate package, *Bulletin Quotidien Europe No.9759*, 9.

[51] Agence Europe. (2008, December). Climate Change Committee sets out policy goals and recommendation for integrated post-2012 EU policy, *Bulletin Quotidien Europe No.9797*, 9.

[52] Agence Europe. (2008, December). Light at end of tunnel for climate/energy package negotiation, *Bulletin Quotidien Europe No.9797*, 10.

more efforts.[53] "More and more countries are discovering the enormous gulf between the words of the EU and its deeds, and this is not helping discussions in Poznan", said the NGO Birdlife. The environment NGOs expressed their disappointment that they were currently seeing too many shameless attempts of the European governments to turn their backs on their own ambitious promises.[54]

At the UN climate change conference in Poznan, China and some other emerging countries were willing to develop renewable sources of energy, willing to improve energy efficiency, and had made national reducing greenhouse gas emissions targets. However, the EU and other developed countries did not want to discuss medium-term emission reduction targets, playing wait and see, in particular to look at the new U.S. President-elect Obama's attitude and other developed countries' actions.[55] These developed countries, Al Gore said, "are backsliding from strengthening their commitment to fighting climate change; they are blocking the introduction of a mid-term goal of cutting 25 to 40% emissions over 1990 levels by 2020 in the industrialized countries."[56] The end of the conference was marked by poor results. The EU's wait and see attitude finally made it lose its leadership in pushing the climate change negotiation to a higher step and in rallying China into the ETS market.

5. Conclusions: China's Advance and Retreat Negotiation Strategy

5.1. Reversing Positions

This research answers the question why the EU could not lead China to adopt the post-Kyoto quantitative reduction targets on greenhouse gases. On one hand, the EU lacked leadership power; on the other hand, China, who was reluctant to adopt binding targets, reversed her passive position in the negotiations with the EU by using her advance and retreat negotiation strategy.

China is a huge country with many problems, but in terms of reducing greenhouse gas emissions, it did make an effort. First, compared with her position in the 1990s, China became much more positive in fighting climate change and dropped its idea of not reducing emissions until the middle of the 21 century. Second, China made a domestic reduction target in 2005, when reducing energy consumption per capita by 20% between 2006 and 2010.[57] Furthermore, this target was gradually adjusted until the Poznan conference. China also raised a number of proposals in mitigation, adaptation, and technology transfer, which reflected the reality of developing countries as a whole and helped the other partners to understand the problems. Third, China pushed the EU and other developed countries to work harder to reach a higher stage in climate control negotiations.

Nonetheless, China was reluctant to adopt the EU's requirements for the post-Kyoto quantitative reduction targets on greenhouse gases. This reluctance was brought about because China first believed that adopting the quantitative target should not be the doing of developing countries. Second, China believed that the developed countries should make

[53] 方芳, 张业亮（2008） "*波兹南大会未获实质性突破*", Retrieved December 17, 2008, from Ministry of Environmental Protection of the People's Republic of China. Web site: http://www.zhb.gov.cn/hjyw08/200812/t20081217_132514.htm.

[54] Agence Europe. (2008, December). Four days before European Council, flurry of diplomatic activity and step up in technical talks on climate change/energy package, *Bulletin Quotidien Europe No.9799*, 13.

[55] 方芳, 张业亮（2008） "*波兹南大会未获实质性突破*", Retrieved December 17, 2008, from Ministry of Environmental Protection of the People's Republic of China. Web site: http://www.zhb.gov.cn/hjyw08/200812/t20081217_132514.htm.

[56] *Gore praises China's contribution to fighting climate change. (*2008). From China Daily. Web site: http://www.chinadaily.com.cn/china/2008-12/13/content_7300887.htm

[57] Agence Europe. (2007, May). Union calls for opening up of Chinese markets but fails to convince Beijing to participate in joint climate change efforts, *Bulletin Quotidien Europe No.9434*, 6.

appropriate national commitments to combat climate change, with quantified objectives for the limitation and reduction of emissions. It was up to the industrialized countries to lead by example, China felt, if they wanted the less industrialized countries to commit in turn. For example, Japan, New Zealand, Canada and Australia were all backsliding from strengthening their commitment to fighting climate change, and even the EU itself could not promote an ambitious reduction plan. Therefore, Beijing believed that instead of the adoption of a quantitative target such as the EU wanted, her effort towards reducing greenhouse gas emissions was effective enough as it was in this stage of the negotiations.

During the negotiations, China read the EU's moves well and prepared well to defend herself and to build a responsible image, which did not leave the EU with complaints. For example, when the EU asked for cooperation from developing countries, Beijing showed its progress and good intensions in fighting the climate battle; when the EU came to visit, Chinese authorities showed their difficulties in lacking funds and technologies, which also pushed their willingness to the EU, thus making the EU responsible for what China could not achieve in the battle. China also gathered other developing countries' ideas and helped these ideas to reach the developed countries, which made her the leader of the G77.

On the other hand, the EU lost its leadership in the bilateral negotiations little by little due to its own lack of ability in creating a consensus among its member states as well as its lack of negotiation skills with China. Facing Beijing's requirements of funding and technology transfer; the EU became optimistic and did not ask China for any quantitative binding target on greenhouse gas emissions in return. Furthermore, after the financial crisis hit the world, the EU did not have enough funding to keep its leadership. The €22 million the EU spent to support projects in Africa and Asia[58] was considered by developing countries as a drop in the bucket.[59]

Therefore, although China did not accept the EU's requirements, it did change its passive position in the negotiations. When China received funds and technology transfer from the EU, it built its responsible international image by using its advance and retreat negotiation strategy.

5.2. Advance and Retreat Negotiation Strategy

The advance and retreat strategy worked well because China prepared well for almost all the negotiations, and did not allow the EU to put blame on them. Furthermore, China read the EU's steps carefully, which provided her with good ideas to use in defending herself. In this case, China knew exactly what it wanted and how to get it from the EU. On the other hand, the EU members lacked a consistent strategy to defend themselves and to push China to the goal which was adoption of a binding target.

From the beginning of 2007 to the Cop 14 negotiations at the end of 2008, China retreated by showing her good intention of taking climate change seriously and by her willingness to reduce greenhouse gases. This could be seen in both every bilateral negotiation and in the international conferences in Bali, Toyako and Poznan. By showing her efforts, China made her point that she was making progress constantly and this should be recognized internationally. The strategy worked well; China's progress was not only recognized well in Poznan, but she also set an example with Ban Ki-moon, the UN General Secretary, which also helped China to bargain with developed countries, especially the EU.

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[58] Agence Europe. (2008, December) Commission announces €22 million investment in clean and renewable energy projects in Africa and Asia, *Bulletin Quotidien Europe, No.9802*, 9.

[59] 方芳, 张业亮（2008）"*波兹南大会未获实质性突破*", Retrieved December 17, 2008, from Ministry of Environmental Protection of the People's Republic of China. Web site: http://www.zhb.gov.cn/hjyw08/200812/t20081217_132514.htm.

Meanwhile, China advanced by asking for help from developed countries, and by arguing about the history of high emissions from developed countries. This action did not stop until the end of Poznan in December 2008, which made the EU worry about its pocket especially in the financial crisis, and made the EU27 fall apart in its attempts to further an ambitious plan to reduce emissions. Meanwhile, Chinese authorities held tightly the "common but differentiated principle" and the Kyoto frame to protect itself from the EU and other developed countries.

With a responsible presence and support from other developing countries, Beijing was much more powerful in negotiating with the EU. Eventually China reversed her passive position in the post-Kyoto negotiations with the EU by using her advance and retreat negotiation strategy successfully.

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Sectoral Approach:
What is in it for The Chinese Economy?

Joyashree Roy[1], Moumita Roy and Shreya Roychowdhury[2]

Abstract

In any international negotiation on climate change close link among science, economics and politics can hardly be ignored. The argument for mitigation in case of long lived stock pollutants can never be rationally based on current growth level. It is a complex situation and any over simplifies approach will further complicate rather than lead to any positive solution. Competitiveness argument, border adjustment, trade barriers on emission intensive goods and services of Annex I countries can hardly be justified even at the current market share in trade, production, consumption. The best way to approach the problem can be to combine domestic and international actions judiciously. Need for transition to globally low carbon economy by the end of the century is least contested today. Common responsibility of attaining decarbonised growth path for global human welfare is uncontested but much contested is the differentiated responsibility design mechanism. Differentiated responsibility is a dynamic notion. So who should do how much and when, in dynamic context, is still an unresolved research question. But what is understood well is a fully functional global carbon market with global carbon price can provide a least cost solution with desired level of autonomy chosen by each country. Past attempts through CDM provide a small short term step towards that for flow of finance in niche investments and new technology, Sectoral Approach (SA) can provide a second level of stepping stone towards fully functional carbon market through financial flow into non niche market such as energy efficiency type of investment. China today is the leader among Non-Annex I countries in CDM and with first layer of capacity building it can be the natural leaders in SA.

I. Background

Need for transition to low Green House Gas (GHG) economy by the end of the century is least contested today. Least contested is also the scientific assessment based on wide variety of information from rigorous research studies that the production and consumption path of the diverse economies followed since industrial revolution till date across the world do not guarantee low GHG future. Global pollutant character and long resident time (decades to centuries) of GHGs emitted from economic activities make it a special challenge in nationally governed world (Roy 2007) to achieve low carbon future. Multiple gases can be expressed in single unit of carbon equivalent so low carbon can be synonymously used for low GHG. GHGs produced by human actions are not primary products rather by products of consumption and production. Various institutions manage production and consumption activities across world where both price mechanism and regulatory mechanism have roles to play. Major challenge is how can these institutions (defined by price and regulations) be redesigned to drive the production and consumption activity decisions towards low carbon future. Hope has been raised by the various global assessments over past years (IPCC 2007, Stern 2007, IEA 2008) that given the global pool of technology and knowledge it is achievable through ideally designed and followed well coordinated global action. However, to deliver this "global good" in the form of low carbon involves costs and investment decisions. Globally efficient solution is possible through co-operation as nationally

[1]Joyashree Roy is Professor of Economics and Coordinator of the Global Change Programme in Jadavpur University (GCP-JU). Roy can be contacted at joyashreeju@gmail.com.
[2]Moumita Roy and Shreya Roychowdhury are Research Associates in the GBP-JU. They can be contacted at moumitaroy_ju@yahoo.co.in and shreyaroychowdhury@gmail.com respectively.

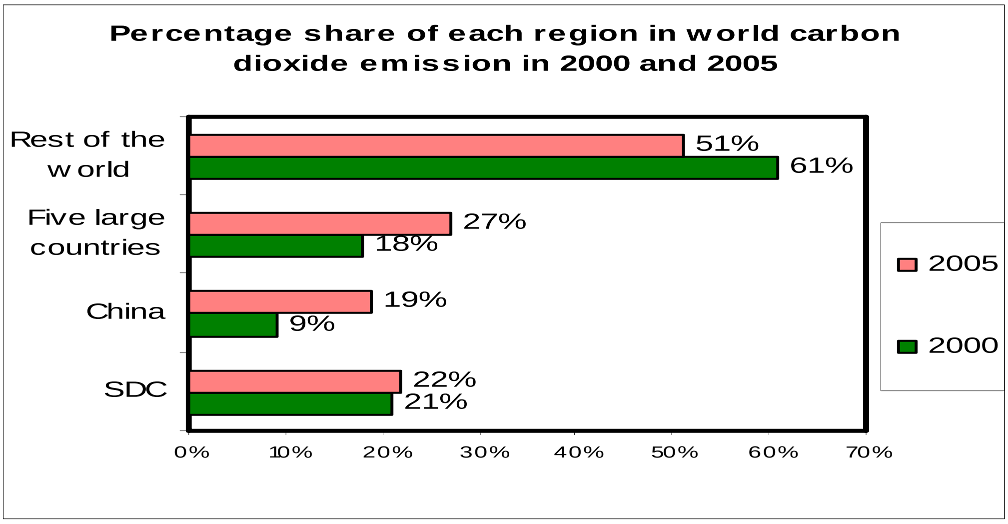
acceptable "global deal" can deliver a price and regulatory mechanism which can deliver least cost solution to achieve low GHG transition. However this transition cannot happen overnight so the path to transition needs to be worked out. This involves inter-temporal decision and investment allocation. Multiple time horizons, multiple countries, and multiple players, multiple goals are creating complexity in a world nationally defined, divided, governed and managed (Roy 2008). However, apparent complexity should not work as a barrier towards solution. So far human society has solved sharing of global goods by defining national boundaries and national endowment of resources. Initial difference in endowments have been solved through creation of market exchange and price has played an important role to allocate across multiple players. Same market-price mechanism has been applied across nations in the form of trade relations. To correct any perceived inequality regulatory mechanisms and various social, economic and political adjustment processes have been tried. It is most logical and possible to show that similar known and much practiced market-price and regulatory mechanisms can be applied to share the 'new global good' as well. So crux of the problem is how do we define the size of the 'new global good' or the natural resource and how the total endowment can be shared initially and then how can trade as a vehicle both intra- and inter- nationally can lead to redistribution of the initial endowment given the demand for it. This implies in macro sense adding to our list of markets like labour market, commodity market, money market, bond market, capital market, a fully functional 'carbon market'. However, this new "carbon market" will have some unique features due to its global public good character. So it is important to design this new market in such a way that it does not distort the current resource allocation, income distribution and political autonomy of the nations. So it is crucial to adopt a systems approach so that additional features introduced through carbon market in the global economic system has a smooth linkages with other markets without creating disruptions in the globally linked national markets. Besides this macro aspect of the transition, micro aspect is can this market generate enough market signals for relevant players. Real challenge is how to make this transition smooth and faster. Sooner we decide the global deal on this carbon market size, initial allocation of the total carbon rights and initial carbon price, better we manage the transition path. Finding the shortest route (time and cost wise) to this ultimate goal is the real challenge today. Major hurdle in the way is to answer this complexity arising out of lack of information on whether least cost solution will produce Pareto efficient solution. Any Pareto inefficient solution i.e., that makes any country worse off than today in the global deal will not be acceptable. It is the distributive impact of transition pathway least understood and most contested. Given the stock pollutant nature historical burden sharing and distributive justice question was attempted to be resolved through common but differentiated responsibility criterion. However, differentiated responsibility is not a static deal it is inherently dynamic. Over time responsibility of various countries will continue to change depending on their contributions to GHG stock.

In this paper we try to analyse how this reality is changing over time for China. How transition towards the global carbon market is emerging and how nations are responding to global deal and what are the forces that might distort emergence of global deal and how national strategies need to be revised in keeping with the changing realities.

II. Changing Reality

The reality is changing fast for FLDCs: China, Brazil, India, Mexico and South Africa, among Non annex I countries. In absolute terms carbon emissions is rising for Non annex I countries. The absolute emission rose for Small Developing Countries in the 2000-2005 period, from 4925.97 million metric tonnes in 2000 to 6031.28 million metric tonnes in 2005. It is interesting to note that over the same period the carbon dioxide emission of the five large developing countries increased from 4292.79 million metric tonnes to 7671.04 million metric tonnes in 2005.The CO_2 emission of FLDC increased by 78% in the span of five years (2000-2005). The percentage contribution of FLDCs in world emissions increased steeply from 18% to 27%.In the same period the carbon dioxide emission of China increased from 2912 million metric tonnes in 2000 to 5322 million metric tonnes in 2005.The percentage contribution of China in world emission increased from 9% in 200 to 19% in 2005.The CO_2 emission of China doubled in the span of 5 years. This is clearly a cause of concern and calls for rapid implementation of low carbon intensive growth policies.

Regional CO_2 emissions in 2000 and 2005



Source: http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls (Authors' estimates)

It is true that still developed nations account for most of the historic emissions but the emerging economies are fast catching up too. It is interesting to note that today's emission becomes historical contribution tomorrow in term of carbon emission so among the developing countries FLDCs, especially China has an important role to play in designing the global deal to facilitate faster adoption of low carbon development pathway through technology and investment decision and choice of carbon free production and consumption behaviour.

III. CDM and Leadership of China

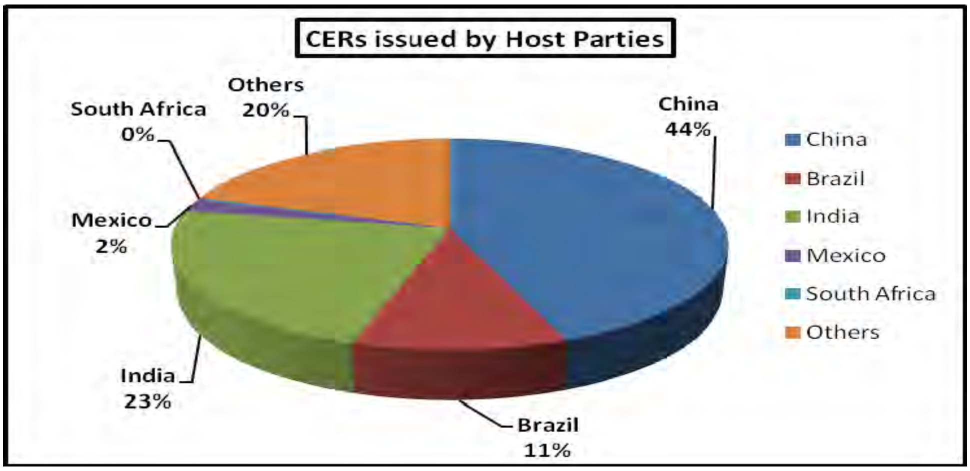
In the process of transition to low carbon economy the missing link is a global carbon market with global carbon price as facilitator. Sooner we start on moving to this inevitable transition path better it is as no other solution is superior to this both in terms of cost efficiency and distributive justice. This implies in macro sense adding to our list of markets like labour market, commodity market, money market, bond market, capital market, a fully functional 'carbon market'. However, this new "carbon market" will have some unique features due to its global public good character. So it is important to design this new market in such a way that it does not distort the current resource allocation, income distribution and political autonomy of the nations. So it is crucial to adopt a systems approach so that additional features introduced through carbon market in the global economic system has a smooth linkages with other markets without creating disruptions in the globally linked national markets. Besides this macro aspect of the transition, micro aspect is can this market generate enough signals for relevant players. Experimentation started at the beginning of this century through Clean Development Mechanism (CDM).

Upfront it is important to understand that CDM needs to be looked into as first experiment in the path of transition through certain niche markets. Niches have been defined through additionality criterion. CDM can at best be understood as demonstration project. Carbon reduction as a ‘good’, eligible for trading, pricing, marketing has been established and accepted today through CDM demonstration projects. Economic agents have an idea now who can be a buyer and who can be a seller. Figures 1 through 4 shows how China has become market leader in CDM. As first mover China has participated and gained in terms of major share in carbon market through new economic activity generation by carbon projects and trading of CERs. China currently accounts for 34% of total CDM projects registered by host country. Almost one third of all the CDM projects (registered by host country) belong to China.

Figure 1

Source: http://cdm.unfccc.int/Statistics/Registration/

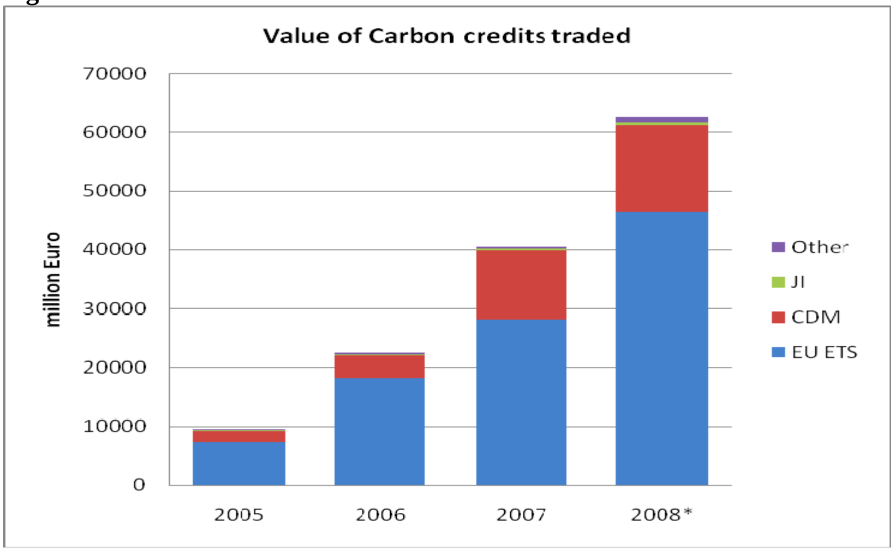
Figure: 2



Source: http://cdm.unfccc.int/Statistics/Issuance/

China accounts for more than 44% of the total CERs generated.

Figure.3

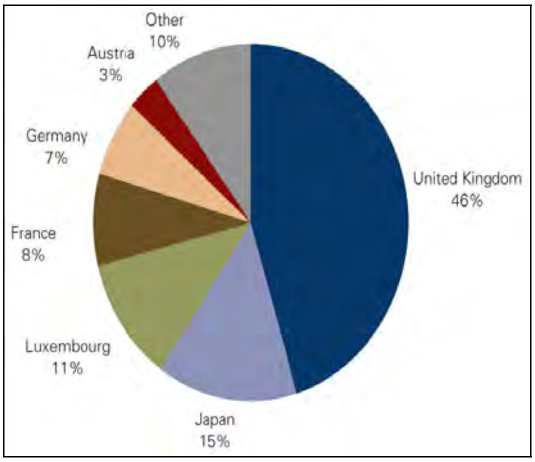


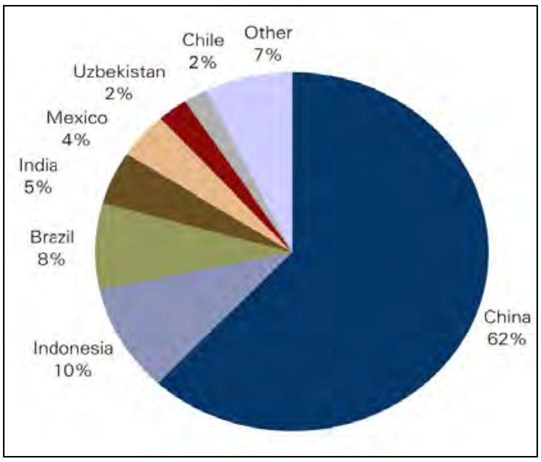
*Estimated

Source: http://www.adb.org/Documents/Events/2008/CDM-Project-Development-Workshop/Carbon-Market-Toru-Kubo.pdf,

Without going into detailed discussion we want to state that EU ETS system which is regional in nature has generated a much bigger market than CDM. This has to do with non participation of few larger emitting countries in the buyers' market, knowledge intensity and high transaction cost has made seller market small as well. In the sellers' market for carbon credit China is the leader (62%) and the buyers' market for carbon credit is dominated by United Kingdom (46%).

Figure: 4.





Buyers of Carbon Credit **Sellers of Carbon credit**

Source: Energy, Transport and Water Division, Regional & Sustainable Development Department Asian Development Bank (accessed 30th Nov,2008)

But what could be learnt so far is through CDM all kinds of stakeholders: government, private producer, financial market players all can relate their benefits through participation in a carbon market. But all these success stories should not lead the current players in CDM market with the complacence or bias for maintaining the status quo (Roy 2008). However, CDM has its own limitations. The chief among them is scale of operation due to the additionality criterion which makes it a good instrument for 'niche investments' only.

So scaling up to economy wide activities and investment is necessary both to achieve stabilisation goal and participation from all. CDM should be taken as a learning phase and now need is to move up to next level for transition towards global carbon price and carbon market. The capacity building under CDM phase in fact puts China one step ahead of other developing countries who are late comers or who have not yet jumped into the business of CDM due to lack of enough knowledge, understanding and capacity to make CDM markets functional. China through South-South Cooperation can indeed act as leader for other developing countries in post 2012 phase for CDM markets in non participating developing countries for capacity building and Annex I countries can continue to participate in niche market investments. However, CDM has long term impact than need for immediate decarbonisation target and can be allowed only for niche markets and new additional mechanism need to be developed to achieve immediate decarbonisation target in post 2012 period.

IV. Sectoral Approach (SA): A New Vehicle to Transition

Target is to decarbonise economic activities globally at such a rate so as to reduce CO_2 equivalent by 50% by 2050. This means the decarbonisation rate needs to be between 0.6-2.5% . Historically, over past decades we could decarbonise by 0.3% which is way below desired rate of decarbonisation. Global collective track record so far has been far from satisfactory. We have added 70% more GHGs over 1970-2004 (IPCC 2007) despite 33% reduction in energy intensity globally. Doubling or trebling of energy efficiency improvement for fossil fuel use in next two decades is urgent need to achieve the target stabilization by the turn of the century somewhere between 450-550 CO_2 eq. However, for some experts the target is even more stringent like 400 ppm CO_2 eq by turn of the century. Much deeper and wider actions must be achieved collectively in a very short span of time. These are facts and need to be accepted. Now the question is what can then be done to achieve such deeper and wider cuts in emission? The target transition cannot be reached with current or enhanced level of unilateral Annex I country actions and CDM driven non-Annex I country actions (Schmidt et al., 2006, Baron et al., 2006).

In case of any other market (financial, commodity etc.) in a fully functional global carbon market each player has the autonomy to select level of emission reduction (supply of carbon credits) and generation (demand for carbon credit). The only difference is total credit or size of the market will be globally managed through negotiation across nations starting from an initial allocation of total endowment across nations. CDM is far off from this final market size and extent. National preparedness also do not show readiness towards that due to lack of enough information, capacity and knowledge. SA is an intermediate step between CDM and global carbon market.

Though not a new concept in climate negotiation literature, sectoral approaches (SAs) have gained prominence in post 2007 and after publication of Intergovernmental Panel on Climate Change (IPCC) assessment of sectoral mitigation potential and in post 2007 Bali Convention. While there are conflicting interpretations of what SAs may bring about but one thing is clear that SA need to target at- broad based participation in mitigation action, widening of options and opportunities in mitigation action compared to current additionality driven narrow coverage of Clean Development Mechanism (CDM), increased financial flow in mitigation activities, making technology diffusion faster in sectors with high mitigation potential, bridge the gap between now and future globally active carbon market without creating distortions through early actions.

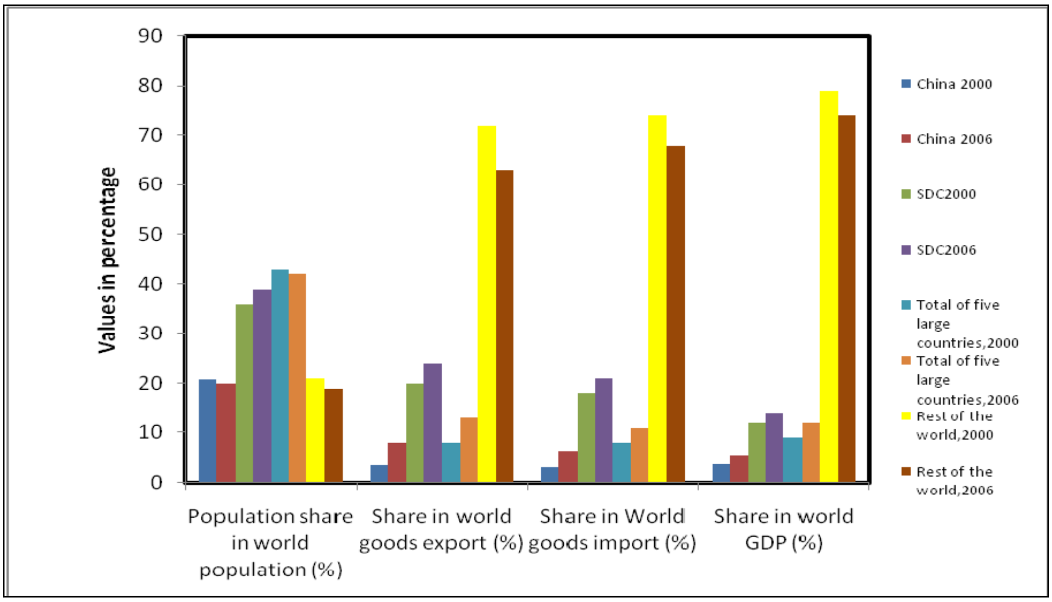
Sceptics argue SA is designed to address leakage and/or competitiveness argument of current carbon constrained developed countries. It is important to understand that it is neither a time for scepticism, nor of blame game nor of non cooperation. Rather it is time to put forward national priorities with clear goal oriented targets and to find out of the box solutions to help in evolving a globally functional carbon market through information generational and negotiation. SAs is not a closed chapter rather it provides a platform for global discussion and opens up scope for designing mechanism for each country/ group of countries to choose a win-win kind of interim solution in post 2012 period. This paper focuses on the concerns of China and how China can play an integral role in SA negotiations, ensuring that SAs reflect their interests and long-term development goals. With voluntary participation, they can realise the potential gains of sectoral approaches that can facilitate technology transfer, utilise carbon trading mechanism for broader development goals, enhance existing capacity and pave the way for global carbon market participation.

V. Competitiveness Argument based SA and Trade Instruments: Weak Argument to Trigger Participation

Competitiveness argument in sectoral approach focus on large developing countries Brazil, China, India, Mexico and South Africa. Because of their low historic emissions, FLDCs do not face mandatory emissions cuts under the Kyoto Protocol, given the principle of "common but differentiated responsibilities" and they have not been actively engaged in the "universal" sectoral approaches negotiating process. Producers of steel, cement, aluminium, pulp and paper and agrochemicals and other energy-intensive goods in the developed nations allege that such climate change policies would put them at a disadvantage compared to developing nations as far as international trade in the energy intensive goods sector is concerned. They argue that by introducing a price for carbon, the cost of production in the energy intensive sectors in developed countries would rise compared to developing nations and that would cause them to lose market share to foreign competitors that do not face similar costs at home. Many of these industries are facing tough competition in the global market from large emerging economies such as China, India, and Brazil that are not bound to have emission cuts under the current international climate regime. The developed countries propose to either limit the price of carbon these producers face or impose similar costs on imports of carbon-intensive goods from their competitors in developing countries.

In figure 5 rest of the world is Annex I countries and the small island countries whose share is almost negligible. Annex I countries dominate with disproportionately high share in world export, import as well as GDP barring population which gives them market power, competitive edge and more responsible. China represents only 8 percent of world merchandise exports (Figure 5). The share of China in world exports of merchandise goods has increased from 4% in 2000 to 8% in 2006 and share of China in world imports have increased from 3% in 2000 to 6% in 2006. Any kind of trade barrier will be detrimental to their growth and cannot make them competitive in next one decade with rest of the world.

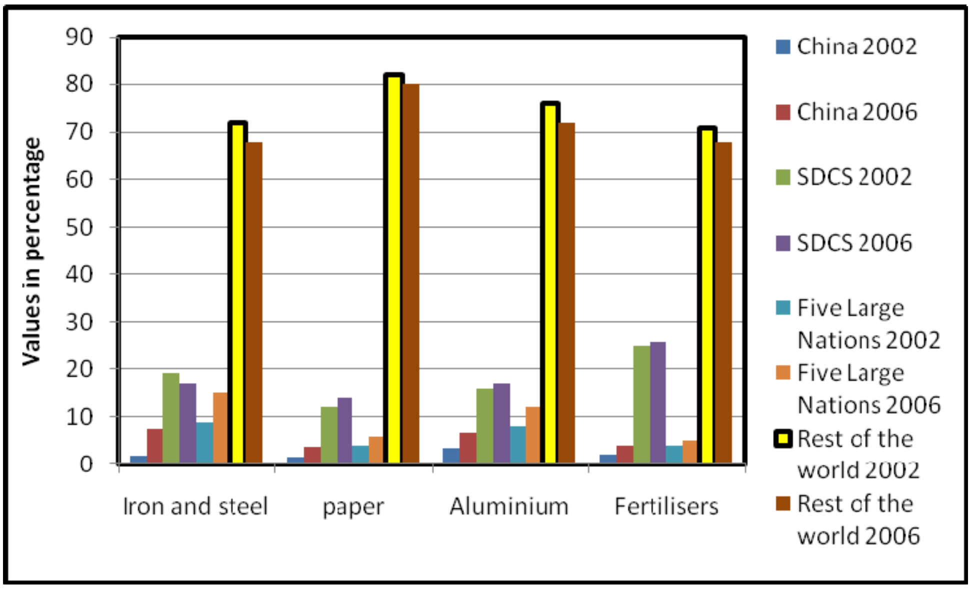
Figure 5 Regional shares in global total 2000, 2006



Source: (Roy and Roy 2008)

As of now, Annex I countries clearly dominate in both the export and import of energy-intensive goods (Figure 6). Apart from iron and steel where China commands nearly 8 percent of the worlds export in 2006, China and other FLDCs could barely make their presence felt in other indicators and sectors. Pulp and paper, aluminium and fertilisers exports are almost entirely dominated by Annex I nations. Annex I nations account for 80% of the world export of pulp and paper in 2006.Thus the competitiveness argument proposed by developed countries saying that climate change strategies that do not impose carbon constraints on developing nations are going to hurt the competitiveness of developed countries in energy intensive sector is not validated in the light of empirical evidence. Annex I countries therefore dominate the global market for energy-intensive goods, it is clear that all developing countries should be given preferential treatment in catching up, with emphasis placed on emerging economies like China. Thus any climate policy led trade policy such as lowering the carbon price for producers of energy intensive goods in the developed countries, or imposition of trade barrier in the form of import tariffs on energy intensive goods imported from developing countries cannot find approval from the developing economies in post 2012 period. Also such trade barriers are not efficient as only one third of China's steel is traded, the rest is consumed domestically. Exporters will have any incentive to cut emissions in case their goods are checked at the border. But the domestic producers will not have any incentive to adopt cleaner technology if trade instruments are used. So the basic aim of achieving a broader participation is not addressed.

Figure 6. Share in Global total exports of Iron and Steel, Pulp and Paper, Aluminium, Fertilisers, 2002 and 2006



Source: (Roy and Roy 2008)

Sectoral Approach that address the issue of competitiveness and at the same time aim to involve new players especially the large developing countries and does not show how large emitters like US can be involved, in climate change framework will find low success story. However, a sector wide approach based on self assessment of sectoral mitigation potential with crediting facility may be more acceptable to developing nations than an arbitrary country wide target in very near future.

VI. Efficiency Target Based SA

Large untapped potential for mitigation through energy efficiency improvement is widely accepted fact among various stakeholders. But CDM additionality criterion cannot take it as niche investment. This potential is not only in non annex I countries but exist in developed countries as well though this is not obvious from aggregate metrics as emissions GHG intensity as it is 0.68 kg CO2eq/US$ GDPppp for Annex I countries and 1.06 kg CO2eq/US$ GDPppp for non-Annex-I countries. Sectoral assessment across various countries can yield accurate mitigation potential assessment and market size. How sectoral potential can be achieved through all country participation through trading will be an effective vehicle to enhance the market and realise the potential through technology and financial flow. Although new facilities in developing countries in major energy intensive sectors are adopting new efficient technologies replacement need of existing technologies are high but competition for investment fund do not make it attractive for investment. Top down CDM cannot achieve this due to its specific goal. Bottom up approach for Deployment of best available technology (BAT) in a sector across countries sound idealistic solution. In practice either it should lead to monopoly or few firms dominating the sectors with multinational character which will face several known barriers. Second option will be diffusion of technology liberally across companies which may be facing hindrance through competitiveness argument and business ethics. So transnational sectoral standard or deployment of BAT both may fail to succeed though may look attractive upfront. Who owns BAT to be used as standard is highly controversial due to asymmetry of information. Moreover, this may act as disincentive for new technology development.

VII. Possible Components of SA and Role of China

SA can best be an intermediate step between CDM world and globally functional carbon market world. It needs to maintain the trading in carbon credit feature of CDM and need to include two essential features of future global carbon market: one, negotiated total emission level and decision by players to select their chosen emission reduction level based on self assessment. This will honour business ethics and will incentivise the players for correct reporting. In practice these two market features for SA will be negotiating among sectoral players. For example, it may be for emission reduction level in 2012-2020 period and declaration of reduction targets by each player at the beginning of the period. These two need to match through negotiation among the players. Throughout the committed period players will get chances to trade among themselves. Carbon price will be determined through demand and supply within the market or on a pre negotiated price. Price will act as incentive. Defaulters will need to pay the price of committed but unrealised reduction and any reduction beyond committed reduction will fetch revenue at the carbon price. If there is over supply for good practices by each player in the sector a pool of carbon credit can be created that can be auctioned and money be redistributed among the players and if there is default that will fetch in pool of finance from the defaulters at carbon price at the sectoral level and through sectoral action money can be ploughed back . Ideally in a macro economy wide functional market these will be traded across sectors and macro balance will be maintained through price mechanism.

To be broad based SA must have wider coverage by allowing any measurable carbon reduction strategy starting from energy efficiency. It avoid political apathy for commitment due to enough information, but allows the direct stakeholders to participate in the negotiation process. However the players need to consider national circumstances and macro goals. They need to be consistent and players cannot commit with private motive alone. So there is need for close interaction among national government and sectoral players as the sectoral players' commitments need to be consistent with country's development goals. This may need some enabling policy support as well. This sector wide participation of investors in carbon trading and market generation with third party investor's role will help in capacity building towards smooth transition to global carbon market. Therefore, in order for sectoral approaches to be effective both government and business needs to build mutually acceptable incentives to be a reliable partner in the process.

To encourage both developing country objective of development and new investment and Annex I country problem of lock in through high emission intensive investment due to past decisions but ownership of efficient technology can be solved if voluntary target emission reduction declaration by industry players are allowed and trading is allowed in carbon with third party investment possibility as well then all players across nations get incentive to reduce efficiency. The trading can be within one group of industry players as well as between industry players and third party investor. Carbon price will be determined by size of the market. This SA arrangement can continue with CDM for investments in niche areas as well as mandatory target for Annex I countries. There is no need for country wide commitment for Non annex I countries. Emerging economies due to sheer size of their market and economic activity can take leadership in SA and gain much through financial flow and technology transfer in non CDM covered markets and build additional capacity and preparedness for next beyond 2020 period. CDM with niche character will be shrinking in China and will be finding new locations in unattended markets so far and SA can play much larger role in China. This will help China to monitor emissions in its high growth path with ultimate aim of decoupling emissions from growth and will allow on carbon neutral growth path .

In the global economic transition China is bound to play important role with almost one fifth of the global population. Human welfare at global scale will be determined by how fast China and other developing nations can generate and distribute economic benefits. So anticipated growth rates in the range of 5-10% is inevitable. So how to manage this global economic transition on a low GHG pathway is the challenge which is a global responsibility in a very idealistic situation. But as soon as national interests and national autonomy creeps in aligning national goals with global goals becomes a major challenge. The conflict of global and national goal becomes explicit when goods cross borders. When it does not then issue is much simpler. Best strategy for countries in SA will be to select major emitting sectors like power, steel, aluminium, cement, transport and buildings etc and allow each country players to come up with nationally consistent strategies. It makes next few month very crucial in terms of information generation. Unless such intermediate step is followed in post 2012 period the stabilization process will be delayed leading to more adaptation and steep mitigation cost burden on developing economies in near future. Additionally wide capacity building through practical experience will be delayed. Neither efficiency nor justice can be achieved by delaying the process of expansion of carbon market through SA especially when world is not ready for globally functional full scale carbon market. China with peaking economic activities in next one decade need to take lead role in design of SA to achieve low carbon growth path in next decade and to avoid high adaptation and mitigation cost a decade later and gain in 2012-2020 period from historical advantageous position due to low share in global GHG pool.

VIII. Concluding Remarks

Sectoral Approach (SA) needs to be clearly defined keeping mind its role as stepping stone towards fully functional carbon market. It need to go beyond CDM and replicate global carbon characteristics at a sectoral scale. China today is the leader among Non-Annex I countries in CDM and with first layer of capacity building they can be the natural leaders in SA and by assuming an active role can enhance the financial and technology flow from the very beginning by expression of interest consistent with national advantage. In global deal for 2012 period China can bargain for much broad and target flow of finance and technology as per national developmental need assessment and very well play the role of Global deal maker in voicing their need in SA and in determination of carbon price and sector selection. How carbon price can be used as incentive for participation of low emitters and as payment vehicle for non delivery of commitment by large emitters for ploughing back into the system through enhanced investment are some of the bargaining points for China in post 2012 period. In CDM, China needs to push for more niche investments from Annex I countries and can become provider of knowledge and capacity building in underserved nations in CDM first phase. CDM and SA can scale up the experiments with newer carbon market concept and lead the way to fully functional carbon market through appropriate capacity building. Next few months for China before 2012 deal is made are very crucial in terms of information generation towards SA. Post 2012 period need to be devoted for knowledge sharing in design of initial endowment and carbon price that will prevail in future.

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Evaluating CO_2 Capture Ready Investment in New-built Thermal Power Plants in China

Xi Liang[a*], David Reiner[a], Jon Gibbins[b], Jia Li[b]

Abstract

The total thermal power capacity has grown by 65GW to over 600GW by the end of 2008 (CEC, 2009). Chinese government, industry and academic stakeholders perceive that China will not mandate new plants to be built with carbon dioxide capture and storage systems in the short term and there is little incentive even to contemplate

the first steps needed to fit plants with capture equipment (Reiner et al, 2007). Therefore, we evaluate CO2 Capture Ready (CCR) investment, which would enable thermal power plants to be retrofitted to capture CO2 without unnecessary additional costs when the appropriate policy and /or economic drivers are in place (IEA, 2007).

In order to understand the value and investment characteristics of CCR in China, a typical 600MW pulverized-coal fired ultra-supercritical power plant was assessed. Combined with a detailed engineering assessment, we obtained the costs for different CCR scenarios. To analyze CCR investment opportunities, we apply a cash flow model for valuing Capture Options, as developed in Liang et al (2007). Results are obtained by Monte-Carlo simulation, with assumptions based on engineering surveys and the IEA (2007) CCR study, as well as plant performance information and expert estimations on carbon prices, coal prices and electricity prices.

1. Introduction

Fossil fuel power plants are the largest source of carbon dioxide, accounting for more than 40% of CO_2 emissions globally, and the trend is expected to continue through 2050 (IEA, 2006). Most of incremental emissions globally will come from China and India and the largest increase in magnitude comes from coal (Figure 1).

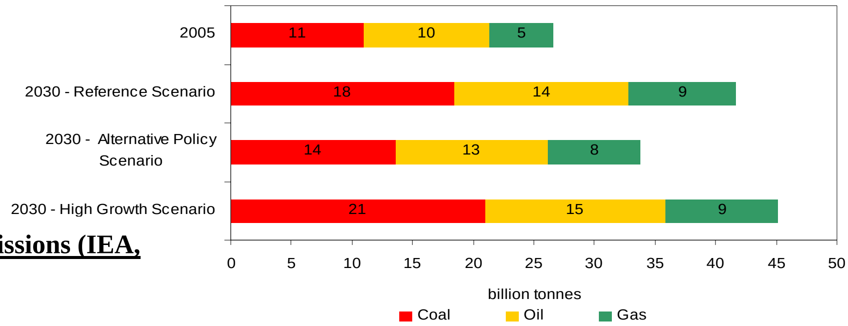


Figure 1 Energy Related CO_2 Emissions (IEA, 2007)

Mitigating climate change must be treated as an investment, spending now can help avoid the risks of serious damage in the long term (Stern, 2006). Ideally, all fossil fuel power plants should be built with Carbon Capture and Storage to minimize the risk of dangerous climate change. However, currently there are insufficient incentives and no mandatory policy is currently in place in any countries to encourage large scale CCS deployments before 2015.

CO_2 Capture Ready (CCR) is a modest investment expenditure in the planning, design

[a]Judge Business School, University of Cambridge, Cambridge, UK
[b]Energy Technology for Sustainable Development Group, Mechanical Engineering Dept., Imperial College, London, UK
[*]Corresponding author. Tel.: +44-787-897-5366，Fax: +44-122-333-9701, Email: x.liang@jbs.cam.ac.uk

and construction stage of a fossil fuel plant, to minimize the risk of future ‘carbon lock-in’ by significantly easing a future retrofit of carbon capture and storage (CCS). Following the Gleneagles G8 (2005) submit, the IEA Greenhouse Gas Programme (2007) published a study which identified the following key elements for CCR power plants:

- *A CO_2 capture ready power plant is a plant which can include CO_2 capture when the necessary regulatory or economic drivers are in place. The aim of building plants that are capture ready is to reduce the risk of stranded assets and carbon lock-in.*
- *Developers of capture ready plants should take responsibility for ensuring that all known factors in their control that would prevent installation and operation of CO_2 capture have been identified and eliminated. This might include:*
  - *A study of options for CO_2 capture retrofit and potential pre-investments*
  - *Inclusion of sufficient space and access for the additional facilities that would be required*
  - *Identification of reasonable route(s) to storage of CO_2*
- *Competent authorities involved in permitting power plants should be provided with sufficient information to be able to judge whether the developer has met these criteria.*

A minority of companies are considering making their plants Capture Ready. Appendix shows examples of the industry approach to planning new plants Capture Ready by self-motivation. However, there have been relatively few studies looking at CCR investment decisions. Rutkowski et al (2003) investigated the impact of pre-investment on NPV and Sekar (2005) applied real option analysis on the value of pre-investment IGCC or Oxyfuel. Both studies emphasized the absence of economic drivers needed to make capture ready pre-investment worthwhile. These studies mainly focused on pre-investment in the form of the extra cost of building an integrated gasifier combined cycle (IGCC) systems, however, while most new coal-fired power plants built by 2020, are likely to be conventional pulverised coal power plants. They also assumed limited fixed retrofitting date, rather than the likely real situation of a range of possible dates, which may lead to the value of pre-investment being underestimated. Liang et al (2007) conducted a stochastic analysis on the option value of CCR in pulverised coal power plants in China, but this study used data inputs from public domain sources for generic power plants rather than realistic plant data and also only used standard deviation to describe risk.

In this paper, we conducted a more detailed survey of actual pulverised coal power projects in China which began construction in 2005 and 2006 and decided to focus on a plant located in Guangdong which began construction in 2007 and started operations in 2009. All costs and revenue data are adjusted by historical or estimated inflation. As the risk of a project cannot be assessed simply by comparing the NPV of a project, we also analyze the risk profile in addition to NPV analysis.

The paper aims to address the following research questions:

- Is CCR a sound economic investment in China?
- What are the implications of different CCR configurations for the economics of post-combustion at pulverised coal power plants?
- What are potential mechanisms to make CCR happen?

2. Valuation Methodologies

The principle in evaluating the value of CCR and capture options includes eight steps in evaluation process are explicitly stated below:

Step 1: Set up project lifetime cash flow projection profile (annual basis, static), and build a decision tree on retrofitting to capture and early closure applying backward deduction methodology to determine the optimal retrofitting option exercise policy.

Step 2: Investigate the distribution and inter-correlation of stochastic inputs, including carbon prices, coal prices, and electricity prices.

Step 3: Assume plant performance variables without CCS, such as power supply efficiency, load factor and etc

Step: 4: Estimate economic variables, including inflation rate, tax rate, depreciation schedule and etc.

Step 5: Determine a proper discount rate.

Step 6: Input plants performance, required capital investments, operating and maintenance costs with respect to retrofitting to capture CO_2. The costs for storage, monitoring and transportation are accrued to CO_2 per ton.

Step 7: Run Monte-Carlo simulation to generate results and conduct sensitivities studies for different scenarios. (10,000 trials give the best trade-off).

Step 8: Analyse results including the option value, the impact of capture option on project risk profile, retrofitting probability and early closure possibility

2.1 Valuing Option for Retrofitting CO_2 Capture (Capture Option)

For the purposes of this analysis, we assume the mean net present value (NPV) of cash flow is the main investment decision criteria. The NPV is the net present value of the future after-tax cash flows after subtracting initial investment outlay and adding present value of terminal year non-operating cash flow, or

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - Outlay + \frac{TNOCF}{(1+r)^n} \qquad (2\text{-}1)$$

CF_t = after-tax cash flow at year t
r = required rate of return for the investment (or discount rate)
Outlay = initial investment cash flow at time zero
n = life of the power project
TNOCF = terminal year after-tax non-operating cash flow

The value of being CCR is calculated by subtracting the 'mean NPV of total cash flow of a project without option of retrofitting CO_2 capture during its lifetime' from the 'mean NPV of total cash flow of a project with option of retrofitting CO_2 capture':

$$Value_{Option} = \overline{NPV_{with-option}} - \overline{NPV_{without-option}} \qquad (2\text{-}2)$$

$NPV_{with\text{-}option}$ = NPV of total cash flow with retrofitting option
$NPV_{without\text{-}option}$ = NPV of total cash flow without retrofitting option

In order to estimate the mean NPV of total cash flow including the option of retrofitting to CO_2 capture, a decision equation with regard to retrofit timing is required. The model assumes that plant owners or capture option holders are free to retrofit the plant to capture

CO_2 at year T when the projected average NPV of total future cash flow with retrofitting is larger than the projected average NPV of future cash flow without retrofitting:

$$\text{Retrofitting to Capture if } \overline{\sum_{t=T}^{n} \frac{CF_{retro\_t}}{(1+r)^{t-T}}} > \overline{\sum_{t=T}^{n} \frac{CF_{no-retro\_t}}{(1+r)^{t-T}}} + Value'_{option} \quad (2\text{-}3)$$

CF_{retro_t} = expected after-tax randomized cash flow at year t with retrofitting to Capture
$CF_{no\text{-}retro\_t}$ = expected after-tax randomized cash flow at year t without retrofitting to Capture
$Value'_{option}$ = the option value of retrofitting to Capture in the future
T = retrofitting year
n = life of the power project

2.2 Assessing Benefits of CCR

The additional capital investment required to make a new plant CCR can be quite different depending upon the siting of the plant, engineering design and local costs of reserving additional land, thus we focus on the gross value (before capital outlay) of CCR:

$$GValue_{cr} = Value_{option-cr} - Value_{option-nocr} \quad (2\text{-}4)$$

$GValue_{cr}$ = value of CCR before capital outlay of CCR
$Value_{option\text{-}nocr}$ = value of Capture Option without CCR
$Value_{option\text{-}cr}$ = value of Capture Option with CCR

A distinct advantage of building new plants as CCR is increasing the cumulative probability of retrofitting CCS economically over the course of a plant's lifetime:

$$P_{capture-T} = 1 - P_{unCapture-T} = 1 - \prod_{t=1}^{T}(1 - p_{capture-t}) \quad (2\text{-}5)$$

$$p_{capture-T} = p(\overline{\sum_{t=T}^{n} \frac{CF_{retro\_t}}{(1+r)^{t-T}}} > \overline{\sum_{t=T}^{n} \frac{CF_{no-retro\_t}}{(1+r)^{t-T}}}) \quad (2\text{-}6)$$

$P_{capture\text{-}T}$ = cumulative probability of retrofitting to Capture at Year T
$P_{uncapture\text{-}T}$ = cumulative probability of not yet retrofitting to Capture at Year T
$p_{capture\text{-}T}$ = probability of retrofitting to Capture at Year T

The net value of CCR is equal to the 'gross value of CCR' less 'additional capital outlay on CCR':

$$NetValue_{cr} = GValue_{cr} - Outlay_{cr} - PV\_O\&M_{cr} \quad (2\text{-}7)$$

$NetValue_{cr}$ = net value of CCR (after CCR capital outlay)
$GValue_{cr}$ = gross value of CCR (before CCR capital outlay)
$Outlay_{cr}$ = capital outlay of CCR
$PV\_O\&M_{cr}$ = PV of the additional operating and maintenance expense of CCR

2.3 Cash Flow Components

The base power project in the study is a new investment, thus the initial capital outlay is equal to the investment in new fixed capital plus investment in net working capital.

$$Outlay = FCInv + NWCInv \quad (2\text{-}8)$$

FCInv = Investment in new fixed capital
NWCInv = Investment in net working capital

The annual after-tax operating cash flow is equal to 'revenue (or sales) less cash operating expenses and tax expense, plus depreciation charge':

$$CF_t = (S_t - C_t - D_t)(1 - Tax) + D_t \qquad (2\text{-}9)$$

S_t = revenue from electricity sales at year t
C_t = cash operating expenses (fuel cost + carbon cost + other O&M costs) at year t
D_t = depreciation charge at year t
Tax = corporate tax rate

The paper assumes the net salvage value (including site cleanup) is zero at the end of the project, because the salvage value has little impacts on either the value of capture option or the value of CCR. Therefore the terminal year non-operating cash flow is equal to

$$TNOCF = NWCInv + Tax \times B_{TN} \qquad (2\text{-}10)$$

$TNOCF$ = terminal year after-tax non-operating cash flow
B_{TN} = book value of fixed capital on the terminal date

2.4 Option of Terminating Ahead of Schedule

If the prospect of continuous operation (with a retrofit option or after retrofitting CO_2 capture) is extremely unfavourable, the underlying plant will be closed down ahead of the end of its intended life. The paper assumes that the plant will be shut down if the spot NPV of estimated future cash flow with closure options is lower than zero. The paper also evaluates the value of the closure option and the probability of early closure under different CCR scenarios.

3. Assumptions

3.1 Costs and Performance Assumptions of CCR

The assumption regarding additional proportion of costs and performance for CCR in Table 1 is based on the IEA GHG (2007) study of pulverised fuel power plants, using figures for post-combustion amine scrubbing technologies.

Unit: million euro/MW (net output)	Non-CCR	CCR essential with throttled LP turbine	CCR essential design with floating LPT	CCR essential design with clutched LPT
Total investment cost (2006)	1.2850	1.2913	1.2945	1.3220
Additional pre-investment		**0.49%**	**0.74%**	**2.89%**
Total investment for retrofit (2006)	0.3030	0.2828	0.2828	0.2807
Additional investment for retrofit (Total Investment for retrofit/Total investment costs)	**23.58%**	**21.90%**	**21.85%**	**21.23%**
Non-fuel O&M costs before retrofit (2006)	0.0585	0.0585	0.0585	0.0585
Non-fuel O&M costs after retrofit (2006)	0.1013	0.0974	0.0958	0.0948
Additional O&M costs	**73.15%**	**66.43%**	**63.73%**	**62.07%**
Electricity output change after retrofit	**-25.78%**	**-22.78%**	**-21.51%**	**-20.70%**

Table 1 Capital investment and O&M costs comparisons across different configurations of CCR in PC power plants (IEA GHG, 2007: 61-62)

3.2 Technical, Operational, Financial and Market Assumptions

Based on a detailed assessment for a power plant in South China, we assumed the operational performance, financial and market assumptions of the 600MW ultra-supercritical pulverised coal power plants as shown in Tables 2, 3 and 4. Inputs regarding future costs and prices are adjusted by the long term inflation rate. The net reductions of CO_2 per MWh electricity are assumed to be 83.1%, consistent with the IEA GHG (2007) case study on CCR plants. However, we assume the average capacity load can increase to 80% to partially offset the effect of the energy penalty. The paper also assumes that the resulting carbon reductions can provide an extra income stream through the CDM from beginning operations until 2020 and then that carbon emissions will be constrained and hence subject to a penalty after 2020.

Unit Type	Ultra Supercritical Pulverised Coal			
Installed Capacity	600 MW			
Start-Construction Timing	Jan 2009			
Construction Cycle	24 months			
Operating Life	30 years or 2010 to 2040			
Average Capacity Load	Before retrofit	66%	After retrofit	80% (estimated)
Equivalent Availability Factor	94.5%			
Power Supply Efficiency (average)	44.1%			
Emissions Factors before Retrofit	0.752 ton CO2/MWh			
Initial Capital Outlay	CNY3900/kW (2006 base, 0 salvage value) plus extra 5% working capital			
O&M costs	CNY0.236 million/MW (2006 base)			
Storage costs scenarios	CNY-50/tce (low), CNY50/tce (medium), CNY100/tce (high)			
Potential retrofitting year	2015, 2020, 2025, 2030			

Table 2 Technical and operational performance assumptions

Exchange Rate (consider forward price)	6.5 (CNY/USD), 10 (CNY/Euro)	
Corporate Tax Treatment	25% tax rate (10-year straight line)	
Base Required Return	8%	
Inflation assumption	Base	3% (applied to fixed capital, O&M, and retrofit costs)
Average Coal Prices	Base	CNY469 (2007)
	Std dev	10%
	Annual Growth	= basic inflation
Local Carbon Prices (costs after 2020)	Base	CNY80/ton (2006)
	Std dev	20% (< 2020), 10% (> 2020)
	Annual Growth	= 2 times basic inflation
Average On-grid Electricity Prices	Base	CNY312/MWh (2007)
	Std dev	2.5%
	Annual Growth	= basic inflation
Correlation (coal, carbon)	-20% (low), -80% (high)	
Correlation (electricity, coal)	20% (low), 80% (high)	

Table 3 Financial and Market Assumptions

4. Results

The stochastic cash flow model reveals that the value of CCR ranges from CNY-29.6 to +10.5 million (or €-3.2 to +1.1 million), depending on the level of CCR investment, as shown in Table 4. The economics of Essential CCR with a simple throttled LPT and Essential CCR with floating LPT are both promising; their difference is not significant as Essential CCR with throttled LPT has slightly higher mean NPV but higher standard deviation. By comparing with the non-CCR scenario we find that, although CCR investment would not be recovered if a plant is not retrofitted during its lifetime, the overall economic impact of CCR pre-investment is not significant (as shown in Figure 2).

	non-CCR	Essential CCR with throttled LPT	Essential CCR with floating LPT	Ess.CCR with clutched LPT
Capture ready pre-investment				
Mean Value		**9.6**	**10.50**	**-29.6**
Std dev		**25.0**	**33.63**	**39.2**
Std err		0.3	0.3	0.4
Power plants with retrofitting option				
Mean NPV	**620.6**	**630.1**	**631.0**	**590.9**
Std dev	**243.4**	**247.0**	**249.8**	**251.8**
Std err	2.4	2.5	2.5	2.5

Table 4 NPV of projects investment and CCR additional investment in USCPC plant (million CNY)

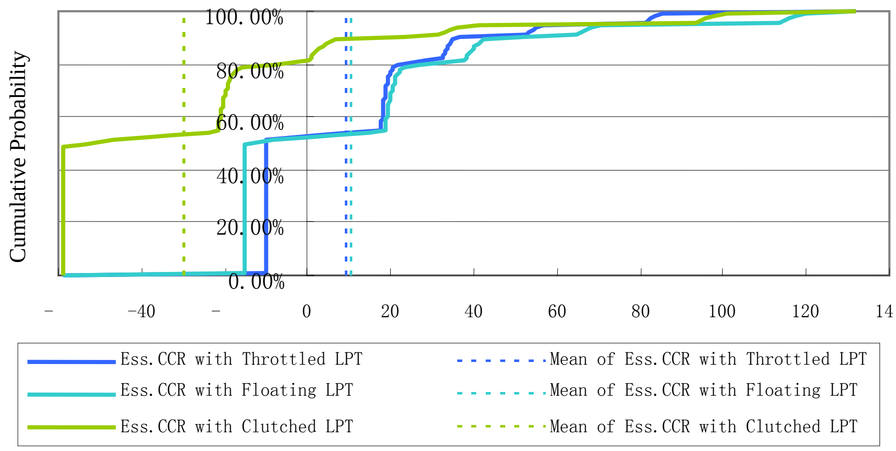


Figure 2 Cumulative probability distribution of NPV for CCR investment (million CNY)

The value of a capture option ranges from CNY113 to 144 million (€11 to 14 million), a substantial fraction (18.2% to 24.4%) of the power plants' NPV (Figure 3). By revealing the value of capture option, perhaps more importantly, we find the maximum loss at a confidence level of 99% of a non-retrofittable plant with 'carbon lock-in' can be significantly improved by enabling retrofitting options, from a loss of CNY150m (€15 million) to a gain of CNY179m (€18 million). Furthermore, by investing in an Essential CCR plant, the retrofitting option increases the maximum loss of project NPV at 99% from a loss of CNY272 (€27 million) to a gain of CNY201 (€20 million).

The significant option value found from making plants CCR to avoid 'carbon lock-in' status can be much higher than the performance benefits estimated by IEA (2007), reflecting the flexibility of an 'American' option as assumed here rather then using a fixed retrofit date. The conclusion of the IEA study, that significant expenditure beyond that required to avoid 'carbon lock-in' is not justified, still stands, however.

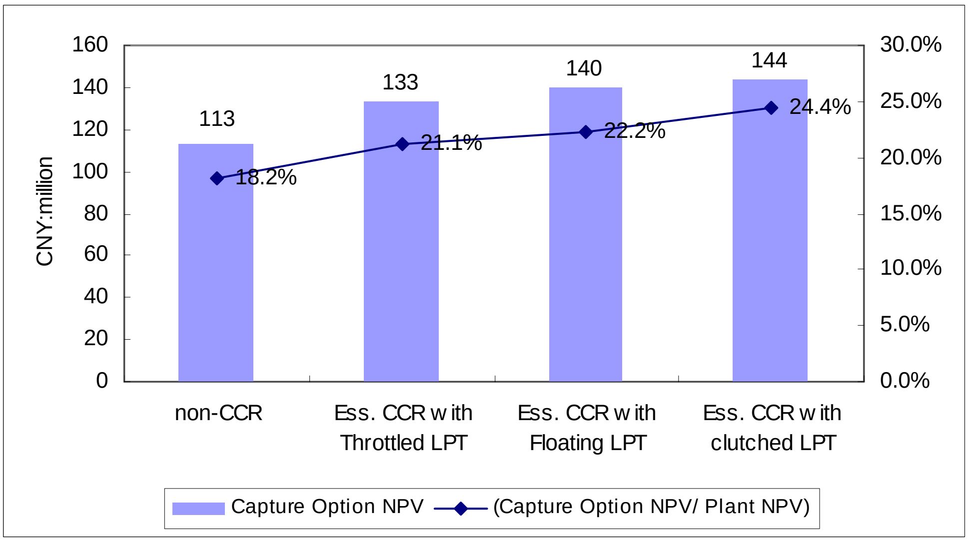


Figure 3 Value of capture options and as a percentage of total NPV of power plant

CCR increases the cumulative probability of retrofitting capture by 4.8% to 6.7% from 2015 to 2030 (Table 5). The CCR configuration also affects the probability distribution: greater investment in CCR can achieve a higher probability of capture and greater likelihood of retrofitting earlier. By investing in CCR, the probability of closing a plant prior to its design life is 6.5% to 9.8% lower (Figure 4), and consequently the value of closure option is less valuable after investing in CCR. Plant operators can decide whether to close or to retrofit CCS to cope with high carbon emissions costs. Both closure and retrofitting have higher odds of happening in 2030, 20 years after starting operation, than in 2015, 2020 or 2025.

	Non-CCR	Essential CCR with throttled LPT	Ess. CCR with floating pressure LPT	Ess. CCR with clutched LPT
2015	4.25%	5.20%	6.50%	6.30%
2020	4.44%	5.80%	5.40%	6.90%
2025	8.90%	10.00%	12.10%	8.70%
2030	26.10%	27.50%	27.60%	28.00%
Cumulative	44.77%	49.59%	50.75%	51.52%

Standard error < 0.1%

Table 5 Retrofitting probability distribution

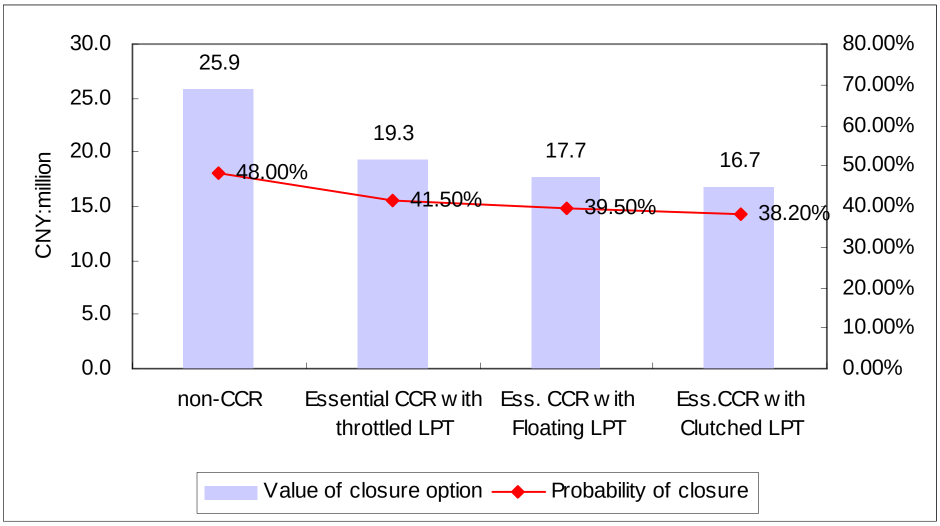
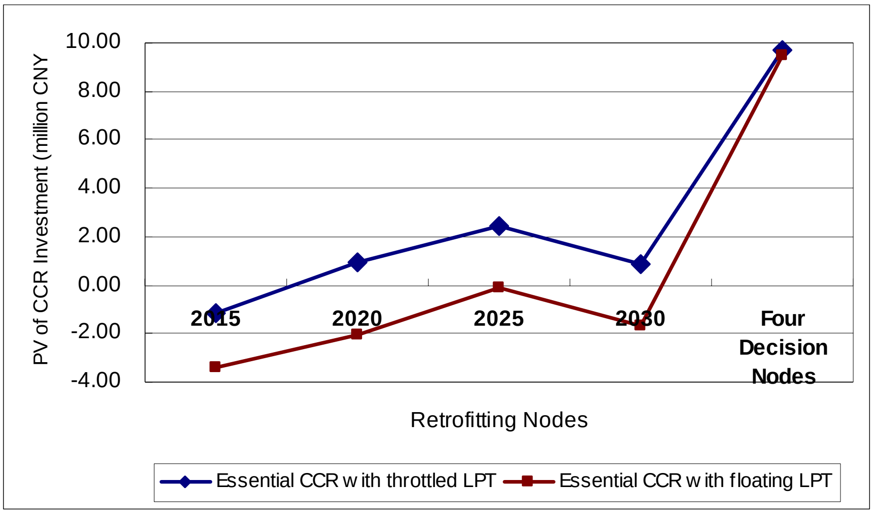


Figure 3 Closure probability and value of closure option

When we assume only a single potential retrofitting date (option) in each scenario, we find the value of CCR is significantly understated. As shown in Figure 5, some CCR investments which could be justified under the scenario of four potential retrofitting dates are not economic in the case of a single retrofitting date. In reality, a plant can be retrofitted to capture at any time during its life. As the retrofitting nodes are thus unlimited, the value of CCR using the four retrofitting options nodes assumed in our study may still be understated.



<u>Figure 4 Present Value of CCR under Single Potential Retrofitting Date Scenarios vs. the Four Retrofitting Dates Scenario</u> (This graph shows how the present value of an option to retrofit at any one of the four dates shown is more valuable than an option to retrofit at a single discrete date.)

5. Enabling CCR Via Market Based Mechanisms

CCR does not reduce emissions directly, and therefore it is not eligible to be financed through either the EU Emissions Trading Scheme (ETS) or the Clean Development Mechanism (CDM) available to developing countries. Unlike developed countries, where there is a credible possibility that governments will mandate CCS on all new coal plants in the near future (e.g. Committee on Energy and Commerce, 2009), developing countries such as China may rely on outside investors to encourage CCR, at least in the short term.

Furthermore, China is building more new coal-fired power capacity than anywhere else in the world. However, the current prospects for financing CCR domestically in China are not promising. Reiner et al (2007) conducted a survey of more than 100 key opinion leaders on CCS in China. CCR, described as a pre-investment option to ease retrofitting with CCS in the future, was recognized as an option by a majority of respondents, but about half of respondents suggested that the Chinese government should not intervene in the CCR decisions of individual projects. Industry, especially the electric power industry, was also found to be risk averse with respect to CCR investment. As a result, the chance of incentivizing CCR through existing channels, whether through the Chinese government, industry or the CDM is low in the near term.

To resolve the dilemma, Liang et al (2008) suggest that newly built fossil fuel plants, which are not currently considering CCR because of the absence of any incentive, issue Capture Options in order to finance and optimize CCR by drawing in foreign investors and others interested in this unique low-carbon investment opportunity.

6. Conclusions

Across one non-CCR and three CCR scenarios applied to a pulverised coal power plant, the ‘CCR essential (throttled low pressure turbine)’ and ‘CCR essential with floating pressure

LPT' options are the most promising, as they can be justified by positive NPV, higher retrofitting probability and a higher chance of retrofitting earlier. We find the value of CCR may be significantly understated if only considering only one or few retrofitting potential dates.

Under all scenarios the value of a capture option is significant, approximately 20% of base plants' mean NPV, therefore 'carbon lock-in' will cause plant owners to lose significant capture option value. Thus, there are sufficient market-based incentives for the modest CCR investment that avoids a plant's initial 'carbon lock-in'. In other words, in the absence of clear retrofitting strategies from both the technical and regulatory sides, making a plant CCR is an attractive investment option. To conclude, the economic value of avoiding 'carbon lock-in' can be much greater than the cost of CCR.

- *Is Carbon Capture Ready (CCR) an economically sound investment in China?*

Investment in CCR for pulverised coal-fired power plants in China can be justified on several grounds: USCPC plants with CCR have a 5% to 7% higher probability of retrofitting to capture at a later date, a 6.5% to 10% lower probability of early closure (thereby enhancing the security of the electricity supply), and a positive NPV for the additional CCR investment (for 2 out of 3 CCR scenarios). The detailed economics of CCR depends on a number of factors, including the initial design of the plant, the level of CCR pre-investment and carbon price assumptions

- *What are the implications of different CCR configurations for the economics of pulverised coal power plants?*

The paper evaluated the three PC CCR technical scenarios investigated in the IEA GHG (2007) study and found CCR with essential features and CCR with essential features plus throttled low pressure turbine or floating low pressure turbine to be more economic than CCR with essential features with a clutched low pressure turbine. It is also worth noting that a clutched turbine cannot so easily take advantage of advances in CO_2 capture plant performance (Lucquiaud, 2009).

- *What are potential mechanisms to make CCR happen in China?*

Although China is building more than 1 GW of coal power plants per week, currently, there is no immediate financial mechanism or policy available to encourage CCR in China. However, the capture option concept could finance and optimize CCR immediately. Furthermore, power generation companies who place a reasonable probability on a high carbon price scenario or are concerned about the risks of mandatory early closure for coal plants because of their carbon emissions may consider investing in CCR to avoid 'carbon lock-in' and lower early-closure probability.

Acknowledgements

We are grateful for partial financial support from the UK Department of Business Enterprise and Regulatory Reform Chinese Advanced Power Plant Capture Options (CAPPCO) project, UK-China Near Zero Emissions Coal (NZEC) project and Cambridge Trusts.

Appendix: Projects with Proposals for CO_2 Capture Ready Design

Data	Company	Activity
2005	SaskPower (Canada)	Feasibility study of Capture Ready lignite fired power plant, focus on technology and economics (Booth 2005)
2006.6	Scottish and Southern Energy (SEE)& Mitsui Babcock	Retrofit SSE's 500MW Ferrybridge Power Station in Yorkshire by installing Mitsui Babcock's supercritical boiler and turbine unit onsite to facilitate the subsequent development of post-combustion technology for carbon capture and storage (SEE 2006).
2006. 10	E.ON	Submitted a proposal to build two new 800MW coal fired power plants with Capture Ready in Kent, if successful, the plant can be operated by 2012 (Platts 2006)
2006. 11	TXU	New plan to build 9000 megawatts (MW) of coal fired capacity; it also mentioned that the new plants would have room for construction of additional equipment for capturing CO2. The plant design will consider its access to Enhanced Oil Recovery (EOR) sites for CO2 burial as well (TXU 2007)
2006	SASOL	Study the feasibility of building two 80,000 barrels per day (bpd) CTL plant in China, involves Capture Ready design (SASOL 2006).
2007.8	Barking Power	The Chequers Lane Power plant at Dagenham got a CCGT extension for being capture ready (Barking, 2007).
2008. 1	EDF	West Burton's 1270MW Capture Ready CCGT plant is now under construction (EDF, 2008).
2008.4	UMPPs	Totally nine Ultra Mega Power Projects of a capacity of 4GW each. Aiming at established the definition of capture ready plant for India, and ranking of all nine proposed projects in terms of feasible CCS option (FCO, 2008).
2008.7	CIC Energy	Mmamabula power plant will be designed as 'capture ready' by Environmental Resource Managers (ERM). It will focus on potential storage sites in Botswana. (CIC Energy, 2008).
2009.3	Dong Energy	One 800MW CCGT Power plant at Newport, South Wales. The plant is due to start Operating in 2010, which was acquired from Seven Power in March, 2009 (SEVERN, 2009).

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Liability for Climate Change:
A Decentralized Approach to Long-Term Climate Policy

Detlef Sprinz[1]

Abstract
An international agreement on deep emission reductions is unlikely to materialize in the near future. What can be done if we wish to further an ambitious long-term climate policy goal? This article proposes a liability system that starts with at least one frontrunner and allows itself to be taken to court for the damages related to its emissions. Such a system will be fully upscalable to larger liability pools, and allows the rule of law to prevent dangerous climate change to a reasonable degree. Furthermore, I suggest strict proportionality as a distributional rule to provide powerful incentives to mitigate emissions. In order to limit the challenge of time inconsistency, we need one actor to serve as the frontrunner. The EU can credibly serve this function if it chooses to do so; alternate frontrunners are welcome to join or build their own liability fund(s). Since all four components (ambitious benchmark, liability system, distributional rule, and prevention of time inconsistency) reinforce each other, it appears to be prudent to believe that we can make substantial headway towards achieving a low greenhouse gas future by the end of the century without having to rewrite politics as we know it.

1 The Challenge

The Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC) mandates ratifying industrialized countries to undertake emission reductions during 2008-2012. Given recently agreed upon scientific evidence as reflected in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change 2007a), it appears to be wise to halve anthropogenic emissions of greenhouse gases (GHG) until 2050 (German Advisory Council on Global Change 2008) and to go for a low greenhouse gas economy by the end of the 21st century. Among the major emitters, only the EU shows willingness to pursue such a challenge. An international agreement on deep emission reductions is unlikely to materialize in the near future. What can be done if we wish to further an ambitious long-term climate policy goal? This article proposes a liability system that starts with at least one frontrunner and allows itself to be taken to court for the damages related to its emissions. Such a system will be fully upscalable to larger liability pools, and allows the rule of law to prevent dangerous climate change to a reasonable degree. Furthermore, I suggest strict proportionality as a distributional rule to provide powerful incentives to mitigate emissions. In order to limit the challenge of time inconsistency, we need one actor to serve as the frontrunner. The EU can credibly serve this function if it chooses to do so; alternate frontrunners are welcome to join or build their own liability fund(s). Since all four components (ambitious benchmark, liability system, distributional rule, and prevention of time inconsistency) reinforce each other, it appears to be prudent to believe that we can make substantial headway towards achieving a low-GHG future by the end of the century without having to rewrite politics as we know it.

The paper is structured as follows. In the second section, I briefly show why climate change is a challenging long-term policy problem and why hopes for a "global deal" (e.g., Stern 2008) within the near future may be overly optimistic. In the third section, I introduce the fourfold architecture of what is needed, incl. a guidepost for a long-term target, the setup of a liability system, the distributional rule for liability and awards, as well as how to get it

[1] PIK – Potsdam Institute for Climate Impact Research, PO Box 60 12 03, 14412 Potsdam, Germany, Tel.: +49 (331) 288-2555, Fax: +49 (331) 288-2540, email: dsprinz@pik-potsdam.de, www.sprinz.org ,

started by overcoming the time inconsistency problem. A response system based on this fourfold architecture will raise legitimate doubts among policy practitioners and academics alike. In response, the fourth section is geared towards proposing a range of practical fine-tuning of the liability system. The architecture proposed will never be able to solve the challenge of preventing dangerous climate change by itself, yet the concluding section will highlight the central advantages of the proposed scheme which requires comparatively little international agreement and relies on decentralized enforcement for a transition to a low-GHG future.

2 Why Responding to Long-term Climate Change is Difficult[2]

Governing climate change is not a trivial problem. It encompasses a range of challenges, including generic ones such as intergenerational, distributional, informational, and time inconsistency issues. Superimposed on this are domestic policy problems and the challenge of international cooperation. Given that any of these challenges is not trivial to solve, we should not expect to simultaneously solve all of them as well as the interactions among them.

Adverse impacts from climate change are likely to grow over time (Intergovernmental Panel on Climate Change 2007b). Much of the atmospheric changes have been set in motion by present and past generations, but given current trends, we are unlikely to immediately switch to a low-GHG economy. The benefits of a low-GHG economy are likely to be felt by future generations, thereby not offering present generations the positive rewards of an investment into a low-GHG economy. We thus face an *intergenerational* problem. In addition, we are confronted with the distributional issue between industrialized and some industrializing countries – the latter wishing to keep open the option to substantively increase their GHG emissions as part of their development process. Furthermore, present generations may not believe that future generations will share their preferences for a low-GHG future, thereby creating an incentive not to invest now into a GHG-frugal future. It is difficult for present generations to bind future ones; and for future generations, it is difficult to bind present ones. We therefore face *time inconsistency* problems in terms of rule adherence, and the expectations mechanisms favors moral hazard among the present generation. This aspect is devoid of any aspect of lobbying for the status quo in order to pursue industrial policy, defend current markets, or favor particular groups in society.

Partially cutting across this set of challenges are the domestic politics and international cooperation issues. Put briefly, even the best internationally agreed plan can be pulled apart by the push-and-pull of everyday politics and the eagerness of most leaders to appeal to particular constituencies in return for their vote. As climate changes may often not be as high a priority item as food security for the near future (although it may very well be the case for long-term food security), requests for improving social security for particular constituents, or dealing with the next budgetary crisis, we should expect an imperfect domestic climate policy in most countries – especially if we are interested in long-term climate policy. Furthermore, the transition to a low-GHG world economy requires open or tacit collusion among the top 10 to 20 emitting countries and to a lesser degree collusion by countries embarking on adaptation (Sprinz 2001, 272-276). Based on past observations, including the Kyoto Protocol, we are unlikely to see the replication of the relative success of the efforts to reduce stratospheric ozone-depleting substances under the Montreal Protocol as well as successor agreements. It would indeed be a rare feat to see the world manage a couple of percents of world GDP collectively and harmoniously over a century for the sake of protecting planet Earth. Even the World Trade Organization is characterized by sufficient

[2] Hovi et al. (forthcoming) provide an in-depth treatment of time inconsistency, domestic politics, and international anarchy in the context of global climate change policy.

difficulty to promulgate a world of perfect international trading. Not even common markets, such as the EU, would claim this privilege. We should not expect global climate policy to easily beat well-oiled regulatory institutions such as the EU or the GATT/WTO system. The negotiations about a post-2012 climate order appear to have arrived at some stage of uncertainty or crisis. But crisis also implies opportunities, and this article sketches the outline of a strategy that circumvents a range of the problems mentioned above.

3 A Fourfold Architecture

The architecture proposed consists of four components. First, we need an ultimate goal that gives some operational meaning to the ultimate objective of the UNFCCC (United Nations 1992, Article 2). Second, I propose a liability system that compensates for damages caused by anthropogenic climate change. Third, awards through the liability system necessitate a distributional structure. I propose that strict proportionality of shares in the causing agents should guide proportionality in awards. And fourth, such a system has to come into existence by overcoming aspects of time inconsistency. I suggest that a leading actor, such as the EU or others, could set a liability system in motion that might evolve and mature over time.

First, a benchmark is needed to establish liability. At a minimum, a positive price for GHG emissions should prevail. The Kyoto Protocol succeeded in creating the difficult-to-revert belief that there will be a positive price for carbon now as well as in the foreseeable future. The governance structure of the Kyoto Protocol essentially displays all the problems described briefly in Section 2. Therefore, it is difficult to imagine that the present Kyoto architecture by itself – rather than different factors – will serve as a self-propelling and energetic incubator for a transition to a low-GHG future. A positive price for carbon or GHG emissions is, however, not sufficient. Only an ambitious long-term target can serve as a benchmark, and only the impacts caused by *deviations* from the (counterfactual) benchmark can serve as grounds for liability for "residual damage," (Verheyen 2005), i.e., damages not prevented by mitigation or adaptation.

In effect, the UNFCCC stipulates such a benchmark:

> The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (United Nations 1992, Article 2).

Interpreting this objective is a non-trivial undertaking (Ott et al. 2004). In practical terms, there is no universal agreement what this goal means and whether countries can be held accountable to fully contribute to achieving it. A voluntarily erected liability system actually does not necessitate universal agreement on Article 2, but it needs an ambitious benchmark to establish that residual damages should be avoided and otherwise be compensated. An ambitious goal such as a 2 degrees Celsius temperature change as compared to pre-industrial periods[3] or a 450ppm carbon equivalent goal may serve this purpose. There is *no* need for universal support for such a goal in legal form, just a broadly held belief that such an ambitious goal would be in line with Article 2 of the UNFCCC. It is the climate impacts associated with an operationalization of Article 2 UNFCCC which would

[3] http://europa.eu/press_room/presspacks/energy/comm2007_02_en.pdf (accessed 01 July 2008).

constitute a zero liability benchmark, and any excess damages relative to this benchmark would be considered for compensation. The damages themselves need to be caused by anthropogenic climate change, not by normal fluctuations in climate.

Second, Immanuel Kant's categorical imperative serves as a point of departure for liability for damage. As Kant stipulated:

> Act only according to that maxim whereby you can at the same time will that it should become a universal law (Kant 1993 [1785], 30).

Kant suggests that a concerned party should act in accordance with a collective goal in mind and no fallacy of aggregation exists (Sprinz 2000). If everyone behaved accordingly, there would be no need for a liability fund as everyone would be satisfied. This is unlikely to be the case for the foreseeable future as a transition to a low-GHG world economy is expected to take 25 to a hundred years. The charm of the liability fund is to entice parties to join the liability fund such that the emissions of major emitters become more broadly aligned with Article 2 UNFCCC – akin to compliance with an intertemporal Kantian categorical imperative on unwanted climate change.

Attribution of cause and effects ought to be in the hands of a neutral judicial body that has no interest whether and which amount to award. For simplicity, let us define it as the climate court. It should simply apply judicial rules and procedures to see whether there is sufficient evidence that links anthropogenic emissions to climate-induced damages.[4] If this link can be credibly established based on judicial best practice, the climate court would make an award. The effective award to be made from the liability fund would be proportional to the percentage of emission covered by the members of the liability fund. In terms of establishing cause and effect, climate change resembles liability for smoking-induced health care damages. While early warnings were issued already by the midst of the 20th century (Doll and Hill 1950), it took court cases several decades to reasonably establish cause and effect relationships and make financial awards to relevant parties[5] and to arrive at the WHO Framework Convention on Tobacco Control of 2003.[6] The rule of law and independent adjudication are at the core of a liability system for anthropogenic climate change. Awards would only to go members of the liability fund.

Third, the distributional rule used is strict proportionality. This applies to the damages covered, compensation received, and the contributions to be made. While there are many alternatives to strict proportionality considered in the climate negotiations, including work by this author (Schröder et al. 2002, 140-141), it appears that simplicity and transparency afford the greatest advantage. Proportionality over time adjusts who is liable to which degree. Until now, most industrialized countries would be disproportionally liable due to their high share of emissions. If current projections regarding an increasing share by rapidly developing countries such as Brazil, China, and India are correct, then their share of emissions will increase over time.

This would increase the percentage of contributions which these countries make to the fund. Such a system has one undisputable advantage: It rewards any country for outright mitigation, as GHGs not created cannot cause liability, necessitate no contributions to the liability fund (in the extreme case of no emissions). This rule applies to past emissions since

[4] See also Jaeger et al. (2008).

[5] http://www.naag.org/backpages/naag/tobacco/msa/msa-pdf/1109185724_1032468605_cigmsa.pdf (accessed 02 April 2009).

[6] http://www.fctc.org/index.php?option=com_content&view=article&id=22&Itemid=28 (accessed 02 April 2009).

the reference year, and also provides incentives to curb future emissions regardless of current aspirations for economic development.

The liability fund would make awards using strict proportionality.[7] As we presently consider countries (rather than consumers or individuals) to be liable for climate change, they would be held liable for the percentage of damages caused by climate change in proportion to their emission share since a specific reference year. For example, if the EU were responsible for 17% of worldwide CO2 emissions since 1990 (reference year for emissions in the UNFCCC), then the EU were liable for 17% of the anthropogenically induced climate damages occurring after 1990 (see Figures 1 and 2 for illustration). The same rule applies to all other countries. Alternative reference years could be 1992 (the opening for signature of the UNFCCC). The parties to the UNFCCC, which enjoys close to universal support, have explicitly endorsed both reference years, and it is the integral of emissions since the reference year (minus potential depreciation of GHGs due to atmospheric processes) that creates the basis for counting cumulative emissions. In order to become a plaintiff, the country of the plaintiff has to join the liability fund, and make payments to it in proportion to its intertemporal integral of emissions since the base year. The liability fund thus takes care of the disparity of shares in emissions and shares in damages and provides an overall incentive for emission reductions. Those actively expecting a net transfer in their favor will likely join such a fund, others are more likely to abstain in the beginning. In order to have some funds at its outset, a major emitter needs to join the liability fund. Proportionality of coverage of cumulative emissions translates into identical proportions available for compensation. If this fund covers 40% of worldwide emissions since the reference year, it would only make awards equivalent to 40% of the damages and self-indemnify from the remaining 60% of damages by pointing plaintiffs to the actors responsible for the uncovered damages. This procedure limits the threat of immediate insolvency and a run on the fund, besides the length of time needed for the adjudication of the case. If the damages from smoking are any guidance, it will take several decades for court decisions to award compensation. In the meantime, the fund could be build up to relevant size.

Fourth, the time inconsistency problem has to be restrained. In their Nobel-prize winning work on time inconsistency, Kydland and Prescott (1977) demonstrate that optimal choices at one point in time may be at odds with optimal choices at future points in time. Policies may be designed such that one policy rule is administered in the first period, e.g., encouraging low emissions. However, at a later point in time, it may be the best policy to actually permit high emissions. More generally, governments are tempted to renege on earlier promises given changes in circumstances. “The suboptimality arises because there is no mechanism to induce future policymakers to take into consideration the effect of their policy, via the expectations mechanisms, upon *current* decisions of agents” (Kydland and Prescott 1977, 481). Naturally, the challenge of time inconsistency applies to long-term climate policy.

A prominent way to escape this challenge is to essentially tie one’s hands irrevocably to an ambitious goal and have an institutional setup that does not allow for easy departure from the path chosen earlier. Thus, the need for a credible frontrunner arises who irrevocably wishes to lead in terms of aiming at a low-GHG future while contributing the kernel of a liability fund of credible size to demonstrate its sincerity. At this point in time, the EU may be the only group of countries of substantial size that has a long-term ambition (2 degrees Celsius goal),[8] prepares for unconditional emission reductions (20% by 2020 as compared to

[7] The valuation of economic damages is worth a separate treatment. Due to space limitations, this cannot be accomplished in an architectural sketch.
[8] http://europa.eu/press_room/presspacks/energy/comm2007_02_en.pdf (accessed 01 July 2008).

1990), and aims at halving its emission by the middle of this century.[9] In addition, the EU has created a carbon market for roughly half its industrial emissions and the income generated from auctioning all permits could serve as the contribution to the liability fund. Any other country is encouraged to join, but there may be little competition to be the first mover. As awards are only given to plaintiffs whose countries are members of the liability club, plaintiffs will induce their countries to join.[10] Countries abstaining from joining a mutual liability fund would remain politically vulnerable to being sued directly through their own court system (e.g., the USA) or in other international fora of the UN system (Sprinz 2005; Ochs and Sprinz 2008).

What should the liability fund actually fund? Since mitigation is the central action variable to reduce one's contributions to the liability fund, only adaptation and compensation for residual damage remain as potential purposes. In effect, adaptation and compensation for damages not avoided are essentially two different forms of compensation related to damages. Funding for adaptation is transferred in anticipation of damages, compensation (in the narrow sense) is awarded ex post. The plaintiffs are entitled to compensation for damages proportional to the aggregate emission share of countries covered by the liability fund, and they could use it for adaptation measures or outright compensation. This, however, assumes that we have infinite time to spare when making awards. Given reasonable anticipation, funds sent by countries covered by the liability fund to potential plaintiffs, e.g., for adaptation measures, should be considered prepayments under a potential settlement. To make sure that resources are left for ex post compensation for climate impacts not avoided, at least 50% of the liability fund should be held back for ex post adjudication to avoid that plaintiffs do not sue a fund that already exhausted its resources. This rule also limits the temptation to buy political allegiance under the guise of climate adaptation.

4 Challenges to the Architecture

Readers may consider this architecture to be insufficient to assure that the world will avoid dangerous climate change. This may indeed be the case, yet many alternative architectures share this fate (Aldy and Stavins 2007). Rather than consider complex schemes, I propose Shaker architecture. The proposed liability fund does not rely on elaborate interstate negotiations, yet is fully upscalable to universal membership. The liability architecture requires at least one frontrunner who is willing to expose itself to limited liability, but the architecture is indifferent about the identity of the frontrunner. Under ideal circumstances, such as perfect anticipation and procedures, the architecture proposed achieves full compliance with an ambitious interpretation of Article 2 and need not make awards: Countries would make appropriate emission reductions and avoid liability. If the outcomes are less benign, damaged parties are left with a good chance for actual compensation.

The architecture proposed so far should be augmented by a range of finer points to understand its basic working and make it robust against some likely challenges. These points are addressed in a question and answer format.

Who Will Serve as The Plaintiff?

The law normally operates either by (i) perfect adherence by parties covered under the law or (ii) the courts dealing with infringements on the law. Since there is little expectation that countries are currently on the way to universal implementation of an ambitious interpretation of Article 2 UNFCCC, it is not far-fetched to expect that some actor will seek redress for climate-induced damages. But who shall be entitled to claim damages?

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[9] http://register.consilium.europa.eu/pdf/en/07/st07/st07224-re01.en07.pdf (accessed 02 April 2009).
[10] If nobody sues the liability fund, the contributions could be repaid.

I suggest that any person should be able to make a case for compensation, provided some minimum criteria are met for the sincerity of the case. A pre-screening procedure of the climate court should weed out frivolous cases in order to avoid clogging the judicial system. While anyone or groups of persons or entities (incl. countries and groups of countries) can sue and potentially win cases, awards should be reserved for persons or entities in member countries of the liability fund. Persons or entities in the frontrunner country are equally entitled to sue and receive awards.

This procedure allows the climate courts to start considering questions of cause and effects – which are likely to take more than a decade. The requirement for plaintiff's country being a club member of the liability fund provides incentives for plaintiffs to induce their country or countries to join the liability fund system.[11] As a result, the liability fund system is likely to grow beyond a committed frontrunner.

What Happens If There are Different Interpretations of Article 2 UNFCCC?

Assume a world without universal agreement on the meaning of Article 2 UNFCCC with respect to a zero liability benchmark. Would there be scope for multiple liability funds?

Given our current understanding of the climate system and our future preferences, we are unlikely to arrive at a universally agreed upon interpretation of Article 2 UNFCCC now or in the foreseeable future. But this does not have to be harmful. Our world has different product standards, lives with different laws, and has different economic, political, or social ambitions. Thus, we should expect that more than one liability fund emerges. Let them compete! Some countries may prefer a 350 ppm equivalent goal (Hansen et al. 2008) whereas others may prefer a 450 or 550 ppm equivalent goal. Member countries would self-select into liability funds with different ambitions, may become members of multiple funding systems, and can engage in merger and acquisition agreements between liability funds. Will the "law of the least ambitious program" - the survival of the fund with the least ambitious interpretation of Article 2 UNFCCC - become observed reality (Underdal 1980, 1998; Hovi and Sprinz 2006)?

The outcome depends on the position of the *most* ambitious party that creates a specific liability fund. If it is of sufficient size, it may attract particularly climate-vulnerable parties to join it. Domestic budgetary oversight or competing claims for funds by domestic constituents will quickly limit costly membership in too many liability clubs. But what happens if the most ambitious fund opts for a very unenthusiastic goal, such as 1,000 ppm carbon equivalent goal? If the most climate-friendly country is very unambitious, then there may be no need to care for long-term climate-related damages. To instill more optimism, a liability fund could also be created by interested private persons or private entities (such as charitable foundations), and countries could join private frontrunners. Given the current realities in world politics, it is very likely that at least some financial, societal, or sovereign actor is willing to purse a somewhat ambitious interpretation of Article 2 UNFCCC.

What Happens If a Country Leaves The Liability Fund?

Some countries may be willing to join the fund early on in the expectation that high damages and small premiums will benefit it in the early phase of the fund's life, but that GHG-intensive development plans provide incentives to leave the liability fund after the first awards. These expectations may indeed be realistic. What can be done to keep countries from exploiting the liability fund by way of the timing of membership?

[11] For regions without universally accepted sovereignty or a permanent population (such as Antarctica) a trustee solution will be created.

Membership in a law-abiding system that takes decades to grant awards can be expected to have norm-establishing and socializing functions. But even if it does not, there is no need to make awards in the form of one-time payments. Ex post compensation can be awarded similar to an infinite interest payment for bonds, thereby lengthening the horizon of a party that may otherwise cancel its membership. But even if a party leaves liability fund A to join fund B or to leave the liability system completely, there is scope to limit the gaming of membership: Cancel all undisbursed payments to the party leaving the liability fund, reduce the coverage of the overall fund by using the proportionality rule, and make renewed membership conditional upon immediately paying up for previously uncompensated obligations for emissions. The latter mechanism serves as a membership fee that is not charged on permanent members. During periods of non-membership or membership in less ambitious liability funds, countries would become politically vulnerable. Conversely, if they abandon less demanding liability funds in favor of more demanding liability funds, they become less politically exposed.

What is The Role of International Agreement?

No international agreement is needed. The liability system relies on a frontrunner to come into existence. The only guidance needed is Article 2 UNFCCC, i.e., prevention of dangerous climate change, and nearly all countries have already subscribed to this norm. Potential merger and acquisition (M & A) among rival liability systems may necessitate standard commercial negotiations among M & A partners – besides due diligence. While unified international standards may solve coordination problems, a variety of liability funds may help solve the participation problem.

What is The Role of Science?

There is considerable scope for the role of science, and a liability system actually serves as a test of the credibility of science. In this context, science is understood to be all knowledge generating systems that links causes (emissions) and effects (climate damages), quantifies the effects, and parcels the effects out to relevant causal mechanisms. Without these three aspects of knowledge, the liability system cannot work. Fundamentally, the judicial system will adjudicate climate cases similar to the case of smoking and health- related research, i.e.,

- whether GHG emissions will lead to adverse effects,
- how and in which measurement units damages will be calculated, and
- which part of the assessed damages in a particular case (e.g., storm-related destruction of a large forest) can be attributed to anthropogenic climate change and which part shall be attributed to other causes (see Jaeger et al. 2008).

Those parts of damages which cannot credibly be linked to anthropogenic GHG emissions should be settled through means other than the climate liability fund.

The fact that science often does not speak with one voice should not pose a special problem. There are competing theories of why individuals undertake crimes, and the courts were and remain able to adjudicate cases of murder despite changes in science and its fashions. There is no reason for climate change to pose a new challenge to lawyers. The complexity involved may suggest that climate courts should be able to draw on specialized expertise, but the same is true for any other novel category of court cases.

In many respects, a liability system is a vote of the confidence by lawyers on the science of climate change. Two aspects matter in this context: means and variance. If confidence is below the threshold needed for the award of compensation through the climate courts, then the mean award should be zero. Beyond the threshold of confidence, the awards should be positive. The more exact the knowledge provided by the scientific sector, the lower the variance to be considered in the awards. At the upper end of confidence, we could have awards with zero variance. Zero variance is unlikely to be accomplished in the foreseeable future, but advances of science should allow the variance to be narrowed over time.

Why is a Frontrunner Needed?

A frontrunner of non-trivial size is needed to establish the liability fund. Ideally, the largest cumulative emitter should serve as the founder of the liability fund as it assures potential plaintiffs a sizeable enough award to be worth its country's membership as well as the pursuit of a court case. For practical reasons, the founder or founding group should ideally cover 10% or more of cumulative emissions. The USA, China, and the EU qualify for such a role. The EU appears to be the most suitable candidate at this point in time, but any other coalition with an ambitious interpretation of Article 2 UNFCCC is welcome.[12]

How Can The Credibility of The Liability System be Assured?

There is no guarantee that the liability system will come into effect, and there is no guarantee that the system – once erected – will remain credible. To limit the first challenge, a credible frontrunner has to be found who pursues the project as a private good even while creating global public benefits. The second challenge can be addressed by a Political Climate Exchange.

The Council of the EU has decided in March 2007 to pursue an unconditional emission reduction of 20% of GHGs by 2020 as compared to 1990, irrespective of the ambition of other countries.[13] Current efforts at creating a climate and renewable energy program are meant to add credibility to this political goal. Why the EU is willing to advance an ambitious goal until 2020 and pursue halving its emissions by the middle of this century remains somewhat clouded. The EU may test its authority as an aggregate vis-à-vis its member states, may be willing to show world leadership on an issue it cares for while having a reasonable chance to implement its past promises under the Kyoto Protocol (European Environment Agency 2007), or may have other reasons for pursuing its ambitions. To make the degree of credibility of the frontrunner's resolve transparent and to assess the credibility of the liability system over time, it would be desirable to create a Political Climate Exchange (PCX).

The PCX would trade assets similar to those found on the Iowa Electronic Markets.[14] Rather than offering bets on who the next US president will be or which monetary policy decision the US Federal Reserve Board will take in the near future, the PCX could offer future trades with different maturities whether the frontrunner will comply with its announced goal. Prices of 100 units would signal 100% trustworthiness, a price of 0 units would signal complete untrustworthiness. As long as sufficient liquidity is guaranteed via market makers, strategic interventions by influential actors curbed, and insider trading avoided, the PCX could signal the resolve of the frontrunner. In addition, this system could later be applied to the liability system at large. The point is to make transparent to all interested parties whether a liability system and the policies of frontrunners are credible and when crises of trust ensue. Ratings of sovereign bonds by rating agencies fulfill the same function – with all the known imperfections. In essence, information markets would substitute for political access to

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[12] Scholars of international relations will think of hegemonic stability theory and the provision of global public goods (see (see Keohane 1984; Kindleberger 1986; Olson 1971). The good provided here is potentially global in scope but in fact a club good: Only members of the liability fund are eligible for awards. The phasing of disbursement of awards makes the execution of the exit option less likely as compared to a situation with a cost-free exit option.

[13] http://register.consilium.europa.eu/pdf/en/07/st07/st07224-re01.en07.pdf (accessed 02 April 2009).

[14] http://www.biz.uiowa.edu/iem (accessed 02 April 2009).

decision-makers by the few. The liability fund should be audited by at least three accounting firms to limit conflicts of interest, with rotation of auditors after 5 or 10 years. The audits should be made available to the public as well as the responses by the PCX's management.

How Can The Architecture be Made Universal?
The architecture is universal and fully upscalable. The liability fund, once erected, can grow with the help of new members. Plaintiff's countries have to become club members before awards can be disbursed, thereby inducing growth in membership. The fund is upscalable to complete membership of the UN membership system, and in this case, the awards would cover nearly all anthropogenic emissions. As membership grows, a governance system has to be created. It should resemble those of stock exchanges, not that of the UN system. In effect, the credibility of the management of the liability fund would be reflected in the PCX quotes. As there is no necessity to have just one liability system, I would expect competing systems to emerge, with some of them offering gold standards and others only silver or bronze standards for management and their ambitions to curb climate change. Their respective price quotes should reflect the differences in products offered.

How Can We Deal with Parties Claiming Repeat Damages?
Climate change is an enduring challenge, not a one-time problem. The liability fund is created with a perspective towards long-term operation. It is funded on the basis of cumulative emissions over time, and it shall make awards for cumulative anthropogenic climate damages. Assume in a thought experiment that the same cumulative emissions trigger damage X at time t_0 and a different damage at t_1. An insurance would normally be entitled to cancel an insurance plan after settling a claim for t_0. Given that we know considerably little about cumulative climate damages and substantial inertia in the climate system (even if we reduced GHG emissions to zero overnight), liability should cover damages. Given that the liability fund cannot exclude cumulative damages by design, it should be allowed to make deductibles to limit damages at t_0 and at t_1 at the latest. In effect, the climate courts could stipulate that some part of the award at t_0 has to go to adaptation measures to limit the damages at t_1. Insurance for earthquakes, such as the California Earthquake Authority, mandates deductibles to align the interest of the insured with that of the earthquake fund and avoid moral hazard by the insured. Adaptation funding granted in advance of settlements could be transformed into prepayments for later awards. Thus, there would be a proper nexus between adaptation funding for vulnerable areas and ex post compensation for unavoided damages, using the former as prepayment towards the latter.

Is a Liability Fund Politically Realistic?
Whether a sovereign entity (or any other credible actor) is willing to bind itself for centuries to come remains an open question. States are organizations build originally for eternity with long-term dependence of the rulers on the ruled or its selectorate, i.e., those factually keeping rulers in power or replacing them with alternative rulers (Bueno de Mesquita et al. 2003). By this benchmark and several millennia of experience with political organization, cautious optimism is warranted. Nothing qualitatively new is required of countries, private actors or other actors in the creation of a long-term liability system.

What are The Ulterior Motives for a Climate Liability Fund?
In essence, selfishness on behalf of the plaintiffs and limited altruism if not selfishness on the part of the frontrunner are needed to create a global public good. While human organization can always lead to undesired and counterintuitive consequences (e.g., liability for gynecologists may lead to a reduction in medical assistance to those wishing to deliver

babies), it is conceivable that a climate-related liability system will encourage strong mitigation and reserve a minor role for litigation. In this case, the expectations mechanism would have achieved the desired goal. In the case of a substantial role for liability, making excessive awards would certainly run the system bankrupt. This would be properly picked up by the PCX. Judges aware of such a possibility and with a mind on their future employment are likely to keep an eye on the tradeoff between actual damages, putative fines, and the liquidity of the liability fund. And even if such a system were to undergo bankruptcy, members of a successor liability system could treat past contributions as a prepayment to a successor liability fund. At best, selfishness would propel strong mitigation while insuring damaged parties that they will not be left alone if mitigation is less than perfect.

5 The Case for Decentralized Responses

Carbon-labeling of foods is emerging, organic food has acquired substantial market share in several countries despite unproven health effects and a premium on prices, and some industries consider carbon neutrality. Even a whole industrialized country such as Norway has proposed to become carbon-neutral by 2050.[15] Thus, there is enthusiasm for a more climate-friendly future, and we have some reason for cautious optimism. An ambitious "global deal" appears unlikely to emerge in the near future due to a variety of simultaneous challenges. Instead, a simple, decentralized system of liability funds could take over some of the challenge to avoid dangerous climate change.

Long-term climate policy needs a reminder why it is useful and for whom. Once financial power is given to those facing damages, the emissions side will be reminded of its exposure. A liability system by itself is unlikely to deliver avoidance of dangerous climate change, but it can

- establish a well-known social mechanism of compensation for damages based on the polluter-pays principle,
- it is fully adjustable to various levels of the maturity of science,
- the architecture outlined here does not require international agreement,
- invites the damaged to become part of a permanent liability club while erstwhile recipients may become net contributors later,
- signals powerful incentives to mitigate,
- it furthers the rule of law in all member countries as well as among sub-national and trans-national plaintiffs, and
- we have considerable experience with most of the components needed.

The system outlined here does not require new preferences, a new world order, global agreement, a green consciousness, political correctness, or other characteristics. It simply requires appropriate allocation of property rights, business sense, legal experience, and a politically courageous frontrunner. Keep it simple, and let a frontrunner step forward!

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[15] http://www.regjeringen.no/en/dep/smk/primeminister/Prime-Minister-Jens-Stoltenberg/Speeches-and-Articles/Speech-at-Trafalgar-Square-London/Speech-to-the-congress-of-the-Labour-Par.html?id=463749; http://www.regjeringen.no/en/dep/smk/Whats-new/News/2007/The-Prime-Minister-sets-new-climate-goal.html?id=463791 (accessed 02 April 2009).

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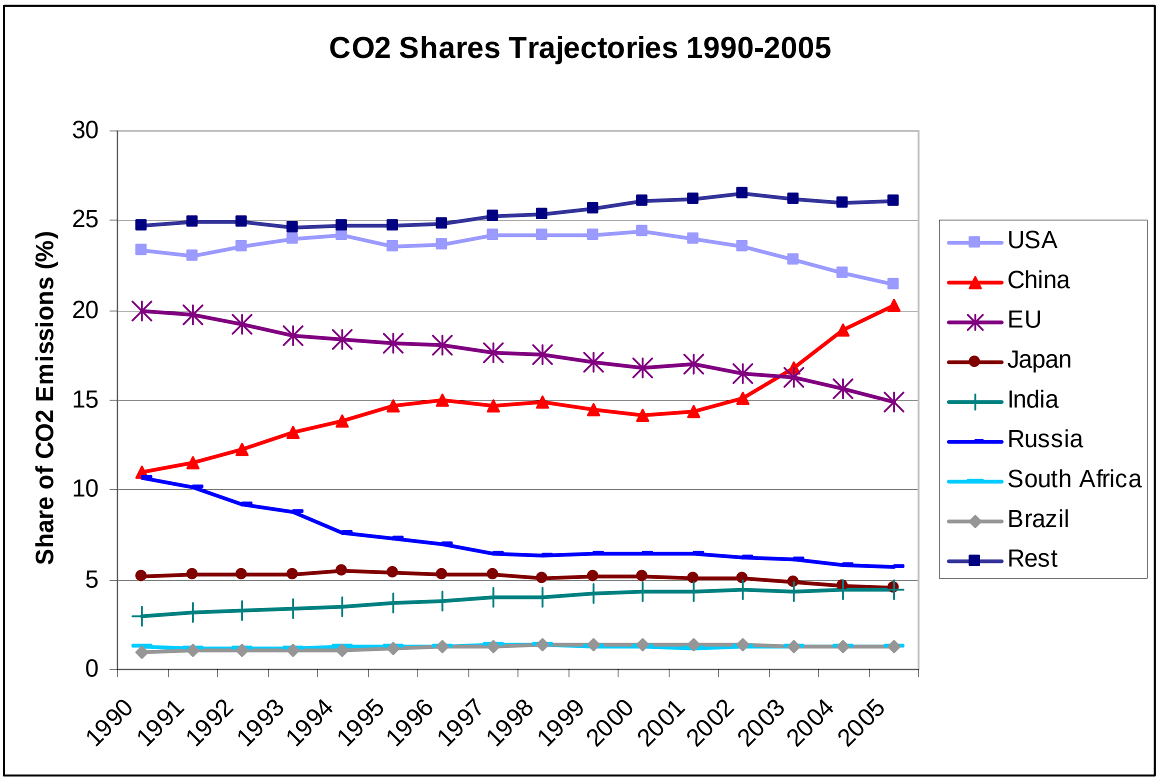
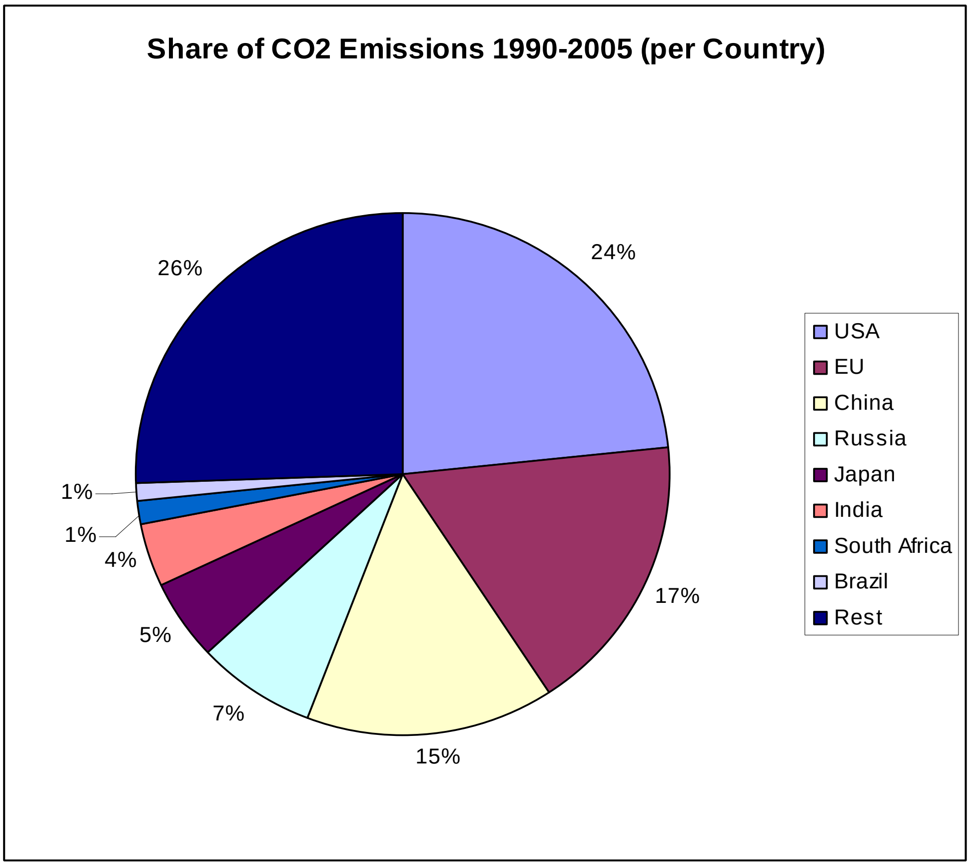
<u>Figure 1:</u> CO2 Shares of Major Emitters (1990-2005)



<u>Source:</u> Climate Analysis Indicators Tool (CAIT) (2009).

<u>Figure 2:</u> Share of CO2 Emissions (1990-2005)



<u>Source:</u> Climate Analysis Indicators Tool (CAIT) (2009).

Do All Roads Lead to Copenhagen?
The Case of China's Participation in The Post-2012 Climate Change Regime

Dr. Ho-Ching Lee[1]

Abstract

Climate change is a global challenge and requires a global solution. In late 2007, governments adopted the Bali Roadmap, launching negotiations toward a new global climate agreement. Among nations with large CO2 emissions, only China, sustains a rapid economic growth dependent on the expanded use of carbon-intensive coal. The role of China in post-Kyoto climate negotiations is therefore critical to the international effort to combat climate change and global warming.

In fact, China ratified the UNFCCC in January 1993 and was among the first ten countries to become Convention Parties. Over the years, China has been actively participating in climate change regime and has taken a multiple-track approach in climate change negotiations, including the UN Convention/Protocol hard law path, the APP partnership, multilateral and bilateral climate cooperation agreements, G8 and APEC processes and more recently, the US-led Major Economies Meetings.

China's FCCC/Kyoto Protocol participation draws largely from the previous experience of participating in the Montreal Protocol on substances that deplete ozone layer. To China, participating in climate change negotiations is a legitimate access to assistance and technology. Institutionally, China's led agency in climate change affairs has been shifted from China Meteorological Administration (science), Ministry of Environmental Protection (environment) to Ministry of Foreign Affairs (diplomacy) and National Development and Reform Commission (economic interests).

Internationally, China's multiple-track approach further raises its profile and boost negotiations for the post-2012 regime both inside and outside the UN process. The question that what does China want from the post-Kyoto climate policy depends entirely on how urgent China perceives climate change to be, and how badly it wants the world to agree a solution to the problem.

Introduction

Global environmental and ecological problems have been around for centuries. Among them, climate change has recently entered the center stage of global agenda. It is global in scale, including regional and local impacts that lead to melting glaciers, sea level rise, abrupt weather, and weather extremes. Human activities; mainly burning of fuels, and land use practices are increasing the atmospheric concentrations of greenhouse gases and causing warming of the climate system. It is evident in the IPCC Fourth Assessment Report (2007) that global warming is "unequivocal" in global average air and ocean temperatures. Eleven of the last twelve years (1995-2006) rank among the twelve warmest years since 1850. More specifically, the average temperature of the Earth's surface has increased by 0.74 degree Celsius over the past century, from 1906 to 2005, and is expected to further rise by 1.1 to 6.4 degrees Celsius by the end of the 21st century.

This human-induced global warming is a global challenge and needs to be addressed by globally coordinated policies. Under the United Nations (UN) mechanism, the Framework Convention on Climate Change (FCCC), and the Kyoto Protocol have been signed in 1992 and 1997 respectively as legal instruments. Based on the ozone negotiations, climate negotiations take a convention/protocol approach by setting up a general framework first and

[1] Professor, Center for General Education, National Central University, 300 Chong-Da Road, Chung-Li, Taiwan (32001), email: hoching.riverclear@gmail.com.

calling for specific emission reduction targets. The Kyoto Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities." Furthermore, the Kyoto Protocol requires the industrialized states (primarily OECD countries and economies in transition) to reduce their emissions 5.2% in average as compared to 1990 levels by the 2008-2012 commitment period.

This group of countries, also called Annex I countries, must first take domestic actions against climate change. At the same time, the Protocol allows them a certain degree of flexibility in meeting their emission reduction targets through three market-based mechanisms. Emission Trading (ET) is known as the carbon market, and the Joint Implementation (JI) and Clean Development Mechanism (CDM) are project-based flexible mechanisms which feed the carbon market. JI enables industrialized states to carry out joint projects with other developed countries (usually countries with economies in transition); while the CDM involves investment in emission reduction projects in developing countries.

Since the beginning of 2006, the estimated potential of emission reductions delivered to the CDM pipeline has grown rapidly to 2.9 billion tones of carbon dioxide equivalent, or the combined emissions of Australia, Germany and the United Kingdom. Overall, based on the essential CDM statistics provided by the UNFCCC web page (http://cdm.unfccc.int/Statistics/index.html), about 1,665 CDM projects have been registered as of June 2009, with around 4,200 more in the project pipeline.

Unlike the Annex I countries under the Protocol, China and other developing states (also called Non-Annex I countries) are not currently committed to reduce emissions by the 2008-2012 period. In terms of emissions statistics taken from the position paper titled "China's Policies and Actions for Addressing Climate Change," from 1904 to 2004, carbon dioxide emissions from fossil fuel burning in China made up only 8 percent of the world's total over the same period, and cumulative emissions per capita ranked 92nd in the world. China's carbon dioxide emissions from energy consumption in 2004 totaled 5.07 billion tons.

However, according to a report conducted by the Netherlands Environmental Assessment Agency, China overtook the US in 2006 as the world's biggest emitter of carbon dioxide and the greenhouse gas blamed for the bulk of global warming. A similar report was released in 2008 by UC-Berkeley showing that China overtook the United States as the leading emitter of carbon dioxide about a year ago. Its emissions are now increasing about 10 times faster than in the United States. The current high level of emissions, negative impacts of climate change, a growing concern for environmental improvement, the business opportunities from finance, and technology are major forces at play in shaping China's climate change positions.

Over the years, China and other developing states have been evolved into a voting bloc, expressing specific interests, positions, and ideas. Recognized as the Group of 77 (G77, in fact consisting of over 130 member states now), China and G77 have led in linking environmental protection and economic development, stressing the environmental degradation caused by poverty. The right to development, ongoing industrialization process, rapid increase of energy consumption, and the heavy dependence on coal make it rather difficult for China to reduce emission reductions.

From Bali, Poznan to Copenhagen

In December 2007, at the 13th Conference of the Parties (COP 13) to FCCC held in Bali, Indonesia, governments adopted Bali Road Map towards a new agreement to replace the Kyoto Protocol after it expires in 2012. Throughout the COP 13, divisions between the UA and the EU, along with developed and developing states over the need for binding targets from the Non-Annex I countries almost collapsed the negotiation. India, backed by China and other G77 members, asked that mitigation actions by developing states be linked to financial assistance, technology transfer and capacity building, a move opposed by the US. As the conference dragged on an extra day, there was a dramatic twist.

The Papua New Guinean delegate directly asked the US delegation that "the world is waiting for the US to lead but for some reason if you are not willing to lead, leaving it to the rest of us. Please, get out of the way." The US delegation leader then took the floor, and in an unexpected U-turn, stated that the US would indeed join the global consensus. After a moment of shock, the convention hall erupted in applause, and finally, the Bali Road Map was adopted, setting an ambitious goal of achieving a new global climate agreement in December 2009 at the COP 15 in Copenhagen.

The midpoint conference, or the COP 14, was held in Poznan in December 2008. Governments were taking stock of the progress made since Bali, discussing various proposals that had been proposed and adopted work plans for 2009. On a more political level, Poznan is the final round of positioning by governments before heading into a period of intense negotiations. In general, there are four key issues (or building blocks) to be addressed: mitigation, adaptation, finance, and technology. Among these, some of the most pressing issues include: the emission reduction targets to be adopted by developed countries; the type of mitigation actions to be taken by developing countries, particularly China, India, and other major emerging economies; and the types and level of support to be provided to developing countries for both mitigation and adaptation.

Throughout climate change negotiations, China has taken actions to address climate change with the following principles:

1. Sustainable Development
   For China, climate change can only be addressed within the framework of sustainable development. In this sense, climate change is not only a scientific debate, but also a development issue.
2. Common but Differentiated Responsibilities
   The Article 3.1 of the FCCC is the cornerstone of climate change negotiations for China. Both developed and developing countries are sharing these responsibilities, but the developed countries should take the lead in emission reductions. The Bali Action Plan also calls for "a shared vision" for long-term cooperative action, but China continues to maintain the legal distinction between Annex I and Non-Annex I countries by stressing this principle.
3. Mitigation and Adaptation Strategies
   China thinks that "deceleration is a long and arduous challenge, while adaptation is a more present and imminent task." At this time, adaptation is necessary, inevitable, and currently taking place. Both mitigation (domestic emission reductions from the sources) and adaptation to climate change go hand in hand in China.
4. Access to Finance and Technology
   Taking part in the Kyoto Protocol provides access to financial assistance and technology transfer from the developed countries. China has become the largest recipient country in CDM projects. At the COP 14, China called for a Multilateral Technology Acquisition Fund and the financing for adaptation to be "predictable and stable, new and additional, and adequate and timely." The Kyoto approach offers a special channel to accelerate the development of renewable energy.

Internationally, US climate change policies and actions will have impacts on Chinese responses. The US withdrew from the Kyoto Protocol when the Bush Administration turned its back on emission reduction target of 7%. From 2001-2008, the largest cumulative emitter—US was absent from compliance under Kyoto regime. Without the US at the table and prepared to negotiate, a new international agreement is very unlikely. Due to the change of Administration, President Obama now engages more actively in climate negotiations and calls for a federal cap-and-trade system to reduce emissions to 1990 levels in 2020, and another 80% by 2050.

What roles will the US and China play in reaching a new global agreement? What are realistic expectations for Copenhagen in 2009? For the US, any binding new international agreement must be ratified by the Senate. It would be important for the Obama Administration to consult closely with the Congress in shaping its negotiating positions. And for China, as the spokesperson for the developing bloc, committing to a specific target in Copenhagen would be difficult. A more realistic outcome may be an agreement on the basic architecture of the post-2012 climate change framework with binding economy-wide targets for developed countries; policy commitments for the major emerging economies (such as China); and support mechanisms for technology, finance, and adaptation capacity-building in developing countries.

China's Action to Address Climate Change

China has actively taken part in the FCCC and Kyoto Protocol. In line with the reporting requirement, China has completed and submitted its national inventories of greenhouse gases. A National Plan for Coping with Climate Change was released by the Chinese government in June 2007. Furthermore, the 11th Five Year Plan sets up the mandatory goals to achieve 20% energy efficiency improvement by 2010 from 2005 baseline and 10% key pollutant reductions. On the development of renewables, a target is set to raise the percentage of renewable energy in primary energy supply to 10% by 2010. So far, China has not yet taken any binding emission reduction targets and may not take any reduction targets for the next round of negotiations.

As a power on the rise, China has taken a multi-track approach in climate negotiations. The most important legal instruments addressing climate change would be the FCCC and Kyoto Protocol under the United Nations framework. They have laid the legal foundation for further mitigation and adaptation plans. They have also encompassed some highly technical negotiations over mechanisms for locating funds from carbon trading to mitigation projects, and over reducing emissions from deforestation and degradation.

The Asia-Pacific Partnership on Clean Development and Climate (APP) is another ongoing track addressing global climate regime. It is an innovative new effort to accelerate the development and deployment of clean energy technologies. The APP is currently made of seven partner countries: Australia, Canada, China, India, Japan, Korea, and the United States. These seven countries have agreed to work together along with private sector partners to meet goals for energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction. The Partnership focuses on expanding investment and trade in cleaner energy technologies, goods, and services in key market sectors. The Partners have approved eight public-private sector task forces covering: aluminum, building and appliances, cement, cleaner fossil energy, coal mining, power generation transmission, renewable energy, and distributed generation and steel. Overall, the seven partner countries collectively account for more than half of the world's economy, population and energy use, and they produce about 65 percent of the world's coal, 62 percent of the world's cement, 52 percent of world's aluminum, and more than 60 percent of the world's steel.

For the past few years, climate change has been placed up-high on the G8, Asia-Pacific Economic Cooperation (APEC), East Asia Summit (EAS), and Boao Forum for Asia sessions. At the same time, endorsed by G8 leaders, a US-led effort—Major Economic Meeting (MEM) is now shaping up as an alternative negotiation track to address climate change. Representing the FCCC secretariat, MEM is made of 17 major economies: Annex I countries including Australia, Canada, France, Germany, Italy, UK, EU, Japan, Russia, US and Non-Annex I countries such as Brazil, China, India, Indonesia, Mexico, South Korea and South Africa. The MEM is significant in the fact that in 2005 it is accounted for 87% of world GDP, 64% of world population, 80% of world primary energy consumption, 79% of world carbon emissions from the fossil fuel combustion, and 73% of world greenhouse emissions. The US repeatedly claims that MEM process is intended to support and contribute to the FCCC negotiations. In reality, it stresses business and energy opportunities and tends to neglect to push for any emission reduction targets.

In China, institutional building to tackle climate change started in 1980s when climate change science began to take off. The lead agency at that time was the Chinese Meteorological Administration (CMA), where science initiated policy debates. When climate change became a policy issue that focuses on climatic impacts, the lead agency in the early 1990s was the National Environmental Protection Administration (NEPA) and gradually turned into Ministry of Foreign Affairs (MOFA) with the national focal point established there. NEPA is now upgraded to the Ministry of Environmental Protection and serves as lead agency for ozone protection, desertification, and Ramsar Convention. Later on, when carbon market and CDM was more emerging and developed, and the Kyoto Protocol was put in place and entered into force in 2005. The National Development and Reform Commission (NDRC) also took over.

The NDRC is a huge ministry-level agency in charge of promoting the strategy of sustainable development and undertaking comprehensive coordination of energy saving and emission reductions. In terms of strategic planning, the NDRC also makes plans for resource conservation, ecological and environmental protection, promotion of environment-friendly industries, and clean production promotion. Moreover, NDRC takes the lead with related ministries in attending international negotiations of climate change; to undertake relevant work in regard to the fulfillment of the United Nations Framework Convention on Climate Change at a national level.

To summarize, the Chinese government set up a special institution to address climate change in 1990. The National Coordination Committee on Climate Change (NCCCC) was also established in 1998. To raise profile, the National Leading Group to Address Climate Change, headed by the premier and made of 18 public agencies, was set up in 2007 to assure the overall coordination. The member agencies have been increased to 20 in 2008, and the NDRC started serving as the secretariat in this Leading Group. Taking a programmatic approach, China issued National Climate Change Programme in June 2007, calling on all regions and ministries for full implementation.

China in Post-Kyoto Regime

For the next round of climate negotiations, the pressure is mounting on both Annex I and Non-Annex I countries to further cut down their greenhouse emissions. This pressure is especially high for major developing economies such as China and India to fully participate in a future international climate agreement. But at the moment, it is unclear how China could make the best contribution and be supported in various mechanisms. Based on the project findings from the German Environment Agency, Ecofys and the Wuppertal Institute, China's post-Kyoto participation can be viewed from the three principles of responsibility, capability, and potential.

To estimate reference emissions for major developing countries, four scenarios are outlined to analyze mitigation potentials.

1. Business-as-usual: The BAU scenario follows production, energy consumption, and

energy efficiency trends that are based on moderate assumptions.

2. No-regret: The no-regret scenario involves emission reduction options that can be achieved at negative or no direct costs. Measures related to energy conservation, energy efficiency, and voluntary reductions are in this category.
3. Co-benefit: The co-benefit scenario considers options that are reasonable due to political aims or the increased use of renewable energy at some costs.
4. Ambitious: The ambitious scenario includes reduction options that are technically feasible, but at extranet costs. This ambitious approach can be realized if the non-market barriers are taken away and financial incentives are provided to cover the extra net costs.

In order to meet the two degree Celsius limit, the IPCC calls for a domestic emission reduction of at least 30% below 1990 levels by Annex I countries. Non-Annex countries like China, currently exempt from carbon reductions, should also play a contributing part in the future climate treaties. Highly populated, heavy dependence on coal, embedded emission for exports, and relatively low energy efficiency enable China to have rooms to reduce greenhouse emissions. China's reduction potential is estimated at 8% by no-regret scenario and 15% by co-benefit scenario below business as usual. And the three sectors with highest reduction potential between 2005 and 2020 are power, industrial, and transportation.

Conclusion

China is now the largest emitter in the world and its emissions are rapidly increasing. Under the Kyoto Protocol, China has no binding emission targets from 2008 to 2012. Recently, the NDRC issued the National Climate Change Programme in 2007 and another position paper titled "China's Policies and Actions for Addressing Climate Change" in 2008. At the same time, institutional building to address climate change has been in place with diverse forces of science, the environment, foreign affairs, and economic interests at play.

China has actively participated in climate negotiations, guided by the principles of sustainable development, common but differentiated responsibility, mitigation and adaptation strategies, and access to financial assistance and technology transfer. Taking a multi-track approach, China has become the largest recipient country hosting CDM projects. With the mounting pressure to commit emission reduction target at the COP 15 in Copenhagen, China may consider pathways under the no-regret and co-benefit scenarios to further increase energy efficiency and take voluntary measures. A realistic outcome resulting from Copenhagen may not be a new climate treaty, but an agreement on the basic architecture of the post-2012 climate framework.

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Looking Beyond:
Changes for Climate Change, Changes for Development

Dr. Gerald Schmidt[1]

Abstract

In the climate debate, there is a stalemate when the discussion revolves around other's responsibility based on historical emissions and present (un)willingness to participate in international treaties justified by a necessary focus on development on the one side, and an unwillingness to act if the others do not also do so, based on concern about economic competitiveness, on the other side. The problem arises from a view that sees it as a basic necessity to first develop, get rich enough, and then clean up, as suggested in Kuznet's Curve, and about relative costs of alternative energy and production, respectively. Looking towards the future, considering the changes necessary for prevention of further climate change and/or of adaptation, and the necessities for development that truly improves people's lives and the future economic outlook (e.g. in a more resource-constrained world), however, there is definite common ground. Recently, such ideas received a boost through the argument that "green jobs" were an excellent impulse for revitalizing the US (and other) economies. Taking the view further, either climate change or the effect of "peak oil" (or both) will require new strategies as well: approaches more focused on human well-being and long-term economic and ecological functioning than short-term profits. For those strategies, it will be necessary to have government and popular support, but also possible to build support in both industrialized and developing countries, as they offer a win-win situation. This paper will present the ethical and practical considerations for such a "positive ecological" approach to climate change that goes beyond the stalemate to suggestions for cooperation based on common interests in security, environmental health, and further economic development.

Introduction

Environmental change has always been a part of the human experience. Humans did not have the capability to change more than regional environments, over longer periods of time, and did not usually know much of it in a conscious, reflective way, however. The way humanity survived was simply because the people migrated or because a reduced population got through collapse. Adaptation often took the form of religious or similarly irrational responses, such as the European witch hunts which flared up during the peaks of the Little Ice Age (cp. Behringer 1999). Now, for the first time, humanity is responsible for change on a global scale, of the very climate of Earth, knows about it, and probably faces a danger to civilization. Since the beginning of industrialization, the concentration of atmospheric carbon has risen from 280 ppm to 360 ppm. Much is being done to analyze the state of the matter and to model likely futures, to predict what will happen. It is quite clear, however, that there has to be large uncertainty. After all, we are dealing with the future, and with the highly complex system of the Earth's atmosphere. One impact of climate change that is to be seen already is this: the need to reduce emissions in order to mitigate (further) change is recognized internationally, but its most important implication seems to be that it threatens economic growth. The main question, therefore, has become how to deal, and maybe even more importantly, how to garner enough support for the necessary measures. Unfortunately, this impact is a symptom of the underlying problem rather than a sign of progress. When climate change is discussed only as an environmental issue, the separation between human affairs such as economics and Earth's ecological functioning remains unquestioned.

[1] Lecturer, German Studies Department, Xiangtan University, Xiangtan, Hunan, 411105, China, email: gerald@positive-ecology.org

Economic costs of measures aimed at reducing emissions stand on one side along with the threat to development and/or affluence, on the other side stands the counterweight of potential environmental change and associated danger. Issues of culture and of ecology, let alone their relationship, are hidden and take a backseat to more apparent political wrangling over the formulation and targets of treaties. Considering such undercurrents opens up possibilities, however. It may be a boon to science, which still needs further integration between different disciplines rather than ever closer – and oftentimes myopic – looks at ever more specialized sub-fields. It may be a way to change from taking economic growth as the only indicator of development, progress, and well-being to realizing that there is more diversity than this measure, and these concepts, imply. And ultimately, the connection between ecology and human life is the major question of our times. The issue is not just climate change, certainly not emission reductions, it is coming to understand and work with the fact that human life is dependent on and an integral part of the ecological processes of life on Earth, and at a point where we need to realize that there is no other way than to work with, rather than against, these processes if humanity is to survive in decent conditions and to make further progress. There are bad news and good in this: looking towards ecology, the challenge is even greater than emissions reduction; but considering the connection between ecology and human needs, in the end, there are possibilities for breaking the stalemate and realizing win-win-situations.

Diplomatic Chess

Government action, stipulated in international treaties, is afforded great importance in the fight against climate change. Presently, on the road to a follow-up accord to the Kyoto protocol, climate talks seem to be entering a new stage. There are signs that countries which were formerly reluctant to participate meaningfully, such as the USA and China, are open to dialogue.

Still, many arguments put forward follow a well-established pattern: In 1992, at the United Nations Conference on Environment and Development, then-president of the USA George H. W. Bush declined involvement, declaring that "the American way of life is not up for negotiation." Whether it meant comparative affluence or chances for "making it," it resonated with a large part of the population even while the environmental movement is a strong actor on the American political scene. With the current president Barack Obama, a new willingness to participate in multilateral agreements in general, and treaties to combat global climate change in particular, is to be found. A cap-and-trade scheme, for example, is making its way through the political process and actually seems to have chances of being passed into law. Yet, the recession presently seems more effective in reducing emissions than other measures (emissions from fuel burning in the USA, according to the DOE, are down 2.8%, electricity generation in China is also down, according to Richard K. Morse and Gang He at the Program on Energy and Sustainable Development of Stanford University); and getting back to high levels of consumption is the main "solution" to the recession that is being proposed. The cap and trade mechanism has good chances because it is politically feasible, allowing for emission permits to be handed out. At the same time, there are initiatives towards "green-collar jobs" as ideal revitalization of the economy, alternative energy and a smart grid as necessary preconditions for future growth, and even to re-interpreting the very "American Dream." Not least – and this may have become a strong current (at least of popular imagination) – the recession has led to a rediscovery of such qualities as thrift and resourcefulness as prototypical American traits. Recession or not, economic competitiveness has been a main driver of US standing and diplomacy; the American Dream is mainly one of individual economic success. In domestic politics, participation in international treaties can only garner enough support if other countries (read: economic competitors) also take part.

American lifestyles are highly consumptive, using much more energy than Europeans living in similar affluence. So, they could be changed to reduce consumption, reduce carbon emissions, without losses in quality of life. Still, the political necessity of presenting that there will not be a negative impact only on the US whereas others don't have to act or even to participate in international treaties has to be taken into consideration. (Even if it is ironic, considering the actions of the last administration, that the USA should be so focused on a kind of multilateralism in this regard.) As the greatest rising competitor, China plays the key role in this matter. As long as China does not accept to overall emissions reductions, the argument is that whatever reduction the US achieved would be negated by the emissions from China, plus have a negative effect on the US economy. Therefore, a new climate change treaty without China accepting emissions reductions would not have a viable chance of being accepted by Congress.

China has also been signaling openness to participating in international treaties, but is similarly concerned about any measures' effect on economic growth. Therefore, a contractual obligation to achieve a reduction in carbon emissions has so far been resisted. In China, it is still (taken as) a matter of course that economic growth is equivalent to development. The poverty rate was, thanks to this kind of development, reduced from 64% in 1978 to 10% in 2004. By many measures, it is still a third-world country, however. Therefore, the focus on further development is understandable. On the other hand, its rapid economic growth has led China to become the largest emitter of CO_2 (as well as the third-largest national economy) in the world, and therefore it is argued that it should take its responsibility. Two aggravations are in play, however: For one, the argument of responsibility is used in such a way that it evokes images of China's weakness opposite Western powers; a very sensitive issue. China is asked to take measures. These may be seen to be commensurate with its standing at a general level, it may even be good for the country ultimately. Yet, it is conveniently overlooked that per capita emissions in China are still far lower than those of Europe, let alone the USA, some 15% of emissions are caused producing goods for other countries (Guan et al. 2009), and the standard of living is still sharply lower. Taking a theoretical, absolute, global fairness – equal rights to equal emissions for every human being – as measure, it is easily seen that the citizens of industrialized countries, and particularly the USA, would have to reduce their emissions greatly whereas citizens of developing countries such as China have a right to higher emissions. From the Chinese side, it is also argued that the higher Western standard of living was achieved using cheap fossil fuels and causing by far the greatest share of the increase in greenhouse gases in the process, taking this as basis of a call to industrialized countries for shouldering their historical responsibility for climate change. By and large just asking for China to develop differently while the developed countries themselves, in spite of their advanced economies and affluence, have a hard time changing is – understandably – not taken as the equal partnership that the international treaties (and negotiations) seem to imply.

Still, it might seem as if things were going reasonably well, considering that there are moves towards a successor treaty to Kyoto in which the USA as well as China will participate, even though this is such a complicated issue. To break through such stalemates and truly tackle the problem requires a deeper look and could profit from an approach founded on realities, however.

Failures of Understanding

In fact, climate change is an even more complicated matter, and the complication starts with the focus being on the wrong approach: The approach that has become accepted as seemingly obvious measure is the reduction of emissions. It is what is politically feasible to get into treaties, the best that can be done now. However, taking atmospheric concentration of carbon prior to industrialization as yardstick, we have surpassed levels which are probably safe and would need to, at the very least, halt carbon emissions. Therefore, either carbon sequestration and storage would have to be implemented or alternative energy would have to replace fossil fuel use. This is still misunderstanding the facts, however, as fossil fuels are also at the base of many plastics, and even the food produced by industrial agriculture. In this regard, we are experiencing a fundamental misunderstanding of reality.

As E. O. Wilson pointed out In "Consilience" (1998), economics is not really based on a view of the real world which would be clear about the economy being but a subsystem of Earth's ecology rather than the environment being an afterthought to economics. "Virtualism" (Carrier & Miller 1998) went even farther in this regard, arguing that economics had become less of a scientific attempt at understanding the world rather than a model of how the world should be and to which it is meant to eventually be made to conform. The idea was not only that the market knew best, but even seemed to be that human beings who did not act like the economists' model homo economicus were not being rational, not being as they should be. The present recession has brought into the mainstream the critique of (neoliberal) capitalism that was, not so long ago, the domain of only a few discontents; the hike in crude oil prices up to nearly 140 dollars a barrel had similarly given sudden credence to the observation of peak oil. Still, mainstream economics continues to measure the wealth of nations and seemingly even the happiness of their people through GDP. No matter how incomes are distributed among people, no matter how much negative impact economic processes have on the environment and the people or, for that matter, how much cultural and biological diversity a country has, they are not counted. It only gets worse because economic growth is given the highest importance whereas environmental protection including climate change is seen as a comparative luxury. However, there is also the perspective that the poor depend even more strongly on the health of the soil, air, and water of their immediate surroundings than the better-off; and ecosystem services can be replaced by technology only to some extent and at high cost. These shortcomings are well recognized in the circles of ecological economists, for example. Yet, as Wilson also explains, economics still holds such great importance because politicians can only turn to its practitioners if they want to find ideas for growth and the jobs and decent standard of living which economic growth is seen to imply. Thus, issues like this are most useful in illustrating the failure of environmental communication's focus on apocalyptic warnings to also understand (a) fundamental reality, in this case of psychology and diplomacy.

Environmentalism not only fails to provide any such input. It has developed an unfortunate tendency to revel in dire warnings. As a result, as early as the 1970s, Wiebe (1973) pointed out that people were getting overwhelmed by the tide of information on environmental problems which they could do very little about, resulting in a feeling of "well-informed futility." With climate change, this problem has only become worse: first of all, it is an issue that is commonly misunderstood. Journalists' reporting on climate change changes with the weather (Shanahan 2000); scientific models predicting the likelihood and extent of potential problems such as sea-level rise get mixed in with fictitious renderings á la "The Day after Tomorrow." And eventually, the cause of the problem are just normal ways of life. In fact, it is normal ways of life for the comparatively affluent people in industrialized countries, and decent standards of living which are the aim of development in underdeveloped countries. Thus, even while it is well understood that the world cannot follow in the footsteps of Americans not just because of concerns over climate change, but because achieving such a lifestyle for everyone would require more resources than our one planet Earth has to offer, there are few alternative and promising ideas and examples of how to live better lives in the mainstream. This way, the main motivation to do anything against climate change is the prevention of possible future problems which may or may not occur, through measures that are (seemingly) certain to be deleterious to development, standards of living, and economic standing of nations.

At the root of both the diplomatic stalemate and the lack of radical measures is the fear that economic growth would be negatively affected by (strong) measures to combat climate change. The recession is making steps such as the procurement of venture capital for alternative energy even more difficult, and government support as part of stimulus packages is not as strong as it could have been. At the same time, as pointed out above, there are hopes that a greening of the economy would provide impulses to the economy as well as put it onto more stable footing. These are promising developments, but it behooves science to look deeper, both at the miasma of possible futures, and at the hard facts of human life. One approach that has largely been overlooked but is receiving increasing attention is to focus, simply put, on reality: the ecological functioning is the basis of life on earth, economics but a subsystem of ecology and human life. This is a lesson that, in many regards, still needs to be learned by economists and politicians alike. Yet, if people and governments are to be motivated to do something about the mismatches between economics – simply put, life – and its ecological underpinnings, then it is not enough to present ever more images of environmental apocalypse, whether they come from science with the best of intentions or environmental activists with the strongest of agendas. Rather, the suggested actions must be meaningful in the context of human needs and political necessities. Increasingly, they must also present hopeful prospects in the face of uncertain futures.

Futures, Needs, Necessities

It seems to be too much of a matter of course, so it is not usually mentioned. Still, just why climate change is such a peculiarly difficult issue is easily explained considering that two of the most complex systems interact here: climate and human society. Many if not most of the mechanisms at work in both the Earth system and human minds and societies are only poorly understood. "It depends" oftentimes seems to be the only law of human nature; past climates can be inferred rather well, but models of future climate are necessarily imperfect. And as Niels Bohr reportedly pointed out, predictions are notoriously difficult, especially about the future. At the same time, however, our understanding of the basics of both is good enough for practical matters.

At present, the future is looking rather bleak. Most projections of climate change point to increasing extreme weather events, sea level rise, declining glaciers resulting in decreased river flow, changing (or even collapsing) ecosystems and associated species loss, food scarcity, and more. The more we know, the more dire the projections have become. And the less people seem to listen, the more apocalyptic the reports and campaign statements have turned. However, the strength of the apocalyptic visions hides an opportunity for environmental communication, the possibility that there are multiply functional solutions which will serve different ends at once. There are many such opportunities, however.

In the arena of alternative energies, for example, the main discussion centers around the relative costs of different kinds of energy production. The accounting is that which has been established through times in which cheap oil was the normality, however, and there is a range of externalities – not the least of which are the costs of climate change – which are not figured into current prices. Therefore, the discussion of cost is flawed. One does have to live with this skewed pricing for the near future, but there are other aspects to consider. Higher gas mileage of automobiles, higher efficiency of municipal and industrial energy use, for example, are not just measures to help with the reduction of emissions as a part of climate change treaty measures. They also reduce air pollution, can reduce costs, and provide an impetus to create better, more competitive, technologies and products. This is particularly interesting as the "multiply functionality" of such solutions extends to different possible futures. In the case of energy, for example, it works both towards climate change mitigation, as (pre-)adaptation to a world changed by climate change and/or peak oil, and is a factor in the international security landscape (more on this below).

Popular (scientific) writings have given a lot of attention to the convergence of catastrophes (e.g. Kunstler 2005) and recent developments impacting on the future (e.g. Klare 2002, Heinberg 2005): climate change in its many (potential) manifestations, peak oil, continuing population growth, ongoing environmental destruction. It may be a sign of humanity's growing up that the naïve techno-utopias of the 1950's have all but disappeared, but some remnants of techno-optimism are still to be found. Not least, they surface with the argument that there were no need for measures against climate change at present because we would invent technologies to protect if and when they became necessary (and currently proposed measures against climate change would be costly and used money which could be allocated better). Positive visions of the future do also exist (e.g. "Re-Localization" or the Venus Project). They have a tendency to be either naively bucolic in their assumption that people would return to the land, be happy, and produce enough, seemingly forgetting about the wish for trade and the mismatch between population sizes and regional carrying capacities. Or, in their desire to present an ideal future, the vision would need ideal people, too, who serve their roles with little of the messiness – in other words, creative diversity – that is to be found in reality. It takes a similarly messy – creative, diverse – range of opportunities as the future, in spite of all the predictions and models, is still open, and both it and people are going to continue to be diverse, requiring and wanting different ways of life, dependent on the individual and local (social, political, cultural as well as ecological) circumstances.

Potential measures not just against climate change but also for a promising future would also be "multiply desirable choices" (Kaplan 2000). That is, in serving different ends, they also serve different needs or are desirable for different groups of stakeholders for different reasons. As complicated as human behavior can be, human needs and desires are universal. We seek satisfaction of our basic needs, and some satisfaction of our desires. These range from the well-recognized basic needs such as food and shelter, by way of security, to a need for a feeling of self-determination, i.e. a measure of control about one's life. Action to prevent problems is a human capability, but problematic even when the choices are relatively clear (witness the debts which are oftentimes run up on credit cards). More commonly, action will be taken to overcome problems as they arise. Climate change is a faraway issue that is still hard to grasp in any meaningful way, so more likely to be avoided than taken on if the arguments are only for future problems. Therefore it is necessary to show how climate change is not just about the future climate, the economy, or similarly abstract and far-away concerns, but about nation's standing, development, the satisfaction of human needs and life chances in the present and (near) future. The more this can also be made to be experienced and told as a good story, rather than remain abstract, the better the chances of garnering support for measures.

Environmental Health: The Case of Food

Health is not just the absence of disease in a person. First of all, it is defined as a more encompassing feeling of well-being, and it is intimately related with the condition of the environment. Good health depends, for example, on the absence of harmful pollutants. As ecosystem health, one can also talk about the "stable" state of ecosystems – i.e., the normal conditions and range of change within which the ecosystem is resilient against changes such as those of climatic variability and continues to function. Putting humans at the center, food is the ideal illustration of the complex relationships between factors of ecology, including the impact of climate change, and human ways of life and how they impact the Earth system.

Food is also an ideal case for how present economics and policy tend to overlook ecological and cultural relationships through which change would be good for "people and planet." It also shows how environmental activism tends to overlook chances for motivating by speaking to human needs and desires. And of course, food is one of the most basic needs, as well as one of the greatest pleasures – but increasingly, with the "obesity epidemic" and concerns over food scarcity, also a major cause of concern.

What governments need to consider are food security and public health; people want enough and preferably enjoyable food. The usual argument is that the market should be allowed to do its working, but agriculture is one of the most "un-free" markets, heavily influenced by subsidies. This, at least, is well recognized even if it does not look as if deep change is to be expected. Policies designed to keep at least some food production in place and internationally competitive work against that. Moreover, it is argued that a still-growing world population meant that food production would have to be further intensified, and that only industrial agriculture could provide enough. It has not only been shown that organic/sustainable agriculture can produce similar output, e.g. through Rodale's Farming Systems Trials (Pimentel et al. 2005), however. Improved agricultural practices could also recapture at least 50% of the carbon that has been lost from soils while enhancing food security (Lal 2004). One also sees that the single-minded focus on productivity, achieved through input of irrigation water if necessary, fertilizer and pesticides for certain, comes at a high social and environmental cost whereas there could be a "real green revolution" that is better for farmers and environments (Parrot & Marsden 2002). It is too simple to vilify the green revolution, however. Many problems arise from improper use of technology; and it would be unwise not even to consider the advances that modern plant breeding has been making. Yet, there is a fundamental mismatch between agri-culture that is a part of life and meant to provide for a community, working with ecological processes to achieve a good harvest, and an industrial agri-business that aims to make a profit at every step, controlling food production from seed to supermarket.

In particular when considering the challenges that climate change is likely to bring, the different orientations are highly influential: industrial agriculture aims to maximize profits through a supposed efficiency that tries to control the conditions of production. Rather than supporting soil fertility, for example, mineral fertilizer is employed. The result (especially when also used not quite properly) is reactive nitrogen that is detrimental to ecosystems and human health (Galloway et al. 2003), and a loss of soil carbon which has been contributing to climate change. It is also a part of this technology of production that single high-yield varieties are employed. Given the right growing conditions – irrigation, fertilizer, pesticides – these produce very well. Under more difficult conditions, however, intercropping of different, locally-adapted varieties/landraces is likely to produce a harvest in all but the worst situations; organic agriculture has been shown to be able to produce higher yields than conventional agriculture under extreme conditions (Lotter, Seidel, Liebhart 2003). Given that such less-than-ideal conditions are likely to occur more often in a world the climate of which has been changing, approaches less focused on profitability/production alone and more on resilience and adaptability are sorely needed.

A consideration is also that of health in the more usual sense. Agriculture does not just provide calories, nutrition is a major factor for human well-being. This is commonly missing in the argument of a growing population needing a further intensification of food production. Much of the needed increase in production comes from changes in diets as populations – such as those of China – become comparatively richer and increase their consumption of meat. The connection to climate change, here, is not just provided through the interaction between increased use of petrochemicals in intensifying production and increasing emissions. Also, livestock contributes to climate change through the carbon released from animals. This has received a lot of attention as a study found that 18% of total contributions of greenhouse gases came from the raising of livestock, more than the contribution of transport (FAO 2006; plus, there are other negative effects on the environment). First of all, however, it makes a difference whether these "emissions" come from carbon – plant material – produced with petrochemicals. In this case, carbon is added to the atmosphere which did not use to be there during the last millennia, raising the total level. Livestock raised in more traditional ways, such as grass-fed beef, on the other hand, "emits" only carbon which is already circulating between atmosphere and land/plants. Moreover, if human health is considered, such traditional ways of raising animals tends to be better (except on the basis of profitability, the way this is usually measured). Culture is also a (often overlooked) issue at work here. Meat consumption has been held in high esteem, but that does not mean that it is adamant to change. Healthier and at the same time more climate-conscious ways of eating could gain support through public education somewhat quickly. At least it would appear so if they appealed to the sense of purpose and pleasure that food can provide more strongly, and sounded less like sanctimonious speeches moralizing about meat and responsibility. After all, some food choices around the world have been changing rather quickly – on the one hand, towards fast food, on the other hand, towards "Slow Food."

Ecological Security: The Case of Energy

A common warning about climate change is the impact it could have on entire regions and their populations. Increasingly, environmental issues emerge as the major drivers of the security landscape (cp. Pirages & DeGeest 2003). Environmental collapse could lead to mass migration – and actually, Myers (2001) estimates that there were 25 million "environmental refugees" worldwide in 1995 already. The ultimate reasons for their displacement are environmental problems such as flood, drought, desertification, or soil erosion, i.e. conditions which, it is widely feared, will be exacerbated by climate change (cp. the IPCC Reports, for example). Furthermore, changing weather patterns are near certain to disrupt agriculture severely, imperiling a food supply that already seems hard-pressed to produce enough for a large, and still-growing, world population. (There are actually qualifications to this statement as the effects of culture, for example, are usually taken as a completely independent, not changeable factor.)

Understandably, there is no positive side to this issue in and of itself. Mitigation of further climate change and measures to adapt would have the good effect of (hopefully) preventing such extreme social disruptions; finding any truly positive side to it is all but impossible, however. One aspect is noteworthy, nonetheless: Even within all the political wrangling about the proper phrasing of climate change treaties, countries would be united in not wanting such extreme problems to materialize. Many warnings sound the alarm that the environment is not just an issue for rich countries and people to worry about in their spare time, but rather a matter of life and death and a (inter)national security threat. What one has to notice is that such extreme predictions – even if there are already climate refugees – don't have to be a constant barrage of increasing urgency in order to motivate people and politicians. Rather, they approach the effect of thoughts about death ("mortality salience"), which causes people to think and act more conservatively, even less future-oriented (cp. Schimel et al. 1999). The Stern Review (Stern 2006), for example, is almost strictly economic, but in going into detail and arguing forcefully about the negative effect climate change will have on economic growth as well as the economics of adaptation measures, it has been highly influential. When and where threats to security could be avoided through multiply-functional solutions which, at the same time at which they combat climate change effects also serve to provide economic or other advantage, however, warnings and visions can come together in ways which are motivating. Some of these aspects, as they pertain to alternative energy, have been mentioned already. However, as many people have become aware of thanks to the Iraq War, the dependence of industrialized and developing countries alike on fossil fuel resources which are getting scarcer and which are located in only a few regions of the world is a possible danger to national and international security. And in most of the discussions surrounding that, it is mainly considered how the Middle East is not quite as friendly towards the US as they might like from a region they depend on, or how the waterways through which China also gets its oil from this same region are controlled by the US navy. The possibility that the extreme weather events predicted from climate change would cause disruption are not usually paid attention when discussing whether or not to invest in alternative energy. Even in more local situations within regions, even within and between the USA and Canada, however, there have been examples of how severe weather (and other problems) cause blackouts. Europe has seen heat waves which led to thousands of deaths, and caused disruptions to the energy infrastructure, too, as nuclear power plants, for example, had to shut down because the river water used for cooling had become too warm for it to be used. "Soft" energy paths have been suggested for decades; increasingly it can be seen that localization and diversification, for example, would make energy provision – and with it, probably the world – more secure (cf. Li 2005) and more affluent, as well as be a measure against climate change and other environmental problems.

Agency, Work and Competitiveness

The climate change challenge to the economy offers itself to a "marketing perspective for environmentalism" (as suggested by Gail Whiteman, 1999, for example). Progress falters because of concern over the economy, and this voice has been strong since the beginning not just of the debate on climate change, but even of environmentalism. From another perspective, however, it is a chance for entrepreneurial approaches which could re-invigorate the economy and fulfill the human need to feel agency. What is needed is a different way of producing energy, creating goods, and even, to some extent, of making money. At the very least, stability rather than the quick buck would have to be the orientation – and it is a goal that has received a new ring of promise after the greed and financial games that led to the present recession. With alternative energies, for example, the popular image is that of Silicon Valley at the beginning of the computer revolution. Interestingly, not only the USA's culture of entrepreneurialism seems well-suited to take on this challenge, and with a little more support – which is growing – taking it on in order to make money and do good before problems such as climate change force change upon us. China is in a situation where it has long been necessary to find chances for development through creative solutions using the possibilities at hand which could likely be translated into a movement towards energy independence and other forms of sustainable development. Given the need for employment, the possibilities that "green-collar jobs" in retrofitting for less energy use and the like offer are increasingly promising. It is not only employment alone that counts. It is one of our basic needs that we have to feel that we are somewhat in control over our lives. The rise in popularity that cooking and gardening has been experiencing is probably due, at least in part, to the effect it has on such feelings of agency (in addition to the pleasure of producing food, knowing where it comes from, and – as is more important in a place like China, where such small-scale agriculture is still widespread – saving some money while providing food that is as safe as the grower can make it be). Again, the changes that are necessary to combat or adapt to climate change and work towards a wider transformation to sustainability, in technology, economy, and private life, can be interpreted only as problematic and dangerous, or could be presented as a challenge to which everybody can contribute in meaningful ways. Competence, especially at activities which are of positive influence to life, provides intrinsic satisfaction, and the behaviors that help to protect the future would be especially valuable in this regard (De Young 2000). Energy and food continue to be the best examples, as both are not only large, abstract systems seemingly removed from daily life choices, but in fact intimately connected with what we do each day. Food choices and habits which impact energy use can be changed by individuals, and are a contribution to both how these sectors work, and how well we live our lives. Of course, contributions will differ from individual to individual, and larger changes are necessary as well. Most importantly, however, such approaches could be used by governments in order to improve their citizens' well-being and economic conditions, or independently of such support through NGO campaigns, as they have been.

The Social Capital of Nations

Within countries, the people, their education, and reactions to future challenges are a great, and rather undervalued, capital. Along with economic and military strength, countries increasingly hold a political position that is also based on the perception other countries' citizens have of them, a social capital. In the present climate talks "on the road to Copenhagen," the images that countries want to project of themselves could hold increasing importance. The USA under the new administration of Barack Obama obviously want to present themselves as a partner in multilateral (or at the very least, with the talk about a "G2" of the USA and China, bilateral) relations. China, too, has been showing its reappearance on the world stage rather more strongly than ever before. Domestic issues are still, when in doubt, more important than the world's view, but China certainly does want to be seen as an equal partner. Consequently, neither of those countries would want to give the appearance that they are blocking the negotiations for a successor treaty of the Kyoto protocol. More importantly, if a race towards alternative energies and the like were started, it would not only change the economy towards sustainability. More importantly in the short term, it would likely become a process of a "race to the top" in which countries had to participate if they are not to be seen as backwards and lose out on economic competitiveness.

Conclusion

Looking at the challenge of climate change from different perspective, especially centering on human needs and political necessities, the discourse can quite easily be changed. Many groups are working on that, which makes it all the more unfortunate that science – not only but particularly as far as can be seen from reports – is focused much more strongly on ever closer details rather than on connecting insights from different of its branches and translating them into suggestions and practices which are meaningful to entrepreneurs, politicians and the public. Much more, both research and practical implementation, has to be done to achieve progress both in the discourse on climate change and in sustainability practice. Whether modeling impending climate catastrophes and hoping their prediction will spur into action, or marketing the economic potential of a transformation of society to sustainability, one thing is abundantly clear: Politics are a major influence on the economy and, maybe less so, on society, not least due to government spending. In shaping infrastructure projects, government expenses, and policy shaping the conditions under which companies operate, climate change treaties in which countries agree to emissions reductions hold great influence. Ultimately, however, it is not just on politics to work towards a transformation to sustainability, it is how we live and how we make a living that will decide whether climate change – and all the other challenges we face – will be a catastrophe or a chance to find ways of satisfying human needs, as universal as they are and as different as different people want them to be realized, in ways which make it possible for all of humanity to live good lives. Waiting for politics to put change into law is equally as misguided as thinking that it is the role of science only to provide ever better information; it takes a new drive towards wisdom.

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**Asia-Pacific Partnership on Clean Development and Climate:
China and International Climate Policy Beyond Kyoto**

Dr. jur. Christoph Holtwisch, M.Env.Sc.[1]

Abstract

The Asia-Pacific Partnership on Clean Development and Climate [APP] of Australia, China, India, Japan, South Korea, USA and their new partner Canada is a new phenomenon in international climate policy and open for enlargement by other interested states. This non-legally binding sustainable development Partnership connects climate protection and energy security for the first time in an international agreement. As a potential framework for the other 'parallel tracks' to the UN climate regime of Framework Convention on Climate Change [FCCC] and Kyoto Protocol [KP], the APP – which is still by far underfinanced – at its core is a political agreement for the development and transfer of environmentally-sound technologies. The Partnership intends only relative emission reductions and contains no binding emission reduction commitments.

Officially, the APP is consistent with the principles of the FCCC and intended to complement but not replace the KP. Nevertheless, the APP is only one of the partnerships embodied already in the FCCC technology framework and, therefore, no complement. The APP was intended as an opposing model against the KP and will have to clarify its position for the future. A fruitful cooperation or at least a peaceful coexistence with the UN climate regime is important because every technology-orientated approach needs market incentives. Any international Post-2012 climate change regime will have to combine the as yet competing approaches of market pull (KP) and technology push (APP). Integrating also climate change and energy security concerns is especially important for Asia as a region with a strong economic growth and the APP is a forerunner in this. China plays an especially important role, of course.

The third ministerial meeting of the APP will take place in China in 2009.

1. Introduction

The Asia-Pacific Partnership on Clean Development and Climate [APP] is a relatively new phenomenon in international climate policy. In its own view, the Partnership is a grouping of key nations (or: players) to address various serious and long-term challenges, including anthropogenic climate change and energy security. It contains the first connection of the two important aims of climate protection and energy security in an international agreement and focuses on the Asia-Pacific region. The Partnership founding partners of Australia, China, India, Japan, South Korea, and the USA and their new partner Canada represent more than half the world's economy and population, energy consumption and global greenhouse gas emissions. For that reason, this 'coalition of the emitting' is and will be an essential factor in international climate policy. For China, it is an important part of its climate policy within the wider strategy of 'peaceful development'.

2. Development and Enlargement

After secret negotiations, the APP was announced on 28th of July 2005 at an ASEAN regional forum in Vientiane, Laos, at which time a *Vision Statement* was released. The official creation of the Partnership occurred at an inaugural ministerial meeting on 12th of January 2006 in Sydney, Australia. Here, the APP *Charter* was launched, accompanied by a *Communiqué* and a *Work Plan*. The Vision Statement is now an integral part of the Charter.

[1] Lehmstegge 16a, 48691 Vreden (Germany), +49-2564-396074, email: holtwisch@t-online.de

The first meeting of the Policy and Implementation Committee [PIC] of the Partnership took place from 18th to 21st of April 2006 in Berkeley, California, in the USA. This first meeting produced *Guidelines* for the Task Forces of the Partnership and for their Action Plans. At the second PIC meeting, held in Jeju, Korea, from 11th to 13th of October 2006, additional *Guidelines* for flagship projects were made. The *Action Plans* developed by the Task Forces were also accepted at this time by the PIC. On 4th of April 2007, further *Guidance* to the Task Forces and a *Procedure* for Adding New Projects to the Partnership were published. The third PIC meeting took place in Tokyo, Japan, from 19th to 20th of July 2007. It produced the *Forms* for Project Registration and Status Report already foreseen in the Procedure and the Guidance. The third PIC meeting also prepared for the second ministerial (and fourth PIC) meeting of the Partnership, which took place on 15th of October 2007 in New Delhi, India.

At the New Delhi meeting, the ministers released a *second Communiqué*. Therein, the Partners state that while the climate change, clean development, and energy security challenges they face are considerable, they have pioneered an innovative partnership focusing on practical solutions and have accomplished much in a relatively short time. This communiqué was accompanied by a flagship projects *Brochure* and the launch of an 'Asia-Pacific Energy Technology Cooperation Centre'. The brochure is meant to exemplify the different types of cooperative activities being undertaken by the Partners – these flagship projects are selected to tell and illustrate the broader story of the whole APP. The centre is expected to provide benefit to the Partnership by enhancing the sharing, dissemination of energy efficiency knowledge, and best practices that exist in the governments and industries of the Partner countries, through workshops, train-the-trainer programs and an information database.

The enlargement of the APP with the addition of Canada was also announced at the second ministerial meeting in New Delhi. The ministers decided to meet again in 2009 in China, with the PIC continuing with its work in the meantime. Its fifth meeting took place in Seattle, USA, from 19th to 20th of May 2008; there, Canada was welcomed as the Co-chair for the Cement Task Force. The sixth PIC meeting took place in Vancouver, Canada, from 29th to 30th of October 2008. Both meetings did not produce new important documents. The seventh PIC meeting was held from 19th to 20th of May 2009 in Gold Coast, Australia and was among other things intended to discuss the future of the APP. This indicates that the APP has now finished its founding phase and – like it was stated at the fifth PIC meeting in a secretariat paper on the future of the APP – has transitioned fully into its implementation phase. It has officially declared that it wants to move toward the next phase in its work. Probably later this year the ministers meeting in China will follow, as decided earlier in New Delhi.

The Partnership is open to enlargement by further interested and like-minded countries in the future. All current partners are Asian-Pacific states and the APP is especially important for this world region, but – despite its name – it is not limited to it. Therefore, other countries – even European ones (which are not looking for it) – could be members as well, but the current members will prove potential new partners seriously if they are really like-minded because the focus is on deepening the existing Partnership now more than on enlargement. Canada was said to share the vision of the partners and having worked constructively with all Partners before joining the Partnership officially. Nevertheless, several countries have stated general interest in a membership, especially New Zealand and some ASEAN states. Therefore, an 'APP-plus' with additional partners (which rumors predicted already for late 2007) could become real in the near future. In the meantime, interested states could use the – weaker – options of cooperation opened by the Partnership: They could work with the partners in the Task Forces of the APP and take part in its projects and measures.

3. Character and Aims

The APP is no international law treaty but forms a non-legally binding political 'soft law' regime. This is stated expressively and indicated by terms like “compact” (instead of treaty), “partners” (rather than parties), and “nations” (instead of states). Participation in the Partnership is, therefore, on a totally voluntary basis which renders the existing ending clause devoid of meaning. Each partner determines absolutely individually the nature of its participation in APP activities. Consequently, individual verification and compliance control – which are now key aspects in international law theory and practice – do not play any role in the Partnership; only the general progress of it as a whole shall be assessed regularly to ensure its effectiveness (to guarantee this, the Task Forces will report regularly about their concrete activities to the PIC). However, while the *Vision Statement* uses the misleading expression “non-binding”, the *Charter* prefers the more accurate term “non-legally binding” which indicates clearly that the Partnership is meant to be politically binding. Having this in mind, the APP should not be underestimated because, in the end, political obligations are crucial even in international law that does not contain really effective enforcement.

The APP follows the ideal of sustainable development with interlinked environmental (climate change, air pollution), economical (economic development and growth, energy security) and social sub-aims (development, poverty eradication, safety, health, wellbeing). Especially important are the aspects of climate change and energy security which are connected for the first time that clearly in an international agreement – a link that has become more familiar nowadays. Access to a diverse range of reliable and affordable energy sources is seen as a major determinant of energy security by the APP. Partnership members recognize that renewable energy and nuclear power will represent an increasing share of global energy supply, but stress that fossil fuels underpin their economies now and for the predictable future. The continued economic use of (cleaner) fossil fuels is consequently at the core of the APP policy. Critics, therefore, view it as a 'coal pact' only. This is too simplistic but, without doubt, the promising but still not completely economically available 'bridge technology' of carbon capture and storage [CCS] is one of the central technological options for the APP.

4. Potential

Instead of reducing absolute greenhouse gas emissions, the APP only intends to limit the “greenhouse gas intensities” of economic activities which would lead only to relative emission reductions (compared to a reference case). This political plan presents a very important difference from the 'cap and trade' architecture of the legally binding Kyoto Protocol [KP] to the UN Framework Convention on Climate Change [FCCC] with its general aim of an absolute emission reduction commitment, and is much less ambitious than it. Even in the best case scenario – a global use of the Partnership approach (with CCS) – absolute greenhouse gas emissions would more or less double from now to 2050. Therefore, the Partnership ideas are clearly not enough to respond sufficiently to climate change. Nonetheless, they may play some role in dealing with this challenge.

The relative reduction of greenhouse gas emissions would differ between the world regions and the economic sectors and the importance of CCS would vary between the sectors, too. Therefore, it was absolutely reasonable to found sectoral-oriented APP Task Forces even if there are no sectoral emission reduction commitments.

5. Purposes

The APP is meant to serve as a framework for international cooperation between its partners – based on their respective competencies – and for the coordination of the national strategies of the partners (with capacity-building). At its core, the Partnership is a political agreement for the development and transfer of (existing and future) environmentally-sound technologies and practices. Economic freedom – with its legal and political aspects – is important for this as an enabling environment (economic freedom leads to more energy efficiency which causes less greenhouse gas emissions), so the Partnership contains an – yet little noticed – institutional dimension as well. Therefore, it is – in addition to the existing and planned national initiatives, of course – also an aim of the APP to promote (economic) freedom in states like China and India as an enabling environment for technology transfer and climate protection. The Task Forces are responsible for this promotion, too, but it is mainly a mission for the PIC since this sensible topic requires a high-ranking political platform.

The technology cooperation of the APP builds on a great number of existing bi- and multilateral political initiatives such as the G8 'Gleneagles Dialogue' and 'Plan of Action' (2005), the 'Methane to Markets Partnership' (2004), the 'Carbon Sequestration Leadership Forum' (2003), the 'International Partnership for the Hydrogen Economy' (2002), the 'Global Gas Flaring Reduction Partnership' (2002), the 'Generation IV International Forum' (2001), the 'Climate Technology Initiative' (1995), the 'Greenhouse Gas R&D Programme' (1991), and the 'Clean Coal Centre' (1975). All these initiatives are, like the APP, non-legally binding and often US-dominated 'parallel tracks' to the traditional UN climate treaty regime. As the new Partnership APP is not limited in terms of particular technologies, it has the potential to build up as a future framework for these initiatives which would strengthen enormously the political relevance of the APP.

6. Intellectual Property and Financing

The technology affected by the APP cooperation is usually intellectual property of private companies which explains why the private sector is so important for the Partnership. These (big) companies normally have to be interested in profit and not that much in climate protection – which leads to the question why so many of them participate in the APP and are willing to share their knowledge. The answer is that it may be reasonable to cooperate in this way if it prevents the states from other measures that are assessed as more dangerous for the economic model and success of the companies. This is especially important for the energy production industry from fossil fuels which is increasingly seen as environmentally very problematic; here, CCS may be an option to maintain the general business model by taking measures of climate protection and sharing them with companies in other states. Nevertheless, there are various ways of protecting the intellectual property of companies in different states. Having in mind these different national laws, all matters regarding intellectual property are to be addressed case-by-case in the APP. The draft of the 'International Code of Conduct on the Transfer of Technology' may give some advice here.

The crucial point for the Partnership will be the financing of the technology development and transfer. The *Vision Statement* of the APP called for solid financial arrangements, but the *Charter* only states that each partner may – at its discretion (and subject to its laws, regulations, and policies) – contribute funds, personnel, and other resources to the Partnership; any costs arising from APP activities are to be borne by the partner that incurs them, unless other arrangements are made. As a result, the financial contributions of the (developed) partners available so far are very limited, relatively vague, and definitely not enough for the APP to have noteworthy success. For that reason, the inclusion of the private sector is fundamental for the Partnership activities, or, as one APP spokesman said: “The real dollars we are looking for are the private sector dollars; we are talking tens of billions of dollars if not hundreds of billions of dollars. If we do not get the investment sector we cannot succeed.” Currently, it does not look as though there will be enough financial support for the Partnership to be particularly successful, even if most of the presentations at the second, fourth and sixth PIC meeting dealt with the problem of insufficient financing. The *second Communiqué* states that in the next phase of the APP work the partners will continue their efforts to locate additional financial resources.

7. Work Plans and Institutions

To come up to its purposes mentioned above, the APP will develop and implement Work Plans. These programs are the heart of the APP. They follow a 'bottom-up' approach (which differs from the more 'top-down' concept of the UN climate regime): They want to bring together key actors and leaders of the private sector, research communities, governments, and – if appropriate – also developing banks, intergovernmental and non-governmental organizations. In Task Forces these actors shall develop sustainable solutions to the “shared challenges”. Only these (future-orientated) challenges are mentioned, but not the (more past-orientated) concept of 'common but differentiated responsibilities' (that plays a very important role in the traditional UN climate regime to justify dissimilar obligations between developed and developing countries). The APP views itself as a genuine partnership of equals based on mutual respect and cooperation.

The *Vision Statement* describes a wide field of – not concluding – sectors of cooperation. In the short term these are energy efficiency, clean coal, integrated gasification combined cycle, liquefied natural gas, CCS, combined heat and power, methane capture and use, civilian nuclear power, geothermal, rural/village energy systems, advanced transportation, building and home construction and operation, bioenergy, agriculture and forestry, hydropower, wind power, solar power, and other renewables. Areas for mid- to long-term cooperation may include, but not be limited to, hydrogen, nanotechnologies, advanced biotechnologies, next-generation nuclear fission, and fusion energy. All these fields describe technological measures for the reduction of greenhouse gas emissions; geo-engineering to cool down the atmosphere does not play a role in the APP even if this could be integrated into its framework as well.

The APP focuses very much on fossil fuels as a short-term field of action. For that reason, it is seen as critical to develop, demonstrate and implement promising cleaner and lower emissions technologies that allow for the continued economic use of fossil fuels while addressing air pollution and greenhouse gas emissions. Therefore, the first Work Plan of the Partnership focuses on power generation and distribution, as well as key industries. It is seen as a deficit that until now no Task Force deals with nuclear energy because the strengthened use of it is promoted by APP governments and businesses; Australia – the main exporter of uranium – is the only partner without own nuclear power plants.

Eight temporal public-private Task Forces have been established in addition to the permanent political PIC and its Administrative Support Group [ASG]. The US government serves initially as this secretariat (which indicates some dominance of it); each partner has to designate an administrative liaison as a point of contact for the ASG. All decisions or recommendations of the PIC or the Task Forces require consensus. The eight task forces cover cleaner fossil energy (CFE), renewable energy and distributed generation (RDG), power generation and transmission (PGT), steel (STF), aluminium (ATF), cement (CMT), coal mining (CM), and buildings and appliances (BATF).

8. Action Plans

The range of projects and activities foreseen in the Action Plans developed by the Task Forces are to be untertaken by the APP partners, but no partner has any legal obligation to join in for a concrete project; nevertheless, there exists political pressure to collaborate with the partners, of course. The Actions Plans are intended to identify ambitious and realistic goals as well as specific opportunities for cooperation. Each Task Force has to formulate detailed Action Plans outlining both immediate and medium-term specific actions, including possible flagship projects and relevant indicators of progress. The yet existing eight Action

Plans all contain a survey of the current technological situation of the sector, technology aims and concrete measures, projects, and activities. They contain very different numbers and types of concrete projects, but all of them include assessment, best practise, and capacity building measures.

The Action Plans have been accepted by the PIC in late 2006, but lots of further projects – also cross-cutting ones – have been added to the project roster later. All the projects are described in detail at the APP homepage (*www.asiapacificpartnership.org*) – where all APP documents are available – and it is impracticable to analyse them in the context of this paper. The complete list of projects gives an impression of the wide range of the Partnership activities. It shows that the APP analyses different technologies from diverse sectors, but one has to have in mind that lot of these projects are in an early or middle stage only and often their financing in the long run seems unsure. Some of the projects have been cancelled in the meantime.

9. APP and UN Climate Regime

The possibility of an enlargement of the APP shows its potential competition for an important role in international climate policy which is still dominated by the traditional UN climate regime. The regime interplay of these two regimes can be described as a recipient regime (the UN one) which is confronted with a new tributary regime (the APP one). A positioning, therefore, could only be done by the newer regime, the APP. The Partnership does this explicitly and differs between the FCCC and the KP: The purposes of the APP shall be and remain "consistent with" the principles of the FCCC and be and remain intended to "complement but not replace" the KP. The Partnership is, indeed, consistent with the – relatively general – FCCC principles, but its position regarding the KP is much more dubious.

If it were to act as a complement, the APP must, like the KP, go beyond what is embodied already in the FCCC which is the joint focal point of KP and APP. For that reason, the technology development and transfer rules of the APP must go further than the technology-orientated norms of the FCCC, especially its technology framework created by the relevant decisions. This is not the case because the Partnership is only one of the technological partnerships embodied already in the FCCC technology framework. To give an example, the FCCC has an expert group on technology transfer which develops action and work plans. To sum up, the APP does not have potential to complement the KP content.

So what are the exact intents of the APP – is the Partnership intended to replace the KP instead? Some statements made by its representatives and also the timing of its meetings – often a few months before the FCCC/KP meetings – indicate this. It seems likely that the APP was set up as a competitive regime to the KP because the KP contains legally-binding individual emission commitments which the APP states opposed (USA and Australia, which did not ratify the KP by then) or did not favor for the future (China, India and Korea) at the time of founding.

China, together with other developing countries, is not obliged to limit or reduce greenhouse gases by the KP now, but it's still strong economic development clearly leads to greater pressure in this regard. Therefore, China has to argue for a right to further industrial growth combined with a climate policy that is able to help reaching a (sustainable) 'peaceful development'. It's 'scientific outlook on development' calls for conservation of energy and resources, protection of the environment, stress on infrastructure, increase of economic performance and identification of potential development. The APP may serve as one aspect in China's climate policy within the wider strategy of 'peaceful development', together with the KP, to which China is a party as well, of course.

The opposition towards the KP meant that the USA and Australia could not use the flexible mechanisms of the KP which allow additional technology transfer to developing countries (clean development mechanism) and transformation states (joint implementation). Therefore, for the USA and Australia, the APP was an alternative also in this regard, while for the other – developing – partners it basically allowed even more technology transfer. Japan simply widens its political options with a membership in both clubs. Overall then, the APP was primarily intended to be an opposing model against the KP – so far, it was constructed in many ways as a replacement of the KP.

The situation is a bit more complicated now. After the time of founding, Canada joined the APP club (after stating that it will not meet its KP target and wants to focus more on technological solutions), but Australia changed its position with the KP ratification of its new government. By now, the APP definitely has to clarify, both internally and externally, the role it wants to play in any international climate policy future.

As the APP is dominated by the USA, this probably will not happen before further declarations of its new government, but President Barack Obama seems to be more interested in an UN-dominated international climate policy than former President George W. Bush. His concrete plans are not clear yet but he has started to be much more cooperative in the processes leading to progress in the UN regime and he has invited 16 mayor economies to a ’Major Economies Forum on Energy and Climate’ in April this year in Washington D.C. The White House said in a statement this summit "will facilitate a candid dialogue among key developed and developing countries, [and] help generate the political leadership necessary to achieve a successful outcome at the UN climate change negotiations." This indicates some difference to similar earlier talks organized by the Bush administration which had a focus on progress outside the UN regime. Therefore, the APP could be less opposing to the KP than in the past and much more complementary in the future.

The KP in its present form will expire in 2012. This leads to the question of whether the APP could be integrated into the steadily developing traditional UN climate regime after that. Because of some then probably still existing opposition towards the KP approach, such integration is conceivable only under the FCCC framework. Since the creation of the APP, the FCCC stressed its openness towards technology-orientated concepts, and the importance of these were also mentioned – for example – at the G8 summits of Heiligendamm, Germany (June 2007), and Toyako, Japan (July 2008). In addition to that, the processes hopefully leading to progress in Copenhagen, Denmark, under the FCCC and the KP on ’Long-term Cooperative Action’ and ’Further Commitments’ show a great openness for a much stronger focus on technology as regards both mitigation and adaptation measures. This has been shown – for example – in the first Bonn climate change negotiation session in March of this year.

Nevertheless, a formal integration of the APP via a new technology protocol or a second technology decision is very unlikely because the first option would lead to a legally-binding APP (against the declared will of its partners) and the – non-legally binding – alternative would install parallel procedures and institutions to the existing FCCC technology framework (which would undermine it against the will of the other FCCC parties). But maybe the APP will influence the further development of this framework. As a result, in the short run, only a non-formal integration is a realistic option which could lead to a fragmented but synergic 'orchestra of treaties' with a fruitful cooperation between the traditional UN climate regime and the APP. To avoid the destructive potential of the APP, a peaceful coexistence with the traditional UN climate regime is necessary at least. It would be in China's interest to argue for a stronger coexistence of the two regimes in international climate policy.

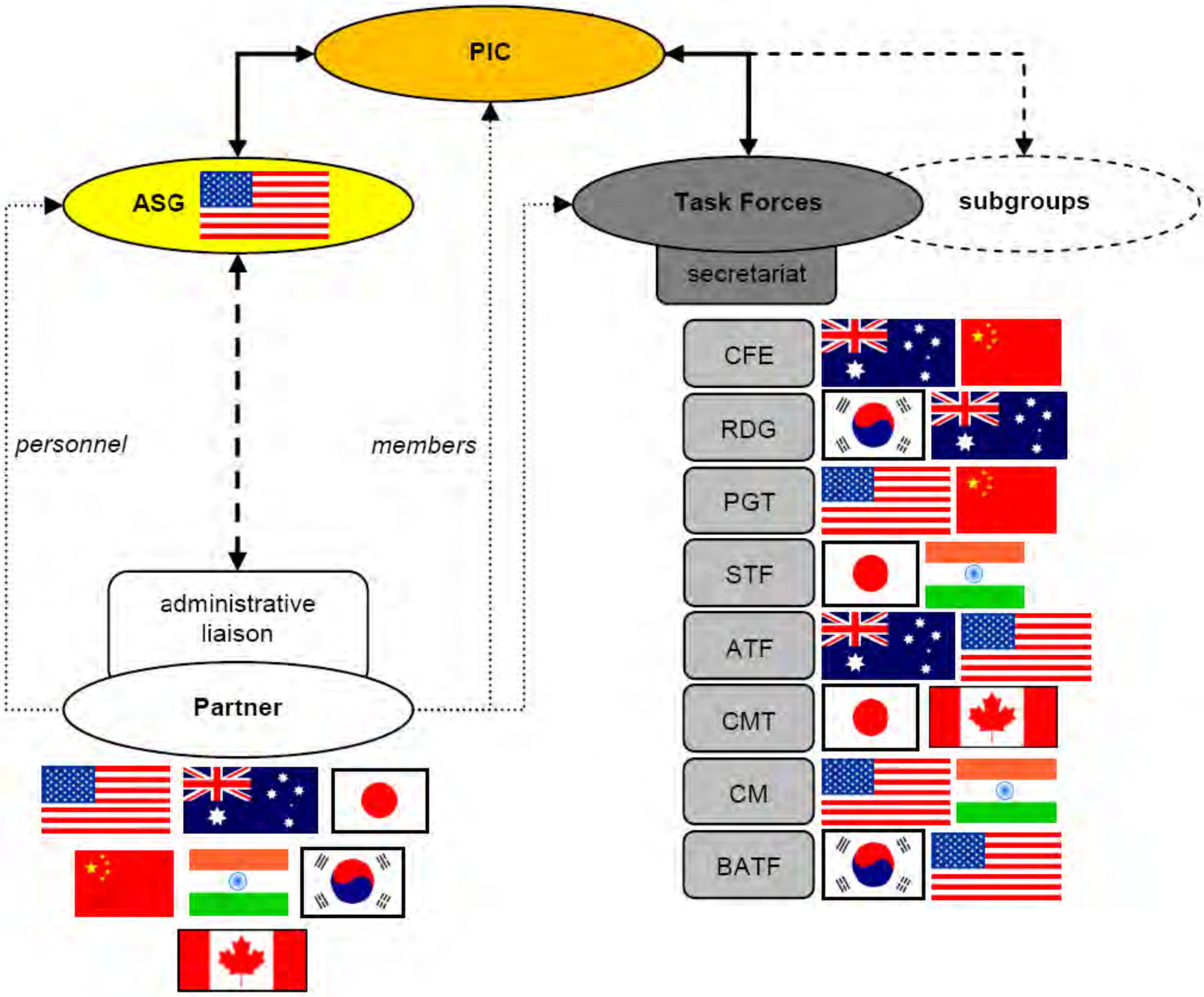
Such a cooperation or coexistence is important because every technology-orientated approach needs market incentives for the development and transfer of technology. It may be an 'inconvenient truth', but these can be created only by external emission commitments (or other market mechanisms). Any international Post-2012 climate change regime has to deal with the difficult task of combining the as yet competing approaches of market pull (KP) and technology push (APP). Technology is an important – but only one – component in a portfolio of measures against climate change. Integrating also climate change and energy security concerns is especially important for Asia – with China in the center – as a region with a strong economic growth and the APP is a forerunner in this. All this will be by far the largest and hardest task that environmental policy has ever faced and very difficult for the policymakers of the Post-2012 climate change regime, but, nonetheless, we should be optimists like Sir Nicholas Stern, the economist who published a famous review report on climate change: He imagines a "real festival of technology, fired by constantly stricter commitments".

References

This paper summarizes the following book with further references on the topic:

Holtwisch, Christoph: Asiatisch-pazifische Partnerschaft für umweltverträgliche Entwicklung und Klima – Blockade oder Antrieb für das internationale Klimaregime? [Asia-Pacific Partnership on Clean Development and Climate – Blockade or Impetus for the International Climate Regime?], Stuttgart 2008, Fraunhofer IRB Verlag, ISBN 978-3-8167-7788-5

Figure: Institutions of the APP



China's Dilemma in Climate Change Mitigation:
The Energy Problem

Bo Miao & Graeme Lang[1]

Abstract

The vulnerability of China to the adverse impacts of rising global warming is outlined, including projected impacts on coastlines, agriculture, water supply, land degradation, and public health, since these are important reasons why China, partly for reasons of national security, is increasingly addressing the climate change problem in national and international discussions. This paper then profiles China's greenhouse gas (GHG) emissions and illustrates how the pressure from the international community, especially that from the US, would impel China to make more substantial contribution to global climate effort. After examining China's coal-dominated energy mix, we review the current approaches undertaken by China to combat climate change. They are essentially programs that aim to increase energy efficiency and deploy alternative energies, thus reducing energy costs and bringing about ancillary climate benefits. China's active participation in the Clean Development Mechanism (CDM) is then discussed. We show that it appears to be impossible, with current or currently developing technologies such as Carbon Capture and Storage (CCS), to produce the 80% reductions in GHG emissions which scientists recommend over the next four decades. What other measures might be feasible for China to make more substantial contributions to global climate-change-mitigation efforts? China's dilemma is the need to sustain a developing economy which depends crucially on GHG-emitting processes. It appears to be impossible to do this without some radical restructuring of economic activity, since it seems that it cannot be done by some combination of greater energy-efficiency and substituting fossil fuels by renewables or nuclear power. An alternative over the longer term is to promote relocalization of production and exchange using local and regional renewable resources. There are many towns and cities in the world in which groups are planning and beginning to implement such changes. In fact, China is almost uniquely well-qualified to take this approach, and indeed, could become a leader in such innovations and such technologies. In the longer term, it is very much in China's national interest to follow this path.

***** We would like to acknowledge research support from City University of Hong Kong.
(Project # 961055: *Environmental Best Practice: a Comparative Study*)

Introduction

China's importance in the international climate change regime cannot be underestimated. As one of the largest GHG emitters, and maybe the largest one though Chinese senior officials have repeatedly rejected such claims, it is a must for the international community to engage China effectively in any coordinated effort to combat global warming. Unlike any other conventional air pollution that is either local or regional, climate change is global and everyone has a stake. All nations will be affected to various degrees by the adverse impacts of the most far-reaching environmental problem that human society has faced since the end of the last ice age. China is not immune to such adverse impacts, though it may not be hit as heavily as some low-lying island countries. China's own research has pointed out that China is one of the most vulnerable nations to the potential risks in climate change (NDRC, 2007). It is therefore in China's own interest to work with other major emitters to moderate the rapid growth of GHG.

[1] Department of Asian and International Studies, City University of Hong Kong, email: bomiao@cityu.edu.hk; graeme.lang@cityu.edu.hk

However, it would be unrealistic to expect China to undertake the same emissions reduction commitments as other developed economies. China only accounts for a small portion of the GHG that have accumulated in the atmosphere in the past two hundred years. It has every reason to ask the developed nations who have historically emitted large volumes of GHG and currently have much higher per capita emissions to bear primary responsibility and take the lead in any mitigation action. The US, as the largest historical GHG emitter, has been refusing to undertake any mandatory responsibility to cut its emissions, and China has used US recalcitrance as an excuse to shun any binding duties. This scenario is very likely to change since the new US President Barrack Obama has explicitly expressed strong interests in making more substantial contribution to combat climate change, and the adoption of a mandatory cap-and-trade GHG emissions program is under heated discussion in the Congress. Once US is on board, China will be under greater pressure to make more constructive climate action. The latest visits by the Secretary of State Hilary Rodham Clinton and the House speaker Nancy Pelosi both highlight the importance of climate change collaboration between these two largest emitters. The latest news is that these two nations are negotiating a deal, a kind of joint agreement, in regard to a schedule for emissions reductions and overall climate policy, and this will be a big step as the world moves closer to the Copenhagen negotiations (Dyer, 2009).

The Chinese government is not blind to the potential costs that climate change could cause for its cities, its agriculture, and the sustainability of some regions of the country. It is promoting a series of energy-oriented policies and measures such as energy efficiency and renewables programs that would also generate ancillary climate benefits. The Central Government claims that it has effectively reduced 835 million tons of CO2 equivalent by energy conservation and promotion of alternative energies in 2006 and 2007 (State Council, 2008). But China's aggregate GHG emission has continued to grow rapidly in the past few years, with no sign of slowing down. The dilemma is, with China's heavy dependence on coal to fuel the burgeoning economy, can China effectively mitigate the GHG emissions while sustaining development and eradicating poverty?

In order to answer this question, this paper is divided into four sections. Section 1 will address the question of why China should care about climate change. The vulnerability of China to the adverse impacts of rising global warming is outlined, including projected impacts on coastlines, agriculture, water supply, land degradation, and public health. It is pointed out that it is in China's own interest to work with other nations to prevent the catastrophic results of climate change from happening. Request from the international community, especially that from the US, would also play an important role in impelling China to make more substantial contribution to global climate efforts. China's GHG emissions profile is also described in order to provide a better understanding of the nature of such international calls.

Section 2 reviews China's action against climate change. It first examines China's coal-dominated energy mix, showing that coal will continue to power China for a long period of time and the CCS technology would not be commercially viable within foreseeable future. It then discusses the energy efficiency and renewables programs that are promoted by the Central Government with the purpose of addressing issues like energy security but also produce remarkable climate benefits. As the largest host country for CDM, China's active participation in this flexible mechanism offered by Kyoto Protocol is also reviewed.

After acknowledging that current climate-change-mitigation approaches are meaningful but far from adequate, section 3 explores what other measures might be feasible for China to significantly mitigate its GHG emissions. It is suggested that an alternative over the longer term is to promote relocalization of production and exchange using local and regional renewable resources. The essence of relocalization and initiatives taken by many towns and cities overseas were briefly examined. The section also discusses China's advantages in marching on this path, especially those in the agriculture. The last section provides some concluding remarks.

Section 1: Climate Change: Why Should China Care About It?

1.1. Reason I: Vulnerability of China

Experience tells that one will not act unless it is in its own interest to do so. The grave long-term challenges that are posed by climate change have drawn increasing attention from all nations, including China. As one of the major greenhouse gas emitters, Chinese policymakers are not blind to the adverse effects that could be caused by the continuing concentration of greenhouse gas in the atmosphere. In 2007, the National Development and Reform Commission (NDRC) published *China's National Climate Change Programme,* acknowledging that China is one of the most *vulnerable* countries to climate change, which has already had certain impacts on it in various ways. "Vulnerability" could be understood as the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change (IPCC, 2001). Indeed, China is climatically vulnerable in two senses:

On the one hand, the current and likely adverse impacts of climate change on China are huge and could be even worse than many expect should the development pattern fail to be significantly changed. The following description of those adverse impacts is primarily drawn from *China's National Climate Change Programme* (NDRC, 2007, pp.16-19) and *China's Policies and Actions for Addressing Climate Change* (State Council, 2008).

First, China's agriculture and livestock industries have experienced certain changes with regard to the rising temperature, mainly shown by the 2-to-4-day advancement of spring phenophase since the 1980's. Declining crop yields are a risk. Rice production is sensitive to increased temperatures, and thus can be affected by climate change. Forests and other natural ecosystems in areas where average temperatures are increasing would also be affected. The frequency and intensity of forest fires and of insect and disease outbreaks in forests are likely to increase as a result of climate change.

It is expected that future climate change would also lead to expanding deserts and shrinking grassland in some arid regions in western parts of China. Desertification is already a serious problem for the country, and the resulting loss of grazing land and farmland, 1along with the inevitable dust storms, all of which bring huge costs for the country, could be worsened by global warming.

Second, global warming would challenge China's water resources and distribution. One of the biggest longer-term impacts would be the melting of glaciers on the Tibetan plateau, because runoff from these glaciers provides the water for some of the greatest rivers in East and Southeast Asia, including the Yangtze and Yellow Rivers in China. Vast areas of agricultural production depend on the flow of water from these glaciers, that is, from winter snow-pack which melts through the spring and summer of each year. If global warming leads to earlier runoff from snow-pack, the summer flow from glaciers can be greatly reduced, as is apparently already occurring in the western U.S. Water supply for agriculture, industry, and domestic uses in northern and central China would be threatened, even if precipitation increases in parts of southern China. This is of course a long-term projection. But the glacier area in north-western China has apparently already shrunk by 21% according to some accounts, and the thickness of frozen earth in Qinghai-Tibet Plateau has declined in recent years. A decreasing trend in runoff has been observed during the past 40 years in China's six main rivers.

In early 2009, China experienced the most severe drought in some northern regions in the past fifty years and significant losses were reported. Some northern river basins, particularly the Haihe-Luanhe River basin, are clearly very vulnerable to climate change.

Third, the accelerating trend of sea level rise along the Chinese coast in the past 50 years is clear evidence of the impacts of climate change upon coastal environment. China is not as exposed to rising sea levels as some other countries such as Bangladesh, but some of China's richest agricultural regions, such as the Pearl River Delta, are close to sea level and could experience decreased production as saltwater intrusions onto land and into river deltas increases. Coastal erosion, seawater intrusion, mangrove and coral reef degradation are observable and expected to further deteriorate. Some major cities such as Hong Kong, Guangzhou, Xiamen, and Shanghai would also be affected by sea-level rises. The worst-case scenarios for sea-level rise (e.g. from melting of the Greenland Icecap) would force the abandonment of some of these cities. But less extreme and currently more probable scenarios of sea-level rise would also produce heavy costs for cities and for coastal agriculture. Global warming will also evidently increase the severity of extreme and costly weather events such as typhoons and storm surges, to which China is especially vulnerable because of its long coastline and exposure to storms moving toward the coast from the south-western Pacific oceans.

Fourth, climate change would also increase the intensity and frequency of heat waves, which have been devastating already to populations in Europe and Australia, and would also facilitate the northward spread of diseases such as malaria and dengue fever from Southeast Asia into southern and central China.

On the other hand, China currently lacks the personnel, technical and financial resources to deal with these kinds of impacts caused by climate change and therefore might suffer great losses in the future, both in urban and rural areas.

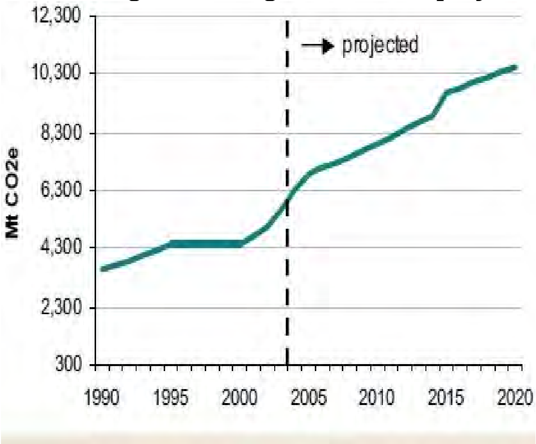
These climate change-related impacts could be even worse should China, along with other major economies, fail to change significantly their development pattern and effectively control their greenhouse gas emissions.

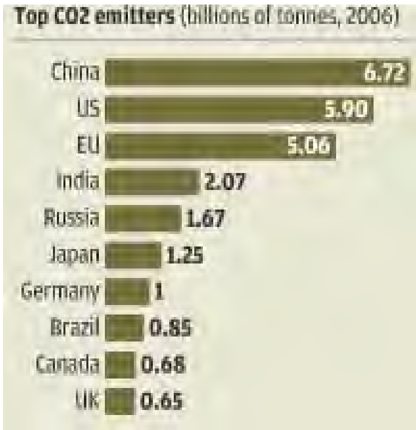
1.2. Reason II: Pressure From The International Community

Meanwhile, the international community's calls for China to undertake meaningful action to control its greenhouse gas emissions have never ceased since the day climate change became an issue. In order to understand the nature of such calls, it is necessary to first take a look at China's GHG emissions scenario.

The emission of China's greenhouse gas has certain interesting features. Although China historically only accounted for a relatively lower percentage (7.3% from 1850−2000) in globally cumulative greenhouse gas emissions, it has kept increasing its share in the last decade up to 14.8% in 2003 and became the second largest annual emitter in absolute terms in that year, where GDP and total population are the decisive determinants. The rising trend has continued and it is claimed by many researchers that the annual greenhouse gas emissions in China have already surpassed those of the US and that China has already became the world's largest emitter (IEA, 2007; see Figure 2). Furthermore, given China's continuously soaring energy-related CO2 emissions, what could be expected in the coming decades is continuing increases in greenhouse gas (Figure 1).

Figure 1: China's greenhouse gas trends and projections; Figure 2: Top carbon dioxide emitters

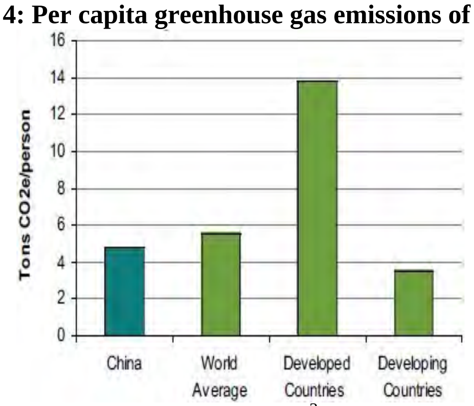


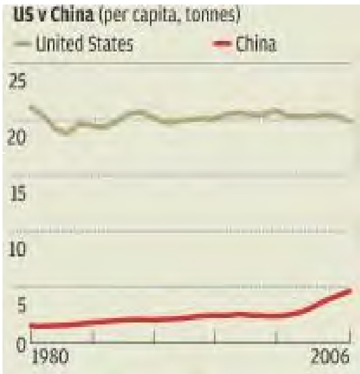


Source: Pew Centre, 2007[2]   Source: Shi, 2009

However, in sharp contrast to the enormous overall amounts, China's greenhouse gas emissions, in per capita terms, depict a strikingly different picture, in which China only ranks 97th globally in 2004, just slightly higher than the average for developing countries but below the world average (NDRC, 2007, p.6). A recent report states that China's per capita emissions are 78 percent lower than that of the US, although China's per capita emissions are growing at a rate four to six times as fast as those of the US (Asia Society & Pew Centre, 2009, p.19). Along with the sharp increase in overall greenhouse gas emissions in the past a few years, it is reported that China's per capita emissions are approaching the world average (Figure 3; see also Tu, 2009, p.12).

Figure 3: Per capita greenhouse gas emissions in 2004
Figure 4: Per capita greenhouse gas emissions of US and China





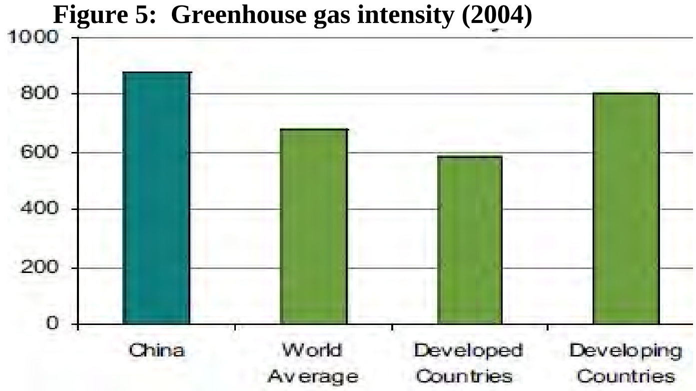
Source: Pew Centre, 2007[3]   **Source: Shi, 2009.**

It is also interesting to observe the decrease of China's carbon intensity − the level of CO_2 emissions per unit of economic output. Carbon intensity not only serves as a strong determinant of a country's overall emissions, but also reflects the energy intensity and fuel mix within carbon-related industries (Baumert et al., 2004, p.4). China has offered a striking case in this regard. As of 2004, China's carbon intensity was above the world average, and above the average for developing countries (Figure 5). But China's carbon intensity evidently fell 47%, while GDP grew 162% from 1990 to 2000 (both much as a result of privatisation and introduction of market reform). In comparison, between 1990 and 2000, the

[2] 'Climate Change Mitigation Measures in the People's Republic of China', Pew Centre on Global Climate Change, 9 April 2007. Available HTTP: <http://www.pewclimate.org/docUploads/International%20Brief%20-%20China.pdf> (accessed 18 January 2009).
[3] Ibid.

greenhouse gas intensity of the US economy declined by 17.5% (Robert & Kyle, 2003). International Energy Agency (IEA) also confirms that China's emission intensity in 2004 continued to decline.

Figure 5: Greenhouse gas intensity (2004)



Source: Pew Centre, 2007[4]

However, some less optimistic predictions with regard to China's decreasing trend of carbon intensity exist, such as "*It remains to be seen whether these trends are anomalous one-time shifts reflecting particular circumstance … the opening of China's economy to market forces … or whether they suggest the potential for a longer-term decoupling of economic and emissions growth*" (Baumert et al., 2004, p.6). It is argued by some observers that carbon intensity of China may not be able to continue to decline due to the rapid growth in industrial demand, its heavy dependence on coal and the increasing constraint on securing oil from overseas (Garnaut et al., 2008, p.3). Some even claimed that '*China's trend of decreasing energy intensity reversed between 2002 and 2005 with energy growth surpassing economic growth…China is now four times as energy intensive as the US and nine times less efficient than Japan*' (Asia Society & Pew Centre, 2009, p.19). This claim is not invalid given that China indeed invested more on heavy industry since 2001 in order to maintain the two-digit growth rate. There also exist arguments that Beijing's impressive greenhouse gas reduction achievements in late 1990s is largely due to an embarrassing underreporting of coal statistics (Tu, 2009, p.13). However, despite all these arguments, it is safe to say that the Beijing government has remarkably reduced its energy intensity and has thereby produced climate benefits.

Indeed, although China's low per capita GHG emissions can still provide some support in international climate negotiations, the soaring growth rate in its absolute emissions has made it spotlight in any climate talks. The debate with regard to China's climate responsibility has become even more heated since China recently replaced the US as the largest greenhouse gas emitter.

While developed economies such as European Union have been trying to introduce various incentive programs to get China more actively involved in climate-change-mitigation action, the play between China and the US over the international climate change regime deserves special attention.

During the eight years of the Bush regime, China used US inaction as an excuse to shun constructive greenhouse gas mitigation efforts, and the U.S. used Chinese inaction for the same purpose. Neither of these two largest greenhouse gas emitters undertook any mandatory obligations to set a limit on or reduce its emissions under the Kyoto Protocol. Nevertheless, there are new trends in the climate strategy of the US. In 2009, a number of senate bills were under active discussion in the Congress, and it is likely that a mandatory emissions control scheme will be put in place in the US no later than 2010, under which the

[4] Ibid.

global politics of climate change will be thoroughly transformed (Clauseen, 2007). Driven by concerns about the negative economic effects such as losing competitive advantage to those without the same emissions controls as the early-movers, in particular China, the US will have strong incentives to drag China into the global climate effort and insist that China fulfil its share of responsibility as well.

The cover that China has been hiding behind will be eliminated once the US takes the lead and commits itself to mandatory emission reductions, which would probably come true since the new president, Barrack Obama, has expressed strong interests in combating climate change. It is reported that the President '…has pledged to bring emissions down to 1990 levels by 2020 and endorsed a bill that would cut emissions by 17 per cent from 2005 levels in 2020 - a reduction of 5 per cent from 1990 levels, according to EU calculations' (Bloomberg, 2009). The Energy and Commerce Committee in the House just passed the Waxman- Markey bill, a climate and energy bill that incorporates the establishment of a nation-wide emissions trading scheme, the use of renewable energy and the long-term target of reducing GHG emissions. While it is a long process before such bill can turn into law, the passage has illustrated to some extent the legislature's determination to set mandatory limits on US's GHG emissions. In addition, a number of states have participated in regional initiatives such as Regional Greenhouse Gas Initiative and Western Climate Initiative that set up cap-and-trade systems to control their GHG emissions.

Experience has proved that when the US is prepared to lead, others, too, will often be far better able to muster the necessary political will (Clauseen, 2007). The recent call for joint efforts to curb greenhouse gas between the US and China by Secretary of the State Hilary Rodham Clinton when she visited China in February 2009 may indicate the Obama administration's hope to make climate change the centerpiece of a broader, more vigorous engagement with China.[5] Even the outspoken China critic and US House Speaker Nancy Pelosi puts climate change on top of agenda and steers away from human rights in her latest visit to China (SCMP, 2009). All of the five members of the delegation led by her are members of the House Select Committee on Energy Independence and Global Warming. In fact, there are news claiming that China and the U.S. are apparently negotiating 'deal', a kind of joint agreement, in regard to a schedule for emissions reductions and overall climate policy (Dyer, 2009). US Energy Secretary Steven Chu recently said that the US may accept targets for cutting its greenhouse gases in an international treaty, even if China does not (Bloomberg, 2009). Observers also state that the cooperation between China and US on energy and climate change would produce mutual benefits for both parties (Asia Society & Pew Centre, 2009).

In the future climate framework, whether multilateral or otherwise, while China may not be required to take on quantified greenhouse gas emissions limits as the developed countries do, it might have to demonstrate its sincerity in contributing its fair share to the international climate efforts by making some forms of binding commitments. In fact, the Bali Roadmap which was passed in 2008 by the United Nations Framework Convention on Climate Change conference has already called for 'measurable, reportable and ***verifiable*** nationally appropriate mitigation commitments or actions' from developing countries including China. It is expected that the 2009 Copenhagen conference will witness more climate progress from both US and China.

Indeed, it is a fact that China's greenhouse gas emissions, even with tremendous uncertainties in national-level projections, will continue to rise sharply due to the growth of its economy, population and energy consumption and heavy reliance on coal. Under these circumstances, it will eventually become a must for China to put in place concrete action in

[5] 'Clinton paints China policy with a green hue' authored by Mark Lander, *New York Times*, 22 February 2009. Available HTTP: <http://www.nytimes.com/2009/02/22/world/asia/22diplo.html?_r=1> (accessed 23 February 2009).

response to the international community's request, particularly that from the US, for its more meaningful participation in climate-change-mitigation efforts (Cao, 2008).

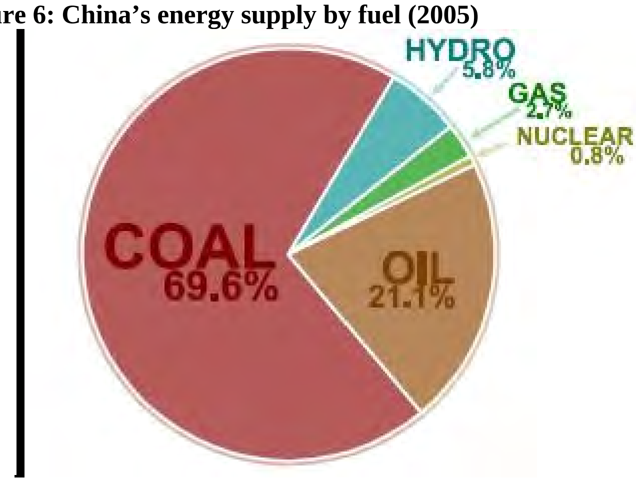
Section 2: China's Action Against Climate Change

Climate change is not a new concept for the Beijing government but it has developed slowly. China has not yet established an orchestrated national climate regime that provides effective regulatory mechanism, though it did set up some climate committees and published a series of white papers about climate (State Council, 2008). As will be discussed later, apart from the Clean Development Mechanism (CDM), the current climate change-mitigation policies in China are energy efficiency and renewable programs, which are essentially energy-oriented-and-targeted but produce ancillary climate benefits. Most of the GHG emissions in China take the form of CO_2. It is reported that the share of CO_2 in China's total greenhouse gas emissions is 83% in 2004 (NDRC, 2007, p.6). As emitting CO_2 in China is primarily a byproduct of energy production and China's emissions are dominated by heavy industry, it would be useful to first outline China's energy profile in order to obtain a better understanding of China's action against climate change.

2.1. Energy Profile: Coal-Dominant Energy Mix

As a country rich in coal—nearly 13 percent of all the known mineable coal still in the ground is in this country—it is natural to find that China's primary energy mix is dominated by this carbon-intensive fossil fuel (British Petroleum, 2006). In 2005, coal contributed more than 69% of China's energy use (Figure 6) including approximately 80 percent of its electricity generation, while oil accounted for around 20%, natural gas less than 3%, hydro, nuclear and others together approximately 7%.(China's Statistical Yearbook, 2006).

Figure 6: China's energy supply by fuel (2005)



Source: China Statistical Yearbook

In addition, China has recently witnessed a fast growth of coal power plants. In 2006 and 2007 alone, approximately 170 gigawatts (GW) of new coal power capacity were installed in China, equivalent of about two large coal power plants per week. There are currently more coal-fired power plants in China than in the US, the UK, and India combined (Asia Society & Pew Centre, 2009, p.20). In fact, burning coal is the largest contributor to $CO_{2,}$ not only because it dwarfs the consumption of natural gas and oil in absolute terms, but because coal combustion emits almost twice as much CO2 per unit of energy as does the combustion of natural gas, whereas the amount from crude oil combustion falls between coal and natural gas.

The implication of China's heavy reliance on coal for its energy supply is two-fold: first, the operations of desulphurisation equipment or other in-use coal cleaning technologies that reduce traditional air pollutants such as SO_2 did little to mitigate the emission of $CO_{2.}$ It indicates that when coal consumption expands, which is inevitable under its current policy scenario, it will be equally inevitable for China to emit more greenhouse gas. Second, as coal is more carbon-intensive than other fossil fuels, China's CO_2 emission intensity of energy consumption is and will continue to be relatively high. As a result, China's per capita CO_2 emissions will approach the world average at a fast pace while other major emitters, such as OECD countries, are more diversified in energy supply and rely less on coal.

The coal-dominant energy mix is unlikely to be significantly changed in the near term, which is absolutely unavoidable in a country that is developing rapidly and is so heavily dependent on coal as the fuel to light up the cities, run the trains, and so on. For alternatives to coal, China is having a difficult time in increasing domestic oil production, and securing oil supply from overseas is not always easy (Lang and Miao, 2008). The current global economic turndown may offer China some opportunities in pursuing more overseas oil reserves. It is reported that '…China has committed more than US$50 billion to loans-for-oil agreements with Russia, Kazakhstan, Venezuela and Brazil since February' (Richardson, 2009). Should these deals be finalized, China would be able to obtain more than one third of 4.1 million barrels it currently imports a day.

Studies also show that China's gas production is increasing but not fast enough to satisfy demand growth (Rosen & House, 2007). In effect, although China has discovered new gas fields in Sichuan and Erdos Basin and made enormous efforts to obtain gas from countries such as Australia, Indonesia, Malaysia, Russia and central Asia, it is believed that it would be a daunting task to meet the forecast four-fold increase in demand which is largely driven by the fast-growing chemicals industry and an urbanization-led need for clean household heating and cooking fuel (Downs, 2006).

It is a fact that this most carbon-intensive fossil fuel will continue to engine China's burgeoning economy at least in the short to medium term. The Chinese government is not blind to the air pollution caused by burning coal. It formulates a series of polices to retire old, outdated coal power plants and replace them with new, more efficient ones. It is reported that '…China has since become the major world market for advanced coal-fired power plants with high-specification emission control systems' (IEA, 2009). With the installation of more efficient coal power plants such as the one recently build in Tianjin that uses extremely hot steam, it is likely for China to greatly increase the average efficiency of its coal-fired fleet and accordingly reduce the emission of CO2 per unit of electricity it generates. Experts expect that the application of newest technology would produce a cut of more than one third of the CO2 emissions compared to the weakest one (Bradsher, 2009a). It is also predicted that China may increase the average efficiency from 32 percent in 2005 to around 40 percent by 2030 by installing more supercritical units (Asia Society & Pew Centre, 2009, p.28).

However, it should be noted that only 60% of the newly built coal-fired power plants use advance technologies that improve their efficiency, and the numerous inefficient power plants that China built in the past decade will remain in operation for a long period of time. The overall amount of CO2 emissions from China's heavy reliance on coal is bound to increase rapidly. The question is, can China continue its reliance on coal in a carbon-constrained world? Or put another way, can China successfully deploy low-emissions or zero-emissions coal technology, such as Carbon Capture and Storage (CCS) to help abate the GHG emissions from coal-fired power plants?

CCS is a technology that captures CO2 either before combustion or after combustion, compresses the captured CO2 and transports it through pipelines for storage in deep, underground geological formations such as depleted oil fields (Asia Society & Pew Centre, 2009, p.29). The CCS is promising in controlling CO_2 emissions because should it be adopted, a coal-fired power plant will virtually emit zero greenhouse gases. The CCS technologies have been widely researched by many nations, but many of them are still at very early stage and there are only a few small-scale demonstration projects. China is also devoting resources to the CCS research with other international partners. In collaboration with the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO), Huaneng Power Group (China's largest electricity generator) started running a 3,000-ton post-combustion carbon capture pilot project near Beijing in 2008 (IEA, 2009, p.106). The CO_2 captured is not stored but used for beverage production. Other proposed demonstration projects including GreenGen (a 400-megawatt IGCC plant with CCS to be added by 2020) and Near Zero Emission Coal are also under planning (Asia Society & Pew Centre, 2009, p.29).

The major hurdle for wide application of CCS is cost. It is estimated that the electricity produced by a coal power plants that uses CCS would be 75% to 100% more expensive than the electricity produced by conventional coal power plant (IEA, 2009, p.106). The concern of 'energy penalty' of running the capture equipment should not be ignored, either (Asia Society & Pew Centre, 2009, p.30). With current CCS technology, the energy that is required for capture is significant and may reduce a plant's combustion efficiency by roughly one third. While transportation from power plant to storage site is a further costly complication for carbon sequestration, the storage of the captured CO_2 is another problem. While some initial assessment of China's storage capacity has been conducted, it is too early to conclude that China would be able to store the CO_2 generated by its enormous amount of coal-fired power plants. Indeed, the volume of CO_2 currently generated by combustion of coal, when compressed for storage, would be much larger than any current storage sites, which in any case are usually very far from existing or planned power plants. The magnitude of the CO_2 emitted by all China's coal power plants would undoubtedly make the transportation and storage a daunting task.

Neither can the risk involved in the potential leakage of stored CO_2 be underestimated—the leaked CO_2 could be lethal. Insurance companies would not act unless scientific research can convincingly ensure that leakage would not be a problem; and without the financial assurance from the insurance companies, it is hardly possible to expect any large-scale CCS project which normally demands huge amounts of investment to kick off. In addition, some researchers have argued that burying carbon dioxide from coal-power plants could increase the emissions of other pollutants such as NO_x and SO_2, casting some shadow on this highly-acclaimed technology (Barry, 2008).

Indeed, whereas the international community has admitted that technologies such as CCS are key to the continual use of coal, it is widely agreed that large-scale promotion of CCS would not be commercially viable until 2030. It is a fact that China is actively participating in the research and development of this clean coal technology, but it is unrealistic to expect that China would adopt a technology which is not yet in commercial use in the developed economies.

2.2. Promoting Renewable Energy

No matter how efficient it is, burning fossil fuels still emits GHG. It is suggested by many that the real solution for combating climate change would be a complete shift to renewable energy such as hydro, wind, solar, biomass, tidal, etc. As the renewables are virtually zero-carbon emitting, powering the world by them would absolutely alleviate the concern about the continuing concentration of GHG in the atmosphere, though other concerns may arise along with their wide use.

While obtaining 17 percent of its electricity and 7 percent of the primary energy from renewable sources in 2008, the central government in Beijing is making efforts to further diversify the supply with hydro, nuclear and other renewable power. It announces a target of 16% of primary energy from renewable energies and 20% of electricity capacity by 2020. In order to achieve the target, the Beijing government has put in place a series of policies and measures that provide various forms of incentives to enterprises (Asia Society & Pew Centre, 2009, p.37). However, the development of non-carbon emitting energies in China is complicated.

Hydropower is currently the primary source of China's renewable electricity. The production of hydropower increased by 10.8% in 2007 and provided for more than 6% of China's overall energy need in that year. Much of the increase was contributed by the Three Gorges Dam that was newly put to use and expected to provide China with 18,000 megawatts of energy, more than ten percent of China's total electricity needs. The benefits and damages that would come along with this large-scale campaign have been well documented. Whether this project would be an economic success or an ecological disaster remains an open question, but the fact that it has received considerable domestic as well as international criticism has cast some shadow on its future (Boland, 1998 and Heggelund, 2004). Meanwhile, it is not rare to see strong political resistance, mainly from the displaced people and environmental groups, to new major hydropower projects such as those planned to be build on Nu River and Mekong River. The Central Government's decision to postpone those constructions until the controversy was settled and the environmental concern properly addressed has indicated the government's cautious attitude toward massive hydropower programs.

The latest news is that MEP has suspended two new large dam constructions on upper Yangtze River as the companies started construction without passing environmental impact assessment.[6] These two dams are part of the ambitious program of building 12 hydropower projects along the Jinsha River that flows from Qinghai province to Yunnan and Sichuan provinces, which would altogether produce an equivalent amount of electricity to the Three Gorges Dam when completed. However, voices like such construction would severely damage the local biodiversity have never ceased since the construction plan was proposed. In addition, the declining water resources would also take a toll on the development of hydroelectric facilities.

In regard to nuclear power, China has recently expressed strong interests in accelerating the build-up of nuclear plants.[7] It is reported that China plans to build eight nuclear plants from 2009 to 2011 with a total capacity of more than 10 GW, exceeding the overall capacity in all the past years.[8] The first inland nuclear plant is to be located in Hebei province and expects to commence construction in early 2009.[9] Despite the continuing opposition to building nuclear plants by many environmentalist groups (e.g. Greenpeace), some analysts in China and overseas argue that China can and should try to reduce coal consumption through replacing some electricity production from coal with electricity

[6] 'MEP suspended the application from Huadian and Huaneng electricity group', New Beijing Report, 12 June 2009, Available HTTP: <http://news.163.com/09/0612/02/5BIV63C2000120GR.html >(assessed 15 June 2009).

[7] 'The Third-generation Nuclear Power Plants is to be laid out in China', *Phoenix Finance*, 2 September 2008. Available HTTP: <http://finance.ifeng.com/zq/hybg/200809/0902_932_757826.shtml> (accessed 23 February 2009)

[8] 'China will promote the self-development of nuclear power plant', *Caijing*, 19 February 2009. Available HTTP: < http://www.caijing.com.cn/2009-02-19/110071355.html> (accessed 24 February 2009).

[9] 'China expects to build the first inland nuclear plant in 2009', *Xinhua Net*, 7 December 2007, Available HTTP: <http://news.xinhuanet.com/newscenter/2008-12/07/content_10469198.htm> (accessed 23 February 2009).

production by nuclear power in the medium term.[10] The Daya Bay nuclear power plant has been supplying about 30% of the power to one of Hong Kong's two major electrical utilities without problems for more than a decade. The argument of these analysts is that the risks and likely damage from substantial global warming are orders of magnitude greater than the risks of accidents and the problems of storage of waste associated with nuclear power plants such as the one at Daya Bay. Concerns such as China's coal reserve is finite and might not be able to eternally sustain the booming economy also partly encourage China to pursue further the development of nuclear power.

It is also possible that with new technology such as the 'pebble bed' reactor, which is currently being tested in China, the country may be able to reduce risks and costs involved in building and operating nuclear power plants.[11] It is therefore more likely for China to promote the use of this "clean" power on a larger scale and help reduce greenhouse gas emissions.

On the other hand, we cannot be blind to the potential risks in nuclear power. It may be too early to conclude that China has obtained nuclear technologies that are mature enough in all aspects to support extensive construction of nuclear power plants and that a boom in construction of nuclear power plants will occur. It is fair to say that although the central government has indicated its support for China's nuclear power development and some technological progress has been achieved, it still remains to be seen how those policies and measures will actually play out.

The development of other renewable energy is also encouraging. Wind power is becoming cost-competitive in certain areas and China has become one of the world's largest markets for wind turbines along with US and Spain. At the end of 2007, China's installed base of wind power totaled just over 6 gigawatts (GW), making China the fifth largest producer of wind power, after Germany, the U.S., Spain and India. As a consequence of the rapid build-out of wind power projects in China, in April 2008 the National Development and Reform Commission revised its 11th Five Year Plan Period plan for wind power development from 5 GW to 10 GW by 2010. Wind power industry statistics show that by the end of 2008 China's total installed base of wind power production will have already reached 13 GW, two years ahead of the revised plan. Some experts are estimating that by 2010, the total installed capacity for wind power generation in China will reach 20 GW and that by 2020 China's installed base of wind power will total 100 GW.[12]

Meanwhile, solar-water-heating is widely used by Chinese families due to the relatively low costs. China is also the world's largest producer of photovoltaic (PV) cells. As solar-generating electricity is generally ten times more expensive than that from traditional coal-fired power plants, 98% of China's photovoltaic cells are exported overseas (Xin, 2009). The current economic turndown is giving most of China's PV a hard time as the demand from overseas market is shrinking dramatically. The Ministry of Finance issued *Application Guidelines for Demonstration Projects of Solar Photovoltaic Building* on 20 April, 2009 and provides a maximum subsidy of 20 RMB per installed watt for eligible applicants (Ministry of Finance, 2009). Since the current installation cost for PV cells in China is roughly 24 RMB/watt, the demonstration projects can significantly reduce the installation cost to as low as 4 RMB/watt with the maximum subsidy. It is estimated that the electricity price from these

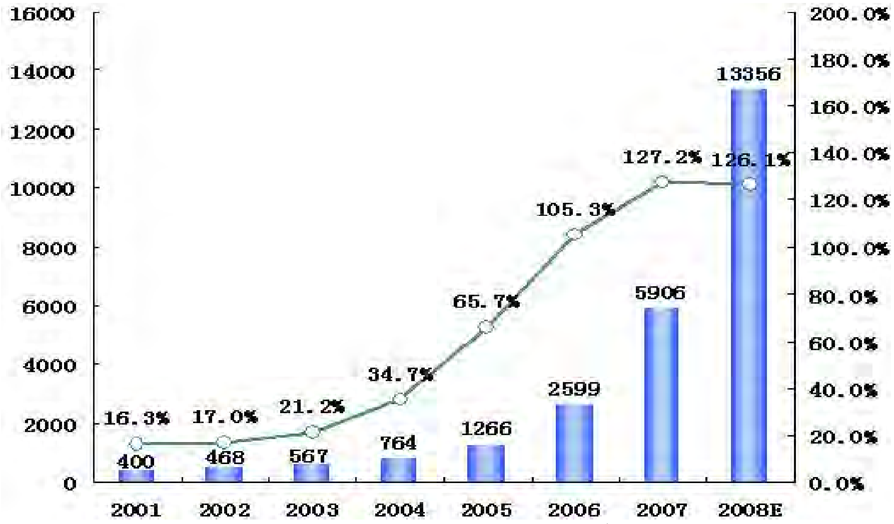
[10] 'China should promote significant the construction of nuclear power plant in inland area', *China News, 19 June 2008.* Available HTTP: <http://www.chinanews.com.cn/cj/cyzh/news/2008/06-19/1286065.shtml> (accessed 23 February 2009).

[11] 'Let a thousand reactors bloom' authored by Spencer Reiss, *Wired. Issue 12.09,* September, 2004. Available HTTP: http://www.wired.com/wired/archive/12.09/china.html?tw=wn_tophead_7 (accessed 23 February 2009).

[12] 'China's Wind Power Industry: Blowing Past Expectations' authored by Lou Schwartz & Ryan Hodum, 16 June 2008. Available HTTP: http://www.renewableenergyworld.com/rea/news/story?id=52764 (accessed 23 February 2009).

projects would therefore even have a slight competitive advantage over electricity from other sources (Xin, 2009).

Figure 7: China's wind power capacity and increasing trend from 2001-2008



Source: Huajing Shidian Research Centre, 2008（Column: installed capacity in MW; Curve: growth rate)[13]

Indeed, the rapid development of renewable energy, including building more nuclear plants and wind farms, would provide more electricity from non-coal sources and help abate China's greenhouse gas emissions in absolute terms. Nevertheless, there is bound to be a long way to go before renewable energy can make a significant dent in China's rising overall power demand given the aggregate amount of energy that are needed to fuel China's booming economy (Lang and Miao, 2008). For now, it is implausible to expect that they would reduce substantially the consumption of coal and other fossil fuels, and lead us into a carbon-free world at anywhere near current rates of energy consumption. But in the medium to long term, renewable energy could help China address the great dilemma caused by the heavy dependence on coal and the urgent need to mitigate greenhouse gas emissions.

2.3. Improving Energy Efficiency and Conservation

Another important energy policy that would produce significant climate benefits is the government's attempt to reduce energy consumption through greater efficiency and conservation. China sets an ambitious goal of cutting energy intensity (energy consumption per unit of GDP) by 20% below 2005 levels by 2010. It is estimated that a 20 percent energy intensity improvement can translate into an annual reduction of over 1.5 billion tons of CO_2 by 2010, making this largely local-pollution and energy-security-oriented effort one of the most significant carbon mitigation initiatives in the world (Lin, 2008).

The pillar project of achieving the 20 percent reduction target is the Top 1000 Enterprises Program (including 1008 enterprises actually), which was launched by the National Development and Reform Commission (NDRC) in 2006 and aims to improve the energy efficiency in China's 1000 largest enterprises that devour one third of the country's primary energy. It is expected that these 1,008 energy-consuming enterprises will achieve an overall reduction of 450 million tons of CO2 by 2010. Even for a large emitter such as China, this amount of reduction is not small, if we take into account the reduction target of 300

[13] 'China's wind power development in 2008', *Huajing Shidian Research Centre*. Available HTTP: <http://www.chinahyyj.com/news/r_20081218143332925628.html> (accessed 23 February 2009).

million tons of CO2e put forward by EU in their Kyoto commitment. It should be noted that local governments are also required to develop similar programs with an additional 100,000 smaller firms in order to achieve the 20% reduction national goal by 2010.

Meanwhile, in an announcement made in early 2007, NDRC was making efforts to retire a wide range of inefficient industrial plants. China is also improving the fuel economy standards for passenger vehicles fleets. The current standards are more stringent than those in Australia, the US and Canada (although less stringent than those in Japan and the EU). What is more important is that China revised the Energy Conservation Law in 2008, putting forward new and more stringent efficiency standards for buildings, industries and appliances.

However, these energy-oriented policies do not always perform as planned. It is reported by NDRC that 7.8 percent of the 1008 enterprises failed to meet their energy saving targets in 2007 (Xinhua Net, 2008). If we take into account local officials' conventional practice of massaging the data, chances are good to have a less aspiring percentage of compliance. China also failed to meet the energy intensity reduction target both in 2006 and 2007, though 2008 stands a relatively good chance to meet the target. Reasons for that are complicated: first, the target set by the central government is deemed as, though laudable, too ambitious; second, it takes considerable time for industry to invest in energy-saving facilities and change their business-as-usual behavior. It also takes time for the investment to produce actual energy-saving results; third, it is not easy for China to shift away from a heavy-industry-led consumption which is relatively energy intensive, as capital has been locked in on the basis of expected returns; fourth, the order to shut down small energy inefficient firms was not fully obeyed by local officials; and fifth, the financial costs of improving energy efficiency are rarely small in amount for selected firms, who cannot always obtain adequate financial assistance from the government. The prospect for China achieving the 20% reduction goal appears dim.

Aside from targeting large stationary enterprises, transportation is another sector that China can make great improvement in both ensuring energy security and combating climate change. The most significant case is the development of electric vehicles.

Unlike the hybrid car that still consumes oil and emits GHG, electric car produces no emission at the tailpipe, and in most models, it does not even has a tailpipe, making it virtually zero-carbon emitting. Many have expressed interest in developing electric vehicles including China. The Central Government recently put forward the goal of becoming a world leader in electric car by 2012 with the purpose of creating jobs, reducing urban pollution and decreasing oil dependence (Bradsher, 2009b). In order to achieve the goal, the government has allocated large amount of funds to the electric car research. It also runs a pilot program in 13 cities which offers a subsidy of up to $ 8,800 to each electric car that joins the taxi fleet or is purchased by the local government agencies (Bradsher, 2009b). Complimentary infrastructure such as charging station for electric cars is also under construction in Beijing, Tianjin and Shanghai. It is reported that China aims to boost its production of hybrid or electric vehicles from 2,100 in 2008 to 500,000 by 2011 (Bradsher, 2009b).

In fact, some companies in China, like Shenzhen-based BYD Auto, China's Tianjin Qingyuan Electric Vehicle Company and Hafei Auto Group, have successfully developed several electric car models and passed strict safety test. But how to commercialize them in the market remains an open question in China as it does in other countries—even with the government's subsidy, the retail price of these electric cars are still much more expensive than the gasoline-engine counterparts. Other concerns about its development in China also exist. For instance, the demand for electricity in China is so huge that it may leave little room to provide sufficient amount of electricity to recharge the battery for the large scale promotion of electric cars.

Electric vehicles also have an eco-label—the Well-to-Wheel CO_2 emissions of electric vehicles is always lower than those of conventional cars. The question is, as electric cars replace the burning of gasoline and diesel fuel by the burning of coal to produce electricity, will there be great ‘emission saving’ for China?

The answer is closely related to the emission intensity of China’s existing electricity infrastructure. As previously discussed, 80 percent of China’s electricity is produced by coal, and it could be expected that most of the electricity that will be used to recharge the battery for electric cars would be provided by coal-fired power plants. Bearing in mind the fact that many of China’s coal power plants are still inefficient, using electricity coming from carbon-intensive fossil fuels would negate to a great extent the climatic benefits brought by the efficiency advantages of electric vehicles. A McKinsey & Company report states that ‘…given China’s reliance on coal-fired plants for electricity, electric vehicles today only have a 19 percent carbon abatement potential over current internal combustion engine technologies.’ (Gao, et al. 2008).

However, electric cars could produce better environmental benefits if more renewable energy is introduced to the grid. By diversifying the energy source to fuel cars, China would be able to achieve as much as 49 percent carbon abatement potential (Gao, et al. 2008). However, it is a long way for China to realize the high carbon abatement potential since its coal-dominant energy mix would not be significantly changed in the foreseeable future.

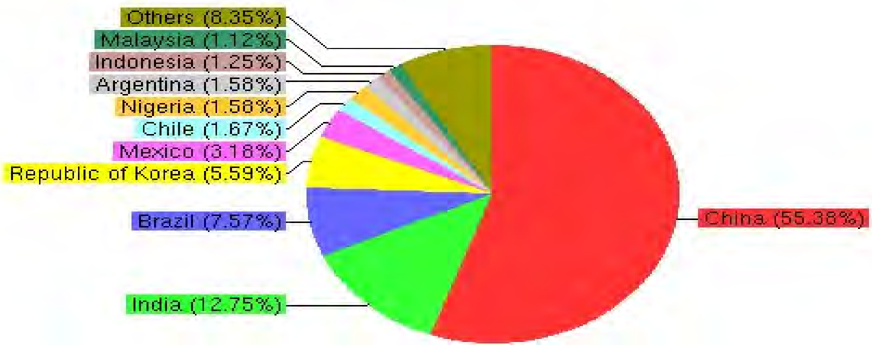
Indeed, these energy-oriented polices do not aim directly to reduce China’s GHG emissions, but they have produced remarkable climate benefits in the absence of a concerted national climate policy providing effective regulatory mechanism. The Chinese government claims that by energy conserving and using renewable energy, China reduced 835 million tons of carbon dioxide equivalent in 2006 and 2007 (State Council, 2008). These climate change mitigation-related policies and measures are important in China’s efforts to cut GHG emissions. It should be noted that China has also launched a campaign of nation-wide tree-planting and reforestation and enhanced ecology restoration and protection, which also cut the emission of CO_2. And we should bear in mind that the effective control on the growth rate of population through family planning has contributed greatly to the reduction of greenhouse gas emissions.

2.4. Participation in the Clean Development Mechanism (CDM)

Apart from these climate-related energy policies, China also gets involved in the global climate change regime by its active participation in the Clean Development Mechanism (CDM). With the Kyoto protocol’s entry into force in 2005, China has been actively making use of CDM—an international emission-reduction-credit system offered by the Protocol to produce mutual economic benefits for both the investing and host countries. It is reported that China is by far the largest source of CDM credits, accounting for more than 40% of those generated to date. China even has a larger share (55.38%) in the expected average annual Certified Emission Reductions (CERs) from registered projects by host party (Figure 8, UNFCCC, 2009, up to 21/02/2009)[14]

[14] ‘Percentage of CDM host countries’. 21 February 2009, Available HTTP: http://cdm.unfccc.int/Statistics/Registration/AmountOfReductRegisteredProjPieChart.html (accessed 21 February 2009).

Figure 8: Percentage of Clean Development Mechanism host countries



Source: UNFCCC, as of 21/02/2009

Within the CDM credits already obtained, most of which came from destruction of trifluoromethane (HFC_{23}), representing roughly 90% of all the issued CERs. Other key project types involve the capture of methane from landfills and nitrous oxide (N2O)—both are potent greenhouse gas. An increasing number of renewable energy and energy efficiency projects is getting registered in the past two years and is expected to represent a larger share in China's CDM projects.

It is claimed by some researchers that China's dominance in the carbon trading market is partly due to its entrepreneurship in developing CDM projects and also to its relatively low risk investment environment, compared to other host countries.[15] Indeed, China did spot the commercial opportunity embedded in the CDM and made institutional arrangements to smooth the way for its introduction to China. For instance, the central government established the National Coordination Committee on Climate Change in 1998 and clearly stipulated it as the review and coordination agency for CDM projects in 2003. An Office of National Coordination Committee on Climate Change was also created as the executive body to deal with CDM issue (located within National Development and Reform Commission).

As early as 2005, National Development and Reform Commission, along with some other ministries, issued *Measures for Operation and Management of Clean Development Mechanism in China*, which provides policy framework as well as detailed instructions for industry to effectively participate in CDM. It is reported that the CDM office has provided clear guidance on eligibility, application and approving procedures, and benefits sharing for registering as a CDM project. And thus potential applicants are better equipped to make a successful registration. The establishment of three carbon trading centers in Beijing, Tianjin and Shanghai in 2008 also provides trading platforms for the carbon credit transactions. All these institutional arrangements have effectively created a friendly investment environment for both overseas investors and domestic enterprises. The CDM project boom then came as no surprise.

Indeed, it is true that the enormous amount of revenues that could be generated from CDM projects is the major motivation for both the Chinese government and private industry. Although the government takes a large share of the revenue (65% in HFC23 projects and 35% in other types of projects), the enterprise's enthusiasm for reaping the windfall profits

[15] 'Climate Change Mitigation Measures in the People's Republic of China', Pew Centre on Global Climate Change.

from CDM projects still remains great. The revenues taken by the government are used to set up an environmental fund that supports energy saving and deployment of renewables. It is noteworthy that the promotion of CDM projects will help enhance the environmental capacity-building and institutional development. For instance, it is imperative for the host country to establish credible emissions baselines so that the reduction credits created under the projects can be reliably measured and verified. In order to realize the mutual benefits of the CDM projects, there is every reason to expect China and the investing countries to exert real efforts to meet the baseline-setting standards.

However, there also exist barriers for the development of CDM in China. For instance, it took a long time for the Executive Board (EB) to pass a methodology for assessing a new type of CDM projects. Therefore, only a small number of CDM projects that registered with NDRC could eventually be approved by the Executive Board and create financial benefits for the host enterprises. Most other registered projects will be refused and have no way to recover their financial costs—which are not always small. How to ensure enterprises are not intimidated by the potential loss of their initial investments still remains an issue unsolved. In addition, since most applicants in China normally lack expertise to participate in CDM, they are often placed in a disadvantageous position when negotiating with foreign investors who are usually better equipped with relevant knowledge. As a result, the contract price for Certified Emission Reductions (CERs) tends to be relatively low and core mitigation technology transfer rarely takes place (Teng, etc. 2008).

It should also be noted that there are costs involved in international climate change cooperation and the costs may be huge for China. While the CDM projects generate financial income for both industry and government in a short term, they may exhaust the lowest-cost carbon mitigation options currently available in China. In a long term, China may be left with fewer economically affordable mitigation options when it has to shoulder carbon reduction responsibilities in the future.

Despite the potential risks in CDM, the Chinese government has reiterated its support for the continual application of CDM after 2012 while arguing for more technology transfer from the developed countries (State Council, 2008).

To sum up, China's greenhouse gas emissions will continue to soar as a result of its economic boom and its continual reliance on coal. Since the adverse effects of climate change are beyond discussion, moderating its greenhouse gas emissions will be a daunting, but laudable task for the Beijing government. The energy efficiency and renewables programs are meaningful but far from adequate. As discussed above, it appears to be impossible, with current or currently developing technologies such as CCS, to produce the 80% reductions in GHG emissions which scientists recommend over the next four decades. What other measures might be feasible for China to make more substantial contributions to global climate-change-mitigation efforts?

Section 3: Relocalization: Some Preliminary Considerations

China's dilemma is the need to sustain a developing economy which depends crucially on GHG-emitting processes. It appears to be impossible to do this without some radical restructuring of economic activity, since it seems that it cannot be done by some combination of greater energy-efficiency and substituting fossil fuels by renewables or nuclear power. An alternative over the longer term is to promote relocalization of production and exchange using local and regional renewable resources.

One possible definition of relocalization is: the process by which a region, county, city or even neighborhood frees itself from an overdependence on the global economy and invests its own resources to produce a significant portion of the goods, services, food and energy it consumes from its local endowment of financial, natural and human capital

(Talberth et al, 2006). It can be seen that the idea of relocalization covers a wide range of functions and changes, from food supply, transportation, urban planning, to the energy restructuring.

There are many towns and cities in the western world in which groups are planning and beginning to implement such changes. For instance, the Transition Town Initiative, which originates from a small town in England, has now "gone viral" in England and beyond (Hopkins, 2008). The focus of transitioning one's community centers on rebuilding local resilience which refers to '*an ecosystem's ability to roll with external shocks and attempted enforced changes. In the context of communities and settlements, it refers to their ability to not collapse at first sight of oil or food shortages, and to their ability to respond with adaptability to disturbance*' (Hopkins, 2008, p.54). The transitioning also aims to address the question: '*…for all those aspects of life that this community needs in order to sustain itself and thrive, how do we significantly increase resilience (to mitigate the effects of peak oil) and drastically reduce carbon emissions (to mitigate the effects of climate change'* (Hopkins, 2008, p.56).

It is claimed that the resulting coordinated range of projects across all these aspects of life could lead to a collectively designed *energy descent* pathway which means the transition from a high fossil fuel-use economy to a more frugal one (Odum and Odum, 2001).

Although 'relocalization' may not explicitly be put forward as the target, some cities and towns have already established task forces to address climate change issues, sometimes together with other pressing concerns such as energy security and peak oil, assess their vulnerability to the adverse impacts of climate change, and to plan their moves to types of urban economies that minimize the consumption of fossil fuel (Lang and Miao, 2008). Some of these initiatives focus on 'energy efficiency' or energy-supply-volatility, and some also explicitly link the problems of global warming and other concerns such as peak-oil, intending to address both by major reductions in the consumption of fossil fuels. These reductions would be achieved by some combination of greater efficiency, better design of buildings and appliances, reduced consumption, and relocalization in the supply of food, goods, and energy. Some cities have produced a lot of local activity, a planned sequence of changes in transportation and regulation, and early support for local food production. No city overseas has come close to achieving a transition to an economy that relocalizes all aspects of life. But many of these cities provide useful models of some of the activities and plans that will be needed.

Of course, the social and ecological conditions in Chinese cities are quite different from most of these overseas communities. Planning must take account of local conditions. The political conditions are also quite different, and civil-society groups have played a major role in many of the overseas 'transition' initiatives, while such civil-society groups are much less vigorous in China for a variety of reasons. But there is no doubt that if citizens in China's cities can be engaged by local government agencies in collaborative discussions about transitions to sustainable urban life, that there are large resources of expertise which can be mobilized for such discussions and planning.

It is particularly notable that many Chinese cities are surrounded by agricultural districts in which agricultural knowledge and skills are still strong. It is crucial to preserve these rural districts, since their food production will be essential in the future for the life of the local cities. It is also important to maximize food production within cities. Again, China's cities are probably more well-prepared to promote intra-city food production than most overseas cities. But the importance of intra-city food production must be recognized, and plans developed for progressive expansion of such production.

Finally, the transportation systems and the related planning of residential districts, and the question of sustainable populations and population densities in cities, need much more attention from citizens and planners. Cities must not be allowed to sprawl outwards into rural agricultural districts, with accompanying demands for energy-intensive transportation.

In fact, China is almost uniquely well-qualified to take this approach, and indeed, could become a leader in such innovations and such technologies. In the longer term, it is very much in China's national interest to follow this path.

Conclusion:

Climate change is becoming more and more important in China's political agenda. The vulnerability of itself to the adverse impacts of climate change, coupled with the increasing pressure from the international community, will impel Chinese policy makers to take climate change seriously. However, China's GHG emissions will continue to rise rapidly as it will rely heavily on coal, the most carbon-intensive fossil fuel, to engine the economy for a long period of time. And although China is installing more high efficient coal units, a high efficient coal-fired power plant emits twice as much CO2 as that of a gas power plant. The absolute increase of GHG emissions is likely to strain China's development in a coal-constraint world.

Meanwhile, China has improved greatly energy efficiency in the past few years and set up ambitious target of boosting the supply of renewable energies such as hydro, solar, winder and even nuclear power. The Beijing government is trying to reduce China's dependence on fossil fuels, in particular imported oil, by diversifying the energy sources. Whereas climate-change-mitigation is obviously not the concern that bred these energy-oriented policies, they have produced remarkable climate benefits. However, although the development of these programs is encouraging, they are far from adequate given the absolute amount of primary energy that is needed to maintain the high growth rate of China's GDP. Fossil fuel, especially coal, will still remain as the dominate source. In addition, there is no timeframe to put the CCS into large-scale commercial use and the carbon abatement potential of electric car in China is limited as most of the electricity for recharge would come from coal-fired power plants.

It would not be easy for China to address the dilemma of sustaining a developing economy which depends crucially on GHG-emitting processes. Fundamental changes are needed, and relocalization is an interesting option. Many overseas towns and cities have provided various models to reduce their dependence on fossil fuels by relocalizing many aspects of life, including food supply, energy structure, transportation, urban planning, etc. China may not yet have faced the same level of energy problems as those in the developed nations do in many of the regions, and it is uniquely well-positioned to make such transition since many Chinese cities still have intensive agriculture right up to the edges of the cities, and even within some cities. China is also capable of producing innovative designs in urban development and redevelopment to minimize transportation costs and promote much greater energy efficiency. The various kinds of so-called 'eco-cities' initiatives in China, and the growing interest in what has been called the 'circular economy' (recycling, re-using materials and goods, minimizing waste), will contribute to these innovative solutions.

It is a must for China to continue to lift more people out of poverty in a much less carbon-intensive way given the magnitude of the problem of global warming. The Communist Party's political legitimacy also rests upon this. The task to deal with climate change while sustaining economic development is unprecedented; and China is bound to be an important player in making the transition to a low-carbon or zero-carbon economy.

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China's Renewable Energy Policy: From Project-based to Strategic Policy Making: Cases of Wind and Solar

Veronica Pei-Fei Chang[1], Hans Bruyninckx[2]

Abstract

China is challenged by the imbalance between rapid economic growth and lacking environmental protection. Economic growth and increasingly intensive use of energy are certainly the main causes of environmental degradation in China. However, the central state tries to find a way out of the energy-environment dilemma. In 2005, the Chinese president Hu Jin-Tao emphasized that renewable energy was "an indispensable measure to deal with the increasingly serious issues of energy and environment". The following year, China's Renewable Energy Law took effect, indicating a turning point in the energy policy.

This paper investigates China's wind and solar energy, because they both reflect proactive policies and major changes in China's energy policy. We will discuss the trajectories that are leading from a past policy which was based on more ad hoc and projects, to an increased institutionalization of renewable energy as a strategic choice in China's energy mix.

Introduction

Since the 1979 economic reform, China went through a major shift in its system of production and consumption.[3] Industrial production has boomed, making China the 'factory of the world'. Improved living standards in urban areas have created a large middle class of urban consumers. This fundamental shift requires massive amounts of (new) energy. China's reliance on mainly coal and to a lesser extend oil to meet its energy demand, explains why the country has recently surpassed the US as the biggest carbon dioxide (CO_2) emitter, and thus the largest contributor to global warming in the world.[4] The international community is calling on China (and other rapidly expanding economies such as India, Brazil, Mexico, …) to take up responsibility by committing to energy efficiency and CO_2 reduction targets under the successor agreement of Kyoto, which will be negotiated in Copenhagen in December 2009. The Chinese national policy is responding by promoting renewable energy, including wind and solar, which will be our focus in this paper.

We will first briefly discuss China's increasing energy demand. The paper then maps out the evolution of both wind and solar energy policies, with an emphasis on the driving factors for change. We conclude with a comparison of both policy reforms. The paper focuses on internal driving forces of both wind and solar policies and less on external factors.

China's Increased Energy Demand and Problematic Energy Supply

The root causes of China's spectacular increase in energy use, leading to a heavy reliance on coal and oil, are economic expansion, urbanization and increased domestic consumption of consumer goods and energy. Since the 1979 economic reforms, China's GDP has increased by about a factor 5, with another quadrupling predicted by 2050. Ever since the mid-1990s

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[1] PhD student, Dept. of Political Science, Katholieke Universiteit Leuven (KUL), Belgium
email: chang0599@yahoo.com

[2] Professor in International Organizations and International Environmental Policy at the Institute for International and European Policy, KUL. Email: hans.bruyninckx@soc.kuleuven.be

[3] Economy Elisabeth. (2006) "Environmental Governance: the Emerging Economic Dimension", *Environmental Politics*, 15(2): 171-189. Mol Arthur and Carter Neil (2006) "China's Environmental Governance in Transition", *Environmental Politics*, 15(2): 149-170. Aden N.T. and Sinton J.E. (2006) "Environmental Implications of Energy Policy in China" *Environmental Politics*, 15 (2):248.

[4] Vidal John and Adam David (2007), "China overtakes US as world's largest CO_2 emitter. Retrieved from http://www.guardian.co.uk/environment/2007/jun/19/china.usnews

China has seen an average growth of 10% in GDP annually. In 1999 the World Bank categorized China from 'low income' to 'lower middle-income' country, which indicated great economic progress. According to the International Energy Outlook the GDP of China is indeed growing by about 9.6% per year, yet energy and electricity demand is reaching 11% and 15% annual growth rates respectively. This means that at this moment economic growth is accompanied by increased energy intensity of the production apparatus.[5]

While most attention has been given to China's role as a major export country to explain its economic growth and the spectacular increase in energy demand, internal shifts in urbanization and consumption are also of importance. China's urban population has increased in a unprecedented fashion to about 600 million urban citizens. While many of them are still living in poor conditions (compared to the Western world), a domestic middle class, possessing improved purchasing power has emerged. Several hundred million Chinese urbanites today have moved beyond the basic needs.[6] Their urban life style is based on the consumption of modern goods and services, the ownership of private cars, larger housing accommodation, etc. The result is a much increased use of energy for domestic purposes.

Coal is the main energy supply for economic growth in China. About 70% of the domestic energy mix consists of coal.[7] The low cost and domestic availability of coal are the main reasons for its wide use by industrial sectors for steam and direct heat. It is also the key source for electricity production. In addition, the consumption of coal is estimated to increase with another 13% to 18% in the next 20 years.[8] The other 30% of China's energy mix consist of oil 24%; natural gas, 3%; hydro, 2%; and, nuclear, 1%.[9] The relative part of oil, which is mainly used for transport and for derivates used in the chemical industry and agriculture, is expected to increase, which means a serious increase in oil imports. China's consumption of oil is bigger than its oil production and the gap is widening.[10] China is now the second largest oil consumer in the world next to the US, and oil use will increase by 80% by 2020 if current trends persist. China's increased dependence on foreign oil has been discussed in many fora in the last couple of years. It is putting extra stress on oil markets and reason for geo-political concerns in sensitive regions such as Central Asia, the Middle East and Africa. In addition, China's strategy for foreign supply of oil (e.g. relations with Sudan and Nigeria) is not met with great enthusiasm in the international community. It estimated that by 2020 China would import 80% of its oil and that by 2025 the amount would reach over 14 million barrels per day.[11] Given the size of the country and the economy, China has thus become a major player on global oil markets, next to the US.

It is fair to say that energy supply is considered as a, if not *the*, key challenge for China's sustained economic growth. In a country where further economic development domestically includes getting large masses of people out of poverty, this is not considered a luxury problem, but an essential element of national social development. Until now the increased supply has come from the rapid and massive building of more coal centrals,

[5] By 2020, GDP will grow four times more; energy, twice more than current use. With energy and electricity use exceeding development pace, various approaches such as clean energy, energy conservation and efficiency are being promoted. Ibid.

[6] Yuan Victor, "The New Consumption Demand Styles of Chinese People" Horizon Research Consultancy Group. Retrieved April 20, 2007 from http://www.sellinasia.com/ChineseMarketInGeneral.pdf

[7] Wang Frank and Li Hong-Fei (2005) 'Environmental Implications of China's Energy Demands: An Overview', in Kristen A. Day (ed) *China's Environment and the Challenge of Sustainable Development*, East Gate, p. 180.

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[9] Wang Frank and Li Hong-Fei (2005) 'Environmental Implications of China's Energy Demands: An Overview', in Kristen A. Day (ed) *China's Environment and the Challenge of Sustainable Development*, East Gate, p. 180. International Energy Agency (2004)

[10] US Energy Information Administration (2004). Retrieved from http://www. eia.doe.gov/emeu/cabs/china.html

[11] Ibid

imports of oil and increased use of gas. In addition, China has the most elaborate national program for the building of new nuclear power plants.[12]

Besides direct economic consequences on the supply and demand side of the energy market, the current dependence on fossil fuels also has significant and increasingly serious environmental and health consequences. Firstly**,** heavy reliance on coal is a major cause of air pollution in China.[13] Burning coal releases sulfur, which causes acid rain-which has affected 30% of land areas nationwide- and contributes to global atmospheric pollution. . Secondly, the use of coal is the major cause of CO_2 emissions, making China a major contributor to GHG emissions. China's per capita emissions were still low 10 years ago; however, they have increased so much that something needs to be done, especially in (the southeast) industrial and urban regions. Thirdly**,** scholars have pointed out that fact that serious air pollution is leading to deterioration of public health.[14]

China's Response: Renewable Energy (RE)

Given the challenge of energy supply, and the consequences of inefficient energy use, the Chinese authorities have also begun to develop a national policy on *alternative* energy sources. These include the increased use of natural gas, hydro electricity and nuclear energy. However, all of those have their own problems: natural gas is largely dependent on import and is still carbon based, and in addition has already led to security debates due to tensions with western minority tribes; hydro projects remain controversial and difficult to realize (cf. Three Gorges Dam); and, nuclear energy also remains controversial, although China is probably developing the most ambitious expansive policy trajectory for the moment. [15,] Given these circumstances, China has decided that a significant evolution in the direction of RE is necessary to secure future energy supply and to deal with problems of pollution and global warming.

China's RE demand is expected to grow rapidly in the coming decades.[16] The capacity of wind and solar up to 2005 was 760 MW and 60 MW respectively.[17] As the government is aiming for 15% consumption of renewable electricity in 2020, capacity is expected to reach 30,000 MW of wind farms and 1,000 MW of solar power.[18] This will result in a huge market for renewable energy. In the following paragraphs we provide a short overview of those energy sources which are considered to be renewable by the Chinese government, namely (small) hydro, biomass, wind and solar.

(Small) Hydro

The 2006 Renewable Energy Law (cf. below) defines small hydro power as renewable. Also, the Ministry of Water Resources is advocating clean energy production by conducting

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[12] Interview with NDRC China, May 26 2009.

[13] Aden N.T. and Sinton J.E. (2006) "Environmental Implications of Energy Policy in China" Environmental Politics, 15 (2): 255-256

[14] Combustion of mineralized coal can lead to arsenic, fluorine, selenium, and mercury poisoning. Kinkelman, R. Beklin H, and Zheng B (1999) "Health impacts of domestic coal use in China" Proceedings of the National Academy of Science 96:3427-31; Aden N.T. and Sinton J.E. (2006) "Environmental Implications of Energy Policy in China" *Environmental Politics*, 15 (2):256.

[15] Wang Frank and Li Hong-Fei (2005) 'Environmental Implications of China's Energy Demands: An Overview', in Kristen A. Day (ed) *China's Environment and the Challenge of Sustainable Development,* East Gate, pp. 189-195.

[16] Li Hong, China: Renewable Energy Policy Set in Motion. Retrieved Nov. 17, 2005 from http://www.renewableenergyworld.com

[17] Ibid

[18] Interview with NDRC China, May 26, 2009.

projects on small hydro power plants.[19] Apart from the controversial Three Gorges dam, other hydro-electricity operations are under way. There are 25 hydro power plant projects in the Yellow River basin; they will provide 15800 MW. Four hundred small hydro plants have already been established in rural areas and hold an installed capacity of 79000 MW.[20] Although hydro-electricity is recognized as a form of renewable energy, critical issues remain, as environmental and social externalities are often rather important[21]: local wildlife habitat or historic heritage destruction; relocation of inhabitants; loss of cropland; etc.[22] Despite the favourable legal recognition, there is a lack of mature policy for promotion, such as uncertain price mechanisms and subsidies, low integration between the national grid and (local) producers, etc.[23]

Biomass

From a policy perspective, there seems to be no concrete policy for the large-scale use of biomass as an energy source at this stage.[24] In 2008, China's biomass capacity reached 2GW. However, due to food security concerns, the Chinese government does not encourage biomass use and has limited consumption.[25] A general fear is that the use of biomass may be in competition with increased demands for agricultural crops and thus leading to competition over land as a scarce resource and high food prices, thus affecting food economics. The poor would suffer the most form this evolution, as they will have more difficulties to afford high-priced crops. The possible growing gap between rich and poor may lead to other problems, such as social tension or rural-to-urban migration for better employment.[26]

Wind and solar

In comparison to the above mentioned energy resources, wind and solar energy have major advantages. They share the following similarities. First, both are clean energy sources because they do not lead to serious pollution problems. They can help reduce CO_2 emissions, harm to public health, and contribute to keep development and environment in balance.[27] Second, China can increase self-dependency by exploring wind and solar energy, thus reducing reliance on foreign imports.[28] Third, developing both energies does not require large-scale resettlements as is the case for hydro and natural gas.

China has very good conditions for developing wind and solar energy. Many of China's largest cities are located close to coastal areas, where it is possible to establish off-

[19] China Council for International Cooperation on Environment and Development (CCICED), Phase III (2002-2007), "2002 Report on Summary and Implementation of CCICED Recommendations". Retrieved from http:// www. harbour. sfu.ca/dlam/history.html:.9.
[20] Cann Cynthia W.,.Cann Michael C and Gao Shanquan, China's Road to Sustainable Development: An Overview, in Kristen A. Day Ed., China's Environment and the Challenge of Sustainable Development, East Gate, 2005, p. 20.
[21] Ibid, p. 21
[22] Ibid p. 20; China Council for International Cooperation on Environment and Development (CCICED), Phase III (2002-2007), "2002 Report on Summary and Implementation of CCICED Recommendations" Retrieved from http:// www. harbour. sfu.ca/dlam/history.html, p.9.
[23] Nangzhou Regional Center, Framework Design of Incentive Policies for Small Hydro Power Development in China, Retrieved from http:// /218.108.40.30/en/rural /4.html
[24] Zhao Li Xin (2006), The Current Status and Prospect of China Biomass Development, Ministry of Agriculture.
[25] Interview with a project officer in the Energy Research Institute, NDRC, China. May 29,2009
[26] Sheridan Barrett (Aug. 20, 2007) "Blame It on Bio-fuels", *Newsweek*, p.36.
[27] For example, wind farms can produce 4.5 megawatts (MW) wind power to help reduce 675,000 tons of CO_2 in ten years. China Wind Energy Association. Retrieved from http://www.cwea.org.cn/main.asp; IT Power News, Retrieved from www.itpower.co.uk/NEWS30.html.
[28] Pan Jiahua and Zhu Xianli (2006) "Energy and Sustainable Development in China: Sustainable Energy Watch 2005-06". Helio International p.5..

shore wind farms.[29] The potential for additional wind power development in China is high compared to the installed capacity.[30] Regarding solar resources, China's rich solar power reserve almost meets the amount of the US and exceeds the amount in Europe and Japan. The current installed capacity equals the power supply of nearly 30 large scale coal power stations and remains rather limited.[31] Solar power development has the potential to increase; the resources are distributed around the north-west areas where they have big advantage for setting up large scale photovoltaic (PV) power station, because of huge availability of space in combination with abundant sunshine (more than 2000hrs annually).[32] Experts recommend further development of large PV power plants in the future.[33]

China's Wind Energy Policy: From Projects to Strategic Policy

The Chinese government policy on wind energy is like 'crossing a river by feeling rocks', which indicates that trial and errors are an integral part of its development as a new energy source.[34] To provide systematic understanding we divide China's wind policy development into several stages[35]; this helps finding factors influencing wind policy changes. In general we notice two evolutions: one is from ad hoc or project based policy to strategic policy making, the other is the shift from fragmentation towards coordination.[36] Both evolutions are interrelated.[37]

The Early Stages (1986-1993)

In the 1980s, the State Council issued "Several Recommendations on Promoting the Development of Rural Energy," which emphasized the development of RE, including wind energy technology to meet rural energy demands. China has developed wind energy since 1985, in a steady yet slow fashion.[38] This was partly due to the lack of a stable market environment nor funding available.[39] Overall, the energy policy focused on the centrally

[29] Ex. Guangdong province in the southeast coast of China; In 1998, foreign assistance has completed a resource assessment of southeast China in 1998 and identified 47 Gigawatt (GW) of potential in Jianxi, Fujian, and eastern Guangdong.

[30] National Renewable Energy Lab.,(2004) Renewable Energy Policy in China: Overview. Retrieved from http://nrel/gov/cn .

[31] The total capacity will reach 100 GWp by 2030. China Renewable Energy Industry Association (2007), Retrieved from http://www.cwea.org.cn/main.asp p.24.

[32] For example, Xingjiang is the western part of China where most of the area is desert. Pan Jiahua and Zhu Xianli (2006) "Energy and Sustainable Development in China: Sustainable Energy Watch 2005-06". Helio International p.5.

[33] The main PV-powered products are solar street lights, traffic signals, garden lamps, calculators and solar toys. In respect to the use of grid-connected system in cities, the industry is still in the initial phase, because most of the self-manufactured PV cell products are exported, despite the fact that China is the 3rd largest PV producer in the world. Nevertheless, there are already encouraging examples, such as Shenzhen city, where the largest grid-connected solar PV system in Asia is completed (with an installed capacity of 1 MWp). Other on-grid PV projects have begun in cities including Shanghai, Beijing, Nanjing, Wuxi, Baoding and Dezhou. Ibid, pp.21; pp. 26-27.

[34] Interview with Energy Research Institute, NDRC, China. May 26, 2009

[35] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7); Raufer R. and Wang Shujuan (2007) "Navigating the Policy Path for Support of Wind Power in China" *China Environment Series* (6).

[36] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7);

[37] Lieberthal K (1992) Introduction: the 'fragmented authoritarianism' model and its limitations. In Lieberthal K. Lampton D (Eds.) *Bureaucracy, Politics and Decision-Making in Post-Mao China*. University of California Press, Berkeley.

[38] Lewis Joanna (2002) "Learning How to Ride the Wind: The Disappointments and Potential of Wind Power in China". *China environmental series* (6): 84-8

[39] Ibid.

planned electricity sector, with the Ministry of Electric Power (MOEP) as the main institutional actor, and coal and oil as the major sources for electricity production.[40]

Wind energy was first mentioned in the 7th five-year plan (1986-1990), which began grid connected wind energy development. The early stage of development was mostly supported by foreign government loans and imports.[41] For example, 55 Kw wind turbines produced by the Danish producer Vestas were installed in the Rongsheng Province.[42] In the past, private investors were not allowed to participate in energy sectors; it was not until 1987 that the monopoly was abolished.[43] From then on, sub-national government, state-owned enterprises (SOE), and even foreign companies were allowed to build and own power producing facilities.[44] .

However, challenges remained in private investments.[45] Firstly, there was no market incentive, because the Kwh prices for wind energy were twice as high as those of coal, which was largely subsidized by the government. Secondly, there was lack of knowledge about the local use of grid-connected turbines. Thus, investors were not sure whether electricity could be sold in secured amount. Thirdly, regarding the bureaucratic structure; there was no specific bureaucracy solely responsible for promoting RE. Given the central role of state institutions in China, this was a serious problem.

The 8th five-year plan (1991-1995) saw progress in research and development on RE. For example, in the early 90s, the Chinese Academy of Meteorological Science conducted the first investigation on wind resources nationwide. It concluded that China had a potential of 253 GW.[46] In fact, this evaluation suggested that the total electricity output could be more than the total electricity capacity installed in traditional energy at that time.[47] Yet, wind development was slow during the 1986-1993 period with an installed capacity of less than 15 MW in 1993.[48] The focus on basic conditions or wind potential could not conceal insufficient technology, a weak and fragmented bureaucracy and a reliance on imports of turbines. This resulted in a small role for wind energy in the national energy strategy.[49] Whatever wind energy existed in this period was planned in a rather ad hoc fashion and not part of a national strategic policy choice in the direction of RE.

However, this period also signifies the start of new ideas about finding solutions to the energy supply problems. Chinese high level policy-makers became aware that coal had a devastating impact on the environment and human health during the 1990s. By the early 1990s China had also become a party to international agreements such as the Montreal and the Kyoto Protocols, which urged China to collect data and establish coordinating institutions, which contributed to the later development of more strategic environmental and

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[40] Andrews-Speed P and Dow S (2000) "Reform of China's Electric Power Industry Challenges Facing The Government." *Energy Policy*,28 (5), p.335

[41] Lewis Joanna (2002) "Learning How to Ride the Wind: The Disappointments and Potential of Wind Power in China". China environmental series (6): 84-8

[42] Zhengming, Z; Qingi W; Xing Z; Harmin J; Baruch S (1999) "Renewable Energy Development in China: The Potential and the Challenges". Center for Resource Solutions, Beijing.

[43] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7).

[44] Ibid

[45] Ibid

[46] Zhengming, Z; Qingi W; Xing Z; Harmin J; Baruch S (1999) Renewable Energy Development in China: The Potential and the Challenges. Center for Resource Solutions, Beijing

[47] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7)

[48] Ibid.

[49] Ibid

energy policies (including RE policy).[50] China also took advantage to ask for funding from international organizations such as the World Bank (WB), the Asian Development Bank (ADB), the United Nations Environment Program (UNEP), as well as technology transfer from Japan and the US. Because of international cooperation and exposure to international experiences, Chinese planning commissions learned the importance of RE policy alternatives and gradually accumulated know-how to formulate an energy strategy which incorporated RE.[51]

From Projects to Programs (1994-1999): First Cohesive Wind Energy Policy in 1994:
In 1994, the "Recommendations on the Construction and Management of Wind Farms" were issued to establish a firm foundation for wind power in China. The first cohesive wind energy policy was also proposed in the same year by the Ministry of Electric Power (MOEP) entitled "Strategic Development Plan for Generation of Wind Energy in China 2000- 2020". The policy aimed to reach 1000MW installed capacity by 2000, through instruments such as Power Purchase Agreement (PPA) and a fixed tariff. PPA means investors had assurance that the government would buy all electricity at a fixed price.[52] The fixed tariff refers to the government buying electricity from investors at a fixed price, plus an additional 15% profit to make sure investors would not lose money and to reduce investment risks. [53] This policy was "enormously helpful in promoting wind power development in China"[54] as installed capacity soared annually with an average of 43MW per year from 1995 to 1998; a big progress compared to 1.6 MW annual growth in previous years.[55]

Several large(r)-scale programs contributed to the early growth of wind energy in China. In 1996, the State Development and Planning Commission (SDPC) allocated one billion Yuan to launch the 'Ride the Wind (chengfeng) Program', which was an industry oriented policy approach. It intended to boost local technology development and production capacity, by stating that 60 to 80% of the wind turbines should be domestically produced, through joint ventures or international cooperation, hoping to achieve 400 MW installed capacity by 2010.[56] One thing that deserves attention was that the goal of development was *reduced* from 1000 MW to 300-400MW, because policy makers were aware of the failure to achieve previous targets because of their unrealistic nature.[57] The Chinese government later offered higher grid-connection tariffs for renewable energy, attracting more foreign and

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[50] Economy Elisabeth (2004), *The River Runs Black: The Environmental Challenge to China's Future*, Cornell University Press, pp.234-235.

[51] Lewis Joanna (2004) "Conceding Too Much? Conflicts between the Government and Developers in Promoting the China Wind Concession Project Model" *World Renewable Energy Congress VIII:* Elsevier.

[52] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7)

[53] Zhengming, Z; Qingi W; Xing Z; Harmin J; Baruch S (1999) "Renewable Energy Development in China: The Potential and the Challenges". Center for Resource Solutions, Beijing.

[54] MOST (May 15, 2002) "Evaluation of Policies Designed to promote the commercialization of wind power technology in China". The Ministry of Science and Technology, The State Development Planning Commission and The State Economic and Trade Commission, PRC.

[55] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7)

[56] Zhang Z, Wang Q, Zhuang X, Baruch S & Hamrin J (2001) "Renewable energy development in China: The potential and the challenges" China Sustainable Energy Program Report. China Wind Energy Association Retrieved from http://www.cwea.org.cn/main.asp; Lewis Joanna (2002) "Learning How to Ride the Wind: The Disappointments and Potential of Wind Power in China". *China environmental series* (6): 84-8

[57] Chinese renewable energy society Retrieved from http://www.cses.org.cn/science_file/2007-11-15/20071115142138.html
China Wind Energy Association Retrieved from http://www.cwea.org.cn/main.asp.

domestic market entry.[58] Two implementation challenges can be identified. Firstly, tax reduction inequality. Even though the import tax on turbines was reduced from 12% to tax exemption; tax for critical components (such as bearings) remained rather high, thus frustrated investors and led to resistance.[59] Secondly, although the Guangzhou Institute of Energy Conversion confirmed that China had 'mastered' the production of key components of wind generators,[60] in practice, Chinese turbines were of poor quality and not durable enough. The overall result was not satisfactory, with lots of money invested in poor operational reliability.[61] These problems and challenges led to wind projects being cancelled, and previous targets not being met.[62]

During the same time period The State Planning Commission (SPC) proposed another strategy in the "Program for Development of New and Renewable Energy Sources in China: 1996-2010"; it was under supervision of the SPC, the State Economic and Trade Commission (SETC) and the State Science and Technology Commission (SSTC)[63] In 1999, the Chinese government issued relevant policy recommendations to remove operational barriers to renewable energy development.[64] One major obstacle was still the cost of wind turbine installations, including high prices for imported equipment, high transaction costs, and local services expenses. A number of implementation problems hampered the program**.** First, there was no strong legal status for PPA. Private investors produced electricity at a higher price than coal plants, and saw themselves facing local distributors (under local governments), who refused to buy wind electricity at a high price, which was a violation of PPA agreements. The lack of enforcement, let alone penalties to force local distributors to purchase the electricity at a higher price led to investment loss.[65] Secondly**,** poor coordination existed between higher level energy authorities. There were three major authorities in charge of renewable energy technology and equipment production:[66] The SPC approved large-scale projects and local manufacturing. The SETC was responsible for domestic enterprises and technology development; the SSTC for R&D and technology transfer from abroad. However, there was no clearly defined division of labor among the three authorities. Rather, there was a power struggle between them to fight for control and funding, which led to lack of coordination and fragmented authority, and in the end negative impact on the development of the wind energy sector.[67] Third, with wind energy producers and distributors in reality under the same government unit, or under the system of state monopoly over the electricity sector (also typical, by the way, for European countries before the liberalization of the electricity

[58] Pan Jiahua and Zhu Xianli (2006) "Energy and Sustainable Development in China: Sustainable Energy Watch 2005-06". Helio International p.5.

[59] Interview with TECO, a wind investor company Aug. 2008.Liu W., Lin G., Zhang (2002) "Cost Competitive Incentives for Wind Energy Development in China: Institutional Dynamics and Policy Changes. *Energy Policy* 30 (9) :753-765.

[60] Lewis Joanna (2002) "Learning How to Ride the Wind: The Disappointments and Potential of Wind Power in China". *China environmental series* (6): 84-8

A local wind energy company claimed that 78% of their 600 KW self-manufactured wind turbine was by local production.

[61] Interview with TECO wind investor, Aug. 2008

[62] The target for the year 2000 was intended to be 1000MW.National Renewable Energy Lab.,(2004) Renewable Energy Policy in China: Overview. Retrieved from http://www.nrel.gov/china

[63] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7)

[64] Chinese renewable energy society Retrieved from http://www.cses.org.cn/science_file/2007-11-15/20071115142138.html

China Wind Energy Association Retrieved from http://www.cwea.org.cn/main.asp.

[65]Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7)

[66] Ibid.

[67] Ku, J., Lew D., Penfei S. (2005) "Wind : the future is now." *Renewable Energy World (*5): 212-223

markets), relevant regulations were likely to be ignored.[68] The 1997 reform, for example, established the China State Power Corporation (CSPC), which was defined as an SOE to increase transparency and create an investor-friendly environment. The problem was that the CSPC was in charge of both transmission and generation of electricity; because of cost-saving concerns, the CSPC tended to opt for coal-fired electricity, yet there was no authority to force it to increase wind energy production.[69]

In conclusion, the 1994-1999 time period saw gradual progress of wind energy development, based on a change from ad hoc installation to a more programmatic approach. The installed capacity increased over ten times with over 200MW installed, compared to less than 15 MW before.[70] Through the Chengfeng Program which was targeting local industry and market development, market actors were encouraged to participate. Yet, progress was very slow. One of the reasons was a lack of domestic production capacity for wind turbines, with 95-97% of the installed turbines being imported.[71] In addition, implementation struggled because of lack of legal sanctions against violation of the PPA principle, lack of coordination and constant power struggles among government agencies. Such low state capacity and fragmented structure fell short of coherent policy. Most of all, the key problem was the Kwh price of wind remained higher than that of coal. As a consequence wind energy was not considered a potential alternative at this stage.[72].

Coordination Taking Shape (2000-2006): From Program to Strategic Policy Objective

The 2000-2006 period was marked by several important initiatives to reform the institutional, economic and legal context of the wind energy sector. We will discuss them in the following paragraphs.

A. Institutional Reform: The Establishment of the Energy Bureau (EB)

To improve coordination, which seems to be one of the major obstacles in effective implementation in the energy sector from past experience,[73] the Chinese government intervened by reforming the existing EB under the NDRC in 2005, as a unified institution for policy administration and *implementation*.[74] In the past, the EB was under the State Development and Reform Commission (SDRC), the former body of the National Development and Reform Commission (NDRC)--China's top economic planning body.[75] The EB was rather weak in coordinating the price system due to lack of authority and sufficient resources.[76] The reform of the EB was considered to be moving towards centralization and an indicator of the central state intervention.

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[68] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7).
[69] Ibid
[70] Ibid.
[71] Lew D.J. (2000) "Alternatives to Coal and Candles: Wind Power in China." *Energy Policy* 28(4):.271-286.
[72] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7).
[73] The reason for poor coordination in the past was due to the overlapping function and conflicts among the SPC, SETC and SSTC
[74] Interview with a project officer, the Renewable Energy Research Center, NDRC, May 28, 2009.
[75] Qiu Xin,(June 3, 2005) "China Overhauls Energy Bureaucracy" Retrieved from http://www.atimes.com/atimes/China/GF03Ad01.html
[76] Due to the growing output of coal since the 80s, coal price was decided by market competition, rather than by the state as it used to be. The EB was too weak to oversee industries, thus reform was needed. China Energy Group (1995) *A Review of China's Energy Policy*, pp.13-20 Retrieved from http://www. china.lbl.gov. China Daily (2005) New Energy Office Confirmed Retrieved from http://www.china.org.cn/english/environment/127513.htm

The State Energy Office (SEO) was established also in 2005 mainly in charge of *policy-making.* The office reports directly to the Energy Elite Group (or National Energy Leadership Group), which consist of Premier Wen Jiabao, Vice Premiers Huang Ju and Zeng Peiyan, high-level representatives from the SEPA (now Ministry of Environmental Protection), as well as the People's Liberation Army (PLA). This signified the importance attributed to the issue of energy supply and energy security at the highest political level.[77] In short, the SEO and the EB were reorganized for different functions. The SEO was responsible for policy-making; the EB for implementation. The reason for this separation of tasks, is to avoid corruption. With 11 trillion Yuan (US$1.33 trillion) allocated to the energy sector, a single unified agency would be exposed to accusations of corruption and conflicts of interest.

In addition, under the NDRC various institutes, among them the Energy Research Institute, which includes the Renewable Energy Research Center operate in this field. The center composes a group of research fellows, who are responsible for not only research and advice to the central government but also participate in policy making, such as drafting the Renewable Energy Law, as well as relevant policy and legal documents.[78]

B. Decentralization: Separate Power Production and Delivery

In order to stimulate effective implementation and to address the problem of having producer and distributor being the same state actor, the government decentralized the CSPC by separating power generation and transmission.[79] For example, power production was decentralized into several SOEs: the Huaneng Group, the Huadian Corporation, the China Datang Corporation, the Guodian Corporation, and the China Power Investment Group. Transmission (grid companies) was decentralized into the State Grid Corporation of China and the China Southern Power Grid Corporation.[80]

C. The Concession Program

The NDRC began issuing wind energy concessions in 2003 for government-selected sites through a competitive bidding process for potential developers, aiming to lower wind energy prices through competition. The overall purpose was to develop wind power at the lowest cost possible, bring down high wind power tariffs, and reflect true prices through a bidding process, yet retain control over developments.[81] This implied that the government was trying to move towards a large scale, market-driven development base, with less uncertainty and more possibilities to strengthen the institutional capacity in wind energy.[82]

In order to be a legitimate bidder, projects had to be between 50-100 MW in size with 50% of the wind turbines locally manufactured (later 70% in 2005).[83] A wind resource site is chosen by the government before biddings, road access and grid connection are provided later to winners.[84] The instruments used to combat high prices were the Renewable Portfolio

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[77] Qiu Xin,(June 3, 2005) "China Overhauls Energy Bureaucracy" Retrieved from http://www.atimes.com/atimes/China/GF03Ad01.html

[78] Interview with the Renewable Energy Research Center May 20, 2009.

[79] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7).:3880

[80] Interview with TECO, a wind investor company , Aug. 2008.

[81] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7).

[82] Raufer R. and Wang Shujuan (2007) "Navigating the Policy Path for Support of Wind Power in China" *China Environment Series* (6):40.

[83] Lewis Joanna (2004) "Conceding Too Much? Conflicts between the Government and Developers in Promoting the China Wind Concession Project Model" *World Renewable Energy Congress VIII:* Elsevier

[84] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7):3884

Standard (RPS) for power producer and the PPA for power delivery. In China, RPS is labeled as Mandatory Market Share (MMS), meaning a quota obligation to take up a certain percentage of RE in power output.[85] For example, large SOEs with projects of over 5 GW total installed capacity, must include a 5% wind power share. PPA is a must buy system for power grid companies to secure stable demand as mentioned earlier.[86]

Some scholars labeled it as "a government tendering system," with the government selecting wind developers based on low price and local content through a bidding process, together with agreements to purchase power on fixed-terms.[87] Problematic in this system could be underbidding and the use of low quality technology to cut the price. Quality concerns also exist regarding this program. Bidding results shows that power developers are mostly the five SOE from the 2000 reform. Foreign developers can hardly win bidding due to high prices. Spanish and German developers, for example, tendered with prices 50-70% higher than those of the SOE winning bidders.[88] The price was decreased from average 0.75 Yuan/kWh to 0.373-0.519 Yuan/kWh in 2006.[89] With price being the determining criterium, those who offer the lowest price, yet poor quality could win the bidding. In case real output is less than the promised or installed capacity or less than the mandatory RPS percentage, the concession program does not seem to have a strong compliance or sanctioning mechanism. A second issue concerns the feed-in tariff, which is considered essential by scholars.[90] The concession program does not include a feed-in tariff. Instead, a project based PPA was used. However, there seems to be no sanction against PPA violation. In addition, it appears difficult to implement the PPA effectively, because of institutional uncertainty in the electric power structure; this is confirmed by Ms. Ma Lingjuan, deputy executive director of China RE entrepreneurs club, who said that the compulsory system of MMS and PPA are merely policy mechanisms yet not often implemented in reality.[91]

In the end, it is important to recognize that the concession program did not completely reduce the price disadvantage of wind power. Wind energy is still higher in price than fossil fuel based electricity. Raufer and Wang believe that a supporting policy (such as price based policy) is needed to complement the concession program.[92]

D. The Renewable Energy Law (REL)

By far the most influential step was the formulation of a REL at the highest legislative level. In 2003, the Government began to formulate the "Promotion Law for Renewable Energy Development and Utilization." The goal of this law was to "confirm the role of renewable energy in China's national energy strategy, create a market base and remove barriers to market development, as well as a social atmosphere conducive to renewable energy."[93] The

[85]For example, by 2020, 10% energy will be supplied by renewable energy, including hydropower, aiming to reduce 15% CO2 energy in 2020. the 10% is considered as MMS; Buruku, B. (2006) "Chinese RE Law." *Refocus* (8):56-57..

[86]Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7):3886

[87]Interveiw with a research fellow of the NDRC May 20, 2009.

[88] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7):3886

[89] Li Jingli, S. Hongwen, X. Yanqiun and Sze. Pengfei (2006) A Study on the Pricing Policy of Wind Power in China. Chinese Renewable Energy Industries Association, Beijing.

[90] Evaluation of China's Energy Strategy Options, p.18

[91] Interview with Ma, May 2009.

[92] Raufer R. and Wang Shujuan (2007) "Navigating the Policy Path for Support of Wind Power in China" *China Environment Series* (6):46

[93] Chinese renewable energy society Retrieved from http://www.cses.org.cn/science_file/2007-11-15/20071115142138.html

China Wind Energy Association Retrieved from http://www.cwea.org.cn/main.asp

Standing Committee of the National People's Congress (NPC) passed the Law on February 28, 2005 after which it became effective in 2006.[94]

It is a sort of framework law, which lays the foundation for the further development of renewable energy production in China for decades to come. Politically it is the expression of the commitment to make RE a *strategic* part of China's overall energy policy and the recognition that in order to fulfill future environmental and climate change targets and commitments, RE production will have to be an essential part of the energy supply system. The framework law indicates government willingness to develop renewable energy on a long term basis: increasing the RE percentage in the total energy mix; help industrial and technological development; focus on market development.[95] Overall, a national MMS of 15% RE of total gross energy production. The law requires a certain percentage of non-hydro renewable power production: "Power generators with self-owned installed capacity of over 5 GW will be required to have a non-hydro renewable energy installed power capacity (self-owned) that accounts for 3 percent of their total capacity by 2010 and for over 8 percent of their total self-owned capacity by 2020. (section 5 (1))"[96]. This indicates an approach to opt for low carbon emission energy resources. During the period of 1994-1999 the PPA had no legal ground, violators faced no sanctions. With the REL as a new legal basis, scholars believe that the PPA in the concession model will work more effectively.[97]

Next to the REL, a system of RE policy making (development, strategy, guarantee measures) including financial mechanisms (public cost sharing by citizens), etc., was developed to make sure that the law would lead to the desired policy objectives.[98] The NDRC is responsible for detailed implementation (including authorization), with the EB representing the central unified institution for coordination. According to some critical voices, it is still necessary to establish an institution solely responsible for wind energy.[99]

E. The 70% Local Content Rule

Before 2005, the major challenge of wind power development was that most wind turbines and generators relied mainly on foreign imports, which was expensive and thus investment costs were high.[100] To reduce the burden of investment, the Chinese government, especially the National State Council, proposed a decision on July 4th 2005 that 70% of the wind turbines should be produced locally.[101] The intention was to stimulate technology transfer to local wind turbine manufacturers and reduce production costs[102] A condition is that the bidding company was to guarantee a collaboration with a wind generator/turbine producer, who guarantees to provide 70% local made wind generators.[103] This rule is controversial

[94] China Energy Group Retrieved from http://china.lbl.gov/china_renewable-wind.html

[95] "The REL of the PRC" (2005) Beijing Review, (29) Retrieved from http://www.martinot.info/China_Re_Law_Beijing_Review.pdf.

[96] Non-authorized English translation of the "Trial Measures for Pricing and Cost Sharing Management for Renewable Energy Power" provisions of the Renewable Energy Law. http:// www.martinot.info.

[97] Lema Adrian and Ruby Kristian (2007), "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy" *Energy Policy*, 35 (7):3889

[98] Interview with the Energy Research Institute, NDRC, May 26, 2009.

[99] Raufer R. and Wang Shujuan (2007) "Navigating the Policy Path for Support of Wind Power in China" *China Environment Series* (6):47

[100] Zhong Shiming, Gao Liang (2006), *Times for Renewable Energy are Coming—Brief Introduction on Wind Energy Generation.* Conference paper for Renewable Energy Development, Jiangsu Province, China.

[101] Pan Jiahua and Zhu Xianli (2006) "Energy and Sustainable Development in China: Sustainable Energy Watch 2005-06". Helio International p.45. www.ndrc.gov.cn

[102] Ibid

[103] Zhong Shiming, Gao Liang (2006), Times for renewable energy are coming—brief introduction on wind energy generation, conference paper for Renewable Energy Development, Jiangsu Province, China.

under WTO regulation as it is considered a form of protectionism.[104] This point is made by other industries and wind energy activists, arguing that this requirement is higher than the 40% local content demand in the car sector.[105] Another issue is the quality of locally produced turbines. Poor quality results in production losses (repair costs) which in turn leads to investment loss.[106] In an interview with Reuters, Shi Pengfei, the vice-president of the China Wind Energy Association, believes that policy change is necessary to deal with poor quality to prevent damage to the Chinese wind turbine manufacturers.[107]

The Maturing Period

All indicators point towards a further development of wind energy in China. Raufer R. and Wang (2007) foresee that wind development will move towards larger scale projects, probably from currently 50 MW to over 150 MW, with larger projects possibly promoted by the central government.[108] This tendency is confirmed by the Director of the Energy Research Institute at the NDRC [109] The concession program will probably be expanded including risk assessments of bidders. In addition, the role of the provincial governments will become more important. Raufer R. and Wang (2007) further assume that green certificates (quantity-based approach) will enter the process, to encourage mass production and help moving towards a market-oriented system.[110]

All of these possibilities are contingent upon further policy development. Based on the REL, new implementation specificities can be issued, including specific objectives for wind energy development. A promising scenario envisioned by Raufer R. and Wang (2007) is that a stable market for wind energy will come into existence. Wind turbine technology will greatly progress; institutions promoting wind energy will be established. Green certificate approaches will be operated and a market will be established for Renewable Energy Credit (REC) to become trading commodities, which seems to be the ultimate goal for wind energy development.[111]

Solar Energy Policy: Still The Underdog?

We will provide an analogous account of solar energy, meaning a historic approach with attention for the main changes in the policies. When we say solar energy, we refer in first instance to the use of PV cells. In China, the most well known use of solar power is probably the solar water heater, but given the totally different nature of this application of solar energy, we do not take this as an example of the type of policy choices and changes we are aiming to understand. From the start it has to be clear that the solar sector is much less developed than the wind energy sector at this moment. There are two key reasons for this. First, the technology of solar energy is less advanced in terms of energy efficiency. Second, the price of solar energy remains significantly higher than that of wind energy on the domestic market.

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[104] Interview with TECO a private wind investor. Aug. 2008.

[105] Interview with TECO, a private wind investor. August 2008. Reuters, (July 24, 2006) China Wind Power Boom May Bust without Policy Change. Retrieved from http://www.planetark.com/dailynewsstory.cfm/newsid/37362/story.htm.

[106]Interview with TECO, a private wind investor. Aug. 2008

[107] Reuters, (July 24, 2006) China Wind Power Boom May Bust without Policy Change. Retrieved from http://www.planetark.com/dailynewsstory.cfm/newsid/37362/story.htm.

[108] Raufer R. and Wang Shujuan (2007) “Navigating the Policy Path for Support of Wind Power in China” *China Environment Series* (6):49

[109] Interview with the NDRC May 26, 2009. Investment in wind power increased 88 percent annually, with 4.66 million kilowatts of wind power capacity Retrieved Jan. 7 2009 from http://www.chinaenvironmentallaw.com/2009/01/07/chinas-power-sector-statistics-for-2008/

[110] Raufer R. and Wang Shujuan (2007) “Navigating the Policy Path for Support of Wind Power in China” *China Environment Series* (6):49.

[111] Ibid

This has created the peculiar following situation: China is by now the largest producer in the world of PV panels, yet the overwhelming majority is exported to Europe and to a lesser extend the US.

The Initial Period (1986-1993): Small Scale, Local Approach

From the 1950s to the 1970s China's interest in solar energy was mainly driven by possible applications in its space or satellite program. Terrestrial use of solar cells began in 1973, but the PV market development was very slow.[112] Solar energy was first mentioned in both the 6th and 7th five-year plans (1981-1985; 1986-1990) in which the government supported PV use in rural areas (disconnected from the grid; local solution) and specific industries. However, it seems that concrete projects on solar energy did not begin until the late 1990s.

Small PV Market (1994-1999): The Brightness Project

In September 1996, the World Solar Peak Conference in Zimbabwe proposed the Brightness Program for regions suffering from power shortage; the Chinese government echoed the idea and launched a national Brightness Project Implementation Plan in 1998.[113] The overall objective was to provide sufficient electricity to 23 million people in remote regions by 2010, including Tibet, Inner Mongolia, Gansu, and Xingjiang; the program aimed to favor low-income households, and to provide 100 watt capacity per person.[114] Given that many poor households could not afford even the smallest investment to obtain the technology, the government funded the program with around 36 billion Yuan. Once the program was implemented it was to provide around 260000 Kwh of green electricity annually, reduce 15.4 tons of carbon dioxide, and 1991 tons of nitrogen emission.[115] The first phase lasted for 5 years and aimed to provide power supply to 8 million people.

The advantage was that it supported poor households with access to electricity. After the first stage, what was left to be done included using hybrid systems that consisted of both wind generators and solar PV to provide further electricity in the Inner Mongolia, Tibet and Gansu provinces[116].

More Programmatic Focus on Rural Use (2000-2006)

In this period China further emphasized the rural use of solar energy. In the following paragraphs we illustrate this approach by giving the most noteworthy examples.

A. Renewable Energy Development Project (REDP)

A representative case was the Renewable Energy Development Project (2001-2006) funded by the WB and the Global Environment Facility (GEF).[117] The aim was to provide power with wind/PV hybrid systems to remote areas, such as Qinghai, Gansu, Inner Mongolia, Xingjiang, Tibet, and Western Sichuan. Also to reduce the cost of PV systems and improve their quality. Further, the program was supposed to support the development of PV market in rural areas.[118] Apart from central government (NDRC) intervention, other actors such as private enterprises, joint ventures, and SOEs were welcomed to participate. The project

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[112] China Renewable Energy Industry Association (2007) *China Solar PV Report*, China Environmental Science Press, p.15

[113] NREL, Brightness Rural Electrification Program. Retrieved from www.nrel.gov/china

[114] Ibid.

[115] Ibid

[116] Ibid

[117] Ter Horst Emil and Cheng Zheng (2006) "PV Market and Industry Development in China: Impact of PV Programs and Technology Improvement" China Renewable Energy Development Project.

[118] Ibid

helped stimulate PV industry of China, especially in the module manufacturing aspect.[119] According to the REDP management office, which is under the NDRC, there are now over 20 PV module producers with annual output of 100 MW, compared to only 7 PV module producers in1997 with annual output of 2-3MW.[120]

B. Rural subsidies: Township Electrification Program (Song Dian Dao Xiang 2001-2005
Assistance from the REDP had influenced subsequent projects, one of them was the Township Electrification Program. With assistance from the UNDP and GEF, the project was lauded by the then State Development and Planning Commission (SDPC; former body of the NDRC) and completed in 2005.[121] Apart from foreign assistance, there was funding granted by both central and local government around 3 billion Yuan altogether.[122]

Different from the REDP which focused on stimulating PV module production, the Township Electrification Program concentrated on maintaining installed technology of PV panels and establishing more PV power plants.[123] The project provided solar electricity to 700 villages, about 300,000 households and one million people in western provinces. With a total installed capacity of 15,537 KWH, the project was the world's largest, using a combined wind-solar power stations to provide electricity to rural area.[124]

The prospect of all these projects was overshadowed by the high production cost, which remained a major obstacle in solar energy policy. The PV electricity price could not be compared with that of coal, because the latter was mostly subsidized by the government. The market price for PV products was still unstable.[125] To save costs, producers were inclined to use cheaper yet lower quality materials, resulting in a very short life expectancy of products. The problem was revealed by local pilot project operations. Unless the government established a pricing system for PV electricity production and linked cost with profits, the market would not have further developed, so it was believed.[126] Yet others were holding a more optimistic view.[127] Wang Wenjing, a solar energy expert at the Chinese Academy of Sciences, assumed that solar subsidies were feasible in the next couple of years. "The lack of government policy is constraining the use of solar energy…If the government would just come out with a policy, I'm certain China could very quickly become the world's largest user of solar energy."[128] This spelled out the policy challenge for the next period.

The 11th Five year plan (2006-2010) and beyond: a more strategic move forward?
The 11th Five Year Plan formulated the goal to provide 250 MW of PV electricity to 2 million households, as well as 50 MW of rooftop through rooftop applications and 20 MW power plants in the Gobi desert.[129] This indicated the government's continuous efforts in promoting

[119] Interview with Ma Lingjuan, Deputy executive director of China RE entrepreneurs club, China, May 29, 2009
[120] NDRC/WB/GEF Renewable Energy Development Project (2004) Retrieved from http://en.creia.net/html/20081281404488.html
[121] NREL, Brightness Rural Electrification Program, www.nrel.gov/china
[122] China Renewable Energy Industry Association (2007) *China Solar PV Report*, China Environmental Science Press, p.42
[123]Interview with Deputy executive director of China RE entrepreneurs club, China. May 29, 2009
[124] China Renewable Energy Industry Association (2007) *China Solar PV Report*, China Environmental Science Press, p. 25
[125] Uses of telecommunication, industrial use and solar PV products are not subsidized by the government. Ibid. p.28.
[126] Ibid p.34.
[127]Kuhn Anthony, "China's 'Sun King' Aims to Lead Shift to Solar Power" Retrieved Dec. 20, 2007 from http://www.npr.org/templates/story/story.php?storyId=17351206
[128] Ibid
[129] World Energy Council (2007) "2007 Survey of Energy Resources", p. 402.

solar energy and its move to a more strategic approach as RE was considered in 2006 to be a central element of energy supply for the future, the fight against global warming and in addition an instrument in the fight against air pollution. The priority remained on remote areas with a further expansion of standalone technology and connections to the local grid in the rural use. But not only rural areas are benefiting from policy initiatives. The Shanghai 100000 Solar PV Roof Plan (2006-2010) foresees to install 100,000 PV panels on roofs of local buildings with an estimated total installed capacity of 400 MW.[130]

Currently, solar energy investors point out that a major challenge is the lack of government for R&D for technological improvements. Consequently, production costs are transferred to users, and high costs discourage the general public to install solar PV systems.[131] Market creation and further investments in technology might be stimulated by government projects. More state institutions or SOE buildings will install PV panels as a way to promote solar. If there is a strong government policy, the market could grow fast after 2010, with a downward pressure on the price per Kwh.[132] As mention earlier, wind power development is more mature than that of solar. Local government has autonomy to approve wind projects under 50 MW, while solar projects remain centrally controlled. For example, the NDRC has most influence to the industry.[133]

The REL

The REL provides guidelines for grid (art. 14; art.19; art. 20) and off-grid PV (art. 15; art. 22) power systems.[134] Two important approaches which influence the solar policy are the MMS and cost-sharing (art.9; art. 12) systems, but in reality, these guidelines and approaches do not seem to be effective.[135] Firstly, the problem of high cost mentioned above remains the major obstacle; the industry hopes that the problem can be reduced through bidding system. So far (until 2009), there are only three projects operated through bidding system. Secondly, there is lack of large-scale PV power development; no PV power systems are granted permission from grid companies to be connected to the grid. [136] A recent project in Gansu province this year seems to demonstrate possibility to combat the problems, thanks to the REL. It is by far the largest solar project with 10 MW capacity, compared to previous two bidding projects in Inner Mongolia of 205 kw and Shanghai Chongmingdao of 1MW.[137] The winner in the Gansu project offers the lowest price of 0.69 Yuan/Kwh, which is probably the lowest price ever so far; There is intense competition in the industry as most investors both home and abroad are eyeing on this opportunity.[138]

More long term objectives (2020 and beyond) foresee the growth of the solar market in grid-connected PV development and a further spreading of the technology, especially in those areas with large solar potential. It is hoped that most villages in western provinces can

[130] China Renewable Energy Industry Association (2007) *China Solar PV Report*, China Environmental Science Press, p. 43
[131] Reuters, (Jan 21 2008) Sun Rises Slowly on China's Solar Energy Sector
[132] China Renewable Energy Industry Association (2007) *China Solar PV Report*, China Environmental Science Press, p. 45
[133] Interview with Prof. Chang Jiwen in the Chinese Academy of Social Science May 27 2009.
[134] China Renewable Energy Industry Association (2007) *China Solar PV Report*, China Environmental Science Press, p. 45
[135] Interview with Deputy executive director of China RE entrepreneurs club, China. May 29, 2009
[136] Interview with a research fellow in the Renewable Energy Research Center, NDRC, China.. May 20, 2009. Interview with Deputy executive director of China RE entrepreneurs club, China. May 29, 2009
[137] Retrieved May 28, 2009 from http://solar.ofweek.com/2009-03/ART-260005-8110-28412352.html
[138] Interview with Managing director of the CBD New Energy Group Limited, Beijing. May 27, 2009.

have grid-connection by 2020.[139] According to the current policy development, the accumulated installed capacity should reach to 10000 MW by 2020.[140]

In conclusion of this part, we can state that the promotion of solar energy in China is based on the fact that it is carbon dioxide free, and would add to the diversification of the energy supply. In addition it is by definition a domestic resources, thus also contributing to a lower dependence on foreign energy and energy security. Solar energy is now included in the REL, five-year plans, mid-to-long term plans, which indicates that the Chinese government is convinced more than ever of the prospect of solar energy and that there is a strong will to develop it on a long term basis through policy programs. The downside is that the industry is facing limited supply of raw materials for producing PV panels(such as polysilicon) and materials to produce wafers, which does give it an aspect of foreign dependence.[141]

Comparing Wind and Solar Policy Changes

Both wind and solar energy are today being regarded as essential components of China's future energy policy. This is a long way from the ad hoc or project based approach at the beginning of the 1980s and into the 1990s. Given the pressures of energy security, environmental protection and climate change and in the context of a booming demand for energy, China's choice for RE is future oriented and in line with the overall national goal of sustained and sustainable development as was formulated by the highest political and state authorities on several occasions.

Both policies demonstrate a number of similarities in their policy development (Table1). First, they have both followed the trajectory from project base, over program driven and finally reached the strategic policy stage. They are both explicitly mentioned in the REL and considered strategic energy sectors (next to hydro and nuclear power) as non-carbon based energy sources. Second, we have witnessed an evolution towards a more coordinated policy at the level of central state institutions. The NDRC is playing a crucial role in this as a government agency with high authority and power in laying out China's development path. Third, although a more coordinated central approach is a sign of centralization, there is also a move towards decentralization. Provinces, regions and cities have increased leverage in how the renewable energy policy will be implemented. This form of decentralization is part of a larger division of tasks between state institutions, with the central government providing policy frameworks and local actors being more responsible for implementation, which takes into account the more local context. Fourth, in both wind and solar energy the market is being introduced as an organizing principle. Market actors, both SOEs and private domestic and international companies have entered the energy production and distribution market because of favourable legislation and a beneficial opportunity structure, created through different instruments. This also means that the price per Kwh is becoming more important and competition between RE and other energy sources has increased.

There are also a number of differences. First, at this moment the spreading of wind energy is much more rapid as the technology is more mature, the price per Kwh more competitive and the scale of installations more in line with a connection to the grid. Solar remains expensive compared to wind. A second difference is that solar seems to have its biggest application until now in rural and remote areas. Often non-grid connected and used as a means to bring electricity to small communities or even individual households. Wind energy is much more connected to the national grid. Third in terms of regulations, there are

[139] Ter Horst Emil and Cheng Zheng (2006) "PV Market and Industry Development in China: Impact of PV Programs and Technology Improvement" China Renewable Energy Development Project.
[140] Ibid.
[141]Ibid

differences between wind and solar. Essentially wind energy works with tax incentives and solar with a feed in tariff. Fourth, wind energy is slowly getting a domestic production capacity (often in joint venture with West-European companies) based on the rule that mandates 70% of the installations to be 'made in China'. Solar energy is very different, with China already being the largest producer of PV panels in the world. But, the production is almost completely exported, mainly to Europe.

Table 1. Overview of solar and wind energy policies comparison.
Compiled based on sources from China Renewable Energy Industry Association (2007) *China Solar PV Report*, China Environmental Science Press; NREL, UNEP

Policies	**Solar energy**	**Wind energy**
Feed-in tariffs	Yes, but no fixed price	no
Direct subsidies	Project specific	Project specific
MMS/ RPS	Over 3% of non-hydro RE output by 2020; 8% for power generators over 50GW	Over 3% of non-hydro RE output by 2020; 8% for power generators over 50GW
PV/wind requirement in RPS	no	no
Green certificates mechanism	no	no
Tax incentives	no	yes
Local content	90-98% export oriented	70%
Specific Institution for solar/wind	No Structural reform needed	No Structural reform needed
National policy targets	Low	high

Conclusion

To answer the question **"***why* does China's (renewable) energy policy change", this paper has touched upon both internal and external factors. Internal factors are mainly economic growth, consumerism, and urbanization all of which have rapidly increased the demand for energy. China wants to be energy independent without relying on other countries. A major part of the solution will be RE development because it contributes to sustainable economic development. The soaring demand for energy use is driving China to seek diverse energy resources, including clean energy like wind and solar. However, wind and solar energy developments are fighting against the dominance of coal use, a source that is abundantly available and relatively cheap.

External factors include the pressures on China regarding climate change policies and thus CO_2 emissions, the global competitions for scarce energy resources, and a set of environmental problems related to the current energy system (coal based) but with transboundary repercussions, such as SO_2.

To answer the **"***how* does China's (renewable) energy policy change" question, the paper concludes that internally, China has been focusing on development since the 80s, and the 90s saw the dawn of renewable energy taken into account in policy strategies or outlines, (ex. the Energy Conservation Law in 1997). The wind and solar policy evolutions and changes demonstrate that the REL seems to be a major turning point from coal-based to RE policy, incorporating environmental concern to institutional policy framework. Externally, China's increasing engagement in international organizations and activities is forcing the country to conduct changes to adopt new principles (ex. sustainable development concept), approaches such as more participation of multi-national corporations (MNC), academics, less central intervention, etc.

The paper has provided an overview to both wind and solar policies, and map out influencing factors mainly from internal aspects. Further study can include external influencing factors for comprehensive analysis. Another approach for further research is to establish a conceptual-theoretical framework to analyze the changing role of the central state and the influence of market actors' participation (ex. private, SOEs and academics) in both wind and solar policies.

Modeling China's Climate Change Policy in The Post-2012 framework:
On The Perspective of Reputation

Edward Xuedong Wang[1]

Abstract

The post-2012 world Climate Change scenario would heavily depend on China's next steps on Climate Change Policy. The world could not coordinate their policies to slow global warming without China's participation. However, China, the world's largest GHG emitter with the rising energy demand, is reluctant to change its high-carbon economic development models by sticking to the concept of Climate Injustice. The ***Economic Cost*** and ***Climate Injustice*** are two major concerns Chinese government faces. This raises the issue of which approach would be most likely to stimulate and persuade China to take appropriate actions in the post-2012 climate regime.

This paper seeks to provide a tentative answer to this question. It compares ***quantity-oriented mechanisms*** like the Kyoto Protocol with the ***price-type control mechanisms*** such as internationally harmonized carbon taxes. It concludes that the price-type approach incorporating the perspective of ***state reputation*** could visualize the possibility that China would take new Climate Policy and low-carbon economic development models. It argues that the sticks-type policies are most unlikely to push China to take actions or adopt measures because China's growing economic and military power, rising political influence, and increasing involvement in regional and international institutions have fundamentally affected the world system. However, since China builds up its reputation by focusing on the multilateral commitments, the ***reputation-based price-type control mechanism*** could be the Pareto Improvement that encourages China to contribute its fair share to the global climate effort.

The pace and face of globalization in the 21 century will be critically influenced by whether or not some specific issues that call for collective action by countries are properly addressed. One of these big questions is to address the problem of global warming. The post-2012 world climate change scenario would heavily depend on China's next steps on climate change policy partly because China, the world's largest GHG emitter with the rising energy demand, is reluctant to change its high-carbon economic development models by sticking to the concept of climate injustice.

In this paper, I try to analyze the probability that China' government would accept some substantial GHG emission cut in the near future on the perspective of state reputation: is it possible that China would take any substantial quantified emissions cut? If so, how could that be? I consider these questions in this article. The first section describes the statistics of China's growing greenhouse gas emissions. The next section describes China's government's unwillingness to accept any binding international commitments to reduce the emissions substantially. The subsequent section describes the fundamental reason behind that. I then describe the reputation-based price-type control mechanism that would be the tentative approach to that issue. I close this paper with a summary of the major issues.

1. Introduction: China's Fact Sheet

Climate change issue is a global concern to all the countries across the world. There is overwhelming scientific consensus that human-induced climate change poses grave economic and environmental risks. Driven primarily by a century and half of rising fossil fuel

[1] Assistant Professor of the Department of International Relations at Sun Yat-Sen University, email: xwng@illinois.edu.

combustion, CO_2 concentrations in the atmosphere had reached 379 parts per million by 2005, 35% higher than pre-industrial level ("4th Assessment Report, Working Group I, Summary for Policy makers," IPCC, 2007). Average global temperatures have risen by 0.76 degree Celsius since the late 1800s, and the effects are evident in extreme weather events, changed weather patterns, floods, droughts, glacial and Arctic ice melt, rising sea levels, and reduced biodiversity (IPCC, 2007). Scientists have studied extensively the global warming issue, which holds that the accumulation of carbon dioxide (CO_2) and other greenhouse gases (GHG) is expected to produce the significant climate changes over the 21st century. Addressing growing concerns about climate change requires a broad understanding of its social, economic, developmental, scientific, political and environmental aspects. Increase in temperature as a result if increasing emissions of greenhouse gases will have serious impacts on our economic well-being and on the ecosystems on which the health of our planet depends.

Minimizing these risks required that global GHG emission decline dramatically over the coming decades. In its causes and potential consequences, climate change has implications for every inhabitant of every nation on earth. Yet the power to mobilize an effective response rests largely with a handful of nations. As the largest developing country, one of the largest energy consumers, and one of the largest greenhouse gases producers, China's attitude toward this issue would be very important.

As awareness of Kyoto's complete inadequacy has increased, calls for participation by developing countries have grown louder and more frequent. Accomplishing this goal will be feasible only after China takes concerted and sustained action, because China began the largest greenhouse gases emitter since 2007. So, Global pressure on China is mounting to take on some obligations to reduce GHG emissions from the use of coal, oil, and gas, which cause climate change, or global warming. But, as a developing country, China is actually excluded from any quantitative obligations to reduce emissions. Some think this approach is probably a fundamental mistake to the world map (Nordhaus, 2007). Before discussing different approaches, it will be useful to sketch the scientific statistics on China's contribution on global warming. The Chinese plan to deal with global warming emissions includes decreasing relative reliance on coal, developing renewable energy sources, a nationwide tree planting campaign, population control, and other regulatory and public education measures. The problem, of course, is that in absolute terms, the Chinese economy is huge. Nominally, China now has the fourth largest economy in the world, after the U.S., Japan and Germany. After adjusting for China's deliberately undervalued currency, China is the second largest economy in the world, roughly eighty percent as big as the U.S. economy.

Furthermore, China is already attracting international attention for its rapidly growing contribution to climate change. According to a 2007 report from the Netherlands Environmental Assessment Agency, it has already surpassed the United States as the world's largest contributor of carbon dioxide. Fatih Birol, the chief economist of the international Energy Agency, even warned that in 25 years China would emit twice as much carbon dioxide as all the OECD countries. [2]

The trend of climate change in China is generally consistent with that of global climate change. According to the *Initial National Communication on Climate Change of the People's Republic of China*, China's total GHG emissions in 1994 are 4,060 million tons of CO_2 equivalent (3,650 million tons of net emissions), of which 3,070 million tons of CO_2, 730 million tons of CO_2 equivalent (tCO_2e) of CH_4 and 260 million tCO_2e of N_2O. According to tentative estimates by experts from China, China's total GHG emission in 2004 is about 6,100 tCO_2e (5,600 million tons of net emissions), of which 5,050 million tons of

[2] See appendix I, appendix II.

CO_2, 720 million tCO_2e of CH_4 and 330 million tCO_2e of N_2O. From 1994 to 2004, the annual average growth rate of GHG emissions is around 4%, and the share of CO_2 in total GHG emissions increased from 76% to 83% (China's National Climate change Program, 2007).

China's historical GHG emissions are very low and per capita emissions have been below the world average. According to the study carried out by the World Resource Institute (WRI), China's CO_2 emissions from fossil fuel combustion were 79 Mt in 1950, contributing only 1.13% of the world total at that time; cumulative emissions of CO_2 from fossil fuel combustion accounted for only 9.33% of the world total during the period of 1950~2002, and the cumulative CO_2 emissions per capita are 61.7 tons over the same period, ranking the 92nd in the world. Statistics from the International Energy Agency (IEA) indicates that per capita CO_2 emissions from fossil fuel combustion were 3.65 tons in 2004 in China, equivalent to only 87% of the world average and 33% of the level in Organization for Economic Co-operation and Development (OECD) countries. Along with the steady social and economic development, the emission intensity defined as the CO_2 emission per unit of GDP declined generally. According to IEA, China's emission intensity falls to 2.76 $kgCO_2$/US$ (constant 2000 U.S. dollar) in 2004, as compared to 5.47 $kgCO_2$/US$ in 1990, a 49.5% decrease. For the same period, emission intensity of the world average dropped only 12.6% and that of the OECD countries dropped 16.1% (China's National Climate change Program, 2007).

2. China's Climate Change Policy

As we know, China faces substantial challenges in mitigating its increasing contribution to global greenhouse gas emissions, which will require a much higher level of effort than what may be achieved by measures already in place. However, China is openly or in private hostile to the idea of talking about post-2012 policy commitments. While the prospect of a long-term meaningful post-2012 global climate pact depends on China's participation in the near future. China is facing two types of pressures: international ones and domestic ones. Internationally, the large increases in GHG emission with the great economic growth in recent years have pushed up China on the stage across the world. Domestically, cost increases include rising wages, higher land lease fees, cuts in VAT export rebates, and imposition of export taxes on energy intensive products.

China's climate strategy remains centered on its energy development strategy as driven by its overall economic development goals. Although attention to climate change has recently increased among China's leadership, climate change has not surpassed economic development as a policy priority (Lewis, Joanna, 2007). By now, there are no indications that international pressures are significantly affecting China's government 's fundamental attitude towards quantified GHG emission cut by now. Chinese government has published its first national climate change program. In that program, China thinks the climate change issue ultimately is "the issue of development" (China's National Climate change Program, 2007). China insists that the largest share of historical and current global emissions of GHG has originated from developed countries, while the per capita emissions in developing countries are still relatively low and their share will grow to meet their social and development needs. As a developing party to the UNFCCC, China takes "fully into account that economic and social development and poverty eradication are the first and overriding priorities." (China's National Climate change Program, 2007)

Improving energy efficiency remains high on the agenda. To help China meets the challenging targets to improve energy efficiency and reduce pollution, the government is working on adjusting the performance evaluation system for local government officials and SOE top management, including the performance in environment protection and energy efficiency as criteria (Xinhua, July 31, 2007). The government is taking additional initiatives in setting standards, trying to close down inefficient power plants and steel and cement plants (see May 2007 Quarterly Update, p.14). The government is reluctant to use price increases at times of high inflation. Nonetheless, such considerations should probably not block needed price adjustments because, in the long run, price adjustments towards levels that reflect economic scarcity and social costs and benefits have a positive impact on resource allocation and economic efficiency, and will help in the efforts to reduce energy intensity (The World Bank quarterly, September 2007).

The Chinese claim to place great importance to the issue of climate change, but as a "developing country," they will only address climate change within the overall context of "national sustainable development strategy." The report estimated that global warming emissions in China have doubled between 1994 and 2004 from 3 trillion to 6 trillion tons of CO2 equivalent. However, they view these emissions in per capita terms, by which measure they are very low. Their immense population provides them the cover they need to avoid any mandatory emission caps.

During the Bali island conference, December 7th, 2007, China's delegation insisted that "any future arrangement on climate change should continue to follow the principles of common but differentiated responsibilities established in the Convention, addressing climate change within the framework of sustainable development, equal treatment of mitigation and adaptation, and effectively solve the problem of financing and technology which the developing country parties are most concerned." And "The UNFCCC and its Kyoto Protocol is the ROAD, and the Montreal action plan is the MAP." (*China's Statement on the Agenda Item of Enhancing Implementation of the Convention,* 2007) China thinks the Developed Countries should at least reduce their greenhouse gas emissions by 25%-40% by 2020 compared to 1990 levels.

On May 20, 2009, China issues the white paper to state its attitude and position on the Copenhagen Climate Change Conference. In that, China urges that all the developed countries to implement the Bali roadmap. Taking the Principle of Common but Differentiated Responsibilities, China thinks that developed countries shall take responsibility for their historical cumulative emissions and current high per capita emissions to change their unsustainable way of life and to substantially reduce their emissions and, at the same time, to provide financial support and transfer technology to developing countries. At the same time, developing countries will, in pursuing economic development and poverty eradication, take proactive measures to adapt to and mitigate climate change (*Implementation of the Bali roadmap: China's Position on the Copenhagen Climate Change Conference, 2009*).

In short, the world's biggest contributor to global warming is in denial about the problem, unwilling to make serious changes out of fear of harming its economies. China's climate change policy heavily relies on the advancement of science and technology instead of modification of development model.

3. The Reason Behind China's Policy

Global warming is a member of a special type of economic activity known as *global public goods.* These are economic or other activities whose impacts are indivisible and whose influences are felt around the world rather than affecting one nation, town, or family. There are at least two kind of public goods: some activities called *focal public goods* in which good policies appear obvious or consensual to most people; for example, it does not take much persuasion to convince people that a reasonable standard is zero AIDS, zero smallpox, zero swine flu. By contrast, with *economic public goods*, it is difficult to determine and reach agreement on efficient policies because they involve estimating and balancing costs and benefits where neither is easy to measure and both involve major distributional concerns.

Global warming is a kind of *economic public goods* that involve huge numbers of economic agents in a large number of countries, in which the costs and benefits of action do not indicate any obvious focal policy or technological fix. (Nordhaus, 2007).

First of all, the question of climate change must be of concern to local, national and international communities for purely prudential reasons: sharp changes in wealth, the exacerbation of extreme poverty, and severe food insecurity can all be expected to breed tension and armed conflict. Who will bear the burdens of that change? Who will be better off and who worse off?

The development history and trend of various countries has revealed the obvious positive correlations between per capita CO2 emissions, per capita commercial energy consumption and the economic development level. In other words, with current level of science and technology, to reach the same level as the industrialized countries, it is inevitable that per capita energy consumption and CO2 emissions will reach a fairly high level. In the history of the world, there is no precedent in that a high per capita GDP goes with absolutely low per capita energy consumption. The Montreal Protocol worked very well when rich countries agreed to include a significant financial transfer mechanism in the global treaty. But, this kind of compensatory justice lesson is probably not transferable to the climate change because that the ozone depletion issue required side payments if $1-2 billion, while the stabilization of climate could cost rich countries hundreds of billions of dollars. (Roberts, J. Timmons, & Parks, Bradley C., 2007).

Secondly, the global warming is all about inequality (Roberts, J. Timmons, & Parks, Bradley C., 2007). China thinks the inequality is not only in which countries suffer its effect most,, but also in which countries created the problem in the first place. In this regard, China's reluctance to commit to scheduled reductions in GHG emissions is not simply a function of high discount rate and the weak technical and administrative abilities, but, more fundamentally, is the result of a cumulative equity problems rooted in the conception of global in equality.

Global warming is a global public good, the key environmental issue is global emissions, and the key economic issue is how to balance costs and benefits of global emissions reductions. Climate change depends only upon total GHG emissions and the time path of emissions, not on the geographic location of emissions. Moreover, the impacts depend primarily upon cumulative emissions that remain in the atmosphere, not on the annual flow of emissions.

China's basic rule of climate change is as easy as the kindergarten ethics that those who created a mess should be responsible for cleaning their share of the mess. But, this rule works as a double-blade sword which points to China itself at well as to the developed countries at the same time. China's attitude on this issue strongly influenced the G-77 position, which nearly entirely ignored the contingent form the small island states in that China focuses on the adaptation of climate change instead of mitigation of global warming. The small island states believe a fair agreement on climate change would immediately stabilize the climate, forestall the complete destruction of island nations and cultures, and address their basic economic needs and extraordinary vulnerability to climate-related stress and natural disasters.

China insists that its GHG emission is survival one instead of luxury one. China favors the per capita approach in which each person on Earth is given an equal right to the ability of the atmosphere to absorb carbon. Under this proposal, China would be given significant room to grow and emit because its per capita consumption of fossil fuels is significantly lower than the world average level. At the same time, China also favors the proposal of historical responsibility that would take into account the amount of damage done by countries in the past to the atmosphere's ability to absorb more GHG. And demands the developed countries to pay the carbon debt.

If the current protocol is extended at the current reduction rates, models indicate that it will have little impact on global climate change (Nordhaus, 2007). Experts think that increases in future emissions will primarily take place in the developing world because the high rates of population and economic growth there. As a matter of fact, China's rise will inevitably come out with growing energy consumption and CO2 emissions. China made it clear that among others, the fundamental political question is who will be responsible for the bulk of future global greenhouse gas emissions. Almost all the countries agree that the current accumulated stock of CO2 in the atmosphere is largely the responsibility of rich, industrialized countries. Why should South Korea, South Africa, Saudi Arabia, and other states be off the hook if their per capita emissions and growth rates are much larger than that of China? If we do not address this issue in a multilateral framework, there could be problems ahead.

In short, global warming issue is something like the tragedy of commons; to this kind of question, neither science nor economics can provide a ‘‘correct’’ answer to the question of how to share the burden of reducing emissions.

4. Reputation-Based Price-Type Control Mechanism: Tentative Approach

The ***Economic Cost*** and ***Climate Injustice*** are two major concerns Chinese government faces. This raises the issue of which approaches would be most likely to stimulate and persuade China to take appropriate actions in the post-2012 climate regime.

To the first question, experts urge that high-income countries should provide financial and technical assistance to low-income countries to induce developing countries' participation. Some experts don't think it in the same way. In his paper "To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming", economist William D. Nordhaus compares quantity-oriented mechanisms like the Kyoto Protocol with price-type control mechanisms such as internationally harmonized carbon taxes. His analysis focuses on such issues as the relationship to ultimate targets, performance under conditions of uncertainty, volatility of induced carbon prices, the inefficiencies of taxation and regulation, potential for corruption and accounting finagling, and ease of implementation. He concludes that price-type approaches such as carbon taxes have major advantages for slowing global warming (Nordhaus, 2007). In the end, he suggests that price-type approaches such as HCTs are more efficient instruments than quantity approaches like those found in the Kyoto Protocol. Under the tax approach, countries set market penalties on GHG emissions at levels that are equalized across different regions and industries. The tax would start relatively low and then, unless the outlook changes for better or worse, rise steadily over time to reflect the increasing prospective damages from global warming.

To the second question, a more logic way should be found. All the countries want to pay as little as possible, and are unlikely to participate voluntarily unless they have a positive net benefit or face the high pressure. The absence of socially shared understanding of fairness and justice can reinforce zero-sum worldviews and causal beliefs, erode conditions of mutual trust, promote risk aversion, and foster retaliatory attitudes.

As Garrett Hardin (Sankar, Ulaganathan, 2001) pointed out that there is no technical solution to the problem of tragedy of commons, if the world countries continue to look for solutions in the area of science and technology only, the result will be to worsen the situation. It is crucial to have a mechanism whereby countries ‘‘graduate’’ into a set of obligations that are commensurate with their abilities to pay—in a way that is similar to the ‘‘ability to pay’’ principle of an income tax system. Part of the challenge is designing a fair graduation procedure; another part is overcoming the Westphalia dilemma of inducing countries to participate when graduation day comes.

The issue of global climate change, which itself is characterized by tremendous inequality in vulnerability, responsibility, and mitigation, can therefore not be viewed analyzed, or responded to in isolation from the larger crisis of global inequality. Any effective post-Kyoto climate treaty will have to address credibility, compensatory justice, the strategic leverage of major global environmental actors, and national development profiles, which bear heavily on states' willingness and ability to ratify these treaties. (Roberts, J. Timmons, & Parks, Bradley C., 2007).

Climate change is a high profile issue because GHG emissions currently arise from virtually all aspects of the global economy. International regulations of GHG emissions thus impinges on sovereignty which states are reluctant to concede, as evidenced by protracted debates on the need for legally binding reductions targets, the legal personality of the COP, majority-voting decision-making and procedures for determining non-compliance. (Farhana Yamin and Joanna Depledge, 2004, p 3.)

The increasingly large role of China in the global economy means that international pressure become more and more sensitive to China's growth and its prospects. Indeed, this influence may in part be self-fulfilling, with markets responding to changes in expectations about China's growth prospects even beyond what would be reasonable on the basis of China's weight in the world economy. By contrast, China has the technical, financial, and administrative capacity than those least developed countries (LDC). [3] Then comes the question: is it possible that China would take any policy to build up its good reputation?

Since the end of the cold war, China has markedly deepened the extent of its participation in international institutions with great speed. But the most significant thing is that China has initiated a clustered series of costly and risky endeavors that benefited the welfare of target states. What are the dominant causes and the prime goal of China's foreign strategy by institutional engagement? All the independent states are motivated more by their own conceptions of self-interest than by devotion to the common good if any. With the deep involvement in the globalization, China has changed its world picture, and holds that a new world war will be unlikely in the foreseeable future. Knowing the cost of getting rid of the network of interdependence, the realistic China wants to bring about a fairly long period of peace in the world and a favorable climate in areas around itself. China has made it clear several times that no matter how the international situation changes, it will keep pursuing the independent foreign policy of peace on the basis of the Five Principles of Peaceful Coexistence. Thus, it goes logically that the socialized China has an incentive to reassure others. China tries to promote trust by adopting a new reassurance strategy, which can be called institutional engagement (Wang, 2007).

China's position in the international climate negotiations has rarely deviated from the rest of the developing world, as collectively articulated by the Group of 77 (G-77), a group of 130 (formerly 77) developing countries. Recently, the financial incentives for emissions reductions provided by the Kyoto Protocol's Clean Development Mechanism (CDM) has also helped shape China's views on the international climate regime (Lewis, Joanna, 2007). Thus, Developing-country solidarity has been used as a strategy since the early days to influence climate change negotiations. But, with the growing economic differentiation and often disparate climate policy interests within them, the developing world is getting more and more diversified on their perspectives on the historical responsibility of GHG and emitting rights per capita. For example, some international group states like the members in SIDS hold strongly different point of view from those leading developing countries like China and India.

[3] See appendix III.

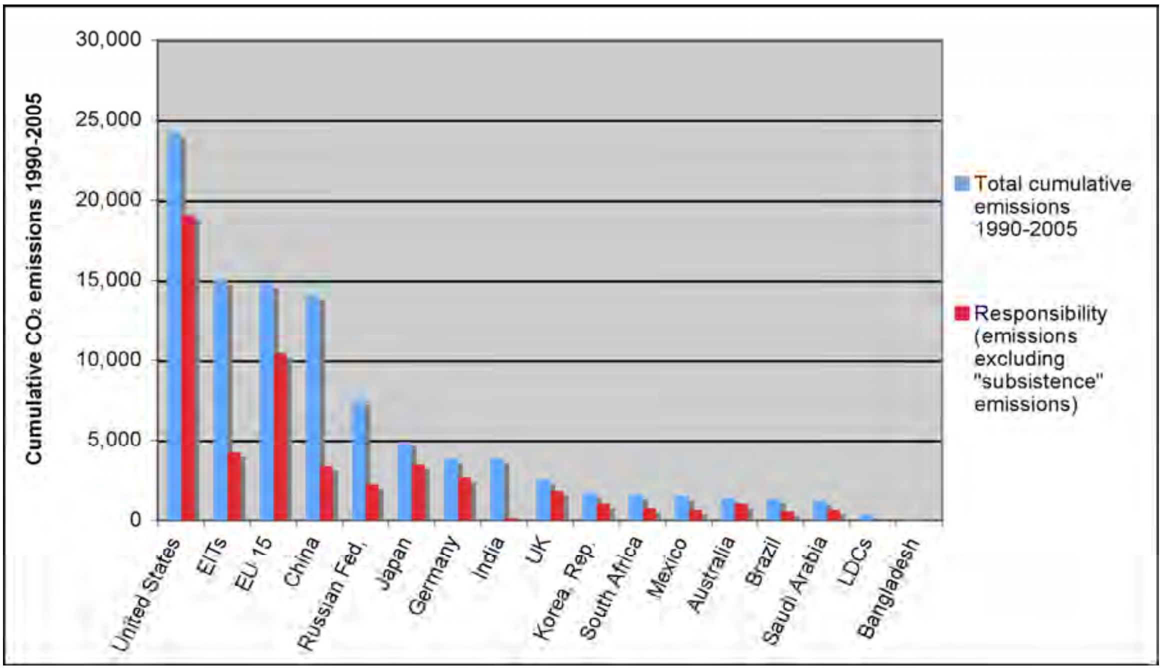
Put in another way, China will face increasing international pressure in the future to devote more commitment to climate change, both due to its emergence as the largest successor on the background of global financial crisis and as international attention to climate change is elevated by government leaders and heads of state in high-profile forums around the world.

To sum up, the world is beginning to consider the structure of climate-change policies for the period after 2008–2012. Some countries are adopting their own climate-change policies containing some mixture of emissions limits and technology standards. But China made it clear that it will not take any emissions cut in the near future. International structure will provide higher pressure to force China to take action.

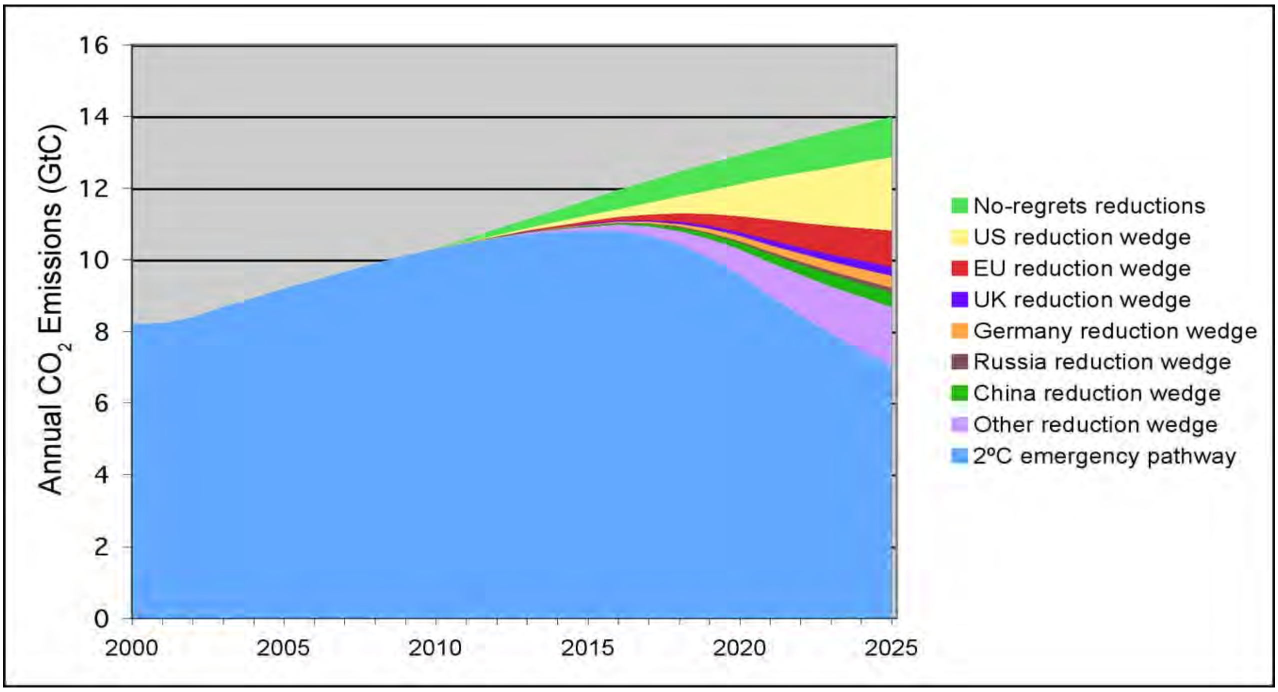
5. Conclusion

China's rapid development and economic miracle would become an environmental disaster if China's energy use is still especially unclean and inefficient, which brings consequences for the country and world. As China's current emissions and populations grow faster than the ones in developed countries, any comprehensive treaty in the 21st century will be futile without China's cooperation. The ***Economic Cost*** and ***Climate Injustice*** are two major concerns Chinese government faces. This raises the issue of which approach would be most likely to stimulate and persuade China to take appropriate actions in the post-2012 climate regime. The price-type approach incorporating the perspective of ***state reputation*** could visualize the possibility that China would take new Climate Policy and low-carbon economic development models. It argues that the sticks-type policies are most unlikely to push China to take actions or adopt measures because China's growing economic and military power, rising political influence, and increasing involvement in regional and international institutions have fundamentally affected the world system. However, since China builds up its reputation by focusing on the multilateral commitments, the ***reputation-based price-type control mechanism*** could be the Pareto Improvement that encourages China to contribute its fair share to the global climate effort.

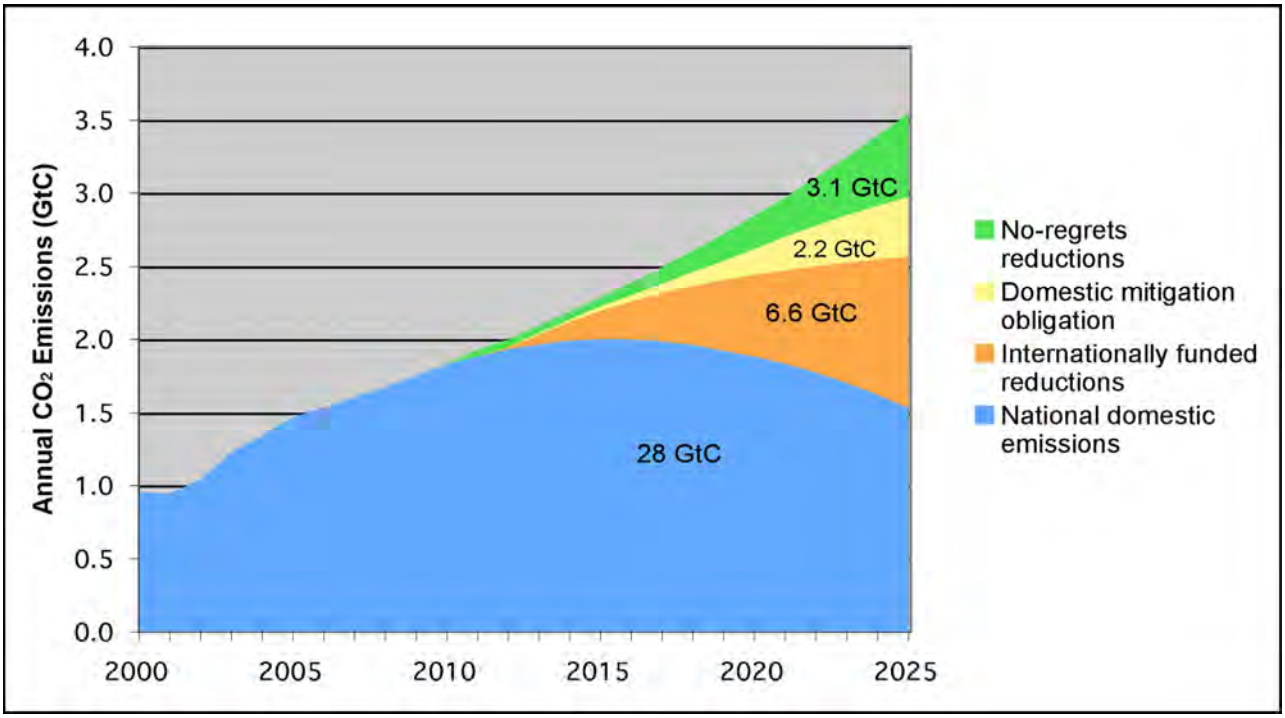
Appendix I: Cumulative CO2 emissions (1990-2005), (SEI, 2007)



Appendix II: National "Obligation Wedges", (SEI,2007)



Appendix III: Chinese participation in a GDRs World, (SEI,2007)



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Are There Policy Tunnels for China to Follow?

Jan Kunnas[1] and Timo Myllyntaus[2]

Abstract

According to the controversial “environmental Kuznets curve” –hypothesis (EKC), some pollution would follow an inverted U-curve related to incomes, increasing at low income levels and decreasing at high income levels. Mohan Munasinghe argues (in a gerschenkronian way): “that developing countries could learn from past experiences of the industrialized world by adopting measures which would permit them to ´tunnel´ through the EKC, providing a possibility to avoid the most serious damage to the environment by avoiding the peak before a downturn of the emissions...” In our presentation, which is based on a comparison of Denmark’s, Finland’s, Sweden’s and Switzerland’s carbon dioxide emissions; we will examine China´s possibility to tunnel through its emissions of carbon dioxide.

With cumulative carbon dioxide emissions over the period 1870–2003 half that of Denmark’s or two thirds of Finland's or Sweden’s, Switzerland seems, at a first glance, to be a fine example of a munasinghean policy tunnel. Switzerland’s carbon dioxide emissions per capita were, however, in 2003 around 30 thirty per cent higher than global average and up to fifty per cent higher than those of China. As, in fact all industrialized countries are emitting carbon dioxide in quantities which can be considered well beyond their fair share of what can be considered as a sustainable global emissions level, there is at present no examples for developing countries to follow in order to tunnel through. Thus, our paper supports unilateral cuts in greenhouse gases, such as those agreed during the Spring Council meeting of EU heads of government in March 2007.

The attractiveness of the Swiss model depends also whether nuclear energy is considered desirable. The Chinese Three Gorges Dam – project, displacing over a million people, also shows that even hydro power can create large problems. If China would consume as much electricity per capita as Switzerland and produce it with the same means, this would require around sixty three gorges dams with an capacity of 85 TWh/a and six hundred medium sized nuclear power plants producing 7 TWh/a. In other words, China would need to build more new nuclear power plants than is at present in the world in total. It is also questionable whether a Swiss development path is possible worldwide, as its low energy consumption is due to a production of highly specialized and expensive products. At least it is not achievable with present consumption patterns in developed countries.

1. Introduction

In the early 1990s, Gene M. Grossman and Alan B. Krueger (1992), Nemat Shafik and Sushenjit Bandyopadhyay (1992), Theodore Panayotou (1993), Thomas M. Selden and Daqing Song (1994) proposed that some pollution would follow an inverted U-curve related to incomes, increasing at low income levels and decreasing at high income levels. Such a relation was named “environmental Kuznets curve” (EKC), after the similar theory of income distribution proposed by Simon Kuznets (1955). According to Anton Naiman and Geoff Antrobus (2005): “The main divergence in the EKC literature is between optimists, who take the EKC as implying that economic growth is ultimately good for the environment; and critics, who point to a number to a number of flaws evident in deriving the EKC or advocate caution in interpreting its causes and implications.”

[1] European University Institute, Italy, email:jan.kunnas@eui.eu
[2] University of Turku, Finland, email: timmyl@utu.fi

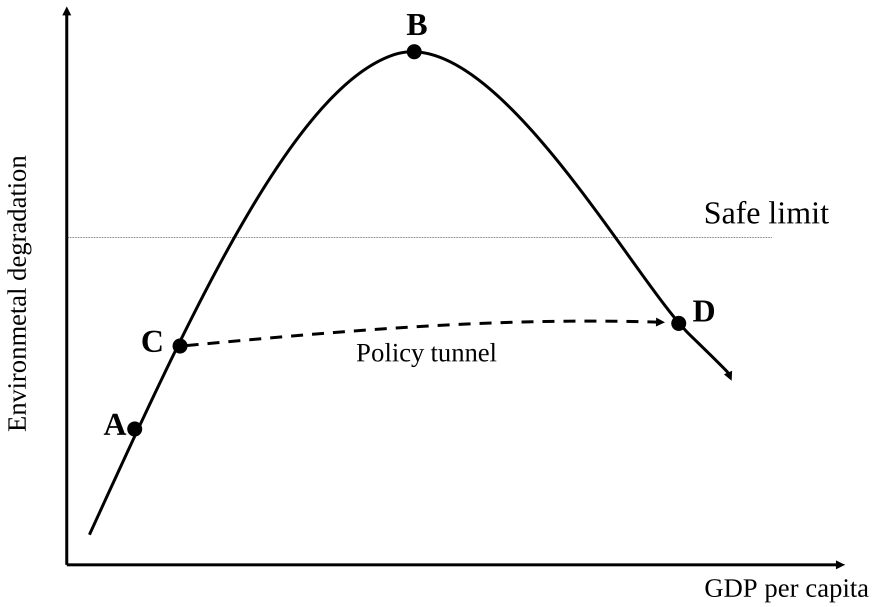

Figure 1. Tunnelling through the environmental Kuznets curve using sustainable strategies. Based on M. Munasinghe, Is environmental degradation and inevitable consequence of economic growth: tunnelling through the environmental Kuznets curve. *Ecological Economics*, vol. 29 (1999) 89-109.

Figure 1 illustrates the assumed relationship between Gross domestic product per capita and environmental degradation, pollution or resource depletion. Point A illustrates a pre-industrial economy with a low level of per capita income, where one might expect rather pristine environmental conditions relatively unaffected by economic activities. Along with industrialization and economic growth increasing use of natural resources and emission of pollutants causes increasing environmental degradation. After a peak in environmental degradation (B), the declining part of the curve is finally reached. In the final stage complementary reasons, like a growing ability and willingness to pay for a better environment, cleaner technologies and a shift to information and service-based activities are expected to result in reduced environmental degradation. (Munasinghe 1995 & 1999.) Kunnas and Myllyntaus (2007) add that the severity of environmental degradation might itself create a turning point for the emissions.

Mohan Munasinghe (1999) argues: "that developing countries could learn from past experiences of the industrialized world by adopting measures which would permit them to ´tunnel´ [C—D] through the EKC, providing a possibility to avoid the most serious damage to the environment by avoiding the peak before a downturn of the emissions..." We will examine this argument at the end of this paper.

We start our paper by comparing Denmark's, Finland's, Sweden's and Switzerland's carbon dioxide emissions for the period 1870 to 2003 using our own emission calculations (Kunnas and Myllyntaus 2007 & 2008) . These emission estimates are compared to the widely used estimates compiled by the *Carbon Dioxide Information Analysis Center* (CDIAC) at Oak Ridge National Laboratory (Marland et al. 2005). We put forward some explanations for possible differences in these different estimations and attempt to evaluate whether differences are substantial. In the second part of this article we use the same emission data to examine the relevance of the environmental Kuznets curve hypothesis in the case of carbon dioxide emissions. Our particular concern is how the cumulative character of carbon dioxide emissions affects the validity of the hypothesis. We also check whether the differences between the emission estimates presented in the first part of the article are substantial enough to alternate the outcome. Then we can finally close our paper with a critical examination of Munsinghe´s policy tunnel; Are there policy tunnels for China to follow?

2 Annual Carbon Dioxide Emissions and Carbon Efficiency

We start our paper by comparing Denmark's, Finland's, Sweden's and Switzerland's carbon dioxide emissions for the period 1870 to 2003 using our own emission calculations (Kunnas and Myllyntaus 2007 & 2008) . The rational for choosing these four countries is similar high dependence on energy imports and industrial exports, while their economies transformed from agrarian to industrial and finally service-oriented within fairly short time spans. In addition, these countries resemble each other because of their similar corporatist democracies, comparable welfare states with high GDP per capita (21 000 – 23 000 $ per capita purchasing power parity in the year 2003) and a fairly small population (5-9 million inhabitants).

We are comparing our emission calculations to the estimates for the same countries made by Gregg Marland, Tom Boden and Robert J. Andres (2005), at the Carbon Dioxide Information Analysis Centre (CDIAC) of the Oak Ridge National Laboratory. This comprehensive database on global, regional, and national CO_2 emissions has been widely used due to its easy availability and regular updates. Its calculation methods have been presented in the Tellus-journal (Andres et al. 1999 & Marland and Rotty 1984). Usually the figures from the database are used as such without critical evaluation about the validity of the data. We put forward some explanations for possible differences in these estimations and attempt to evaluate whether differences are substantial.

To make the emissions in different countries comparable despite the different size of population, we present the emissions in per capita terms. Figure 2 indicates that Sweden and Denmark had a very similar development of carbon dioxide emissions per capita until the mid-1970s, after which Sweden's emissions dropped fast. Finland had the slowest emissions growth until the end of the Second World War. Since then Finland switched from fuel wood to fossil fuels and that made the country's emissions to grow exceptionally fast. Consequently, its emissions per capita passed those of Switzerland by the mid 1960s, those of Sweden by the end of the 1970s and recently also those of Denmark.

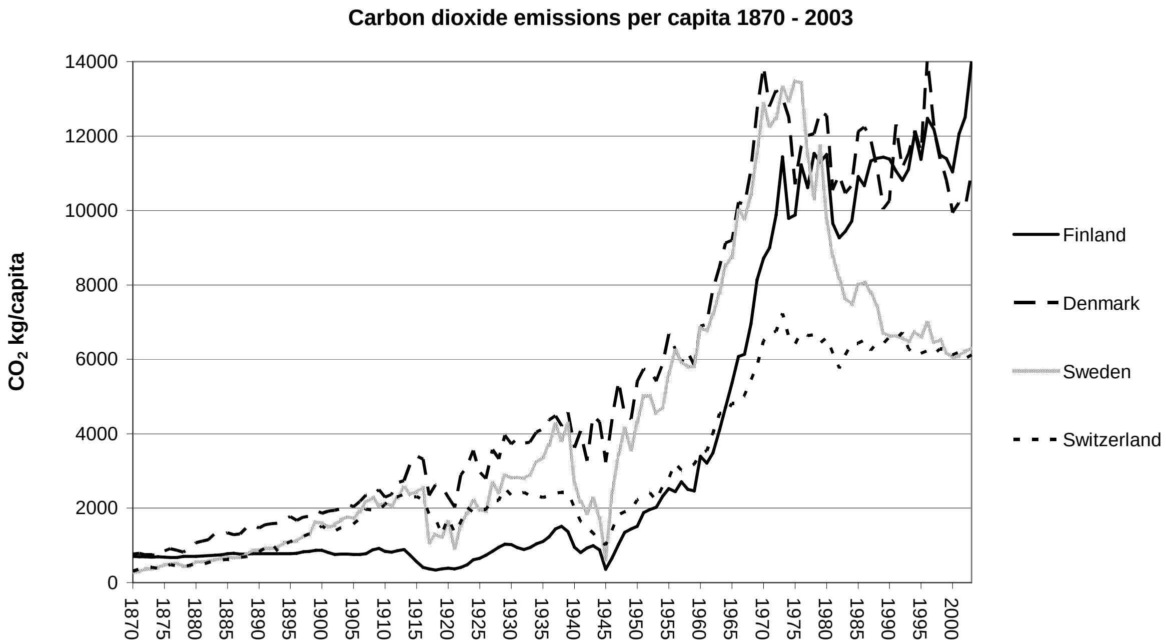

Figure 2. Carbon dioxide emissions per capita in Denmark, Finland, Sweden and Switzerland, 1870—2003
Sources: Kunnas and Myllyntaus 2007 & 2008; UNFCCC 2006; Johansen 1985; Det Statistiske department 1915 – 1976; Etemad & Luciani 1991; Danish Energy Agency 2002; Kander 2002; Mitchell 1992; Conseil Suisse de l'Energie 2001.

In 1870 Finland had the second largest carbon dioxide emissions per capita, of the countries in the sample, with 700 kg per capita. It was surpassed only by Denmark's 770 kg per capita. Sweden's 280 kg per capita and Switzerland's 300 kg per capita was less than half of Finland's emissions. Finland's relatively high emissions per capita at the beginning of the time series, although it had the smallest gross domestic product 1 100 Geary-Khamis dollars per capita in 1870, compared to 1 700 - 2 100 $ for the other countries in the sample, is explained by burning cultivation of peatlands. Consequently, it also explains Finland's flat emission development path at the end of 19th century and early 20th as the withering away of burning cultivation of peatlands counteracted increasing use coals and petroleum products (Kunnas 2005). Our sources for the other countries do not include this peat consuming cultivation practise. Its inclusion might increase 19th century emissions substantially for, at least, Sweden and Denmark. Such calculations are though not available.

Figure 2 is drawn based on our calculations, but if the CDIAC data was used, it would not make substantial differences in the shapes of the curves, except for Finland where our calculations shows 5-30 fold higher emissions in the 19th century. The main reason for this considerable difference is the above mentioned burning cultivation of peatlands, which is not included in the CDIAC calculations. While burning cultivation of peatlands were declining in the beginning of the 20th century and coming to an end by 1940, also the difference between our calculations and the estimates by Marland et al. indicates a clear convergence.

From 1870 to 1913 Sweden's and Switzerland's carbon dioxide emissions grew at an annual rate of almost 5 percent, while Denmark's annual growth rate was 3 percent. Finland's emissions, on contrary, grew at only a half percent a year. Thus by 1890 both Sweden's and Switzerland's emissions surpassed Finland's and at the eve of the Second World War their emissions were more or less on the same level than those of Denmark.

Christian Pfister (1998) has described a shift from the moderate use of energy to the extensive use of fossil fuels and a simultaneous change from sustainability to mass consumption as the “syndrome of the 1950s.” Our sample gives only partial support for this notion. On one hand, Finland's growth of carbon dioxide emissions soared from a mediocre 0.4 percent per year in the period 1870 to 1950 to 5.2 percent in the 1950s and Switzerland’s emission growth doubled from 2.1 percent to 4.5 percent. On the other hand Sweden's carbon dioxide emissions had only a small increase in the growth speed, from 2.6 percent a year in the period 1870 to 1950 to 3.4 percent in the 1950s and Denmark’s emission growth halved from 2.3 percent to 1.2 percent. Rather we could speak of a “syndrome of the 1960s” – In the 1960s Sweden's carbon dioxide emissions annually grew 6.1 percent, Denmark’s 6.4 percent, Switzerland's 5.5 percent and Finland's 10.6 percent!

Interestingly this phenomenal growth slowed substantially down in all of the countries in the sample except for Finland already in the beginning of the seventies before the oil crises. Finally the oil crises slowed also Finland's emission growth, but it was the only country in the sample with growing emissions in the 1970s. From 1970 to 1979 Finland's carbon dioxide emissions grew 2.7 percent a year, while Sweden’s emissions diminished 1.4 percent, Denmark’s diminished 1.3 and Switzerland’s diminished 0.2 percent a year.

Finland's faster emissions growth than the two other Nordic countries in the sample gets an explanation, when we compare the carbon efficiency of the countries. From the Figure 3 below, we can see, that in the beginning of the 1950s, Finland's carbon dioxide emissions per unit of GDP, were only half of that of Sweden and Denmark, although already substantially larger than those of Switzerland. Thus the faster emission growth than the other Nordic countries continuing until the oil crisis can be considered as a catch up.

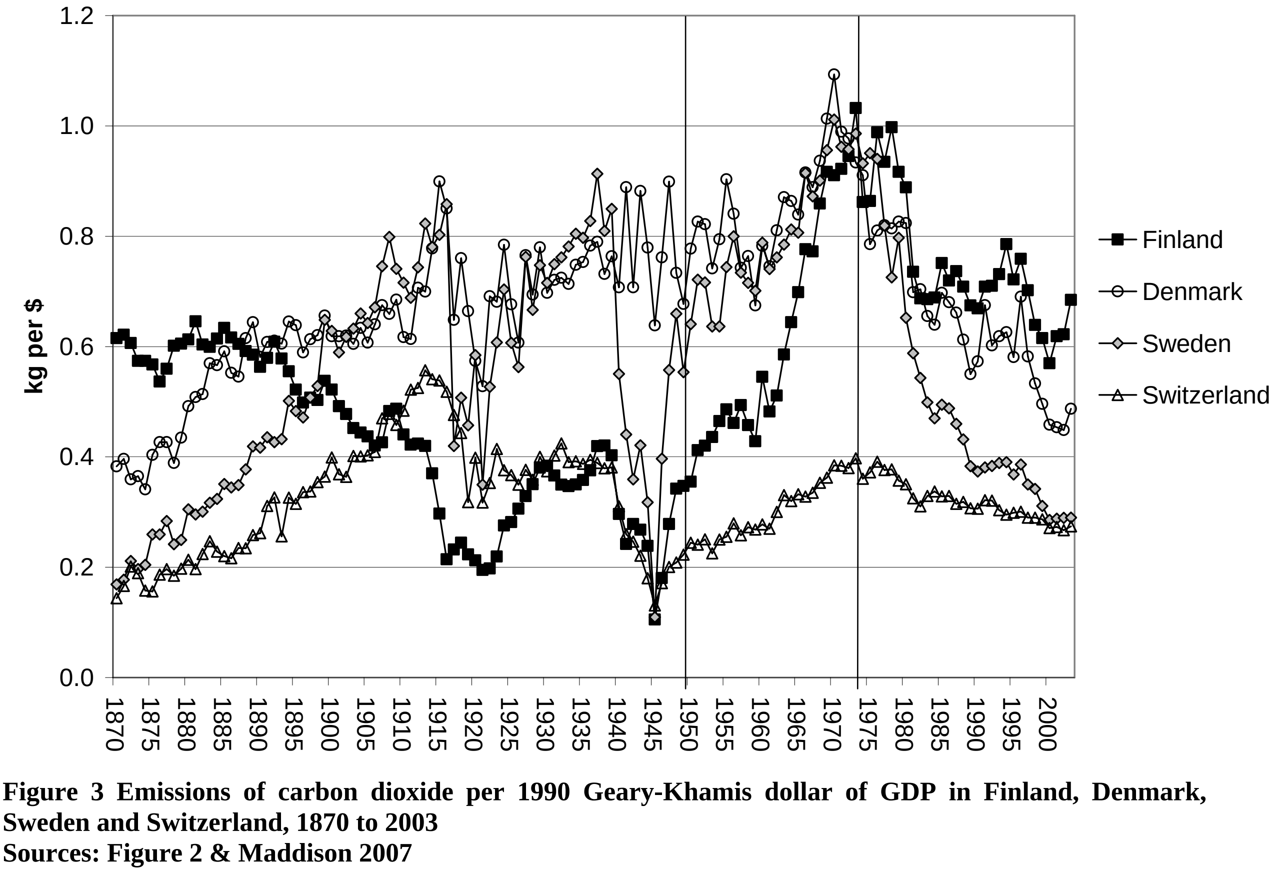

Figure 3 Emissions of carbon dioxide per 1990 Geary-Khamis dollar of GDP in Finland, Denmark, Sweden and Switzerland, 1870 to 2003
Sources: Figure 2 & Maddison 2007

Switzerland’s development in carbon efficiency in the late 19th century and early 20th century mirrors Finland's, as Switzerland had increasing carbon dioxide emissions per unit of GDP until 1913 and thereafter decreasing unit emissions until 1945. It was among the first countries in mainland Europe to industrialize in the beginning of the 19th century. Initially its industrialization was coal driven, but at the end of 19th century it started to utilize its hydropower resources. Thus in 1882 water power represented almost 70 per cent of installed power capacity in Swiss factories (Paquier 1998a: 387). In 1888, 66 per cent of the primary energy used by industry was derived from water power, by 1911 its share had increased to 76 percent, and in 1929 it was as much as 92 per cent (Paquier 1998b: 735). Its industry also took a completely different trajectory from the start with a concentration on highly specialized and expensive products. According to one study of pre-war export trade established the average value of a ton of Swiss exports at 1 500 francs compared to 140 francs for a ton of German exports. From 1913 to 1924 Switzerland's three most important export products were watches and clocks, silk fabrics, and machinery and motor cars (Jones 1926). In 2004 the three most important industries produced chemicals, machinery and electronics, and instruments and watches (Swiss Federal Statistical Office 2005).

Since the first oil crisis to 2003 all of the countries in the sample, have had a more or less constant increase in the carbon dioxide efficiency of the economy as a whole measured by kg of carbon dioxide emitted per $ of GDP. Though only in the case of Sweden, the efficiency growth have been enough to counteract the continuing GDP growth and turning the emissions to a considerable decrease. From 1973 to 2003 Sweden's carbon dioxide emissions per capita declined 2.7 percent a year, while the emission path was more or less flat in the other countries.

3 Environmental Kuznets Curve and Cumulative Emissions

By replacing the time dimension on the x-axis with the gross domestic product, we can compare emissions per capita at different levels of Gross Domestic Product. At a GDP level between 2000 and 5000 Geary-Khamis dollars per capita, Finland's emissions per unit of GDP are at the same level as in Switzerland. At the level of GDP per capita around 6000 $, Finland catches up with Sweden, and at 8000 $ with Denmark.

Finland's relatively low carbon emissions dollar of GDP compared to the other Nordic countries in the sample, between 2000 and 5000 dollars per capita, is due to the fact that its initial GDP growth was mostly based on wood and water power. An increased industrial use of wood was possible due to an improvement in space heating efficiency due to new stove technology tripling the average thermal efficiency, and a fading slash-and-burn-cultivation (Myllyntaus and Mattila 2002, Kunnas 2005).

Sweden had even more abundant wood and water resources, but it also had some domestic coal resources. In contrast, Denmark had less wood resources because it land territory was a smaller and it was more densely populated, and a low elevation feeding the rivers. As a result, it had to fuel its economic growth by imports of coal and liquid fuels from the start.[3]

[3] Nowadays Finland have a forest land area of 22 500 hectares (73.9 % of land area), Sweden 27 528 ha (66.9, Switzerland 1 221 ha (30.9 %) and Denmark 500 ha (11,8 %). (FAO 2006.)

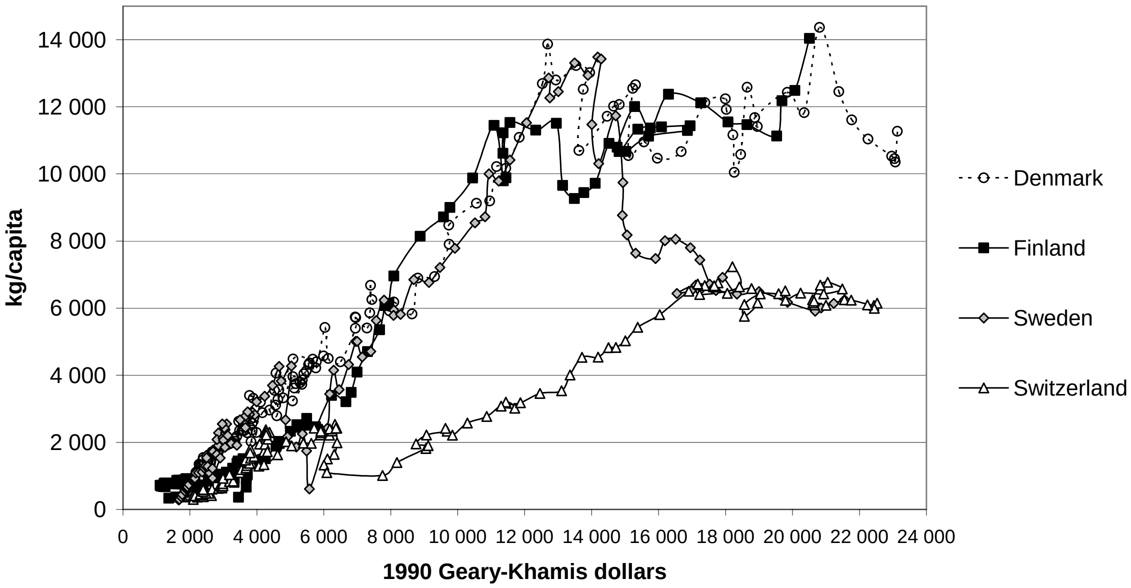

Figure 4. Carbon dioxide emissions per capita related to income level of a fixed price level in Denmark, Finland, Sweden and Switzerland, 1870 – 2003
Sources: Figure 2 & Maddison 2007

The environmental Kuznets-curve hypothesis proposes that some pollution or measures of resource use or environmental degradation would follow an inverted U-curve related to incomes, increasing at low income levels and decreasing at high income levels. All off the countries in the sample have a stagnation of emissions growth at high income levels, but only Sweden's emissions turn to a substantial decline at high income levels in accordance with the hypothesis.

At an income level of 18 000 $ Swedish emission drops to the same level as Switzerland's, or around 60% of Finland's and Denmark's. The main reason for the downward turn in Swedish emissions is nuclear power, and it can be argued, similarly to Gilbert Plass who were among the first scientist raising alarm of climate change, whether this is a genuine environmental improvement or transition from one environmental problem to another. In 1956 he wrote: "It is interesting that two of the most important methods available at the present time for generating large amounts of power have serious disadvantages when used over long time intervals. The burning of fossil fuels increases the temperature of the earth from the carbon dioxide effect; the use of nuclear reactors increases the radioactivity of the earth. It is difficult to say which of these effects would be the less objectionable after several centuries of operation."

So far we have, however, only considered emissions for a single year although carbon dioxide emissions are cumulating to the atmosphere. Since the beginning of industrialization to present the concentration of carbon dioxide in the atmosphere has been increasing from about 280 to 380 parts per million. There is now a clear scientific consensus that the increasing atmospheric concentration of carbon dioxide and other greenhouse gases resulting mainly from human activities are causing global mean surface temperatures to rise. This again is predicted to cause among other things rising ocean levels, the extinction of animal and plant species and increasing extreme weather conditions (IPCC 2007).

When we, instead of annual emissions, take a look at cumulative emissions per capita from 1870 to present, the outcome, as presented in Table 1, is much different. Switzerland with its linear emission-income relation has the clearly smallest cumulative emissions; followed by Finland which emission development path does not either have a downward slope at high income levels as suggested by the EKC-hypothesis. Sweden had the second largest cumulative emissions after Denmark, despite its emissions follow an inverted U-curve as proposed by the environmental Kuznets-curve –hypothesis. Our conclusion is thus that in the case of carbon dioxide emissions and other cumulative pollutants, focusing on yearly emissions can be utterly misleading.

We can also see that from a cumulative perspective, Finland's manifold emissions in our calculations compared to Marland et al. (2005) in the late 19th century are irrelevantly small, as they are mainly related to the increase in emissions caused by the later phases of industrialisation in the 20th century. Emissions of pre-industrial and early industrial periods have a minor significance compared to those of the past sixty years.[4]

Table 1. Cumulative carbon dioxide emissions per capita in Denmark, Finland, Sweden and Switzerland, 1870 – 2003 (1000 kg)

	Denmark	Sweden	Finland	Switzerland
Kunnas & Myllyntaus	626	485	453	313
Marland et al.	615	451	422	310

Sources: See Figure 2 & Marland et al. (2005)

Over the past 200 years the oceans absorbed about a half of the total carbon dioxide emissions from fossil fuels and cement manufacturing (Sabine et al. 2004). This buffer has, however not been a free lunch. When carbon dioxide dissolves in seawater it forms a weak acid called carbonic acid. Because of this chemical process the average pH of the oceans has decreased by 0.1 unit from pre-industrial levels, and an exponential decrease of nearly 0.8 pH unit is forecasted by 2300. Experimental evidence indicates that this could have major effects on calcifying marine biota, such as calcareous plankton and coral reef communities. (The Royal Society 2005, Caldeira and Wickett (2003, Orr et al. 2005)) Thus the absorption of carbon dioxide has not been a genuine environmental improvement, and has therefore not been considered in this paper.

4. Policy Tunnels or Just Levelled Slopes

Now we can finally return to Mohan Munsinghe´s (1999) argument: "that developing countries could learn from past experiences of the industrialized world by adopting measures which would permit them to ´tunnel´ through the EKC…" Graphically Munasinghe´s argument goes that developing countries could go through a policy tunnel (C–D) to point D, a society combining high per capita income with low levels of environmental degradation, without passing through point B associated with a high peak in environmental degradation. This new point should preferably be under some safe limit beyond which environmental damage could become irreversible.

[4] Mark T. Heil and Thomas M. Selden (2001) calculated, based on an earlier Oak Ridge database, that the cumulative worldwide emissions for the period 1881 to 1990 equaled 212 billions tons of carbon, while their projection for the period 1991 to 2100 with equal duration was approximately 1500 billion tons of carbon.

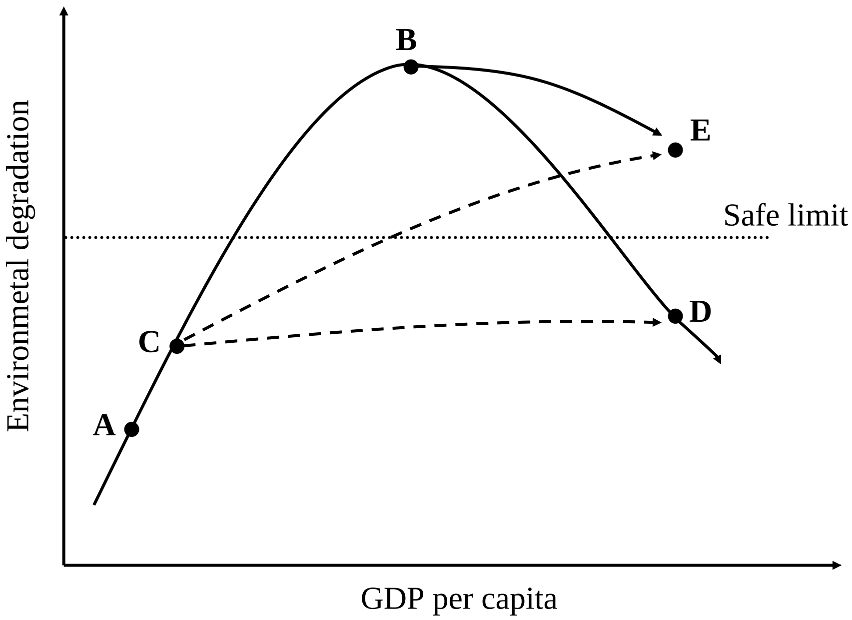

Figure 5. The environmental Kuznets-curve with a policy tunnel, and a levelled slope

With cumulative emissions half that of Denmark's or two thirds of Finland's or Sweden's, Switzerland seems, at a first glance, to be a fine example of a *policy tunnel*, tunnelling through the environmental Kuznets –curve Switzerland's (and Sweden's) carbon dioxide emissions per capita were, however, in 2003 around thirty per cent higher than global average and up to fifty per cent higher than those of China (Marland et al 2005).

This can be compared to EU's goal of keeping the rise in global temperatures to below 2°C compared to pre-industrial level, which would require global emissions to be reduced by up to 50% compared to 1990 by 2050 (Commission of the European Communities 2007). Thus neither Switzerland or Sweden are on the point D, but rather on point E, below the highest point of environmental degradation, but still way over the safe limit. As the per capita emissions of carbon dioxide are above the global average in all 27 high-income OECD countries, they provide no examples for China to follow in order to tunnel through. Their example allows so far only levelling the slope to point E.[5]

The attractiveness of the Swiss model depends also whether nuclear energy is considered desirable. The Chinese Three Gorges Dam –project, displacing over a million people, also shows that even hydro power can create large problems (Heggelund 2006). If China would consume as much electricity per capita as Switzerland and produce it with the same means, this would require around sixty three gorges dams with an capacity of 85 TWh/a and six hundred medium sized nuclear power plants producing 7 TWh/a. In other words, China would need to build more new nuclear power plants than is at present in the world in total; In August 2007 there was a total amount of 439 nuclear reactors in operation worldwide (IAEA 2007). It also questionable whether a Swiss development path is possible worldwide, as its low energy consumption is due to a production of highly specialized and expensive products. At least it is not achievable with present consumption patterns in developed countries.

All energy forms have ecological consequences, although their impacts vary to a great extent. Therefore we support Gunter Schaumann´s (2007) notion that from an ecological view,

[5]For a more hopeful story see: Brajer, Mead, and Xiao (2007).

the reduction of the “energy consumption” is the priority goal, and the reduction of carbon-dioxide emissions again only a partial goal. If the present day developing countries could repeat Finland's “energy less” growth which continued until the First World War, this could buy us time, during which the developed countries would lower they energy consumption and develop as environmental friendly means as possible to provide the remaining needs for energy, there would be a genuine chance for developing countries to tunnel through the environmental Kuznets curve straight to a sustainable emission level.

The accomplishment of this goal requires technology transfer to developing countries. This should, however, not focus on high-tech only; it should be remembered that Finland's initial energy less growth was achieved by a technology which can be considered quite primitive from present day perspective, although it was revolutionary indeed at the time being. The suitability of a technology is more important than how advanced it is (Kunnas 2006).

Unilateral measures to curb climate change could provide an example for later comers to follow, allowing them to tunnel through the peak emissions. Thus, our paper supports unilateral cuts in greenhouse gases, such as those agreed during the Spring Council meeting of EU heads of government in March 2007. In the case of ozone depleting substances the United States took the lead without waiting for actions by the European Community, the forerunner of the European Union. Thus it managed by its own example overcome the scepticism and opposition of regulatory measures by EC, which eventually followed the example (Sunstein 2007). This time it is perhaps the European Union’s turn to take the lead.

Acknowledgments
Heli Koskinen helped with the data collection. We would also like to thank Arto Kokkinen, Giovanni Federico and other commentators for helpful comments, although we stubbornly ignored most of them. David Tréfás kindly answered our question posted on the H-Energy – list. Helsinki University Environmental Research Centre, the Academy of Finland (Research Council for Culture and Society) and European University Institute provided financial support. Earlier versions of this paper were presented at the European Union Policies in the Making conference at Tischner European University, Kraków, Poland, 18-19 April 2008, and at the European University Institute Alumni Conference on EU environmental policy and governance, Florence, Italy 20-21 June 2008.

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Predictability and China's Legally Binding Goal of CO_2 Emissions in The Copenhagen Negotiation

Yuan Xu[1]

Abstract

Two facts define China's status in the global efforts of CO_2 mitigation: China has overtaken the United States as the world's largest CO_2 emitter. And as a developing country with low per capita emissions, China will grow into a much bigger one. Accordingly, in the coming Copenhagen negotiation, whether China will accept a legally binding goal is of great importance. China's CO_2 emissions in the past three decades are analyzed in this paper to distinguish two prominent features: abrupt changes and cycles. Abrupt changes break the past trend and make projections into the future unreliable. China has experienced two abrupt changes of CO_2 emissions since 1998 – one downward and one upward. A likely future one will seriously compromise the application of an absolute CO_2 goal to China. On the other hand, stable cycles characterized China's CO_2 emissions, but the 10-yr period does not overlap with the 5-yr commitment period of the Kyoto Protocol. Intensity goals can much better address these two concerns. A future abrupt change of baseline CO_2 emissions intensity is less likely and no cycles are apparent. China has adopted intensity goals in its domestic efforts of energy conservation and environmental protection. A CO_2 emissions intensity goal is also being considered, which indicates that intensity goals could have a better chance in persuading China to negotiate a legally binding goal in the Copenhagen negotiation.

1. Introduction

China did not get a legally binding goal in the 1997 Kyoto Protocol. With rapid economic growth, China's share in the world's total CO_2 emissions has risen from 10.6% in 1990 to 20.6% in 2006.[2] China's future will be even more important than its present status: during 2005-2030, China's incremental energy-related CO_2 emissions could be responsible for over two fifth of the world's.[3] Upon the negotiation in Copenhagen for a post-Kyoto CO_2 mitigation regime, how to effectively incorporate China becomes one of the most critical factors that will decide the success of the negotiation and subsequent implementation.

Intensity goals have long been suggested to accommodate economic growth especially in developing countries and induce them to accept legally binding goals.[4] Under a cap-and-trade scheme, intensity goals can also reduce the uncertainty of CO_2 permit price.[5] However, the merits of intensity goals were generally discussed among many countries with less attention to a specific country, particularly China with rapidly growing importance and some distinct features of uncertainty. Accordingly, for China in the coming Copenhagen negotiation, intensity goals may not have been fully appreciated.

This paper analyzes in detail China's CO_2 emissions in the past three decades and especially since 1998 to compare intensity and absolute goals. Predictability is the focused perspective. Section 2 addresses two abrupt changes associated with China's CO_2 emission since 1998. Section 3 further analyzes the consequence of the abrupt changes on projecting China's CO_2 emissions. Intensity goals are compared with absolute goals facing the

[1] Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, NJ, 08544; USA, email: yuanxu@princeton.edu

[2] Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.

[3] International Energy Agency (IEA), *World Energy Outlook 2007*. Paris, France, 2007.

[4] J. A. Frankel, "Growth Baselines: reducing emissions and increasing investment in developing countries," Brookings Institution, Washington, D.C. 1999.

[5] F. Jotzo and J. C. V. Pezzey, "Optimal intensity targets for greenhouse gas emissions trading under uncertainty," *Environmental & Resource Economics*, vol. 38, pp. 259-284, Oct 2007.

uncertainty of a future abrupt change. Section 4 studies the clear cycles expressed in the annual growth rates of China's CO_2 emissions. Section 5 introduces the application of intensity goals in China. Section 6 concludes the paper.

2. Abrupt Changes of China's CO_2 Emissions

A key issue in goal setting is to forecast baseline emissions in the year intended for goal attainment. Goals can be constructed around the baseline plus some designated reduction efforts. Obviously, goals are for the future and the baseline is estimated ex ante. However, due to the inherent uncertainty in predicting the future, the ex ante baseline may differ greatly from the ex post one analyzed afterwards without much of the proceeding uncertainty. If the ex post baseline is much lower than the goal, a problem of "hot air" will be created. In the scenario, China will have many extra CO_2 permits to sell and considering China's huge size, the oversupply of CO_2 permits could lead to the collapse of international CO_2 prices and undermine effective CO_2 mitigation. On the other hand, if the ex post baseline is much higher than the goal, China will either resort to methods with high mitigation costs or purchase CO_2 permits in the international market. The excessive financial burden will trouble not only China, but also other countries that plan to purchase CO_2 permits at a lower price. The investment from the business world on CO_2 mitigation can also be hampered facing a significantly uncertain future CO_2 price. In short, because of China's large and rapidly growing share in the world's CO_2 emissions, its uncertainty can greatly affect the world.

China has clearly demonstrated its potential of making surprises in CO_2 emissions. An effective negotiation in Copenhagen requires an acceptable way to China to address the uncertainty if a legally binding goal is wanted from China. The Kyoto Protocol was negotiated in 1997, more than a decade before its commitment period starting in 2008. A short interval as it is for many countries, China experienced abrupt changes at both directions of CO_2 emissions change (Fig. 1). If a new treaty for 2013 and beyond is successfully negotiated in Copenhagen, the interval will be three years. But even three years can be long enough for China to witness unexpected changes of CO_2 emissions. Not only a goal for China will be difficult to negotiate under the huge uncertainty, but also China's willingness to start negotiation could be compromised. Facing particularly the surprisingly high growth of CO_2 emissions since 2002 (Fig. 1) and serious problems in environmental policy implementation, China may not be confident to achieve a legally binding goal of CO_2 emissions, and thus not willing to negotiate one.

China's CO_2 emissions in the past decade looked like riding a roller coaster – coming down and going up at dazzling speeds that surprised both the world and China itself. In the three years from 1998 to 2000, though the economic growth rates were slower than the average since 1980, China's economy still expanded 25.7%.[6] The CO_2 emissions, however, shrank by 5.3%.[7] It was out of the world's expectation: for example, in the reference scenario of the International Energy Outlook 1998, EIA (Energy Information Administration) projected that China would emit 3,586 Tg of CO_2 in 2000,[8] but the actual emissions were 2.967 Tg[9], 17.3% lower than the value projected only two years in advance. In the subsequent years, China surprised the world again but in another direction. China's CO_2 emissions in

[6] National Bureau of Statistics of China, *China Statistical Yearbook*. Beijing, China: China Statistics Press, 2008.
[7] Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.
[8] EIA, "International Energy Outlook 1998," Washington, D.C. 1998.
[9] Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.

2006 were 103% higher than those in 2000 to reach 6,018 Tg[10], surpassing the reference scenario's expectation in the International Energy Outlook 2004 for the year of 2020 – 5,693 Tg.[11]

China was not less surprised. Though China did not make official projection on its CO_2 emissions, its goal of SO_2 emissions could act as a surrogate. For the 9th Five-Year Plan (1996-2000), China established a goal to control its SO_2 emissions in 2000 within 3.8% above those in 1995.[12] But the actual SO_2 emissions went down by 16%.[13] China's ambition for the 10th Five-Year Plan (2001-2005) grew into a 10% reduction goal of SO_2 emissions[14], but the actual emissions in 2005 exceeded by 28% of those in 2000.[15] Because China did not start large deployment of SO_2 scrubbers – a crucial technology to reduce SO_2 emissions at large point sources – until the 11th Five-Year Plan,[16] the goals for the 9th and 10th Five-Year Plans could partly reflect the corresponding baseline emission scenarios plus certain reduction efforts. Clearly, the evolution of China's SO_2 emissions went out of the expectation of China itself. Because of the close relationship between SO_2 and CO_2 emissions due to their common major sources in coal consumption, it is fair to say that China was surprised by its CO_2 emissions.

In other words, China experienced two abrupt changes in the past decade alone, and the most difficult part of prediction is abrupt changes. Neither the international institutions nor China itself foresaw the trend.

The abrupt change is even more obvious in comparison with other countries (Fig. 1). If the trend during 1980 – 1997 remained unchanged, China's CO_2 emissions would still significantly trail the U.S.' in 2006. The unexpected lower growth during 1998 – 2001 delayed China by about three to four years to catch up with the EU-15 (Fig. 1). But the later surprising comeback made China surpass the United States by at least a decade earlier (Fig. 1).

3. Projection of China's CO_2 Emissions

With active efforts in energy conservation, China has already reversed the increasing trend of energy intensity and achieved 10.1% reduction during 2006-2008.[17] CO_2 intensity should follow a similar trend. To project China's future baseline emissions, serious questions will be: whether another abrupt change is coming and whether China's CO_2 emissions trend can stabilize again? Or whether we can design a goal for China with a fairly good knowledge of its uncertainty?

Before approaching the questions, an analysis on the past projections is valuable. World Energy Outlook (WEO) of the International Energy Agency (IEA) and International

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[10] Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.

[11] EIA, "International Energy Outlook 2004," Washington, D.C. 2004.

[12] National Environmental Protection Administration (NEPA), National Planning Commission, and NETC, "The National 9th Five-Year Plan on controlling major pollutants' emissions," 1996.

[13] National Environmental Protection Administration (NEPA), National Planning Commission, and NETC, "The National 9th Five-Year Plan on controlling major pollutants' emissions," 1996.

State Environmental Protection Administration (SEPA), "National report on environmental statistics - 2000," Beijing, China 2001.

[14] SEPA, "National 10th five-year plan on environmental protection," China State Environmental Protection Administration, Beijing 2001.

[15] State Environmental Protection Administration (SEPA), "National report on environmental statistics - 2000," Beijing, China 2001.

SEPA, "National report on environmental statistics - 2005," Beijing, China 2006.

[16] Y. Xu, R. H. Williams, and R. H. Socolow, "China's Rapid Deployment of SO2 scrubbers," *Energy & Environmental Science*, pp. 459-465, 2009.

[17] J. Wen, "Government work report of 2009," 2009.

Energy Outlook (IEO) of the Energy Information Administration (EIA) make annual projection of CO_2 emissions for the world and major countries. The reference scenarios can be viewed as a projection following the present policy and technology path, as a result, the baseline emissions.

An immediate characteristic of Fig. 2 is that EIA and IEA's projections for the year of 2020 receive close influence from the trends proceeding the baseline years. For example, in WEO 2002 with the baseline year of 2000, IEA projected China's CO_2 emissions to reach 5,393 Tg in 2020 (Fig. 2). The equivalent growth rate in every five years would be 15.3%, corresponding to the actual 2.2% increase during 1996-2000. WEO 2008 changed the baseline year to 2006, which witnessed 93.6% growth of CO_2 emissions in the proceeding five years. Accordingly, the equivalent growth rate from the baseline year to 2020 was adjusted upward to 22.7% per five years. Furthermore, the more meaningful impact seen in Fig. 2 for designing China's future goal is the projected CO_2 emissions in 2020, which was 85% higher in WEO 2008 than that in WEO 2002. As a comparison, the difference of the two projected China's emissions for 2020 is equivalent to about 16% of the world's emissions in 2006 – 29,195 Tg.[18] EIA's projections had essentially the same impression. It is not difficult to imagine that China's CO_2 emissions goal for 2020 would differ much if it were negotiated in 2002 instead of 2008.

Another message from Fig. 2 is that neither the pleasing low nor the worrying high growth of CO_2 emissions respectively proceeding the years of 2000 and 2006 were believed to be sustainable. Instead, intermediate growth rates were taken. As illustrated above, though the growth rates went up sharply by 91.4% (from 2.2% to 93.6%) comparing the 5-yr periods ending in 2000 and 2006, the projected rates only increased by 7.3% (from 15.3% to 22.7%). Then the projection indicates another abrupt change somewhere in the near future to greatly decelerate China's recent rapid growth close to the 5-yr growth rate during 1981-1997 – 25.2%.[19] Such abrupt change is probable from the experience of Japan. During 1960-1973, Japan had a comparable growth of CO_2 emissions (Fig. 3) to China's during 2002-2006 (Fig. 4). Their CO_2 emissions intensity both went up (Fig. 3 & 4). Afterwards, Japan witnessed an abrupt change and its CO_2 emissions almost stabilized in absolute terms (Fig. 3).

If the coming of such an abrupt change is of less doubt, when and at what stabilized growth rates will be of great uncertainty. China could have been fundamentally changed and the past growth rates lost their value of reference. Even though China is working hard in energy conservation, a significantly faster baseline emission trend might still be unavoidable in the near future than that during 1980-1997. In another scenario, China could resemble Japan's path since 1990s (Fig. 3) and further decouple the growth of GDP and CO_2 emissions.

Intensity goals are a better choice facing abrupt changes like China's. CO_2 emissions intensity also had an abrupt change in 2002 from a continuous decrease to an increase inexperienced since 1980 (Fig. 4). But the abrupt change of CO_2 emissions during 1998-2001 was barely seen (Fig. 4). Furthermore, though we may also witness another abrupt change of CO_2 emissions intensity in the future, the uncertainty of its stabilized rates will be much smaller than that for CO_2 emissions, as demonstrated in Japan's case (Fig. 3). To recognize China's active efforts in energy conservation and renewable energies in the past several years, a baseline growth rate of 0% is a legitimate assumption for its CO_2 emissions intensity.

[18] Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.

[19] Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.

4. Cycles of China's CO_2 Emissions

Even if only considering the variability of China's CO_2 emissions over years, the goal scheme in the Kyoto Protocol is not appropriate. As displayed in Fig. 4, China's economy and CO_2 emissions have clear cycles. Even the two abrupt changes of CO_2 emissions did not break the 10-yr cycle period. Though the commitment period in the Kyoto Protocol (2008-2013) will likely fall into the decreasing branch of a cycle, a serious probability exists that the commitment period could lie on the peak or the trough of a cycle, which would present different baselines. If a negotiation on China's goal still focuses on CO_2 emissions, the stable cycle and its greater magnitude will disable the commitment period of five years. In order to smooth the peak and trough of a cycle, the commitment period should be last 10 years. Additional mechanism like "banking" can leave the optimization decision to China on allocating emission quota over those years.

In contrast, CO_2 emissions intensity did not show any significant cycle (Fig. 4). Such smoother change over years could facilitate the design of China's goal and the length of a commitment could be more flexible.

5. China's Application of Intensity Goals

Goals are important tools for the Chinese central government to communicate and implement its policies throughout the governmental system and the Chinese society. Five-Year Plans lie in the central stage. In the area of energy and the environment, both intensity goals and absolute goals have been applied.

In the National 11th Five-Year Plan (2006-2010), China enacted an intensity goal on energy conservation to reduce energy intensity (energy consumption per unit of GDP) by 20%.[20] The background was the increasing energy intensity during 2003-2005,[21] a brand-new experience for the Chinese government since the economic reform started. In the context, an intensity goal was favored to seriously work for energy conservation while not worrying too much about the uncertainty of economic growth.

Two goals on pollutant emissions also entered the National 11th Five-Year Plan: 10% reduction of SO_2 and COD (Chemical Oxygen Demand) emissions.[22] Though expressed in relative terms, these are absolute goals: as long as the emission levels in the anchor year (2005) are determined, an emission cap for the attainment year (2010) will be clearly defined. A similar goal of SO_2 emissions was also established for the 9th and 10th Five-Year Plans[23]. However, China's energy consumption growth decelerated in the 9th Five-Year Plan and accelerated in the 10th, which almost single-handedly decided the fates of the goals: a great success in the 9th and a colossal failure in the 10th. The history should have taught the Chinese government an important lesson in goal setting facing vast uncertainty.

On the other hand, in the 11th Five-Year Plan, the reduction of SO_2 emissions in the power sector follows an intensity goal based on grams of SO_2 emissions per kWh of electricity generated from coal power plants. China planned to bring down the intensity from

[20] National People's Congress, "The outline of the National 11th Five-Year Plan on economic and social development," The 4th Conference of the 10th National People's Congress, Beijing, China 2006.

[21] National Bureau of Statistics of China, *China Statistical Yearbook*. Beijing, China: China Statistics Press, 2008.

[22] National People's Congress, "The outline of the National 11th Five-Year Plan on economic and social development," The 4th Conference of the 10th National People's Congress, Beijing, China 2006.

[23] National Environmental Protection Administration (NEPA), National Planning Commission, and NETC, "The National 9th Five-Year Plan on controlling major pollutants' emissions," 1996.

SEPA, "National 10th five-year plan on environmental protection," China State Environmental Protection Administration, Beijing 2001.

6.4 grams/kWh in 2005 to 2.7 grams/kWh in 2010[24]. It disclosed the necessary ambition to achieve the 10% reduction of overall SO_2 emissions.

Though China has not yet declared any national goal on CO_2 emissions, a strong preference to intensity goals have been expressed. In a recent report, the Chinese Academy of Sciences – a key think tank for the Chinese government – advocated reducing China's CO_2 intensity (CO_2 emissions per unit of GDP) by 50% in 2020 from the level in 2005.[25] According to the former chairman of the Environmental and Resources Protection Committee of the National People's Congress, China is officially considering a CO_2 intensity goal in the 12th Five-Year Plan (2011-2015).[26]

To sum up, China has been educated the disadvantages of absolute goals. Intensity goals are gaining ground in energy conservation and CO_2 emissions.

6. Conclusion

China and the world are heading toward negotiating a new climate treaty in Copenhagen in the end of 2009. However, China's role has not been very clear, particularly between following the Kyoto Protocol without a legally binding goal and joining the industrialized countries to negotiate one. As the largest greenhouse gas emitter in the world, China's attitude and deed can greatly boost or compromise the success of the new treaty.

Though intensity goals have been suggested to better involve developing countries and accommodate economic growth, China's specific and somewhat uncommon characteristics have not been analyzed in detail to appreciate intensity goals more. This paper mainly focuses on the importance of predictability in designing a CO_2 goal, particularly concerning abrupt changes and cycles.

Abrupt changes make China's CO_2 emission unpredictable. Since 1998, China has experienced two abrupt changes. The first one was during 1998-2001 when the trend of CO_2 emissions bent downward significantly. Two important institutions – EIA and IEA – had their projected emissions seriously higher than the actual values. The second abrupt change was more worrying for the world, which led China's CO_2 emissions to almost double during 2002-2006. The projections had to be adjusted upward every year by a large margin to recognize the surge. Furthermore, because the growth rate of nearly doubling per five years is hardly sustainable, a slow-down or probably another abrupt change is expected. But when and at what level are unknown.

On the other hand, China's CO_2 emissions have the annual growth rates follow pretty stable cycles with the period of about 10 years. Though the magnitude was getting stronger in the recent decade, the periods can roughly represent a predictable part of China's CO_2 emissions.

Absolute goals behave very poorly facing abrupt changes, which raises significant concern over an expected one in the future. Abrupt changes can cause problems of "hot air" when actual CO_2 emissions are unexpectedly low, and excessive demand of CO_2 permits when CO_2 emissions are unexpectedly high. The five-year commitment period in the Kyoto Protocol added more risk to China because it does not overlap with China's stable cycles. Both factors suggest that the goal scheme in the Kyoto Protocol should not be followed for China.

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[24] National Development and Reform Commission (NDRC) and SEPA, "The 11th five-year plan on SO2 control in existing coal power plants," Beijing, China 2007.

[25] The research group on sustainable development strategy of the Chinese Academy of Sciences, "Report on China's Sustainable Development Strategy -- Probing a low-carbon path with Chinese characteristics," Beijing, China 2009.

[26] R. Mao, "Climate Change and Environmental Protection in China -- a speech to the Chinese Staff Association of the World Bank / International Monetary Fund," Washington, D.C. March 9, 2009.

Intensity goals can much better address the two factors. An abrupt change of CO_2 emissions growth rates in the future is less likely to sway CO_2 emissions intensity significantly away from its trend. This paper recommends adopting a 0% change as the baseline to design China's intensity goals. In addition, China's CO_2 emissions intensity did not display any notable cycles in the annual change rates. No restriction, as a result, is necessary to synchronize the length of a commitment period with the cycles.

China experienced great uncertainty in its SO_2 emissions goals in the 9th and 10th Five-Year Plans. Such uncertainty discouraged real efforts of pollutant mitigation. In the 11th Five-Year Plan (2006-2010), China has adopted intensity goals domestically in energy conservation. SO_2 emissions control in the power sector also applied another type of intensity goals based on electricity generated. A CO_2 intensity goal is incubating in China too, which could be written into the 12th Five-Year Plan. All these makes a legally binding goal built on CO_2 emissions intensity more acceptable to China in the Copenhagen negotiation.

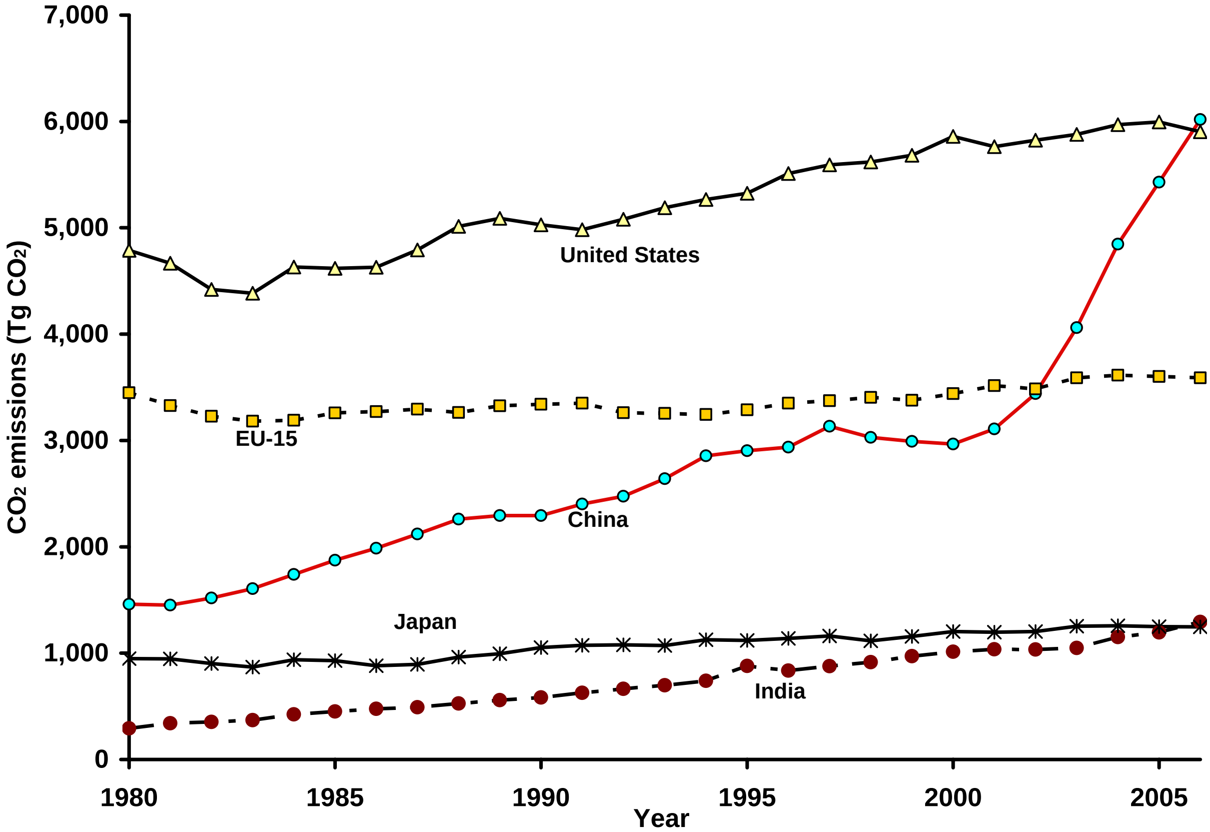

Fig. 1 CO2 emissions from selected countries
Source: Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.

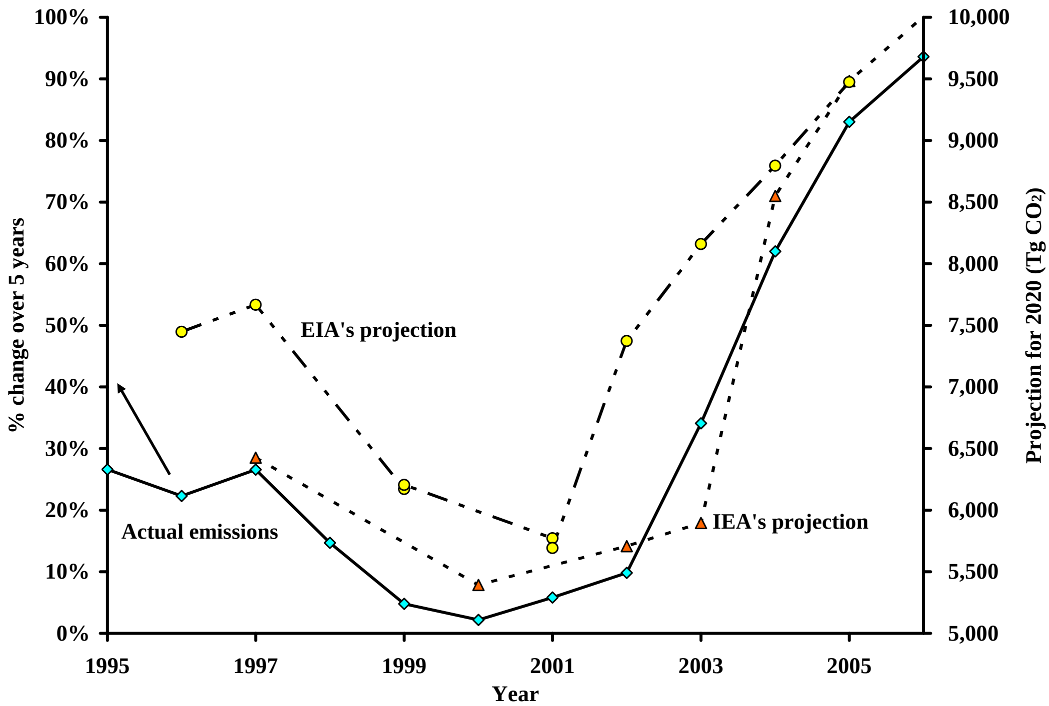

Fig. 2 China's 5-yr growth rates of actual CO2 emissions (the solid line, left y-axis; x-axis indicating the ending years of the 5-yr periods) and projected emissions for 2020 in reference scenarios (right y-axis; x-axis referring to the baseline years used for respective projections) [1, 18, 19]
Source: Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.
EIA, "International Energy Outlook," Washington, D.C. 2000--2008.
IEA, *World Energy Outlook*. Paris, France, 2000--2008.

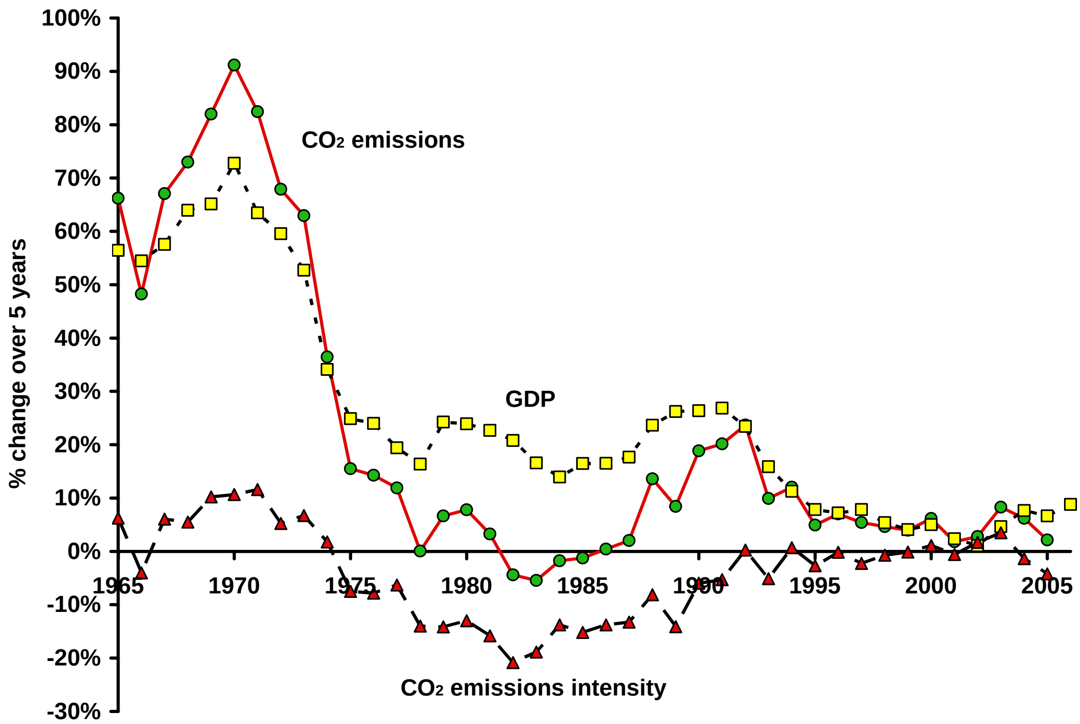

Fig. 3 Japanese 5-yr growth rates of CO_2 emissions, GDP and CO_2 emissions intensity
Source: Carbon Dioxide Information Analysis Center, "Top 20 Emitting Countries by Total Fossil-Fuel CO2 Emissions for 2006," 2009.
World Resources Institute (WRI), "EarthTrends -- the environmental information portal," 2008.

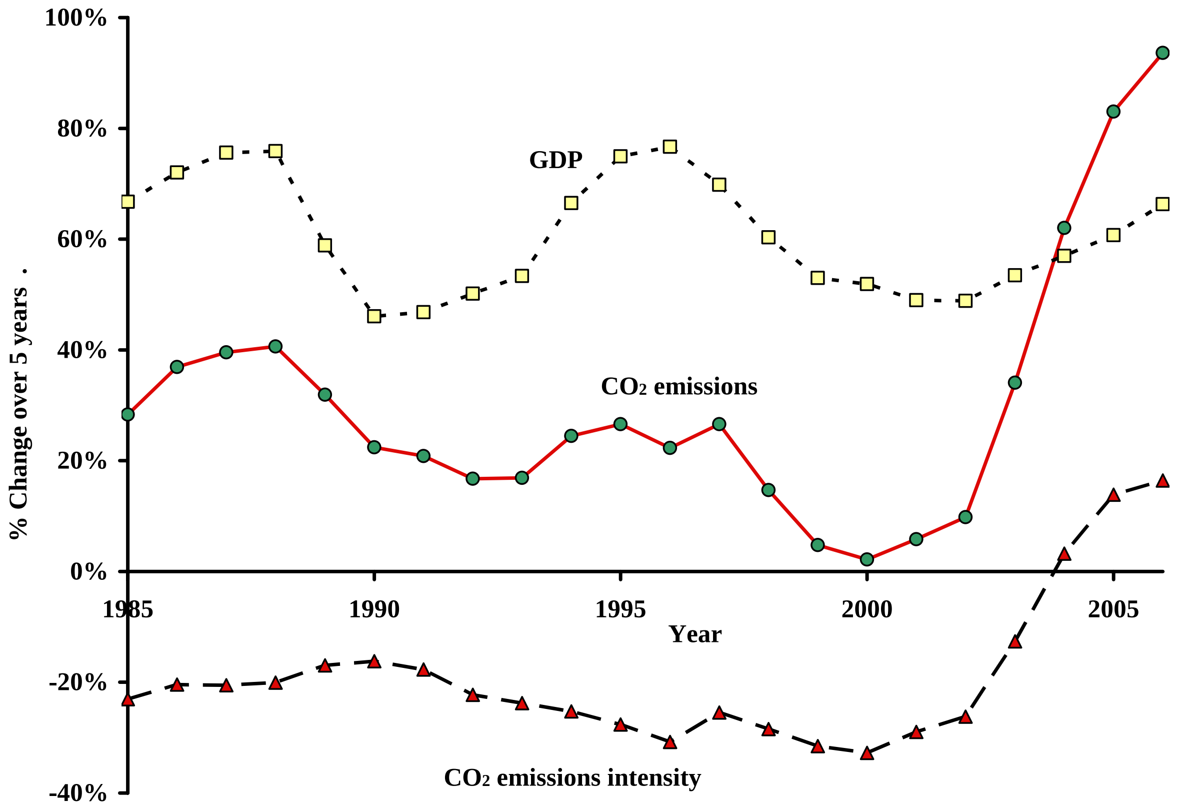

Fig. 4 China's 5-yr growth rates of CO_2 emissions, GDP and CO_2 emissions intensity

Source: Energy Information Administration (EIA), "Official Energy Statistics from the U.S. Government," Washington, D.C. 2008.

National Bureau of Statistics of China, *China Statistical Yearbook*. Beijing, China: China Statistics Press, 2008.

Climate Change in Hong Kong:
Observations and Projections

E W L Ginn, T C Lee and K Y Chan[1]

Abstract

The Hong Kong Observatory has been making meteorological observations at its headquarters in Tsim Sha Tsui since 1884. Analysis of the extensive past records reveals that the temperature rise in Hong Kong during the past 125 years is in accord with the global rising trend. In last few decades anthropogenic influences, especially urbanization, have contributed significantly to the accelerated rising trend. A similar increasing trend is also observed for rainfall but the trend after 1947 is not statistically significant. Other observations such as increasing cloud amounts, decreasing total global solar radiation and rising sea level are all consistent with the global trend. Studies of past occurrences of extreme temperature and rainfall have recently been carried out. It is observed that cold episodes have become rarer while very hot days and heavy rain events are becoming more frequent. The corresponding return periods of heavy rain and very hot days are decreasing while those of very cold days are increasing. The Observatory also makes use of the data from the latest assessment report of the Intergovernmental Panel on Climate Change and employs statistical downscaling techniques to carry out projections of temperature and precipitation in the 21st century. In gist, the findings are that the rise in temperature will be slightly higher than the global mean in the 21st century. There will also be a significant decrease in the number of cold days and an increase in the number of very hot days and hot nights. The annual rainfall in Hong Kong is also expected to rise by the end of the 21st century, so is the year-to-year variability.

1. Introduction

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) states that warming of the climate system is unequivocal. There are evidences of increasing global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea level. Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Besides the shifting of the mean climate, global warming may also alter the frequency and intensity of extreme weather events (such as heavy rain, drought, heat waves, cold spells, etc.) in some regions, leading to significant socio-economical impacts (IPCC, 2007: 2-17).

For the Guangdong province in southern China, under the background of global climate change, there was an increase in the average temperature in the last 50 years and flooding and droughts have also become more frequent (Guangdong Meteorological Bureau, 2007; Chen *et al*, 2007). Significant changes in the climate were also observed in Hong Kong over the last century (Leung *et al*, 2004), including the increase in average temperatures and total rainfall, the decrease in total global solar radiation and the rise of sea level. Apart from global warming, these changes in the climate of Hong Kong could also be partly attributed to the rapid urbanization and increase in population in the past half century (Lam, 2006, Wu *et al*, 2008).

In this paper, the observed changes in different meteorological elements of Hong Kong are reviewed and updated in Section 2. The future projections of the temperatures and

[1] Hong Kong Observatory, email: eginn@hko.gov.hk.

rainfall in Hong Kong in the 21st century using the latest available IPCC model data are presented in Section 3. Section 4 contains a summary of the conclusions. For the trend analysis discussed in this paper, the two tailed t-test was applied to test the statistical significance of the trends at 5% significance level (Karl et al., 1993; Easterling et al., 1997; Storch and Zwiers, 1999).

2. Observed Climate Changes in Hong Kong

2.1. Temperature

At the Hong Kong Observatory Headquarters, temperature readings are available since 1885, apart from a break during the World War II from 1940 to 1946. Analysis of the annual mean temperature data showed that there was an average rise of 0.12°C per decade from 1885 to 2008 (Figure 1). The rate of increase in average temperature became faster in the latter half of the 20th century. In post-war years from 1947 to 2008, the average rise amounted to 0.16°C per decade, accelerating to 0.27°C per decade during 1979-2008. Such an increasing trend is in line with that observed for southern China in the last 50 years, about 0.21°C per decade (Guangdong Meteorological Bureau, 2007). 1998 is the year with the highest global mean surface temperature since 1850 and among the 10 warmest years, all occurred after 1990 (WMO, 2009). For Hong Kong, 1998 is also the year with the highest mean temperature and 9 out of the 10 warmest years occurred after 1990.

Apart from the effect of global warming, the rise in the temperature at the Hong Kong Observatory Headquarters could also be attributed partly to the rapid urbanization in recent decades. The Hong Kong Observatory Headquarters is located at the heart of urban Kowloon. Buildings and other concrete surfaces in the urban areas retain the heat produced by incoming solar radiation during daytime and release the heat in the form of long-wave radiation at night. High-rise buildings also block the sky view and inhibit the transfer of long-wave radiation to the atmosphere (Kalande and Oke, 1980; Oke,1982; Grimmond, 2007; Wu *et al*, 2008). This results in a slower fall of temperatures at night and a higher minimum temperature than when buildings are absent. Moreover, the anthropogenic heat emission by buildings, air conditioning, transportation and industries also contribute to the rise in urban temperatures. Comparing the temperature rising trend between the Observatory Headquarters and Ta Kwu Ling, a rural station in the northern part of Hong Kong, urbanization is perhaps the major contributor to the accelerated temperature rising trend at the Observatory in the last two decades.

Research indicates that the urbanization effect affects the daily minimum temperature more than the daily maximum temperature (Karl *et al.*, 1993, Zhou *et al*, 2004). In Hong Kong, the mean daily minimum temperature at the HKO Headquarters has been rising steadily throughout recent years (Figure 2). This resulted in an increasing trend in the number of hot nights (daily minimum temperature ≧28.0°C) and a decreasing trend in the number of cold days (daily minimum temperature ≦ 12.0°C). The daily maximum temperature has also been rising but the trend was not significant. It is also interesting to note that the rate of increase in the mean minimum temperature in the post-war years was largest in winter, followed by autumn, spring and then summer (Figures 3(a)-3(d)).

2.2. Rainfall

The annual rainfall recorded at the Hong Kong Observatory from 1885 to 2008 also showed a long term increasing trend, at a rate of about 25mm per decade but the trend after 1947 is not statistically significant. This annual rainfall rising trend was small when compared to the year-to-year fluctuations. The strength of El-Nino Southern Oscillation (ENSO) and the winter monsoon in the preceding winter were important factors affecting the interannual variability of the rainfall (Chang and Yeung, 2003). There were also discernable inter-decadal changes.

Recent studies on regional variation of rainfall trends in Hong Kong during the last 50 years (Sun and Evans, 2002; Mok *et al*, 2006) have found that the apparent increases in annual rainfall were concentrated in the central part of Hong Kong. The rate was higher over the urban areas than those of the New Territories, offshore islands and high grounds. It was postulated that these differential increases were unlikely to be a direct result of global climate change but might be due to the effects of urbanization. The higher temperature in urban areas provides a convective background while the increase in concentration of aerosols from urban activities also favours the formation and development of rain-bearing clouds. Chow (1986) also found that rainfall recorded during the rainy season of Shanghai was increasing faster in urban areas compared to rural areas.

2.3. Wind speed

Dense developments in the urban area increase the roughness of the surface underlying the atmosphere and exert a drag on the low-level air flow. The tendency therefore is for wind speed near the ground decreasing in the long run. Figure 4 shows the time series of wind speed between 1968 and 2008 measured at King's Park at the heart of the urban area and Waglan Island, a remote offshore island in the southeastern flank of Hong Kong. For technical reasons and in order to compare like with like, the data points represent the annual average of 10-minute wind speed readings taken twice daily, at 8 a.m. and 8 p.m. Hong Kong time.

Since Waglan Island is positioned well away from anthropogenic influences, the wind observations there are indicative of the background climate without the impact of urbanization. No significant long-term trend in the wind speed could be detected at Waglan Island. However, at King's Park which is situated on a knoll surrounded by dense built-up areas of nearby Yaumatei, Mongkok, and Homantin, there has been a steady decrease in the wind speed.

Since the anemometer at King's Park meteorological station was re-located to another location with a higher elevation in the station compound in 1996, two segments of the time series are shown in the figure for wind speeds of King's Park. Despite the relocation, the sustained decrease in wind speed remains evident. It is clear that urbanization in the broad vicinity of King's Park has reduced the wind speed in the boundary layer of the atmosphere around the station.

2.4. Cloud Amount, Solar Radiation and Evaporation

An increase in cloud amount can cause a decrease in diurnal temperature range by reducing the incoming solar radiation during day time and trapping of long-wave radiation at night. The diurnal temperature range has decreased since the 1950s worldwide and the coincidental increases in total cloud cover are often cited as a likely cause for the observed decrease in diurnal temperature range (Leung *et al.* 2004). In Hong Kong, cloud amount is reported in oktas hourly by trained observers at the Hong Kong Observatory Headquarters. The daily mean cloud amount is taken as the average value of the observed hourly cloud amount in a day. Based on these daily mean cloud amounts, annual mean values were calculated. Regression result indicates that the annual mean cloud amount has been increasing at a rate of 1.2% per decade in the period 1961 to 2008 (Figure 5). One potential cause for the increase in cloud amount over Hong Kong could be the likely increase in the concentration of condensation nuclei in the air that favoured the formation of clouds, which is known to be associated with urbanization and human activities in the region.

Both the increase in the concentration of suspended particulates and the increase in cloud amount would reduce the amount of solar radiation reaching the surface. At King's Park, the amount of solar radiation reaching Hong Kong is recorded continuously by thermo-electric pyranometers. Between 1964 and 2008, there has been a clear, broad falling trend. For the whole period, regression result indicates that the annual mean daily global solar radiation decreased at a linear rate of 0.74 MJm^{-2} per decade (Figure 6).

Evaporation measurements are made daily at King’s Park using evaporation pans with evaporation surface 0.18 m above ground. In general, the amount of evaporation depends on the amount of solar radiation received, the relative humidity as well as the wind speed. Accompanying the decrease in solar radiation and wind speed, the annual total evaporation recorded at King’s Park also decreased at a rate of 142mm per decade, according to a regression fit for the period from 1961 to 2008 (Figure 7).

2.5. Visibility

One visible aspect of climate change in Hong Kong is the turbidity in the sky which the local public and visitors are increasingly concerned about. Particulates suspended in the atmosphere are the primary cause for the reduction in the visibility. Suspended particulates in the atmosphere normally consist of a mixture of sulphates, nitrates, carbonaceous particles, sea salt and mineral dusts. They may be purely dust and natural (e.g. loess from northern China). They could also be anthropogenic particulates formed from combustion products (e.g. vehicle exhaust, power generation and various domestic activities) through photochemical processes.

The number of hours of reduced visibility below 8 km observed at the Hong Kong Observatory Headquarters each year was counted, with cases of visibility impairment that was concurrent with reports of fog, mist and rain or associated with high relative humidity (95% or more) excluded. The visibility observed at the Hong Kong Observatory Headquarters from 1968 to 2008 has a deteriorating trend (Figure 8). There is a rising trend between 1968 and 1987 of +53 hours per decade but the trend is not statistically significant. From then onwards, there has been a dramatic rise in the frequency of reduced visibility. The occurrence of reduced visibility has increased to a rate of about +554 hours per decade during the period 1988 to 2008, a tenfold increase compared to the previous figure.

2.6. Sea Level Rise

On decadal and longer time scales, global sea level changes is due to two major processes, mostly related to recent climate change that alter the volume of water in the global ocean. The first is the thermal expansion of water in a warming climate, and the addition of water from land reservoirs such as melting glacier and ice sheets. In Hong Kong, the tide gauge station at North Point during 1954-1985, followed by a replacement station nearby at Quarry Bay, since 1986 have recorded the sea level of the Victoria Harbour for more than 50 years. As shown in Figure 9, the mean sea level in the Victoria Harbour has risen at an average rate of 2.4mm per year during the period 1954 to 2008 which is similar to the sea-level variations at other tide gauge stations in the South China Sea (Ding *et al*, 2004).

2.7. Severe Weather Events

2.7.1. Heavy Rain and Thunderstorms

The frequency of occurrence of heavy rain events has increased slightly after the World War II. The annual number of heavy rain days (days with hourly rainfall greater than 30 mm) increased at a rate of 0.45 days per decade from 1947 to 2008 (Figure 10).

In Hong Kong, thunderstorms commonly occur between April and September. Thunderstorms are reported by observers at the Hong Kong Observatory Headquarters. The number of days with thunderstorms reported each year was examined. The annual number of days with thunderstorms showed an increasing trend of about 1.9 days per decade during the period 1947 to 2008 (Figure 11), in line with that for heavy rain days. Urbanization effect might have been a cause for the increase in thunderstorm days. The additional heating could have helped to trigger the formation of deep convection (Dixon and Mote, 2003).

2.7.2. Tropical Cyclones

In western North Pacific and the South China Sea (area 0-45^{o}N, 100-180^{o}E), the total number of tropical cyclones decreased from about 35 in the 1960s to about 27 after 2000. Closer to Hong Kong, the annual number of tropical cyclones making landfall along the south China coast within 300 km of the Observatory Headquarters in the past 40 years or so (1961–2008) has decreased from about 3 tropical cyclones in the 1960s to about 2.5 between 1990 and 2008, but the rate of change is not statistically significant (Figure 12). The number of typhoons, i.e. tropical cyclones with a maximum sustained surface winds of 118 kilometers per hour (32.7 meters per second) or more near its centre, landfalling within 300 kilometers of Hong Kong remained unchanged at around one typhoon per year during the period 1961-2008.

On the inter-annual time scale, the most prominent influence on tropical cyclone activity is that due to the most predominant 3 to 4 year cycle associated with El Nino and La Nina events (Wang and Li, 2007). Generally speaking, the number of tropical cyclones affecting Hong Kong is fewer in El Nino years than La Nina years. The reasons for fewer tropical cyclones to affect the south China coast in El Nino years especially in late typhoon season (September to November) are an eastward shift in the mean tropical cyclone genesis positions in these years, and a weaker than normal subtropical ridge over the western North Pacific which steers tropical cyclones more to the northwest than to the west away from the South China Sea (Leung and Leung, 2002; Wu *et al.*, 2003).

2.7.3. Extreme Temperatures and Rainfall

In a recent study (Wong *et al.* 2009) past trends of the occurrences of extreme temperature and rainfall events in Hong Kong from 1885 to 2008 were examined using extreme indices including both local indices and a subset of the extreme indices developed by the Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI) and relevant to Hong Kong. Results showed that the extreme daily minimum and maximum temperatures as well as the warm spell duration index in Hong Kong exhibited statistically significant long term rising trends while the cold spell duration index had a statistically significant decreasing trend. The annual highest temperature and lowest temperature had statistically significant rising trend at a rate of about 0.1^{o}C per decade.

Regarding rainfall, the frequency of occurrence of extreme hourly, 2-hourly and 3-hourly rainfall amounts increased significantly. The annual total precipitation due to events exceeding the daily 95th percentile of the climatological normal (1971-2000) increased by 22.4 mm per decade in the same period, indicating that the contribution of heavy rain to the annual rainfall amount was increasing with time (Figure 13). On the other hand, the maximum length of dry spell in the summer months from April to September increased at a rate of 0.3 days per decade from 1885 to 2008.

Moreover, in a study by Wong and Mok (2009), the analysis of the long term trends of the variation of probability of occurrence of extreme weather events using the time-dependent Generalized Extreme Value (GEV) distribution method (Coles, 2001; Kharin and Zwiers 2005; Feng et al 2007) showed that the return period for a minimum temperature

4oC had dramatically lengthened from 6 years in 1900 to 163 years in 2000. On the other hand, the return periods for a maximum temperature 35oC shortened significantly from 32 years in 1900 to 4.5 years in 2000. The return periods for 1, 2 and 3-hourly rainfall has decreased significantly from 1885 to 2008. The return period for 1-hourly rainfall 100 mm had shortened from 37 years in 1900 to 18 years in 2000.

3. Future Projections

The study of temperature and rainfall projections for Hong Kong by the Hong Kong Observatory utilized the results of the global climate model projections included in IPCC's assessment reports. These projections are simulated using global climate models under different greenhouse gas (GHG) emission scenarios (Nakicenovic *et al.*, 2000). The GHG emission scenarios used in the computer simulations reflect the various assumptions made by experts on the future population, economy, technology, energy and land use patterns of the world. They range from sustainable scenarios involving reductions in GHG emissions to rapid economic growth and fossil fuel intensive scenarios. Projections of the temperature trends and rainfall changes in Hong Kong in the 21^{st} century are made using the results of the global climate models simulations together with observed temperatures and rainfall in Hong Kong and southern China through statistical downscaling techniques.

3.1. Temperature Projection

As urbanization is an additional important contributor to the rising temperature of cities, the temperature projection also takes into account the urbanization effect in Hong Kong (Leung et al, 2007). In the lower-bound situation, the level of urbanization is frozen at the current level; in the upper-bound situation, urbanization effect grows at a constant rate based the historical trend in the last century. Together with the GHG emission scenarios, three sets of results are presented and labeled as:

(a) "middle-of-the-road" - average of the scenarios as well as of the two situations regarding urbanization;
(b) "low-end" - low emission scenario and urbanization frozen at the current level;
(c) "high-end" - high emission scenario and continued urbanization.

It is expected that the average annual temperature of Hong Kong will continue to rise in the 21^{st} century. Against the 1980-1999 average of 23.1^{o}C, the annual mean temperature in Hong Kong in the decade 2090-2099 is expected to rise by 4.8^{o}C according to the middle-of-the-road projection. The corresponding low-end and high-end values are 3.0 and 6.8^{o}C respectively (Figure 14). This is slightly higher than the projected rise in global mean temperature in 2090-2099 (likely range from 1.8 to 4.0^{o}C) as estimated in the Fourth Assessment Report of IPCC (IPCC, 2007: 2-17).

As for extreme weather, the study shows that the annual number of hot nights (days with a minimum temperature of 28 ^{o}C or above) and very hot days (days with a maximum temperature of 33^{o}C or above) in summer will increase. On the other hand, the annual number of cold days in winter (days with a minimum temperature of 12 ^{o}C or below) will continue to drop. The annual number of hot nights in summer is expected to increase from an average of 15 nights in 1980-1999 to 41 nights in 2090-2099 (middle-of-the-road projection). The corresponding low-end and high-end estimates are 30 and 54 nights respectively.

The annual number of very hot days in summer is expected to increase from the 1980-1999 average of 7 days to 15 days in 2090-2099 (middle-of-the-road projection). The corresponding low-end and high-end estimates are 12 and 19 days respectively. The average annual number of cold days in winter is expected to drop below one by the decade 2030-39 (middle-of-the-road projection). The corresponding low-end and high-end estimates are 2040-2049 and 2020-2029 respectively. The average annual number of cold days at the end of the last century (1980-1999) was 14 days.

3.2. Rainfall Projections

Under the influence of global climate change, the average annual rainfall in Hong Kong will increase during the latter half of the 21st century (Lee *et al*, 2009). The projected negative rainfall anomaly in Hong Kong before the 2040s (Figure 15) may, to a certain extent, reflect a possible decadal change in the rainfall of Hong Kong. This is consistent with past trend (Figure 16, 1950-2008) and captured by the model projections (Figure 15, 2010-2039) Model simulations also suggest that this could possibly be the result of a stronger than normal sub-tropical ridge during the rainy season of dry years within this period. Figure 17 shows an example of the stronger than normal sub-tropical ridge at 500 hPa level in 2018, a year with below normal annual rainfall as simulated by the Geophysical Fluid Dynamics Laboratory GFCM20 model.

The second half of the ensemble mean projections, commencing 2040 till the end of the century, are likely to be dominated by global warming with more moisture available in the troposphere as a result large scale warming, which tends to enhance precipitation. The steadily increase in positive rainfall anomaly over southern China in the latter part of the 21st century could be due to the combined effect of the strengthening of the East Asian Summer Monsoon and the increase in the low level moisture supply (Figure 18).

It is expected that, in the last 10 years of this century (2090-2099), the average annual rainfall recorded at the Hong Kong Observatory Headquarters will reach 2572 mm, 248 mm (11%) higher than the 1980-1999 average of 2324 mm (Figure 15).

Apart from the increase in the average annual rainfall in the latter half of the 21st century, the year-to-year variability in rainfall would also increase. The number of extremely wet years will increase significantly from 2 during the period 1885-2000 to 10 in the 21st century (2001-2100) and the corresponding figure for extremely dry year is also expected to increase from 2 to 4. Here, the extremely wet and extremely dry year refer to a year with the annual rainfall at the Hong Kong Observatory Headquarters above 3187 mm and below 1282 mm respectively.

In the 21st century, the number of days with heavy rain is also likely to increase. During the last 30 years of this century, that is 2070-2099, the average number of days in a year with hourly rainfall at the Hong Kong Observatory Headquarters exceeding 30 mm would be about 6.5 days, about 1 day more than the 1980-1999 average of 5.8 days.

3.3. Mean Sea Level

According to IPCC AR4, the projected sea level rise in the South China Sea including Hong Kong is likely to be similar to the global average by the end of the 21st century. The report projects a total sea level rise of 18 cm to 59 cm (Figure 19) for the region.

4. Conclusions

The analysis of temperature records shows that Hong Kong has been warming up during the past 124 years (1885-2008), in line with the global warming trend. This is also consistent with the warming trend in southern China in the past 50 years. The warming trend in Hong Kong can be attributed to the global warming and local urbanization. The reduction in visibility, increase in cloud amount, decrease in global solar radiation, reduction of urban wind speed in Hong Kong might also be related to high density urban development. Also, the annual rainfall and the frequency of occurrence of heavy rain events have increased during the period 1885-2008 whereas the number of tropical cyclones affecting Hong Kong has slightly decreased during the period 1961 to 2008.

The projections of temperature and rainfall in the 21st century reveal that the average temperature in Hong Kong will continue to rise in the 21st century. There will also be a significant decrease in the number of cold days and an increase in the number of very hot days and hot nights. The annual rainfall in Hong Kong is also expected to rise by the end of the 21st century and the year-to-year rainfall variability would increase with more extremely wet and dry years.

Engineers, town planners and other users are interested in frequency of occurrence of extreme events and future changes in return periods of various extreme events. The Observatory will embark on follow-up studies on the frequency of occurrence of extreme events in Hong Kong in the 21st century using IPCC AR4 high temporal resolution projection data and also making use of data to be available for the IPCC 5th Assessment Report (AR5) to update the projections for Hong Kong.

Acknowledgement

The authors would like to thank Dr B Y Lee and Dr M C Wong for their constructive comments, and to Dr W T Wong for his inputs on the observed and projected mean sea level changes.

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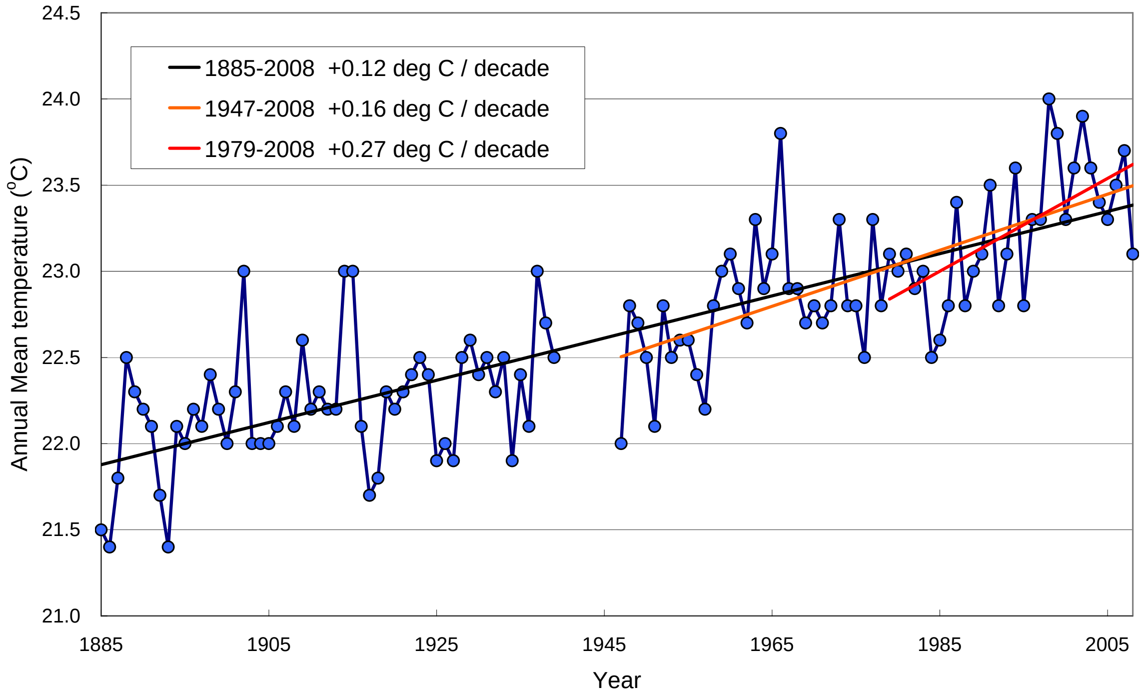

Figure 1 Annual mean temperature recorded at the Hong Kong Observatory Headquarters (1885-2008). Data are not available from 1940 to 1946.

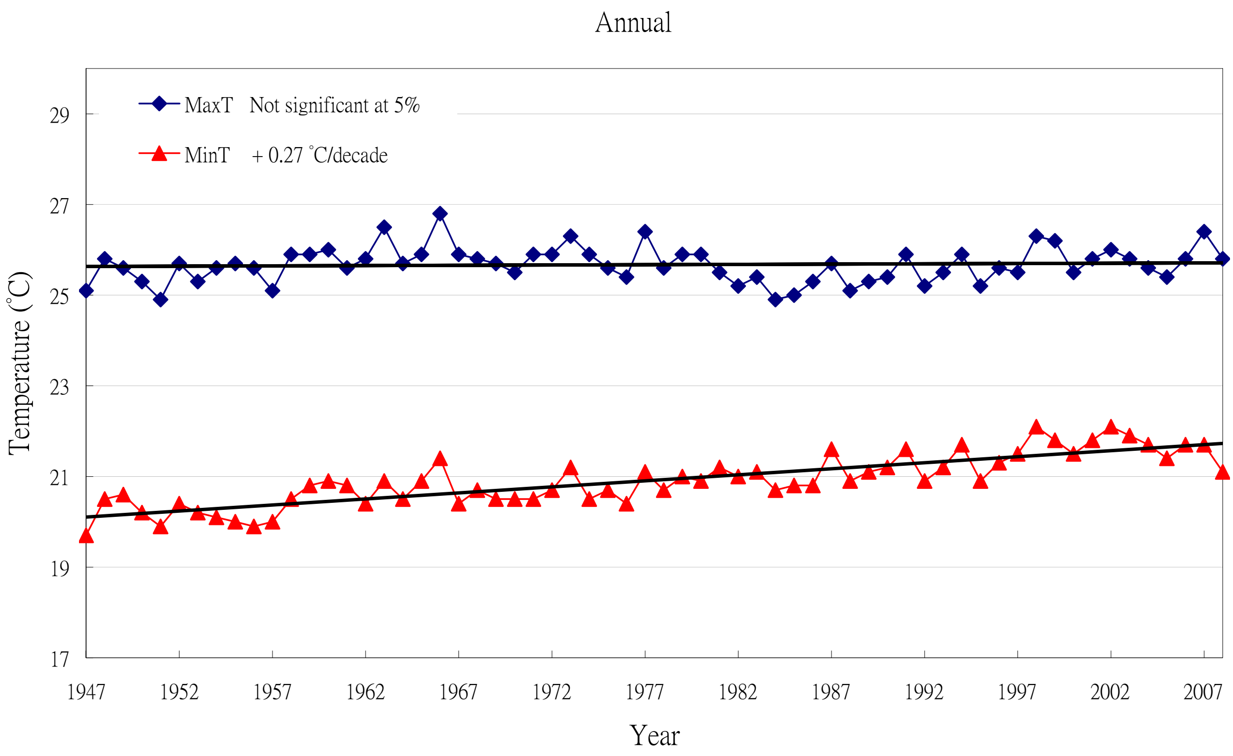

Figure 2 Annual mean daily maximum and minimum recorded at the Hong Kong Observatory Headquarters (1947-2008).

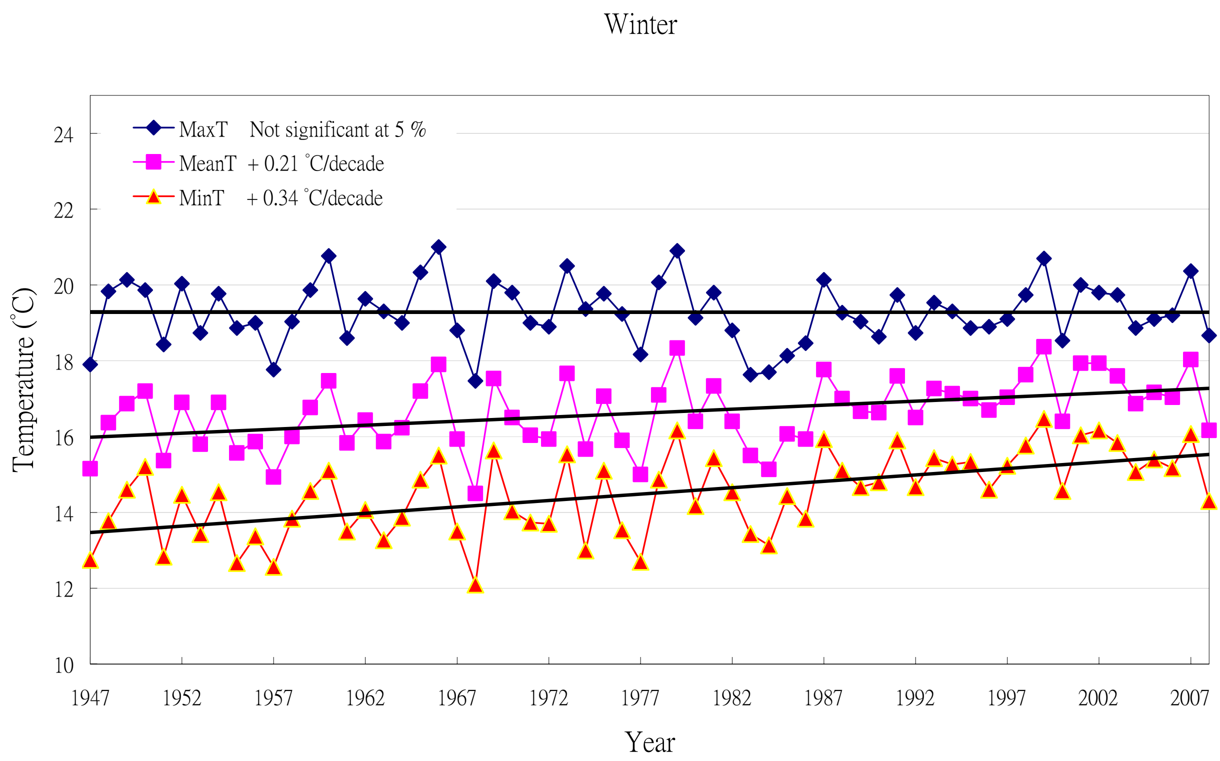

Figure 3(a) Mean maximum, mean and mean minimum temperatures recorded at the Hong Kong Observatory Headquarters in winter (December to February) from 1947 to 2008.

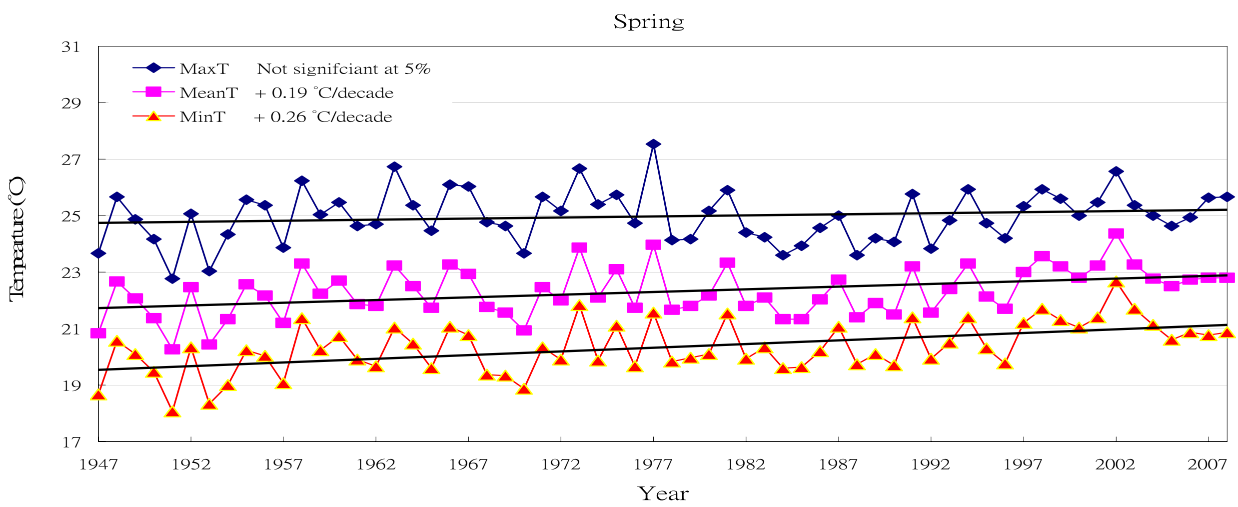

Figure 3(b) Mean maximum, mean and mean minimum temperatures recorded at the Hong Kong Observatory Headquarters in spring (March to May) from 1947 to 2008.

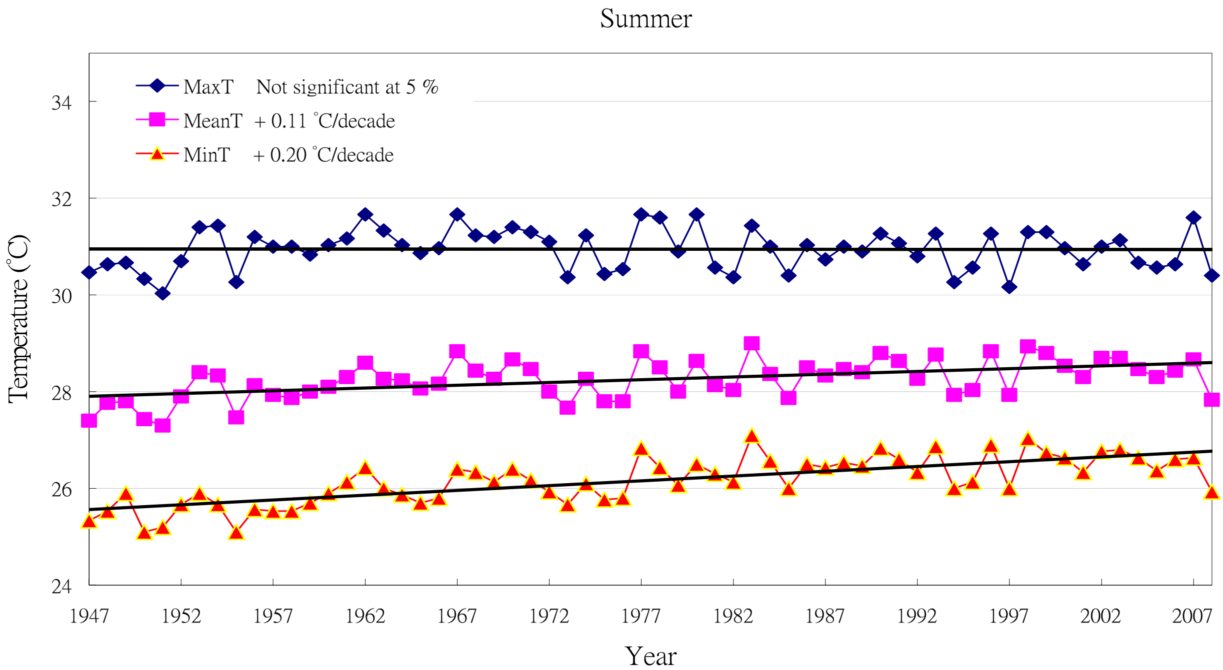

Figure 3(c) Mean maximum, mean and mean minimum temperatures recorded at the Hong Kong Observatory Headquarters in summer (June to August) from 1947 to 2008.

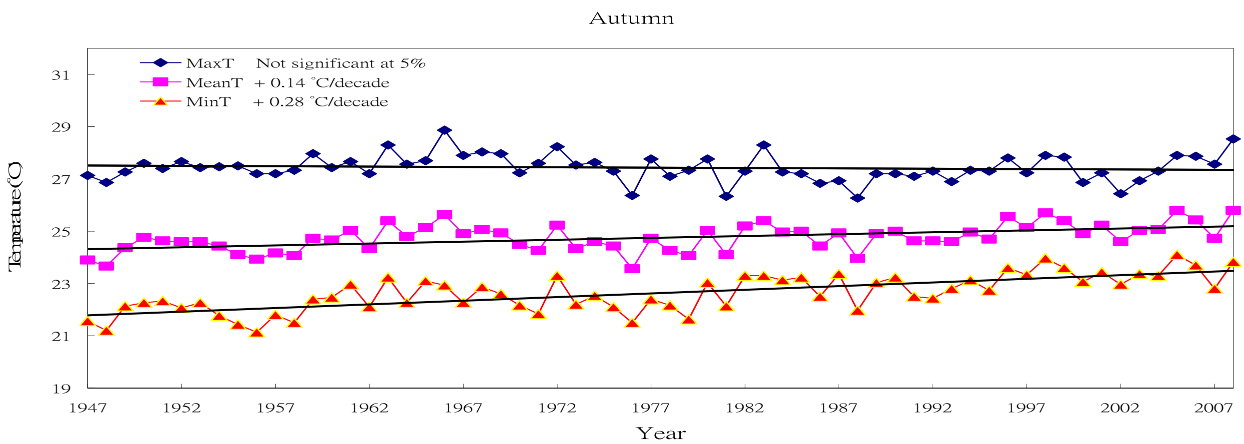

Figure 3(d) Mean maximum, mean and mean minimum temperatures recorded at the Hong Kong Observatory Headquarters in autumn (September to November) from 1947 to 2008.

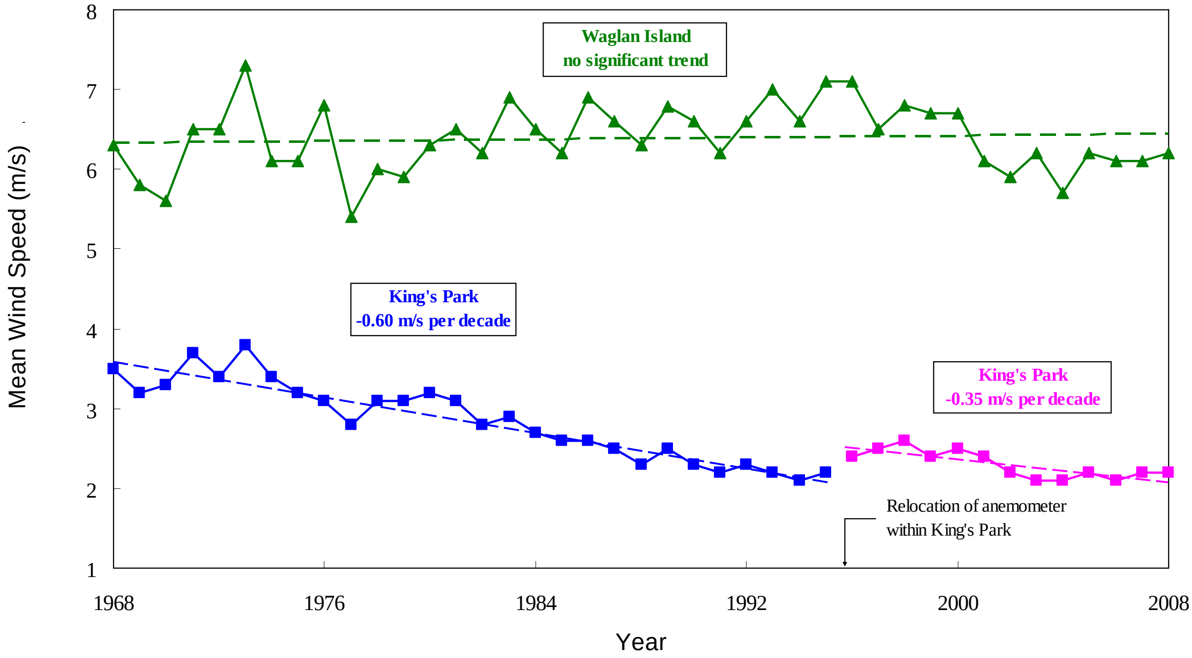

Figure 4 Annual average of 12-hourly 10-minute mean wind speed of King's Park and Waglan Island from 1968 to 2008.

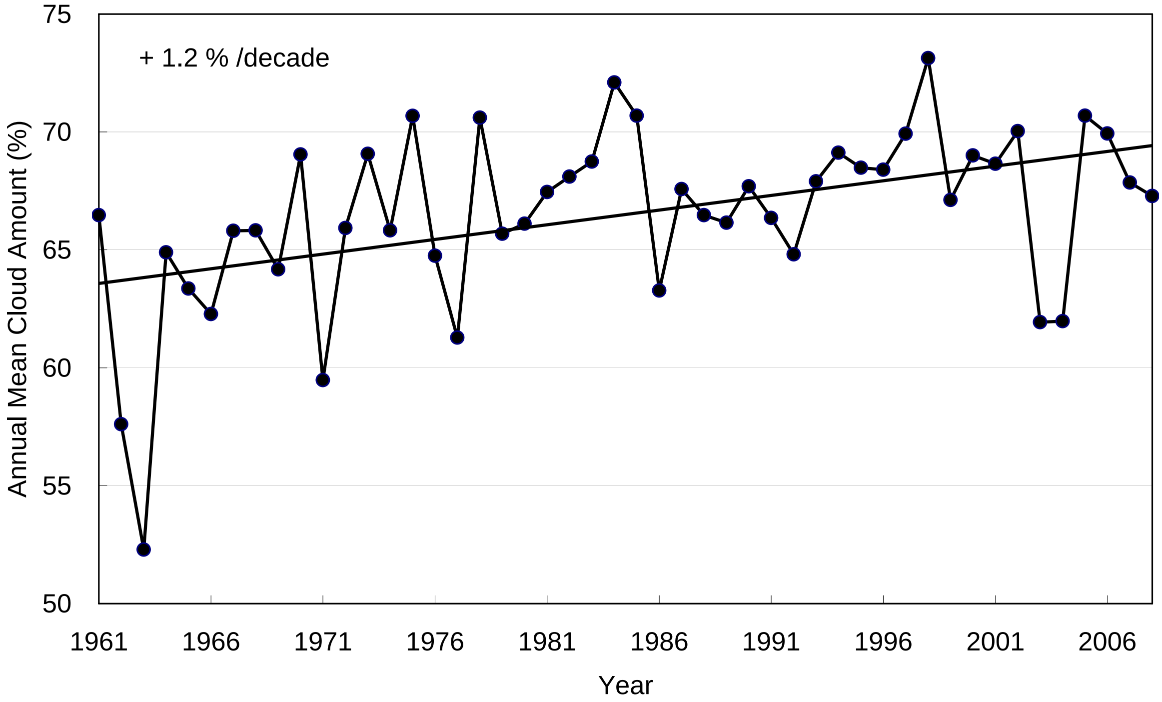

Figure 5 Annual mean cloud amount in Hong Kong from 1961 to 2008.

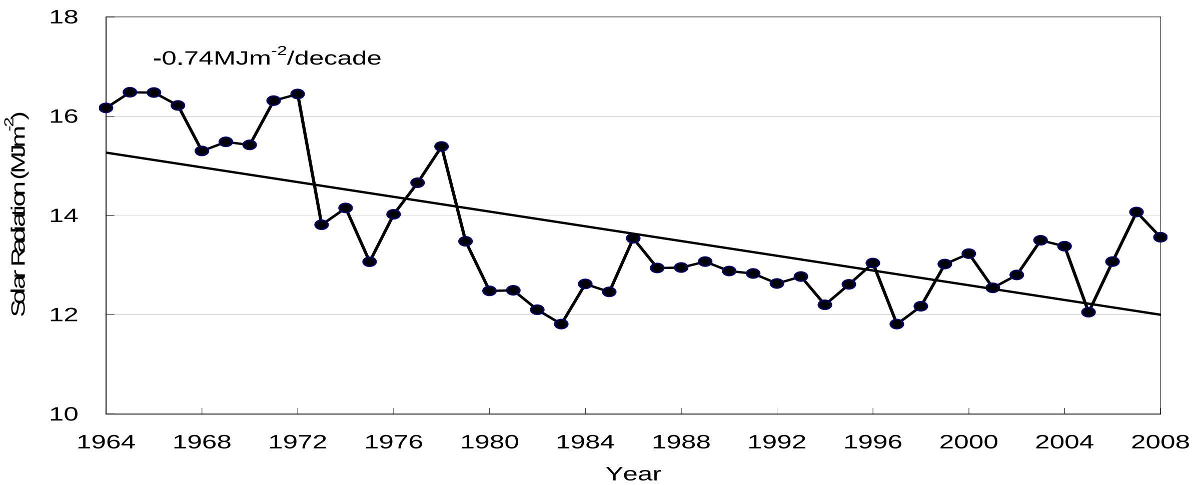

Figure 6 Annual mean daily global solar radiation recorded at King's Park from 1964 to 2008.

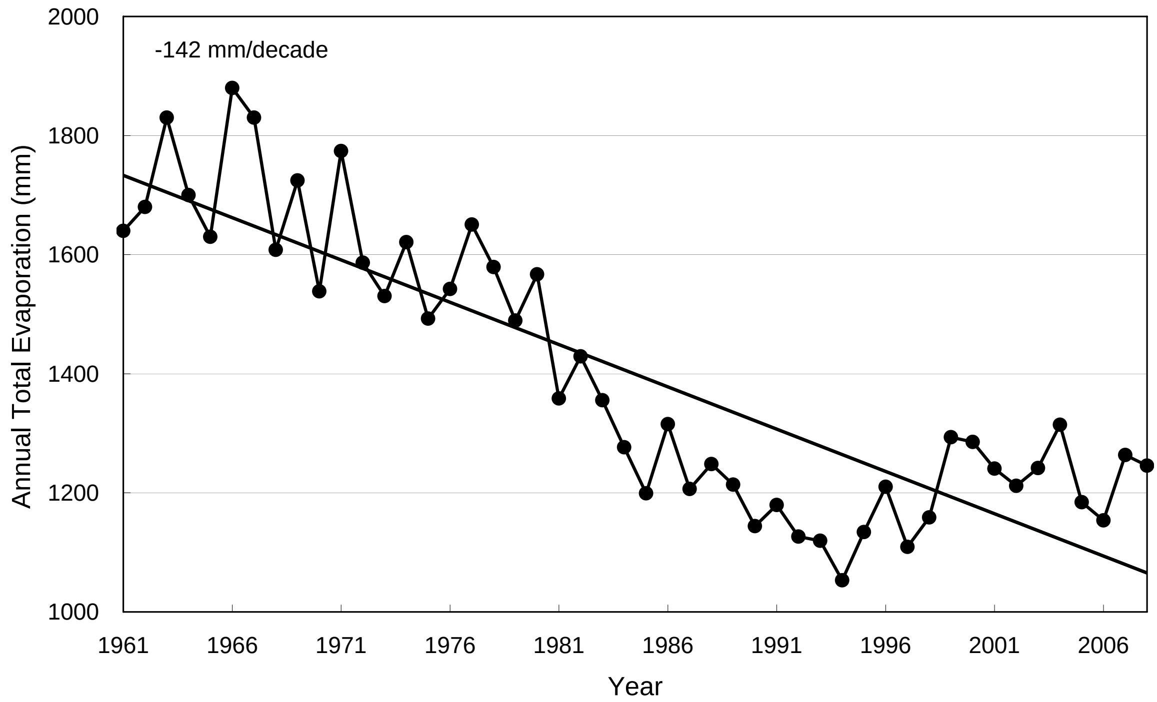

Figure 7 Annual total evaporation recorded at King's Park from 1961 to 2008.

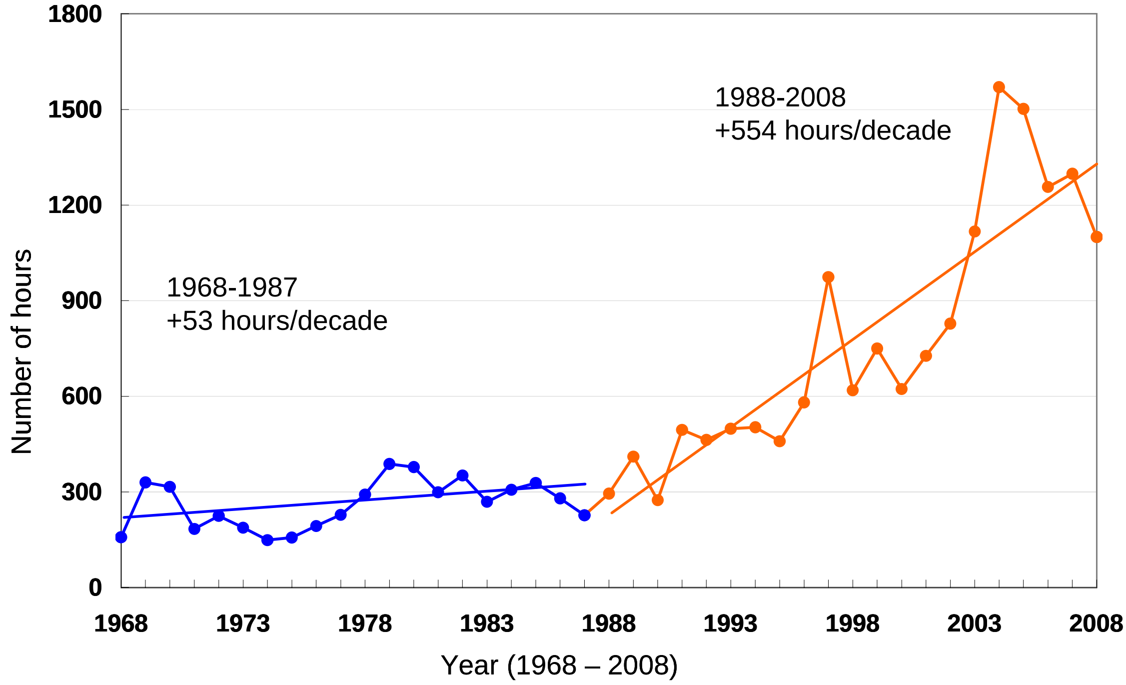

Figure 8 Annual total number of hours with visibility at the Hong Kong Observatory Headquarters below 8 km from 1968 to 2008 (relative humidity below 95 % and not counting rain, mist or fog).

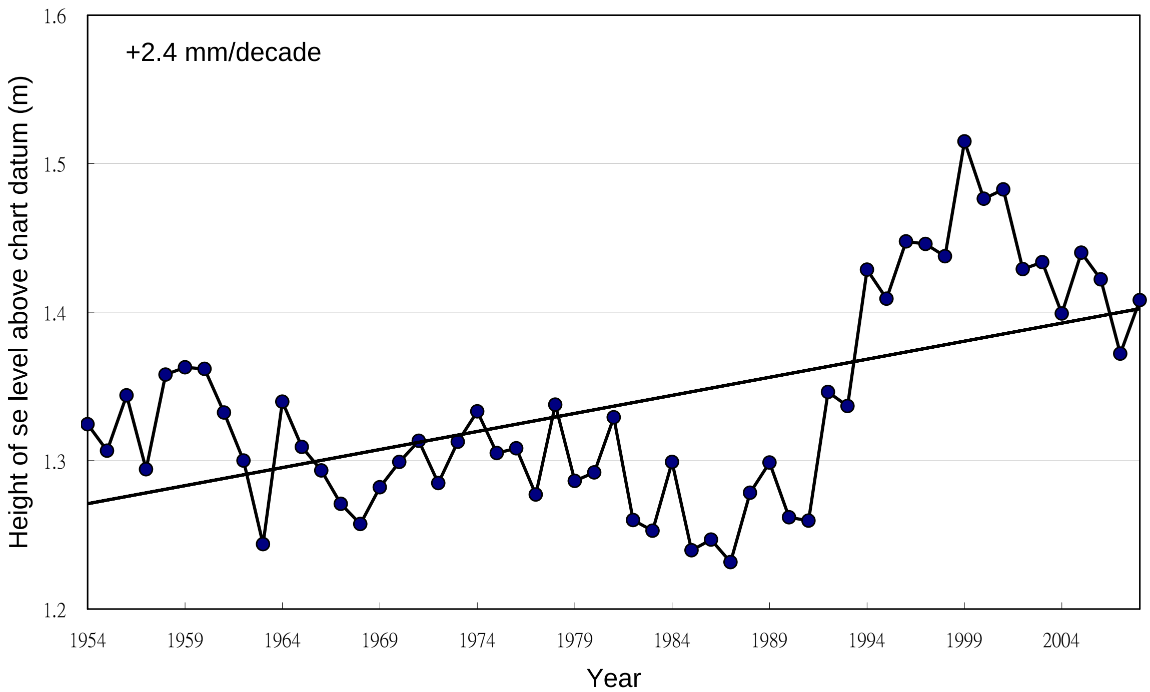

Figure 9 Annual Mean Sea Level at North Point / Quarry Bay.

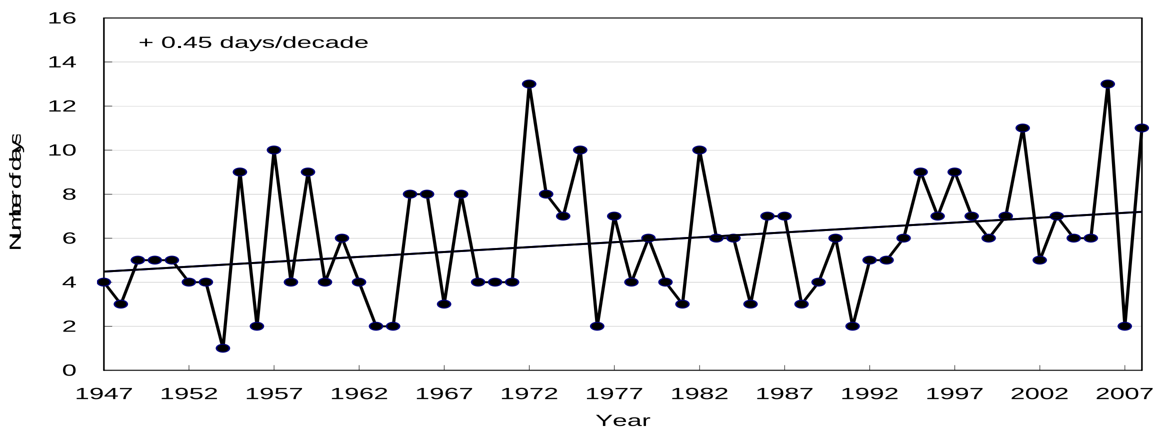

Figure 10 Number of heavy rain days (days with hourly rainfall > 30 mm) recorded at Hong Kong Observatory Headquarters (1947-2008).

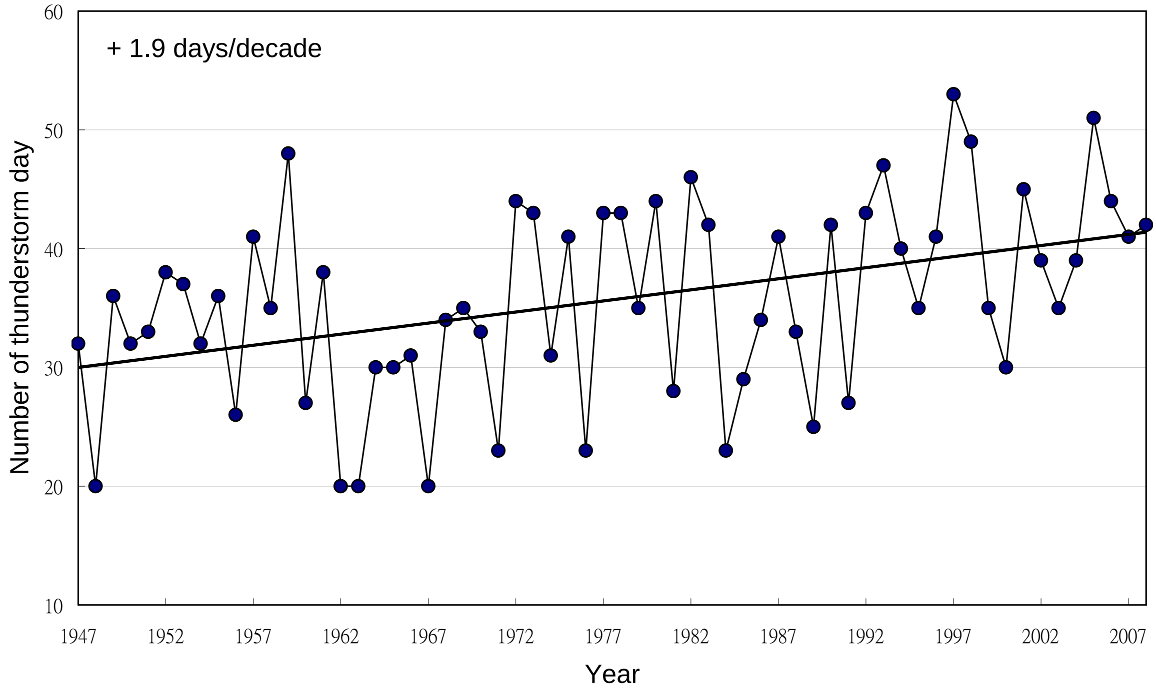

Figure 11 Annual number of thunderstorm day as observed at Hong Kong Observatory Headquarters from 1947 to 2008.

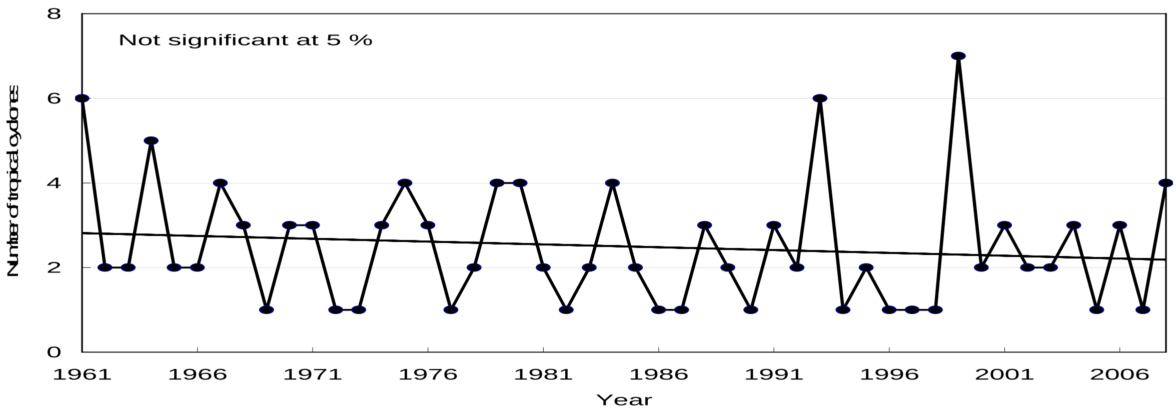

Figure 12 Annual number of tropical cyclones making landfall along the south China coast within 300 km of Hong Kong from 1961 to 2008.

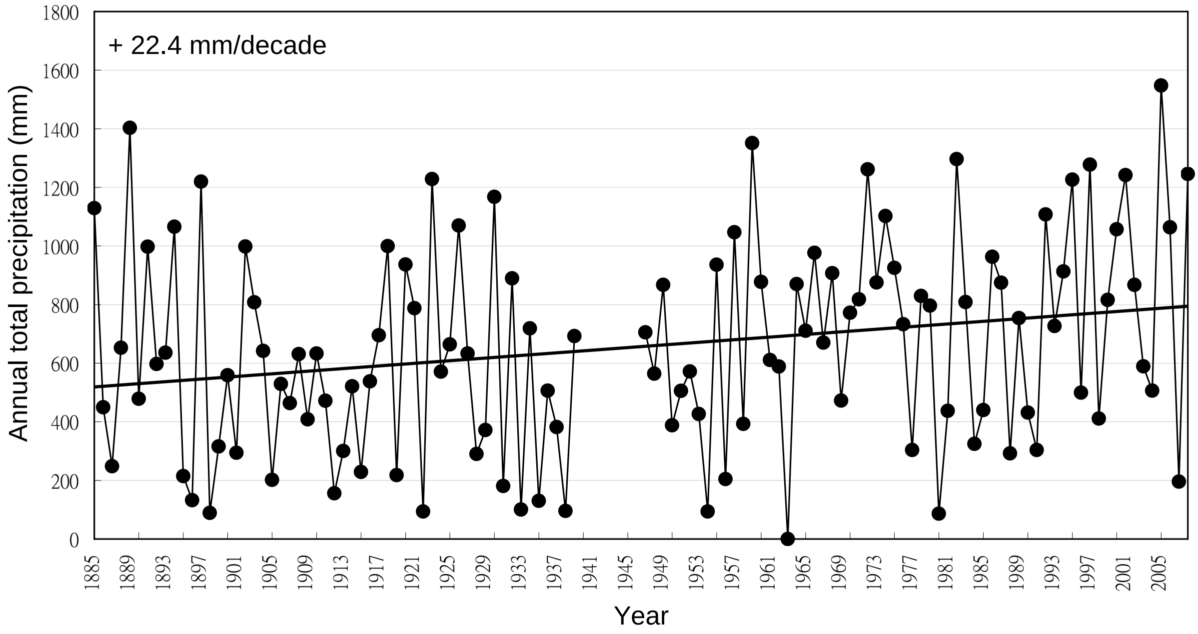

Figure 13 The annual total precipitation due to rainfall events exceeding the daily 95th percentile of the climatological normal (1971-2000) from 1885 to 2008.

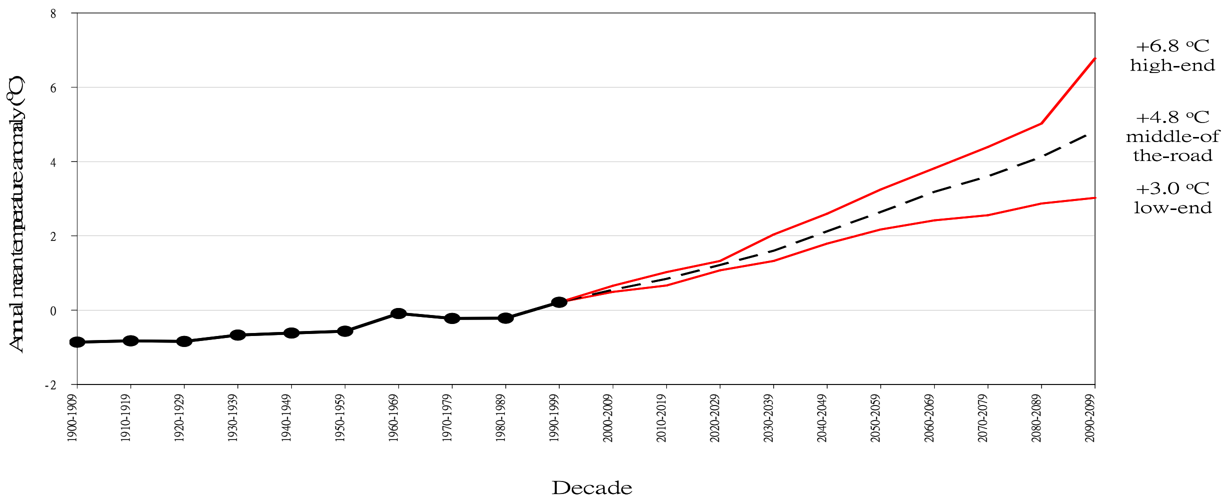

Figure 14 Past and projected annual mean temperature anomaly for Hong Kong (relative to the average of 1980-99).

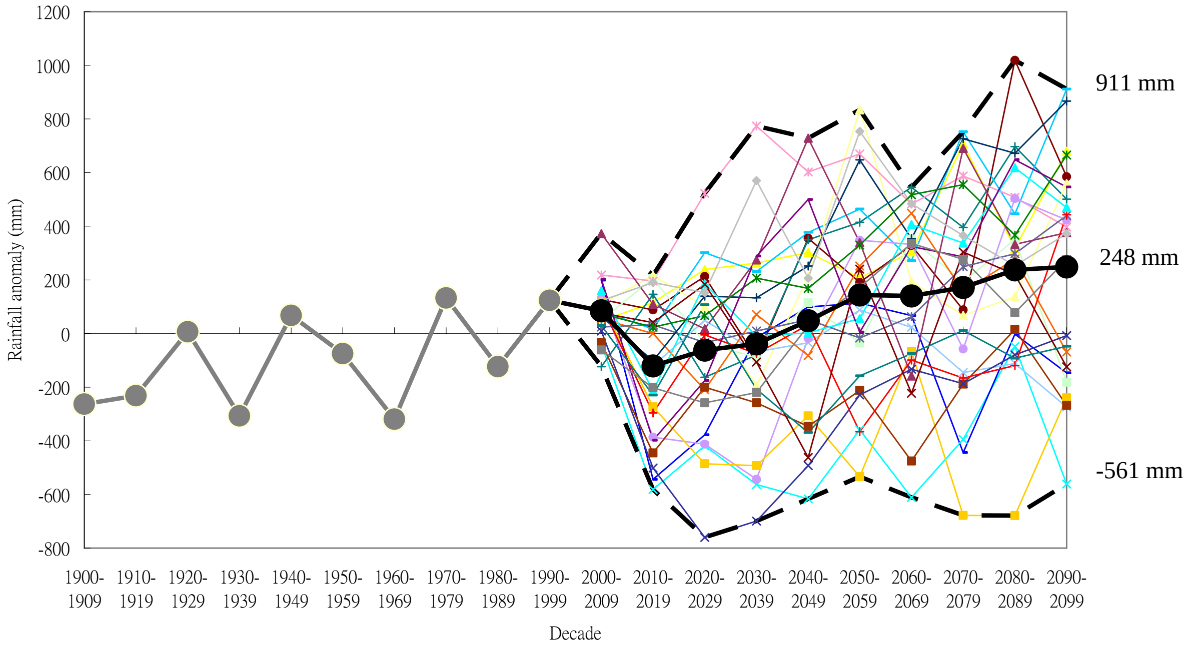

Figure 15 Past and projected change in annual rainfall for Hong Kong (relative to the average of 1980-99)

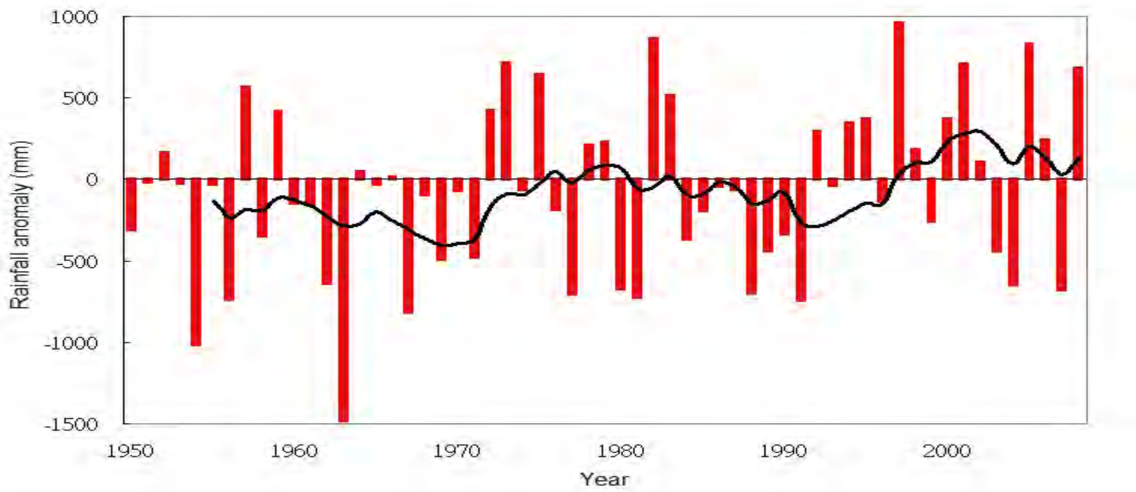

Figure 16 Time series of the annual rainfall anomaly (with reference to the 1971-2000 average) in Hong Kong from 1950 to 2008. Bold line represents the 9-year running average.

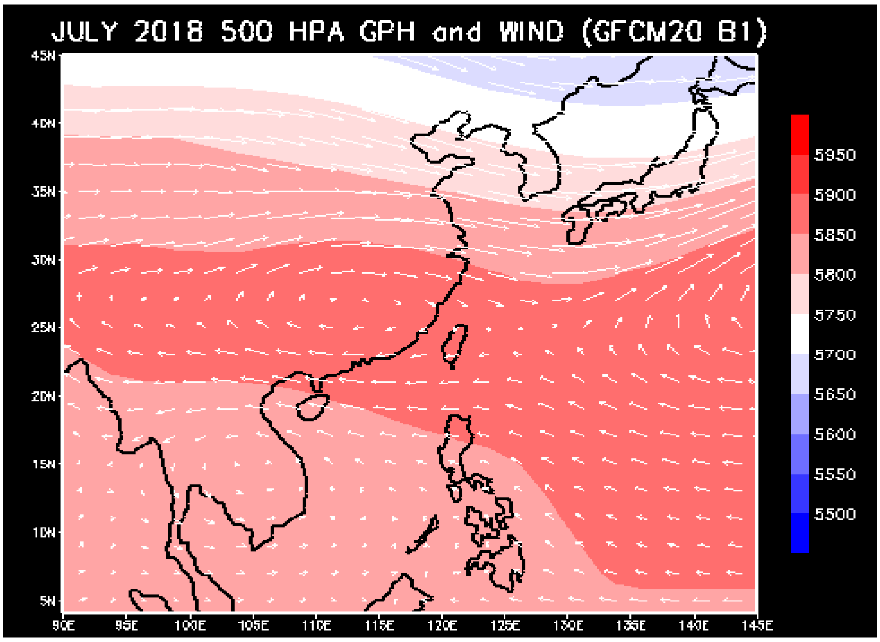

Figure 17 Mean 500 hPa GPH upper-air chart of the GFDL model (GFCM20) under B1 scenario in July 2018, a year with below normal annual rainfall projection (1105.6 mm).

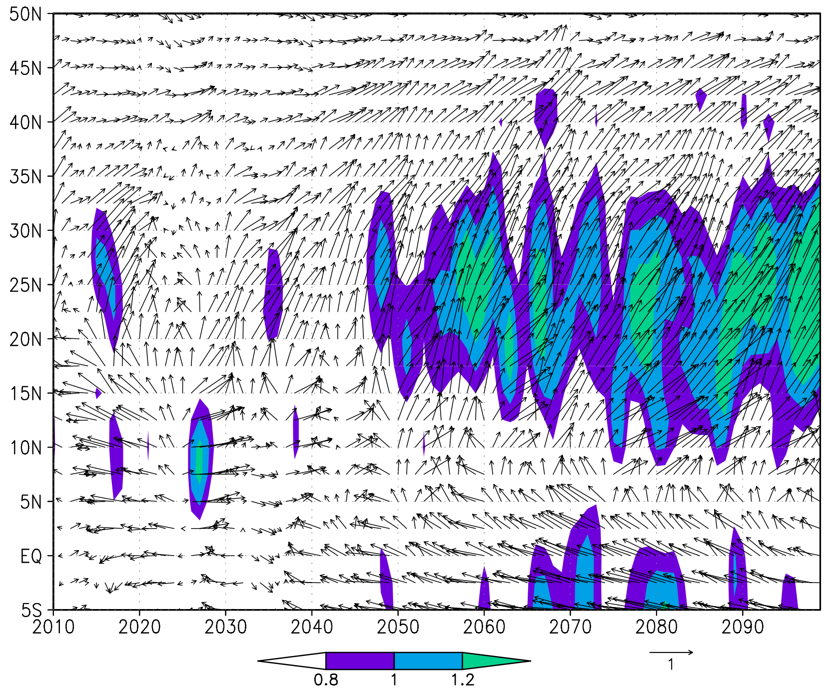

Figure 18 Time-latitude profile of average change in moisture transport at 850 hPa level (Kg $m^{-1}s^{-1}hPa^{-1}$) for June-August over the region from 110-120°E from 2010 to 2099 (relative to the average of 1980-1999).
(Extracted from Sun and Ding, 2009).

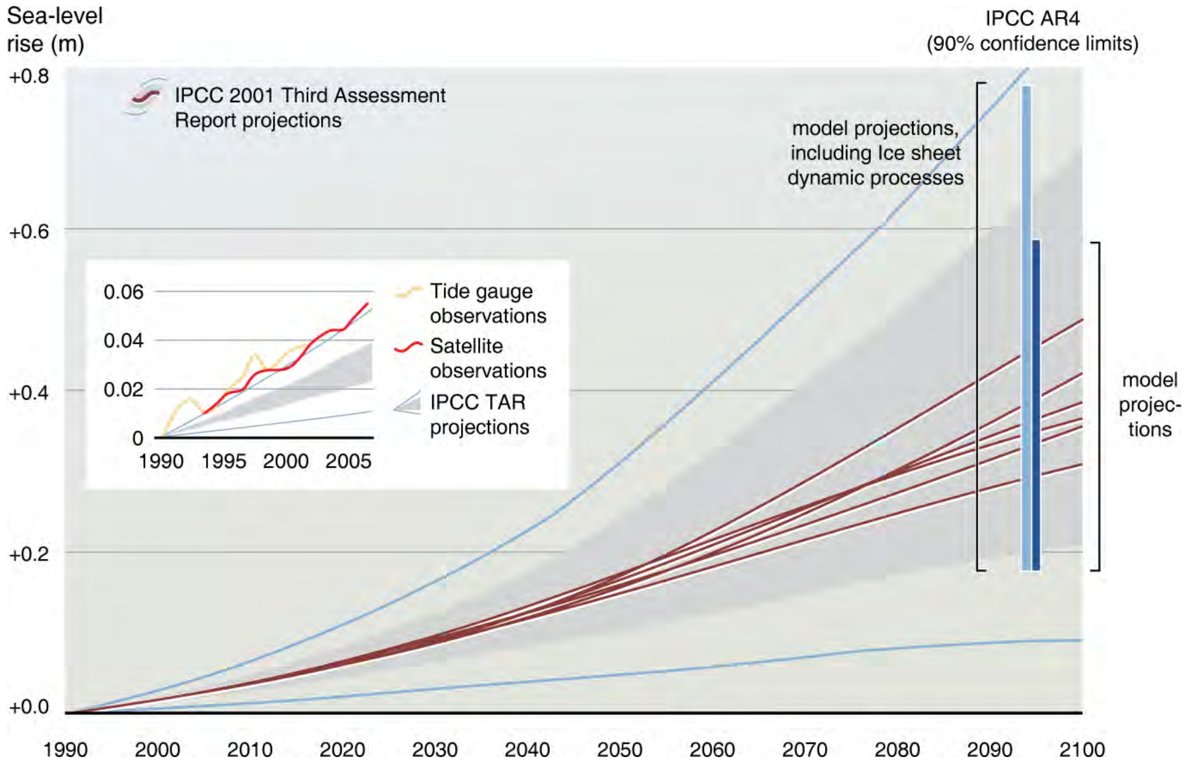

Figure 19 Projected sea-level rise for the 21st century. The projected range of global averaged sea-level rise from the IPCC 2001 Assessment Report for the period 1990 to 2100 is shown by the lines and shading. The updated AR4 IPCC projections made are shown by the bars plotted at 2095. The dark blue bar is the range of model projections (90% confidence limits) and the light blue bar has the upper range extended to allow for the potential but poorly quantified additional contribution from a dynamic response of the Greenland and Antarctic ice sheets to global warming.
(From UNEP/GRID-Arendal Maps and Graphics Library, extracted & prepared from IPCC, 2007).

The Integrated Impacts of Climate Change, Water Availability and Socio-Economic Development on China's Food Production

Wei Xiong[1, 2], Declan Conway[3], Erda Lin [1, 2],Yinlong Xu[1, 2], Hui Ju [1, 2], Jinhe Jiang [4], Ian Holman[5], Yan Li[6.]

Abstract

Food production in China is a fundamental component of the national economy and driver of agricultural policy. Sustaining and increasing output to meet growing demand faces significant challenges including, climate change, increasing population, agricultural land loss, and competing demands for water. The integrated impacts of climate change, water availability, and other socioeconomic pressures on China's food production are poorly understood. By linking crop and water simulation models and two scenarios of climate and socioeconomic change (downscaled from IPCC SRES A2 and B2) we demonstrate that under these scenarios out to 2050 the absolute effects of climate change alone are modest and the interactive effects of other drivers are negative, leading to overall changes in total production. Outcomes are highly dependent on socioeconomic development pathways and the effects of CO_2 fertilization on crop yields which may almost wholly offset the decreases in production. We find that water availability plays a significant limiting role on potential cereal production. Per capita cereal production falls in all cases, by up to 40% of the current baseline. These results are likely to be optimistic because the CO_2 crop yield response function is highly uncertain and the effects of extreme events on crop growth and water availability are likely to be underestimated.

1. Introduction

Food production in China is a fundamental component of the national economy and driver of agricultural policy. Its global importance is measured by the fact that Chinese agriculture supports staple food supply for most of its population (~20% of global population) and produces 30, 15, and 17% of global production of rice, wheat and maize, respectively (as of 2003; Winters and Yusef, 2007). Sustaining and increasing this output to meet growing demand faces significant challenges including, land degradation, maintaining yield gains through agricultural technology, changing patterns of food consumption, increasing population, pressure to use agricultural land for other purposes, and competing demands for water currently used for irrigation (Gale, 2002; Zhao et al., 2008). In the face of these challenges there is increasing concern about the impacts of future climate change, and interaction of climate change, water availability, land use change, and socio-economic development on food security (Gregory and Ingram, 2000; Parry, 2001; Rosegrant and Cline, 2003; Gregory et al., 2005; IPCC, 2007).

The interactions between climate change, crop production, land use and water availability have been largely neglected until recently (Betts, 2005). The drivers of agricultural responses to climate change are direct biophysical effects and their mediation through socio-economic processes. The relentless pressure of increasing population and per

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[1]Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, Beijing, 100081, email: Xiongw@ami.ac.cn;

[2] The Key Laboratory for Agro-environment & Climate Change, Ministry of Agriculture, China, Beijing, 100081;

[3] University of East Anglia, Norwich NR4 7TJ, United Kingdom;

[4] Institute of Quantitative and Technical Economics, Chinese Academy of Social Sciences, Beijing, 100732;

[5] Natural Resources Department, Cranfield University, Bedfordshire MK43 0AL, United Kingdom;

[6] Water resources information center, the Ministry of Water Resources of the People's Republic of China, Beijing, 100053;)

capita food consumption on land and water use are major factors in determining the characteristics of future scenarios of food security and are likely to be key factors in increasing the risk of famine in the future (Slingo et al., 2005). Recent studies have used a variety of models and climate scenarios to analyze the integrated impacts of climate change on food production. Several integrated assessments have incorporated water availability (e.g. Rosenberg et al., 2003; Tao et al., 2003a, 2003b; Rosenzweig et al., 2004) and others have considered different socio-economic development pathways (e.g. Parry et al., 2004; Fischer et al., 2005). Although most of the integrated assessments have been done in developed countries (e.g. Lorenzoni et al., 2000; Izaurralde et al., 2003; Holman et al., 2005, 2008; etc.), results for China have been referred to in global studies such as Parry et al. (2005). They simulated modest changes in China's national potential grain yield by the 2080s (range of 0%~2.5%) which would be indistinguishable from the effects of background climate variability.

This paper sets out a framework to assess the direct effects of climate change (using high resolution regional scenarios) on cereal crop yields (using detailed simulation of rice, maize and wheat) and the indirect effects of changes in water availability (as it affects irrigation water supply). Other factors considered include the direct effects of CO_2 fertilization and changes in arable land and demand for water due to population increase and economic development based on socio-economic scenarios (downscaled from the IPCC SRES, Gaffin et al., 2004). Changes in crop yields and water availability are presented and, using areas of crops sown across China, converted into estimates of cereal production, expressed as a national total or per capita. The analysis explores projections by up to 2050 using two emissions scenarios (A2 and B2), with and without the direct effects of CO_2. Results are presented in a stepwise manner to demonstrate the relative impacts of climate change and other drivers on cereal production. Our objective is to quantify the influence of different drivers of change on future cereal production in China.

2. Methodology

Climate impacts were simulated using process-based models with high resolution climate scenarios. In brief, the overall process can be described in five steps. First, climate change and SES were constructed for China; second, crop models and a hydrological model were used to simulate the impacts of climate change on crop production and water availability; third, total national rainfed and irrigated cereal production was calculated; and finally, the effects of the drivers were combined and compared.

We considered the effects and interactions of climate, CO_2 fertilization, water availability and land use change in relation to their impacts on China's staple cereal production by up to 2050. To do this the socio-economic storylines for China were combined with the results obtained from a high resolution regional climate models - PRECIS, and the CERES crop model and VIC hydrological model. As before limited the analysis to two of the emission scenarios for greenhouse gases developed by the intergovernmental Panel on Climate Change, A2: medium-high emissions from a continuously increasing global population, B2 scenario: medium-low emissions and lower population growth. A step-wise approach was employed to generate the direct effects of climate change on yields of cereal crops (rice, maize and wheat) and the indirect effects of changes in water availability (as it affects the supply of irrigation water). Within this framework factors such as the effects of CO_2 fertilization, changes in arable land and demand for water due to population increase and economic development were also considered. From the areas of the crops sown across China, we converted these changes into estimates of cereal production or per capita based on population growth from the two emission scenarios (Xiong et al., 2008a).

2.1. Climate Change Scenarios for China

Regional climate scenarios were generated using a high resolution (~50 km grid interval) atmospheric regional model (PRECIS – Providing Regional Climates for Impacts Studies, Jones et al., 2004; Xu, 2004; Zhang et al., 2006; Xu et al., 2007). PRECIS takes the output of the global model HadAM3H at its lateral boundaries, and thereby inherits the large-scale characteristics of HadAM3H. Validation of PRECIS' performance in simulating China's climate is described in Xu et al. (2007). Two scenarios of CO_2 concentrations (based on the IPCC SRES A2 and B2 storylines) were used with PRECIS to simulate changes in daily temperature, radiation, and precipitation. A2 represents medium-high emissions and B2 medium-low, together they encompass a wide range of future emissions pathways (Nakicenovic and Swart, 2000). PRECIS simulated future annual values of temperature, and precipitation from 2011 to 2100 for the A2 and B2 emission scenarios are presented in Fig. 1.

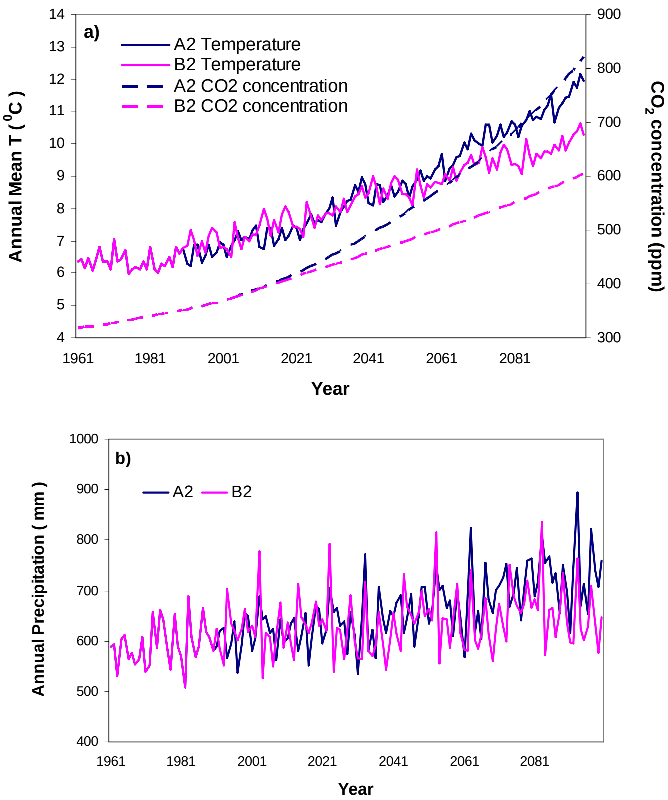


Fig. 1 Average annual surface air temperature (a, corresponding CO_2 concentrations are also given as right axis), precipitation (b) for 1961-2100 under SRES A2 and B2 emissions scenarios simulated by PRECIS.

2.2. Socio-economic scenarios for China

To be consistent with the high resolution climate scenarios available from PRECIS we developed socio-economic scenarios (SES) at provincial level for A2 and B2 out to 2050. The methods are based broadly around those used in Nakicenovic and Swart (2000) and Gaffin et al. (2004) and guided by relevant literature on agricultural and other trends in China (e.g. Yang, 2000; Liu et al., 2005; Zhao et al., 2008). The IPCC SRES B2 storyline fits broadly with China's national social and economic development plans over the medium to long term and is taken here as an optimistic or desired socio-economic scenario. The 'A2 family' represents the higher range of likely CO_2 emissions under the development of business as usual, and is chosen here to represent an environmentally pessimistic development pathway.

Table 2.
China: population and GDP projections in the two SES, plus the general characteristics of the scenarios

	2000	2005	A2		B2	
			2020	2050	2020	2050
GDP (100 M RMB at comparable price in 2000)	99,200	156,000	301,000	837,000	481,000	1,450,000
Pop. (billion persons)	1.27	1.31	1.53	1.94	1.44	1.51
GDP per capita (USD in 2000, 100USD = 828RMB))	950	1,700	2,400	5,200	4,050	11,650
Water demand (Gm^3/year)	550	563	616	747	619	691
AW	378	362	329	290	341	308
IW	114	131	173	262	166	214
DW	58	69	96	158	93	129
MW	0	1	18	37	19	40
Arable land (1000 hectares)	128,250	121,500	113,950	107,700	121,500	117,550
Characteristics			Rapid regional economic growth, Materialist; low GDP growth rate; high population growth; rapid decrease of arable land; and rapid growth of water demand.		Local emphasis and environmental priority; moderate GDP growth rate and population growth; conservation of arable land; and steady growth of water demand.	

Figures are rounded to nearest thousand (50 for per capita GDP).

2.3. The Crop and Hydrological Models

Three CERES crop models (Ritchie et al., 1989; Ritchie et al., 1998; Jones et al., 2003) were modified to simulate yields and potential irrigation demand across China at the same resolution as the regional climate model (50km × 50km): Rice, maize and wheat. Full details of the models are presented in Xiong et al. (2007a, b) and details of recent improvements in their calibration and validation in Xiong et al. (2008b, c). The simulated yields are assumed to represent observed yields obtained in the field assuming technological levels from 2000. Crops are simulated for rainfed and irrigated conditions using areas of crops sown across China based on the distribution in 2000 (obtained from county census data).

For irrigated crops water is applied periodically throughout the growing season and the total irrigation water requirement for each grid and crop is obtained by multiplying by the total irrigation area (Ju et al., 2005). Crop response to CO_2 is based on results from FACE experiments from (Kimball et al., 2002); a 850 ppm CO_2 concentration causes a roughly 40% increase in photosynthesis for wheat and rice, and 15% for maize. Higher CO_2 levels tend to decrease the evapotranspiration rates of crops and improve their water use efficiency.

The Variable Infiltration Capacity (VIC) hydrologic model was used in this study to simulate water yield (surface flow + groundwater flow + lateral flow – loss from evapotranspiration) for the whole of China. VIC (version, VIC-3L) (Liang et al., 1994; 1996) is a distributed, physically based hydrologic model that balances surface energy and water over a grid cell. VIC has been successfully applied to assess the impacts of climate change (Christensen et al., 2004; Wood et al., 2004; Vicuna et al., 2007). For this study, we ran the model at 50km×50km grid resolution over China. The main data inputs required by VIC are vegetation, soil and weather data and we used a similar procedure as Su and Xie (2003) and Xie et al. (2004) to generate the inputs.

Previous studies have validated VIC simulations of runoff for the whole of China and streamflow simulation in some catchments (e.g. Su and Xie, 2003). In order to improve the robustness of the model application, six parameters of the VIC model (the infiltration parameter, the thicknesses of first and second soil layers and three base flow related parameters - the maximum subsurface flow, the fraction of maximum subsurface flow in the second soil layer, and the faction of maximum soil moisture in the second layer) were calibrated for 60 catchments (covering 39% of China's territory) to minimize the difference between the simulated and observed daily water balances. For catchments without observed streamflow data, the parameters were used from the nearest neighbour based on polygon centroids. Daily water yield was calculated from each grid cell and annual total water yield series were calculated for ten main river basins in China. These volumes were used to provide estimates of annual renewable internal water resources in each basin.

2.4. Calculation of Agricultural Water Available, Arable Land, and National Cereal Production

Water available for agriculture (WAA_i) in province i was calculated as (1)

$$WAA_i = \left(\sum_{j=1}^{n} \left(WRI_j \times R_j \times P_{ij} \right) \right) \times \left(AW_i / \left(AW_i + DW_i + IW_i + MW_i \right) \right) \qquad (1)$$

Where R_j is the water exploitation proportion in basin j (an average value of the observed exploitation proportion for each basin from 1994 to 2005 which is assumed to remain constant in the future), P_{ij} represents the proportion of water used in province i that comes from basin j (based on the average value from historical data for 1994 to 2005). For any given grid k in i province, the Available Irrigation Water, AIW_k is computed as (2)

$$AIW_k = WAA_i \times \left(IA_k / IA_i \right) \qquad (2)$$

Where IA_k is the irrigation area in grid k and IA_k is total irrigation area in k province.

The balance between *AIW* and potential crop irrigation demand in each grid cell was used to limit irrigation and estimate the irrigated area of each crop at the grid cell. Because most of the rice planted in China is irrigated paddy rice, we assumed that rice takes highest priority for water withdrawal, with the objective of irrigating as much of the present area of rice as available water permits. The remaining water was allocated to maize and wheat.

Estimates of national total cereal production incorporated scenarios of land use change based on the SES. The future area of crop land in each grid was calculated as a function of current arable land, multiplied by projected arable land conversion rate. The conversion rate was set to the rate of the province in which the grid lies. These estimates, together with an assumption of constant patterns of crop-planting and crop mix were used to calculate total production, by multiplying the area of irrigated or rainfed crops by the yield per unit of land area.

3. Results

3.1. Impacts of Climate Change on Grain Production

In 2000, the total cereal production in China was 395.7 million metric tones (MT), with 189.8, 99.6 and 106.2 MT for rice, wheat, and maize, respectively (FAOSTAT). The corresponding planting acreages for the three crops were 30.3, 26.7, and 23.1 million ha. The projected cereal production for the current conditions was 429.8 MT (rice, wheat and maize comprise 216.6, 104.6, and 108.6 MT, respectively, without limitation from water). Over 70% of production comes from irrigated grain crops which includes irrigated wheat/maize and paddy rice.

Figure 2a shows that without CO_2 fertilization effect climate change decreases irrigated cereal production in China under B2, but increases it slightly under A2. The rainfed cereal production exhibits decreasing trend in the future. The production of rice increases a little under the A2, but decreases under B2. Wheat production increases in all cases and maize decreases in all. CO_2 fertilization effect cause increases in production in all cases, particularly for irrigated crop under A2. The largest change occurs for wheat, and the smallest for maize.

The differences between the effects of A2 and B2 are modest, within roughly 10%, and very small between the rainfed production (<2%).

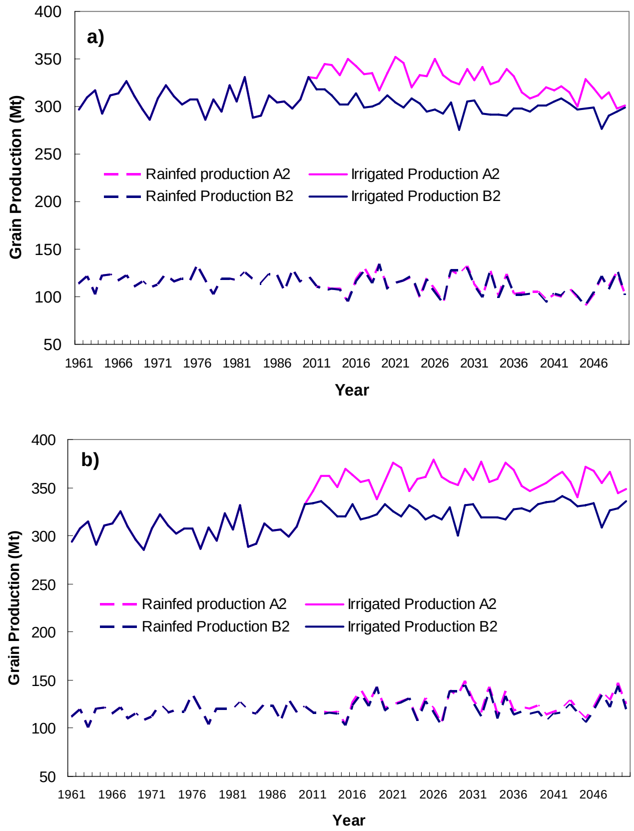


Fig. 2 Changes in rainfed and irrigated cereal production up to 2050 for China due exclusively to climate change, with assumptions of unchanged cultivation areas and maximum irrigation area as 2000. Only three primary cereal crops (wheat, rice, and maize) are included. a) without CO_2 fertilization effect. b) with CO_2 fertilization effect.

Spatial patterns of change in total cereal production (compared to average of 1961-1990) of 2031-2050 exhibit marked differences across China (Fig 3). Without CO_2 fertilization effect, production decreases in most of areas except northernmost part of the northeast China (Fig3 a-b). When considering the CO_2 fertilization effect, production increases generally expect central and southern parts of northeast China and parts of central and southern China (Fig3 c-d). The general pattern shows increases in the northeast and north and decreases in the central, eastern and southern provinces. The increases in northeastern and northern parts are ascribed to enhanced production due to warming, e.g. the increased yield of rice in northeast China and increased wheat in north China. Additional, PRECIS climate change scenarios project increased precipitation in northern China, which to some extent promote the yield of rainfed crop in this part.

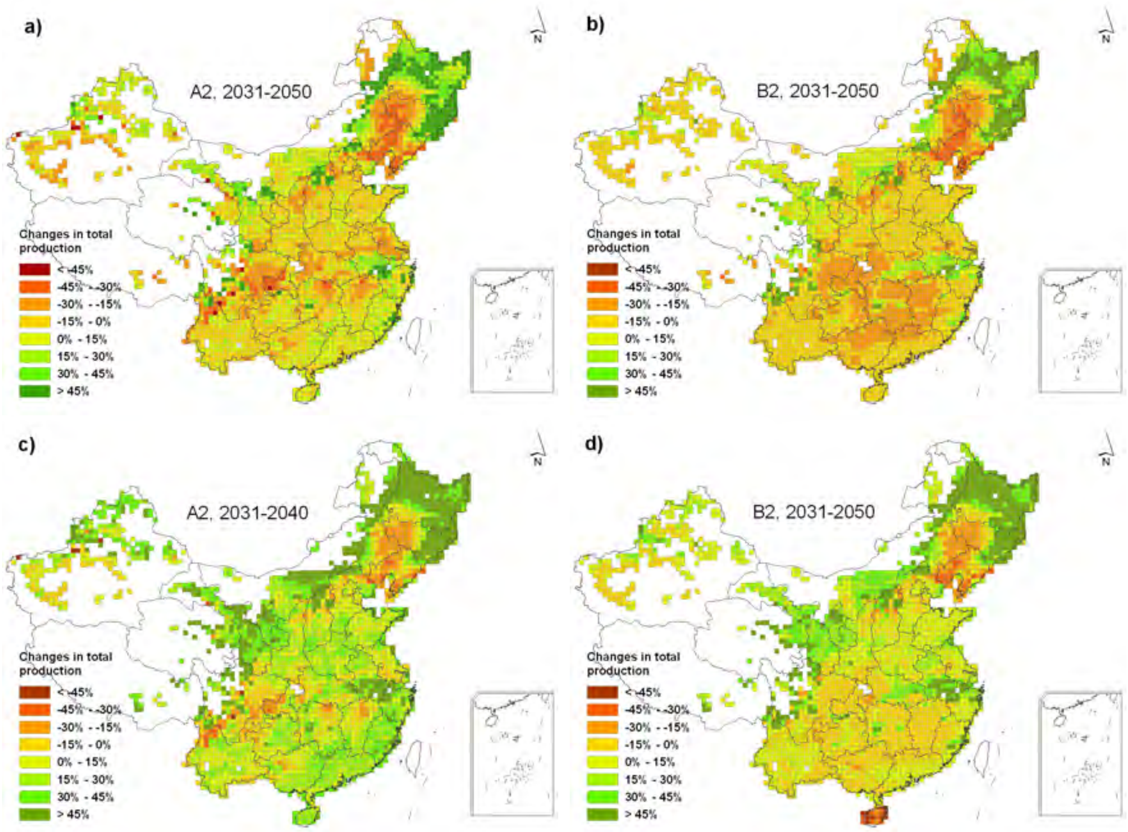
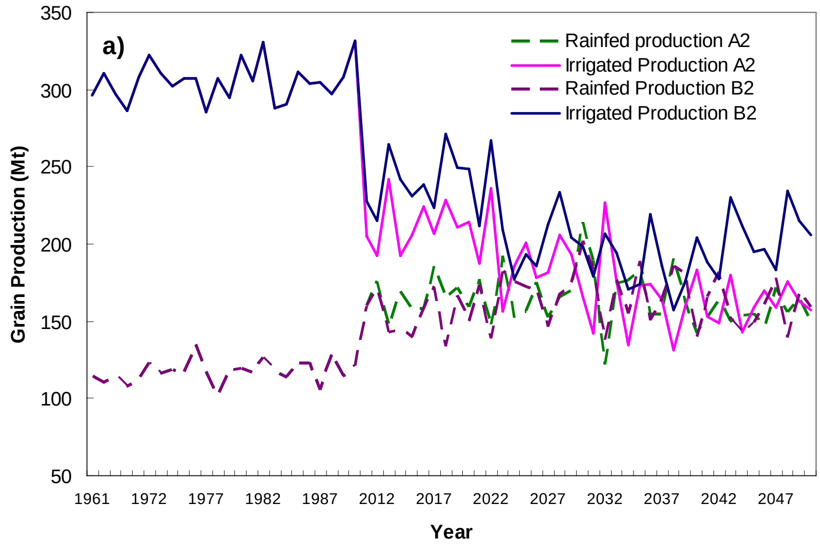


Fig. 3 Percent changes of China's cereal production due to climate change. a) ~ b) denote the results without the CO_2 fertilization effects, and c) ~d) with.

3.2.Integrated Impacts of Climate Change, Water Availability and Socio-Economic Development on Crop Production

Besides climate, water availability and land use change are the two key drivers for China's grain production. Figure 4 shows the changes in rainfed and irrigated cereal production in China under different combinations of drivers. For total cereal production, it decreases under both A2 and B2 if without the consideration of CO_2 fertilization effect, with significant decrease with A2 and moderate with B2. These increases are largely ascribed to the decreases in water availability and arable land conversion, particularly under combination of A2 climate change and socio-economic development scenarios. The changes in total production are generally small under B2, but still with minus signs in the future. With the CO_2 fertilization effect, the total cereal production shows moderate decreases under A2 and slightly but insignificant increases under B2 in the future. Separated to rainfed and irrigated production, remarkable changes are exhibited in the future under both cases of with (Fig 4 b) and without (Fig 4 a) CO_2 fertilization effect. Rainfed production increases under all cases, and irrigated production decreases. The main reasons for these changes are the decreasing water availability for agriculture due to increased water shares by other sectors, e.g. industry and domestic. Land use change causes relatively small decreases in production, compared to attribution of water availability, particularly under the sustainable development pathway B2, in which the policies related to arable land loss control are assumed to be implemented in the future.



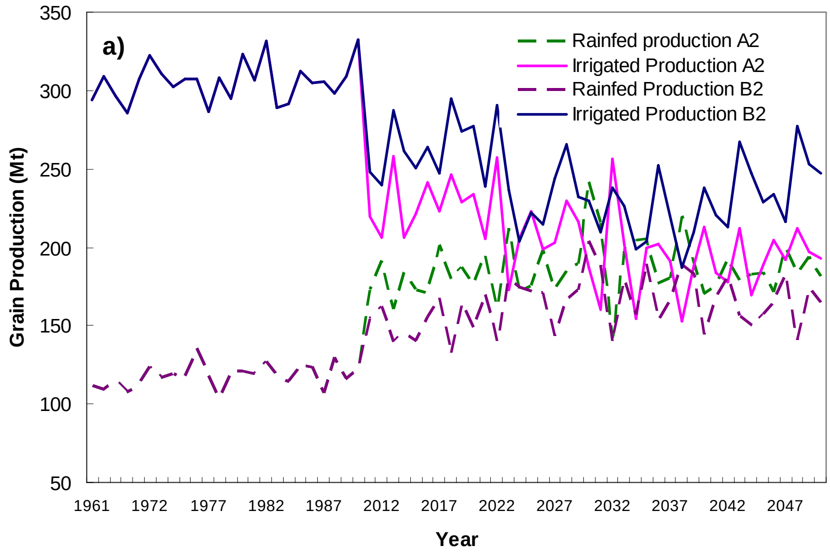


Fig. 4 Changes in rainfed and irrigated cereal production up to 2050 for China under the combinations of climate change and socio-economic development scenarios. Only three primary cereal crops (wheat, rice, and maize) are included. a) without CO_2 fertilization effect. b) with CO_2 fertilization effect.

In the absence of climate change, future socio-economic developments may have significant impacts on national total water demand (TWD), the structure of water requirements by sector, and the availability of water for agriculture. Socioeconomic development following the A2 pathway leads to a 11% increase in the 2020s, and a 30% increase in the period of 2031-2050 (B2 produces smaller increases). However, due to increasing competition for water from other non-agricultural uses, these increases in TWDs convert to decreases of agricultural available water for both A2 and B2. Climate change may significantly impact total water availability through increases in renewable internal water resources and crop irrigation demand, but these impacts are inevitably uncertain due to the uncertainties of the climate models. As different climate models simulate different responses to emissions of greenhouse gases (particularly the response of precipitation), Xiong et al. (2008a) compared PRECIS results with those of 17 other climate models and suggested that PRECIS produces warming similar to the all-model average for China, but predicts wetter conditions than the all-model average. This implies that the projected effects on water availability and irrigation demand caused by climate change might be optimistic.

3.3.China's Food Security in the Future

Production per capita can be used an indicator of food security and driver of agricultural policy in the context of national priorities for self sufficiency in staple food production (e.g. Xiong et al., 2007a). Figure 5 shows production per capita without taking into account international trade for selected combinations of drivers. Excluded the impacts of climate change, socio-economic development (SES, including water availability and land use change) causes declines in production per capita in long term under both A2 and B2. The production fells below 300 kg in 2035 with A2 and in 2040 with B2, indicating an insufficient food supply in securing basic food demand of community. Climate change poses significant impacts on production per capita, but with different direction under different scenarios. A2 climate change deteriorates the food supply in the future, resulted in a further decline in production, with ranges between -1%~ -10%. B2 climate change increases the production, with promotion between 2% to 20%. CO_2 fertilization effect offsets the negative impacts caused by climate change and socio-economic development, leading to highest productions per capita for combinations of both A2 an B2.

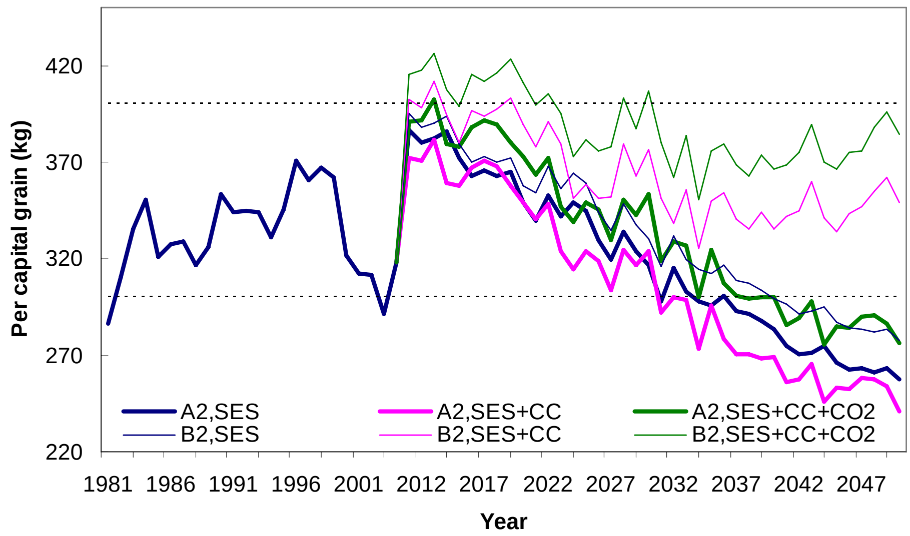


Fig. 5. Changes in per capita grain production under the combinations of diver of A2 and B2, other grains except rice, wheat and maize are included in the estimation, and assumed no change in the future. SES: socio-economic development, CC: Climate change, CO2: CO_2 fertilization effect. Data from 1981 to 2004 is extracted from FAO. Dotted lines denote the assumed threshold of production per capita to secure basic food demand (below) and economic sustainable development.

IPCC SRES scenario B2 describes a medium prosperity society, governance is more inward looking rather than global, cultural pluralism is strong along with environmental protection (Gaffin et al., 2004), which is a mid-range estimate and consistent with the anticipation of China's population and GDP. With B2, temperature increases by up to 2.0℃, and greenhouse gas concentrations rise up to 561 ppm. Considering technology progress and international food trade, climate change would not significantly threat national food security whether CO_2 fertilization is considered or not. A2 implies a world of lower economic development and weak globalization, with high population growth (Gaffin et al., 2004), which represents the upper range of climate change and is different from reality. Under A2, temperature increases by up to 3.9℃, and greenhouse gas concentrations rise to 721 ppm. Even considering CO_2 effects the grain supply would only meet basic demand for human consumption; without CO_2 effects, basic demand would not be meet, which could threat national food security from the 2030s onwards.

4. Discussion

We have presented the first detailed attempt in China to link the interactions of climate change, crop production, water availability and socio-economic development. Our results highlight in terms of cereal production, key challenges and sensitivities, however, it is important to examine the main uncertainties and assumptions and their relative significance to the results.

4.1 Key Uncertainties and Assumptions

The main scientific uncertainties: Standard concentration scenarios for A2 and B2 (based on emissions pathways) were used to drive PRECIS and these do not account for possible acceleration of the CO_2 concentrations due to climate–carbon cycle feedbacks (Meehl et al., 2007). This means that A2 and B2 SES might not necessarily be associated with their corresponding climate scenarios. Differences in the spatial patterns and magnitude of future precipitation between climate models have a large bearing on future yields of rainfed crops and irrigation water availability. Differences in the daily characteristics of climate variables and differences between ensemble experiments will also influence the overall results.

The effects of CO_2 on crop yields are critical to the overall results, but they remain highly uncertain (Long et al., 2005, 2006). CERES simulates the effects of CO_2 on photosynthesis and on crop water use efficiency broadly in line with current experimental and modeling results. Given present state of knowledge it is not possible to attribute different levels of confidence to results either with or without CO_2 effects and therefore we present both with equal weight with the expectation that the reality should lie within this range and not beyond it (Lin et al., 2005).

The significance of extreme events: China's vulnerability to climatic hazards is high; because of its size and geographical extent it experiences many types of hazard and because of its transitional economy, production and employment in sectors such as agriculture remain very important, such that millions of livelihoods are exposed to climate related risks. The annual average crop area affected by meteorological hazards is around 50 million ha and economic losses amount to over 200 billion RMB per annum (Wang, 2007). Drought in 2004-2006 in Ningxia (Northwest China) led to crop failure, increased need for local people to purchase water and significant economic impacts (Yue et al., 2008). China's high exposure and sensitivity were clearly highlighted by the events during January and February 2008 when unusually low temperatures and heavy snowfalls (the heaviest in ~50 years) in southern China brought massive disruption to transport networks during the peak travel period of the Spring Festival. By mid-February the impacts had spread to 21 provinces, caused 129 deaths, destroyed crop harvests across 1.68 M ha, and led to direct economic losses of 152 billion RMB (Wang, 2008).

Climate models, either global or regional, are unlikely to capture fully the spatial and temporal detail of many extreme events across China. This is due to the imperfect understanding of their physical causes and limitations related to model structure. Crop models may also fail to simulate the total impact of events such as temperature peaks and soil moisture deficits during critical stages in crop growth cycles.

Assumptions related to the impacts modeling: The simulation of crop production did not incorporate the effects of changes in distribution and impact of pests and diseases, changes in management practice, crop variety and type, and the multiple cropping index. Farmers were assumed to apply optimum inputs. Water management and efficiency of use were also assumed to continue at current levels and the observed planting and irrigation area were used to calculate future potential production. Water use did not consider non-grain production and livestock requirements, both of which are growing rapidly in China, the ratio of arable farming output value to total agricultural output value fell from 89% (1949) to 49.7% (2005, Zhao, et al., 2008). Also, whilst agricultural water availability was constrained within the simulations, it was assumed that all of the agricultural water is available at the correct times for irrigation. Decreasing groundwater levels due to abstractions for irrigation and urban water use (e.g. North China Plain) and declining soil fertility were not incorporated in the modelling work.

Assumptions in the SES: We downscaled IPCC SRES storylines to China and sub-national scales, however, large uncertainties exist in the SRES SES and it is quite possible that China will follow different pathways to the world and Asia. Indeed, the A2 population is much higher than other projections and given current national policies on population probably unrealistic. Farmers and agricultural policies will respond to many signals and drivers but we have made no assumptions in the SES about their roles in affecting production. The SES does not incorporate incremental responses or anticipatory actions in response to change as it occurs; i.e. there are no feedbacks in the scenarios: they are not co-evolutionary. Our results do not include the effects of extreme events and adaptation related to agronomic practices.

We have made no assumptions about the role of crop prices and international trade in affecting production and incremental responses/anticipatory actions in response to changes as it occurs (i.e. there are no feedbacks in the scenarios). Other important trends not included here are rapid changes in food consumption patterns in China. For example, average per capita meat consumption increased from 8.2 kg to 25.3 kg between 1978 and 2000 (Zhao et al., 2008).

4.2. The Wider Implications of the Results

To provide some traction to the results of this impact analysis we set the results in the context of maintaining national food (staple grains) sufficiency in China. This is an important current policy goal for China and is likely to remain a major influence on agricultural policy and practice over the timescales considered in our study. Nevertheless, this production oriented policy goal ignores issues of sustainability, such as land degradation and over-application of inputs, all of which need to be addressed to maintain and increase future production.

In relation to climate change the results demonstrate the importance of improving our understanding of the effects of CO_2 fertilization in real world situations. Water availability is a critical factor for agricultural production in China and so effective linkages between agriculture and water management/policy will be vital for successful adaptation. Improved projections of future water availability will require better surface and groundwater modeling and simulation of soil moisture dynamics and evapotranspiration.

5. Conclusions

The effects and interactions of multiple drivers of change (climate, CO_2 fertilization, water availability, population and land use change) have been considered in relation to their impacts on staple cereal production by up to 2050. Two standard IPCC SRES emission scenarios and SES storylines provided the quantitative inputs and qualitative context for the future drivers of change and adaptation scenarios. The main conclusions are as follows. By up to 2050 climate change alone produced small to moderate effects on China's potential cereal production. The combined effects of CO_2 fertilization and climate change produced increases in cereal production with both A2 and B2 climate scenarios. The increases were larger with A2. Water availability acted as a significant limitation to national production in the future with or without CO_2 fertilization effects. A decrease in water availability for agriculture reduced the irrigated cereal production in all cases, particularly under A2. The absolute effects of climate change were modest relative to the other drivers. The interactive effects of all drivers together led to significant decreases in total production. In most cases production per capita was projected to decrease, particularly the cases with A2 population, but the decreases were significantly different between combinations of drivers and population scenarios. Outcomes were highly dependent on socio-economic development pathways and their underlying assumptions and the effects of CO_2 fertilization which, assuming sustained positive effects, offset most of the negative effects of the other drivers.

The results demonstrate the importance of integrating climate change with other socio-economic drivers of change in order to generate a system understanding of how climate and socio-economic drivers affect cereal production in China. Other studies that incorporate multiple drivers of change also obtain similar results: increasing demand due to economic and demographic growth leads to large changes in per capita food and water availability, often outweighing climatically-induced changes (Conway et al., 1996; Vörösmarty et al., 2000; Alcamo et al., 2007). Future development pathways will play the major role in determining which of our scenarios is most accurate. Critical scientific uncertainties exist around the future effects of CO_2 fertilization and differences between GCM results. The relative magnitude and direction of change in the results are therefore more important than the absolute values. Access to additional climate model scenarios and consideration of ranges across the major uncertainties and assumptions would generate a more complete representation of future conditions. We believe, however, that this would be unlikely to alter our overall conclusion that, inter alia, climate change represents a potentially major additional stress on China's future agricultural production. This conclusion reinforces the need for China to achieve sustainable agricultural production and support adaptive management and appropriate investment levels in agricultural technology.

Acknowledgements

This study was supported by the National Natural Science Foundation of China (Grant No. 30700477) and the UK DECC (Department of Energy and Climate Change) and UK DFID (Department for International Development) Grant No. 14703821. We acknowledge the modelling groups, the Program for Climate Model Diagnosis and Intercomparison and the JSC/CLIVAR Working Group on Coupled Modelling for the GCM multi-model data.

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Rural Livelihoods and Vulnerability to Climate Hazards in Ningxia, Northwest China

Yue Li[1], Yanjuan Wu[1], D. Conway [2], F. Preston[3], Erda Lin[1], Jisheng Zhang [4], Taoming Wang [4], Yi Jia [4],Qingzhu Gao [4], Shifeng, Hui Ju[1].

Abstract

This study addresses how climate affects the livelihoods of people living in agricultural communities in Ningxia, one of the five autonomous regions in China. The analysis formed part of a vulnerability assessment to contribute to the development of an adaptation strategy for the region. Data were collected through questionnaires and focus group discussions in nine villages, three located in each of three different agro-ecosystems in the region. The survey results showed that drought has been a major hazard impacting rural livelihoods. Farmers in all three agro-ecosystems showed differing levels of vulnerability; susceptibility was higher, for instance, in the middle arid and southern rainfed mountainous areas, due to farmers' greater exposure to climatic hazards and because a greater proportion of income originates from farming activities. Recent climate variability had affected many aspects of farmers' livelihoods but it was not the only challenge they had faced.

The perennially dry climate is a significant limiting factor for agricultural production in the region, greatly exacerbated by periodic reductions in moisture due to drought. Unsurprisingly, farmers have developed and continue to use a wide range of measures to retain and enhance soil moisture and to maintain agricultural production in this harsh environment: adaptation is an inherent feature of their behaviour, but their capacity to act is determined by a range of factors. When questioned on the constraints they faced respondents cited most often lack of money, water shortage and agricultural inputs. Because of the close alignment at the community and household level between adaptation and more generic individual and institutional aims for development there exists good potential to incorporate adaptation objectives and measures into mainstream development plans and poverty alleviation programmes.

Introduction

Climate change is the core of global change, and has attracted broad attention from the international community. The latest research findings published by WGI in the Fourth IPCC Assessment Report show that, in the past 100 years (1906-2005), the global surface temperature has increased by 0.74°C ±0.18°C. In the 21st century, both the frequency and intensity of high temperature, heat wave, extreme drought, and intense rainfall events will see an increase in trend.[5] Climate change will vary across regions, and may lead to the change of many meteorological elements such as rainfall and temperature, rise in sea level, and increased frequency and intensity of extreme events, such as droughts. These changes not only affect natural and human systems independently, but also integrate with other major factors to change ecosystems and production, diversity, and functionalities of livelihoods.[6] In this context, climate change can produce direct or indirect impacts on livelihoods, though different in magnitude.

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[1] Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, Beijing, China, 100081, author of correspondence: jinghonglv@gmail.com
[2] Tyndall Centre for Climate Change Research, University of East Anglia, Norwich NR4 7TJ, United Kingdom
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[5] IPCC, 2007a. Working Group I Contribution to the Intergovernmental Panel on Climate Change.
[6] IISD, Intercooperation, IUCN, SEI, Increasing Community Resilience to Climate-Related Disasters through Sustainable Livelihoods (Livelihoods and Climate Change Information Paper 1), 2003.
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In an academic context and for the purpose of this study, a livelihood is the financial means whereby one lives. It is comprised of capacity, assets, and activities.[7] Of these, assets are the core element, either in the form of natural capital, financial capital, material capital, human capital, or social capital. A livelihood touches every aspect of people's life and production activities. In this sense, it can be the combination of all the resources people are using and their activities to live.[8] Livelihood related studies fall into two categories: those focusing on the theoretical study of livelihoods, and those focusing on the multidisciplinary study of livelihoods. The theoretical study of livelihood in itself includes study of definitions of livelihood[9], analytical frameworks for livelihoods[10], and livelihood systems[11]. A multidisciplinary study of livelihoods tend to focus more on the vulnerability and poverty aspects of livelihoods[12], often including other related topics such as land, forest, ecology, and economy[13], with only limited studies on the relationship between livelihoods and climate. These studies focused on the vulnerability of livelihood.[14]

Previous studies in this area have barely touched on the impacts of climate change on livelihoods, or at most dealt with the subject from a macro point of view, sometimes implicit in the analysis, rarely explicit. In a report on climate change and poverty, written by a number of international organizations under the co-sponsorship of the African Development Bank and Asian Development Bank[15], the impacts of climate change on the livelihoods of the poor

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[7] Chambers, R., Conway, G. Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion Paper296. Brighton, England: Institute of Development Studies, 1992.

[8] http://www.livelihoods.org/info/DLGChinese/gloss/Gloss3.htm.

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[11] Niehof A. The significance of diversification for rural livelihood systems. Food Policy 29 (2004) 321–338.

[12] Bebbington A. Capitals and Capabilities: A Framework for Analysing Peasant Viability, Rural Livelihoods and Poverty World Development Vol. 27, No. 12, pp. 2021±2044, 1999.
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[13] Rigg J. Land, Farming, Livelihoods, and Poverty: Rethinking the Links in the Rural South. World Development Vol. 34, No. 1, pp. 180–202, 2006.
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[14] Selvaraju R, Subbiah A.R, Baas S, Juergens I. Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh 2006.
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Elasha B. Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan, 2005.
Paavola J. Livelihoods, Vulnerability and Adaptation to Climate Change in the Morogoro Region, Tanzania, 2004.
Burton I; Hammill A; Sousan J. Livelihoods and Climate Change, International Institute for Sustainable Development, 2003.

[15] African Development Bank; Asian Development Bank; Department for International Development, United Kingdom. Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation, 2003.

have been elaborated. The report believes that the impacts of climate change on the livelihoods of the poor, both direct and indirect, have found their main expression through ecosystems, water resources, agriculture, food safety, and human health. This is because climate change affects the natural environment (natural resources), social and cultural sectors, and socio-economic environment where humans are living[16]. Climate change may also affect the distribution and flow of resources and capitals, and affects the management of resources. Such changes may impose major impacts on the resources people are using, and on their activities to live; or their livelihoods.

This paper assesses the impacts and responses to climate variability and change in the context of rural livelihoods, based on rainfall and temperature data from 23 weather stations in Ningxia from 1961 to 2004 and livelihood surveys in 9 selected sites. Three different regional scale agro-ecosystems are selected for analysis. The survey includes the impacts of climate change on the accessibility to drinking and irrigation water, grain production, cropping composition and sowing area, and farmers' income. It deals, in a substantive manner, with a number of related topics, including different capitals necessary for sustainable livelihoods, activities for making a living, and rural people's capacity. By using a livelihood survey as part of the study of climate change impacts the aim is to provide detailed context for the impacts analysis and framework for regional adaptation. The objectives are to better understand rural people's exposure and vulnerability to climate (and other) challenges and the local institutions' capacity to cope with and adapt to the types of changes suggested by the impacts analysis.

Basic Facts about the Region

Physically located in the northwest part of China (104°17'E -107°39'E and 35°14'N-39°23'N), Ningxia Hui Autonomous Region is one of the five autonomous regions in China. Under the influence of a temperate semi-humid and arid and semi-arid climate, the inland region enjoys a long duration of sunshine at its high altitude, though suffers from strong solar radiation, lower-than-normal air temperatures, active evaporation, large spatial and temporal variations of rainfall, and an uneven distribution of light, heat, and water resources. The region is lacking in water resources. Per capita water resource is only one tenth of the national average. The Yellow River is a major water source accessible to the region.

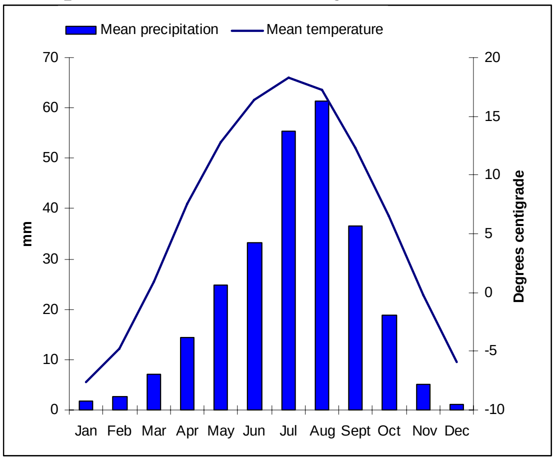
Ningxia can be grouped into three agro-ecosystems, in line with climatic conditions, distribution of farming and animal raising activities, the ecological environment, and traditional customs (Fig. 1):

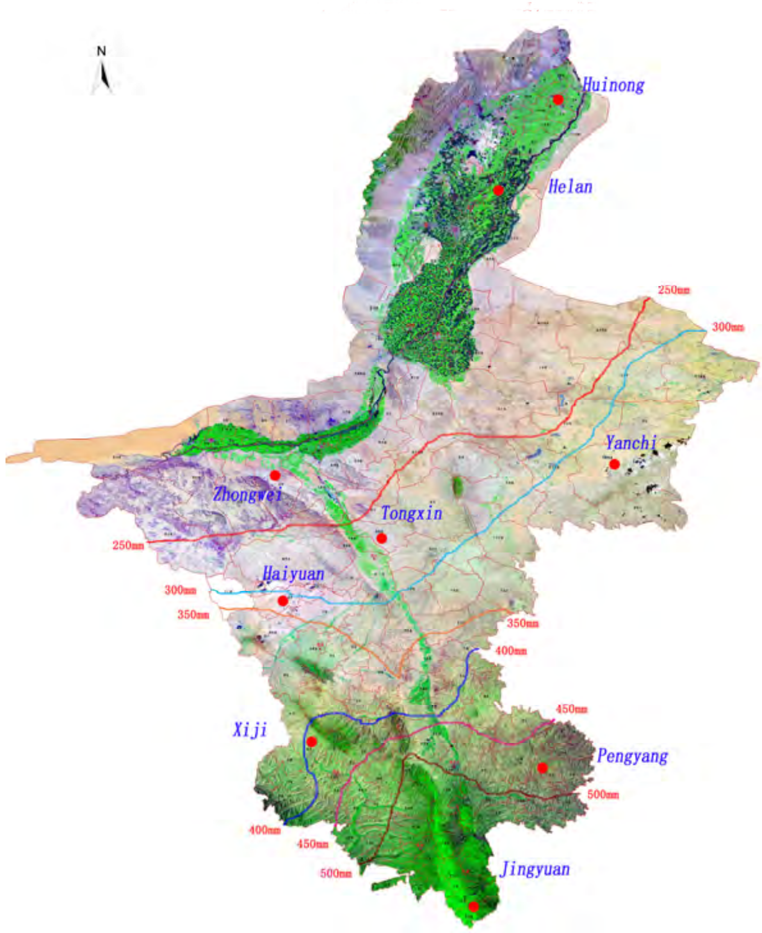
1) The northern irrigation area, using water diverted from the Yellow River, with an averaged annual rainfall of <250mm. Intercropping is the major planting system. The main crops in this area are corn, spring wheat, paddy rice, and potato. Some areas in the northern tip of the region do not grow paddy rice. Cattle, sheep, pig, and chicken are the major livestock raised in the region;
2) The middle arid area, with an average annual rainfall between 250-400mm. The dry land only allows corn, spring wheat, potato, and some cattle and sheep husbandry;
3) The southern rainfed mountainous area, with an average annual rainfall above 400mm. The Guyuan district dominates, where neither irrigation nor intercropping is practiced. Potato is the major crop grown over a large area. This is the only district in the three areas cultivating winter wheat. Some villages in the southern rainfed mountainous area grow silkworms as a special industry. Cattle, sheep, pig, and chicken are the major livestock.

[16] Selvaraju R, Subbiah A.R, Baas S, Juergens I. Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh 2006.

Each sub-region has specific vulnerabilities and risks related to climate change and therefore we identify priorities for action at the regional and sub-regional levels.

Left: Ningxia in China. Right: Ningxia's precipitation and temperature. Below: survey sites in Ningxia

Ningxia is located in North-West China	Precipitation occurs mainly in summer
	



Data and Methodology

Rainfall and air temperature data collected from 23 weather stations in Ningxia from 1961 to 2004. In this study, approaches generally described as Participatory Rural Appraisal (PRA) are used to understand farmers' situations through informal interviews with selected residents in the target areas.[17] Semi-structured interviews are also used in the study, along with questionnaires. Questionnaires are designed to explore the impacts of climate change on different agro-ecosystems in Ningxia. Both the survey sites and questionnaire contents are selected and defined under the guidance of local and technical experts. Climate data and survey results are analysed both quantitatively and qualitatively.

Nine villages are selected in three different agro-ecosystems, in line with the following criteria:

1) Distance to urban areas, and accessibility to resources and other services;
2) The specific crops farmers are dependent on;
3) Levels of wealth.

At least 30 households are selected in a random manner from each target village, with the distribution of 10 wealthy households, 10 medium wealthy households, and 10 poverty households. The survey is designed to collect the following information: background information about respondents, their farming (and other) activities, experiences of recent climate change and associated impacts, adaptation measures and associated costs, opportunities and barriers to adaptation and farmers' expectations of existing and potential government support. The survey and associated data entry were completed between March 2007 and November 2007. 289 households were interviewed, with all questionnaires returned valid.

Climate Variability and Drought in Ningxia

Rainfall

The average annual rainfall (from 23 weather stations) in Fig. 2 shows that Ningxia has experienced a very slight declining trend in rainfall during 1960-2006. 1964 was the wettest year, and 1982 the driest. The rainfall trends during the period 1960-2006 can be summarized into four phases:

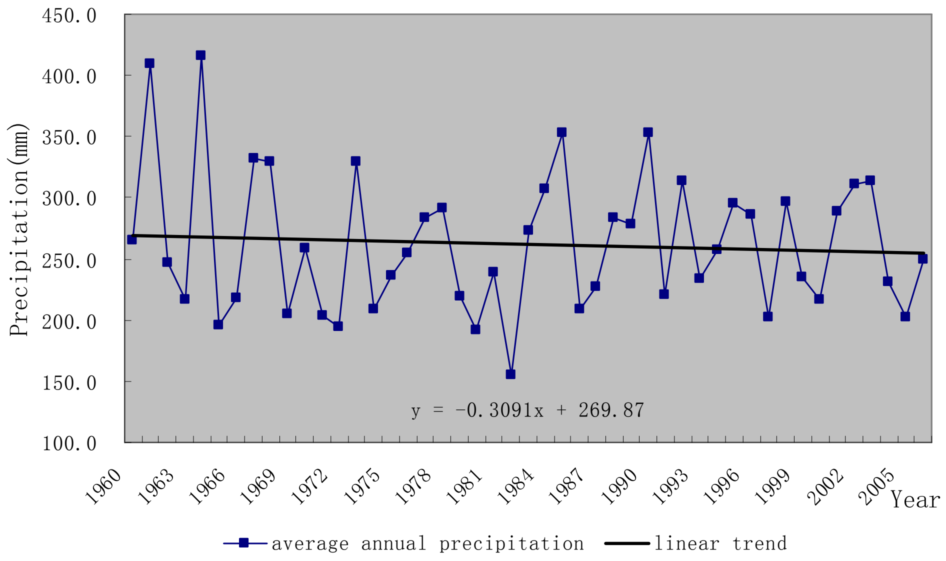
- The region experienced an increasing trend from the early 1960s to the mid-1960s,
- A declining trend from the mid-1960s to the early 1980s.
- From 1980 to 1982 recorded the least rainfall, but recovered after 1982 into the early 1990s.
- The inter-annual variation of rainfall tends to be smaller after 1990.

Another marked feature of the series is the three dry years, from 2004-2006, before and during this survey took place (see section 3.2). It is likely therefore that the respondents' perception of recent climate variability and extremes may be strongly influenced by this recent extreme dry period. In 2005 the average rainfall in Ningxia was abnormally low at only 202mm, making it the second lowest year over the period (in 1982 it was 192mm).

Different areas exhibit large differences in variability and trend. All three agro-ecosystems in Ningxia have shown a noticeable declining trend in average annual rainfall, though different in magnitude. Drying conditions are strongest in the southern region. In terms of the magnitude of variations, both the southern region and middle area have registered large inter-annual variability, with the least variability for the northern irrigation region.

[17] Slocum N. (2003) Participatory methods toolkit – A practitioner's manual. www.kbs-frb.be.

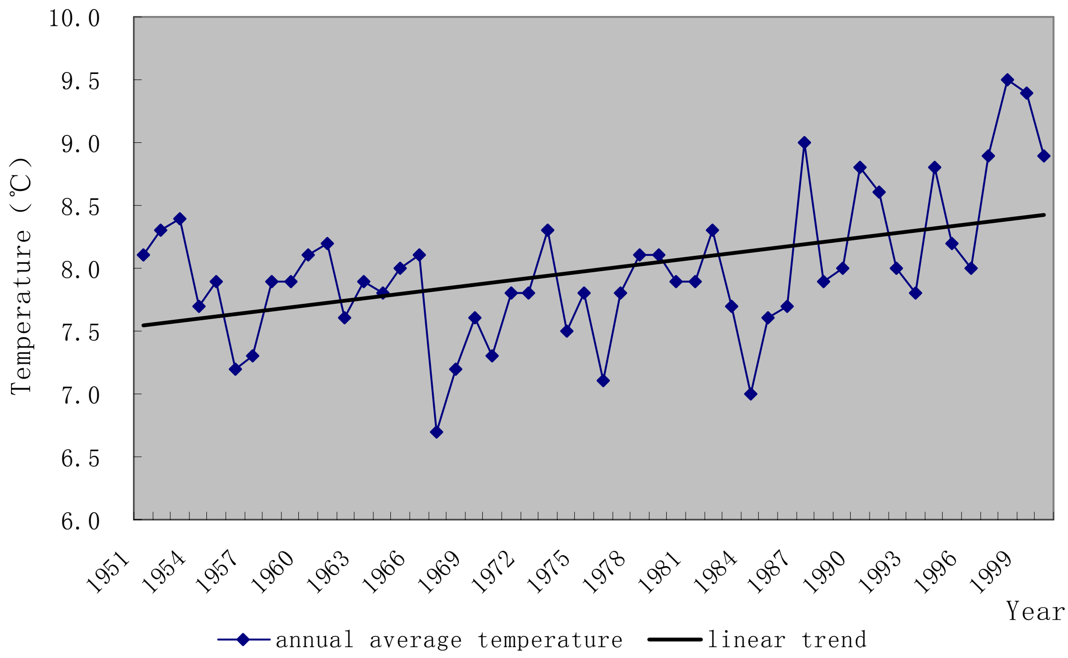
Figure 12: Annual rainfall from 23 sites across Ningxia



Temperature

According to the latest findings of WGI in the Fourth IPCC Assessment Report, in the past 100 years (1906-2005), the global surface temperature has risen by 0.74°C±0.18°C, with a noticeable global warming trend[1]. China is no exception, with a warming trend on the ground in Ningxia. In the first 35 years or so from 1951 to 1983, Ningxia recorded stable annual mean temperatures (Fig. 3), with a fairly marked warming trend from around 1984 onwards, peaking in 1998.

Figure 2: Annual mean temperature in Ningxia[18]



An analysis of variations of annual mean temperature in the three agro-ecosystems from 1961 to 2004 shows the following: all three areas show behaviour very similar to that of

[18] Personal communication, Ningxia's climate change in last 50 years and associated strategy of sustainable development, 2006.

the whole region with recent warming, though slightly different in magnitude. The middle arid area in Ningxia shows the largest increase of temperature.

Occurrence of Drought in Ningxia

Droughts represent a serious threat to farming and animal raising activities across the region. Statistical data on hazards from 1978 to 1999 show that drought accounts for 33% of the total events in Ningxia, and is the number one meteorological disaster in the region. Numerous factors can cause drought, depending on how it is defined; however rainfall is generally the critical factor. We have developed the indexes for droughts, heavy droughts, and drought disasters for the period of 1961-2004 based on the drought indicators defined by the former Central Meteorological Administration (Table 1), and the method used by W.L. Ma[19] for analysing droughts in Ningxia.

Table 1: Drought Indicator

Droughts	Precipitation anomaly (%)	
	Droughts	Heavy droughts
3 months in a row	-25 ~ -50	-50 ~ -80
2 months in a row	-50 ~ -80	≤ -80
1 month in a row	≤ -80 (May-August)	

The results from W.L. Ma and a comparison with the real situation in Ningxia show that droughts with an indicator larger than 0.30 can appear in any year. In this context, we analyse the variations of droughts in Ningxia using the P indicator standard (Table 2).

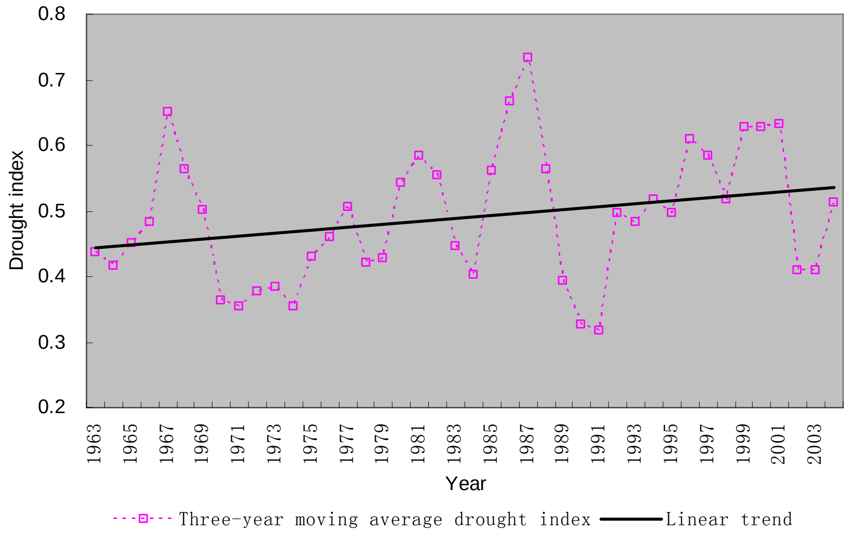
Table 2: Drought grading and indexing

Grade	Magnitude	Impacts on farming activities	Droughts index
5	Heavy	Serious damage to agricultural production, injuries and fatalities, serious property losses, extensive disaster area, and extensive decimation of crops	$P \geq 0.70$
4	Medium	Some damage to agricultural production, some property losses, limited disaster area and decimation of crops	$0.50 \leq P \leq 0.70$
3	Light	Some impacts on agricultural production, with some property losses, and limited damage	$0.30 \leq P \leq 0.50$
2	Limited	No large impacts on agricultural production, with limited property losses and limited damage	$0.10 \leq P \leq 0.30$
1	None	Basically no impacts on agricultural production	$P<0.10$

The variation in the 3-year drought disaster indexes for the period of 1961-2004 shows an ascending trend, with a similar ascending trend for the extremes, though a shortened cycle for such extremes, indicating that the reduced rainfall has escalated (Fig.4).

[19] Li-wen M, Feng-xia L, Xu L, Characteristics of drought and its influence to agriculture in Ningxia, Agricultural Research in the Arid Area, 2001, 19(4), 102-109.

Figure 3: Drought indices over time, for Ningxia



A Focus on the Drought of 2004-2006

The total rainfall in Ningxia from December 2004 to November 2005 ranged from 57mm to 688mm across 23 weather stations. The rainfall in southern Ningxia ranged from 376mm to 688mm, which was about 10% lower than the long-term average in the area. Within southern Ningxia the severity of the drought varied: in Xiji and Liupan Mountain rainfall was close to the long-term average; and in Longde and Jingyuan it was roughly 10-20% greater than the average.

The 2005 drought in other parts of Ningxia was more severe, with rainfall ranging from 57mm to 287mm; roughly 20%-70% lower than the long-term average, indicating that drought and severe drought occurred in most parts of the Yellow River irrigation region and the central arid zone. For some parts of Ningxia this was the driest year in the meteorological records. It is difficult to plant crops in summer and in autumn at Haiyuan, Yanchi and Tongxin, for example. In the central arid zone, 289,000 hectares of crops were damaged by drought; there was not enough water for people and livestock and grass yield decreased significantly. According to the Civil Affairs Department the direct economic loss caused by the drought was 1.27 billion RMB in Ningxia.[20]

Impacts of Recent Climate Variability and Extremes on Rural Livelihoods

In the period from March to September 2007, we visited 289 farmer households in 9 administrative villages, covering five cities in Ningxia (Yinchuan, Shizuishan, Wuzhong, Zhongwei, and Guyuan). We visited 95 households in the northern irrigation area, 101 households in the middle arid area, and 93 households in the southern rainfed mountainous area.

The survey has unveiled the following basic information about the respondents:

1) Distribution of Hui and Han ethnic groups: Han dominates the northern irrigation area and the southern rainfed mountainous area, while Hui dominate the middle arid area (except Yanchi County). All households visited are Hui people in the southern rainfed mountainous area, except one in the southern tip of Jinyuan County;

2) Age groups: differed site by site. In the northern irrigation area, most people interviewed are under the age of 44 (for example, in Helan), and in the middle arid area, the age group of 45-49 prevails;

[20] Source: Project Regional Scoping Study Report, 2006.

3) Education: per capita education received goes down along with the increase of age, in the following order: 5.8 year/person for the northern irrigation area, > 4.2 year/person for the middle arid area, > 3.6 year/person for the southern rainfed mountainous area.

Impacts of Climate Change on Farmers' Livelihood

The following sections present the results of the questionnaire survey and semi-structured interviews. The main themes are ordered as follows; farmers' experiences of recent climate variability, the impacts on their livelihoods (across a range of different activities and assets), their coping and adaptation measures related to climate variability and extremes, their constraints and their views on the role of government to support or enable these activities.

Farmers' Understanding of Recent Climate Variability and Change

In all three agro-ecosystems investigated, most people interviewed believe they have less rainfall than a decade ago. Data published by the Water Resources Bulletin 2006 show that in 2006 the region had an averaged annual rainfall of 249mm, or 14% less than normal[21], or 36.8mm less than 1996. However, the regional rainfall series shows that it is the last three years that have been much drier than usual and this is likely to be what many people are noticing/reporting. Most people in the middle arid and southern rainfed mountainous areas believe that they have seen more droughts in the last decade. In the northern irrigation region, 80% of the respondents believe that they have had some increase in drought frequency. The survey results also show that drought is a major hazard impacting rural livelihoods in Ningxia (Fig.5).

Of all three agro-ecosystems surveyed, drought is the most recognized meteorological disaster, especially in the middle arid area and southern rainfed mountainous area. 90% of the respondents believe that drought is the most damaging of hazards, followed by wind and sand, and high temperature ranking second and third place in the northern irrigation area and middle arid area respectively. In the southern rainfed mountainous area, frost and hail sit in second and third place, respectively. This is mainly because of a damaging frost event for potatoes that occurred in 2006 in the southern rainfed mountainous area. Furthermore, the southern rainfed mountainous area has seen more damaging hailstorms than both the northern irrigation and middle arid areas.

People in the northern irrigation area also believe that both dry hot wind and frost are severe in the area, with more concern about frost expressed in the middle arid area. This is probably due to the type of crops grown and particular extreme events in recent years. For example, spring wheat, which is vulnerable to dry hot winds is a major crop in the northern irrigation area.. On the contrary, in the middle arid area, spring wheat is only grown in Tongxing County. Haiyuan also grows spring wheat. Unfortunately, severe droughts in recent years have forced farmers off the arable land.

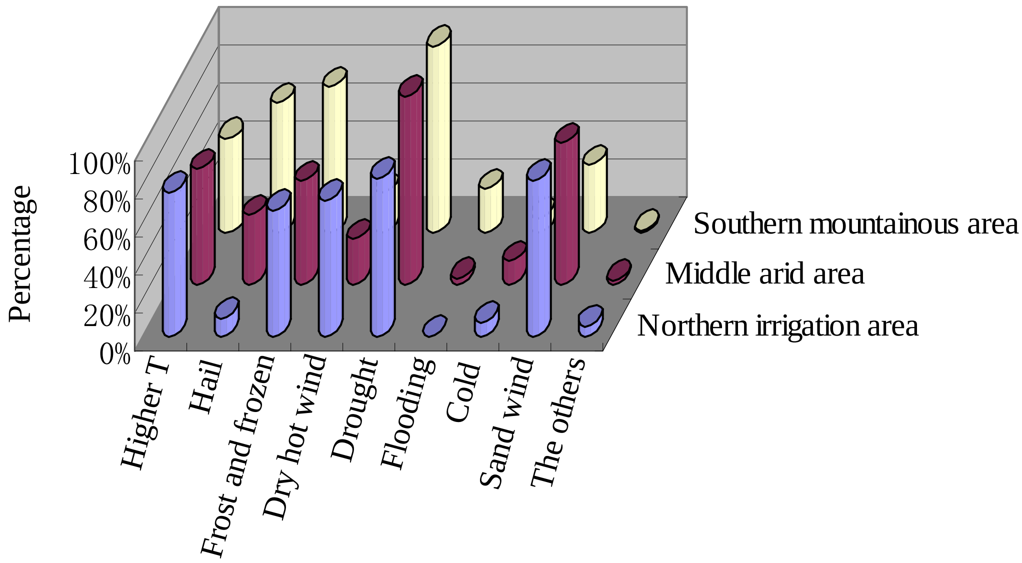
As a result, the impact of dry hot wind on wheat was less expressed in the investigation. In addition, people in the middle arid area feel less strongly about frost, compared with their counterparts in the northern irrigation area. A possible reason is that since 2002, Xuanhe and Helan in Zhongwei, and most of Huinong have experienced frosts each year, though differing in magnitude. People are impressed with its damaging effect on farming activities.

In the middle arid area, people grow fewer crops because of droughts, with little attention paid to what has happened in the fields. The limited occurrence of frost is also a reason for indifference. Furthermore, people in the southern area do not think much of high

[21] Department of Water Resources of Ningxia Hui Autonomous Region (2007) Water Resources Bulletin of Ningxia Hui Autonomous Region (21).

temperatures, winds and sands, which are to a large extent associated with the occurrence of droughts.

Figure 4: The main meteorological hazards impacting agriculture



Major Impacts on Farmers' Livelihoods

The impacts of recent climate variability differ across the three agro-ecosystems in Ningxia. Overall, the northern irrigation area has fewer impacts, with more impacts felt in both the middle arid and southern rainfed mountainous areas, though these differ in magnitude. Recent climate variability has touched many aspects of farmers' livelihoods.

Impacts on Drinking and Irrigation Water

Variation of averaged annual rainfall recorded by 23 weather stations in Ningxia shows a very slight negative trend (Fig 2). An analysis of drought occurrence also shows an increased frequency of droughts. Variation of rainfall and droughts directly affects people's accessibility to both drinking and irrigation water. At the local scale the northern irrigation area is guaranteed its drinking water (excepting upstream or basin scale changes). Farmers have access to both tap water and well water. Relatively affluent water resources leave people with little awareness of the issue of accessibility to drinking water (Table 3). However, 68% of the respondents in Huinong believe that it is becoming more difficult to obtain drinking water as the result of reduced rainfall, though their drinking water is basically guaranteed. Irrigation water has been reduced in terms of both irrigation frequency and quantity, as the result of reduced rainfall and increased droughts. Survey results have fully confirmed the concern. For example, of the three surveyed villages in the northern irrigation area, 40% of the respondents believe that it is becoming more difficult to obtain water for irrigation, as the result of reduced rainfall, droughts, rationed supply of Yellow River water, and increased water tariffs (Table 4).

The middle arid area records significant effects of climate variability. In both Tongxin and Yanchi, drinking water is secured for most people and animals, though people in some localities have to buy water when droughts hit. The farmers who depend on rainwater collection cellars in Haochuan of Huaiyuan have to buy water in the drought period. At least 94% of the respondents in the middle arid area believe that it has become increasingly difficult to acquire needed drinking water. At least 90% of the respondents in the middle arid area confirmed the increasing difficulty of acquiring irrigation water, though Tongxin is the only site provided with irrigation in the area. Overall, impacts of recent climate variability on drinking and irrigation water have been felt most in the middle arid area.

In the southern rainfed mountainous area, Jinyuan County has well water for both humans and animals, while in Pengyang County, rain and snow are the main source of water, though some farmers have to buy water. Xiji County has more water resources, though buying water is also common, with well water and rain/snow water as supplements. Farmers in both Pengyang County and Xiji County are more affected by recent variability, compared with their counterparts in the middle arid area. Almost every respondent (100%) in Pengyang County felt so (Table 3). 97% of the respondents in Jinyuan County have seen no change in the accessibility to drinking water. This is mainly due to the higher rainfall around Liupan Mountain and the surplus ground water in the County. Well water is a major water source for farmers. Droughts have led to a reduced water level, with less groundwater available to farmers, though water needs are basically met. In addition, the southern region practices farming activities mainly dependent on natural precipitation, rather than irrigation (Table 4).

Table 3: Results of questions about access to drinking water. (Question: How do you obtain drinking water for you and your family? Does the availability of drinking water vary from year to year?)

Survey sites		Water resource	Acquisition of drinking water			
			1=easier	2=more difficult	3=no change	4=unclear
Northern area	Huinong of Shizuishan	Tap water	3%	68%	0	29%
Middle arid area	Ligang of Helan	Well water	0	3%	6%	91%
irrigation	Xuanhe of Zhongwei	Well water	32%	0	3%	65%
	Hexi of Tongxin	River water	0	3%	83%	14%
	Dashuikeng of Yanchi	Well water	0	21%	79%	0
	Haochuan of Haiyuan	Bought water	0	94%	6%	0
Southern rainfed mountainous area	Xinmin of Jingyuan	Well water	0	3%	97%	0
	Caomiao of Pengyang	Rainwater collection	0	100%	0	0
	Erfuying of Xiji	Bought water	0	94%	6%	0

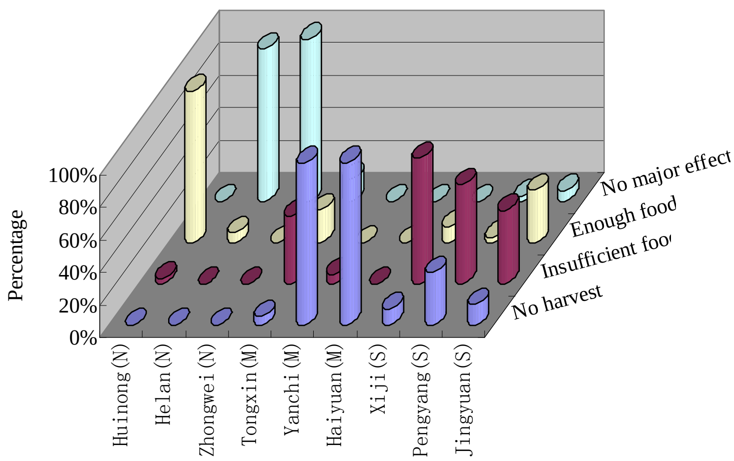
Table 4: Accessibility of irrigation water. (Question: Does the availability for irrigation water vary from year to year?)

Investigation site		Accessibility to irrigation water		
		1= change	2= no change	3= unclear
Northern irrigation area	Huinong of Shizuishan	40%	10%	50%
	Ligang of Helan	58%	9%	33%
	Xuanhe of Zhongwei	62%	19%	19%
Middle area	Hexi of Tongxin	94%	3%	3%
	Dashuikeng of Yanchi	No irrigation		
Southern arid mountainous area	Haochuan of Haiyuan	No irrigation		
	Xinmin of Jingyuan	No irrigation		
	Caomiao of Pengyang	No irrigation		
	Erfuying of Xiji	No irrigation		

Impacts on Grain Production

Survey results show that reduced rainfall and increased occurrence of droughts have jeopardized farmers' grain production activities greatly, though different in magnitude by area (Fig. 6). Reduced rainfall and increased droughts in recent years have affected the grain production in the localities, with the least impact felt in the northern irrigation area. At least 90% of those investigated have marked "having enough food to eat" and "no impacts", indicating that the impact of droughts has not yet reached the point of threatening farmers' food security, though droughts have somewhat affected grain production in the locality.

Figure 5: Impacts of drought on grain production. Note: N is northern irrigation area; M is middle arid zone, S is southern mountainous area



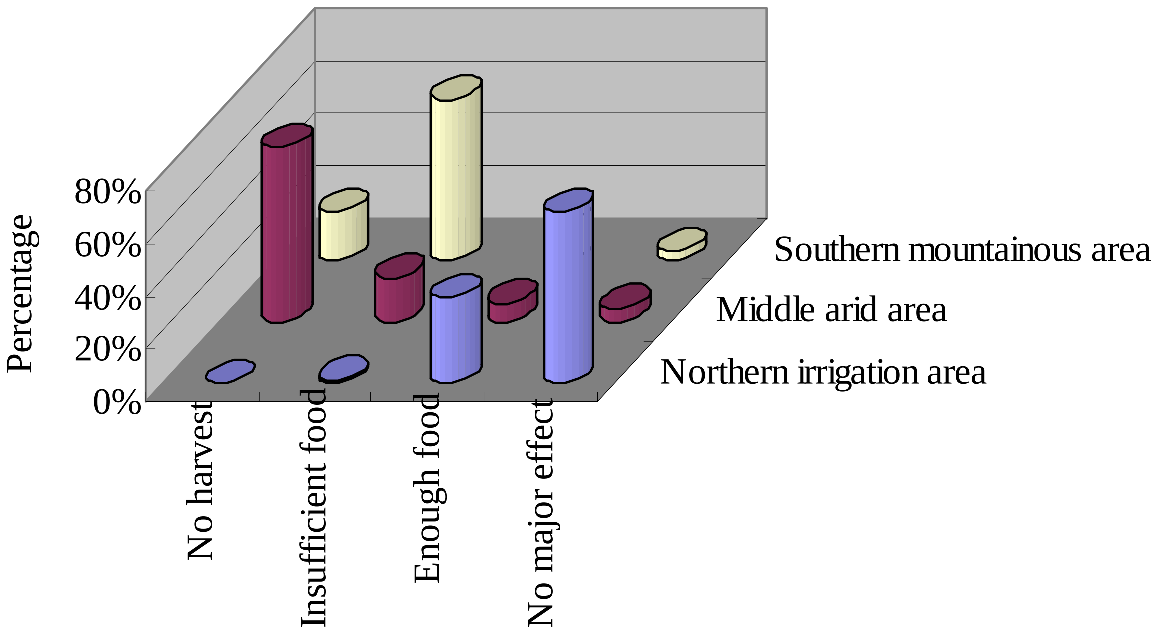
All three survey villages in the southern rainfed mountainous area have at least 40% of their respondents who marked "insufficient food", indicating that some impacts of recent climate variability have been felt on the local grain production, which in turn have affected local farmers' food demand, though most farmers have some harvest.

In the middle arid area, all four options (no yield, insufficient food, sufficient food, no impact) were selected by the respondents in Tongxin, while 95% of the respondents in both

Yanchi and Haiyuan selected 'no-yield'. The relatively even distribution of selected options in Tongxin is associated with the fact that the village has irrigation, so the impacts on grain production are mainly determined by the area of cropland and rationed water for irrigation. Field investigations in Yanchi and Huaiyuan show that reduced rainfall, especially in Haochuan of Haiyuan for five years in a row, produced major impacts on local grain production. The increased frequency and intensity of droughts has forced farmers out of arable farming. As a result, the subsidy from "Grain for Green" Programme has become an important income source for the survival of most farmers.

An integrated analysis of the impacts of reduced rainfall and increased droughts on farmers' grain production (Fig. 7) has shown that all three areas have seen grain production affected, though different in magnitude. The northern irrigation area is least affected. The southern area has a magnitude of impact felt between the northern irrigation area and middle arid area. The middle arid area has been seriously affected. 60% of the respondents selected the option of "no yield", which is consistent with the conclusions drawn by WGII in the Fourth IPCC Assessment Report that the increased frequency of droughts has imposed negative impacts on farming activities[22]. As a result, the negative impact of reduced rainfall and increased droughts on the middle arid area has become a serious issue of food security, which calls for prompt measures from the government. It should be a top priority for government in formulating its policies and action plans.

Figure 6: Impacts of drought on grain production (Question: What was the effect of the most serious drought on your family?)



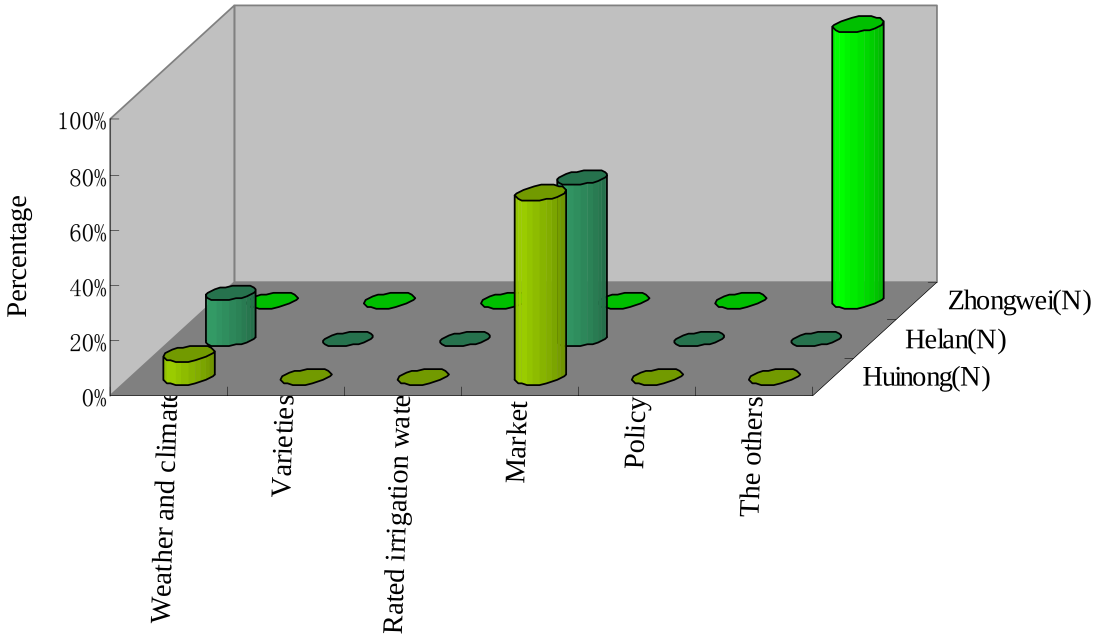
Impacts on Cropping Composition and Sowing Area

At least 50% of the respondents in both the northern irrigation area and the middle arid area believe that drought is a major factor contributing to a change in cropping composition and sowing area in the last decade. Farmers are inclined to choose a crop that is more adaptive, multi-functional, and high yielding with better economic returns, such as corn, potato, Chinese Wolfberry, and sunflowers. In the middle arid area, both weather and climate (decreased rainfall and increased droughts) are believed to be the main reason for the change

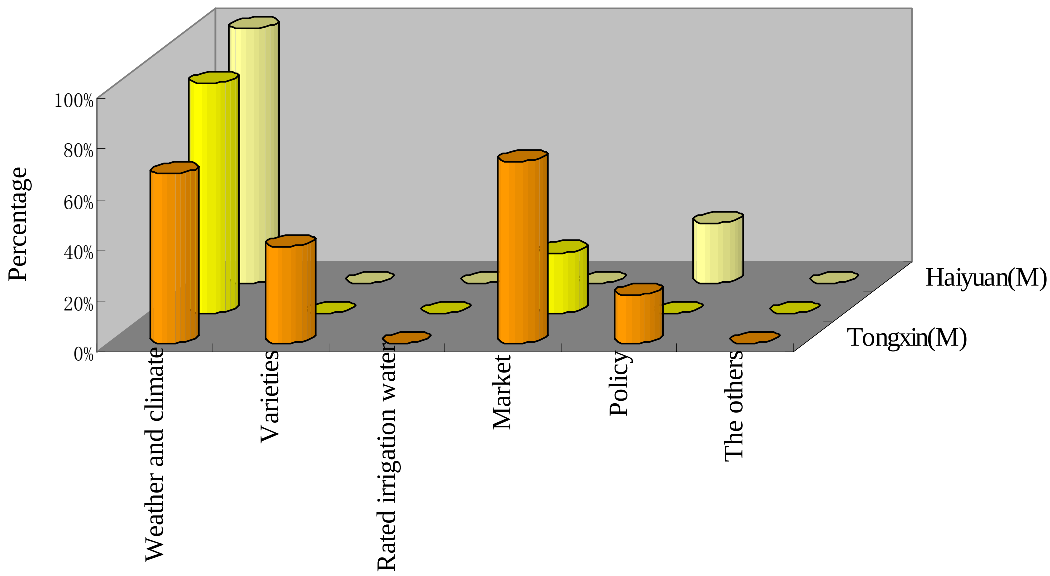
[22] IPCC (2007b) Working Group II Contribution to the Intergovernmental Panel on Climate Change.

in cropping composition and sowing area, topping other factors, such as change of marketplace and distribution of irrigation water (Fig. 8). The salinisation and alkalinity of croplands, indirectly caused by the raised groundwater level as the result of construction of the Qixing Water Canal, is another
major factor.

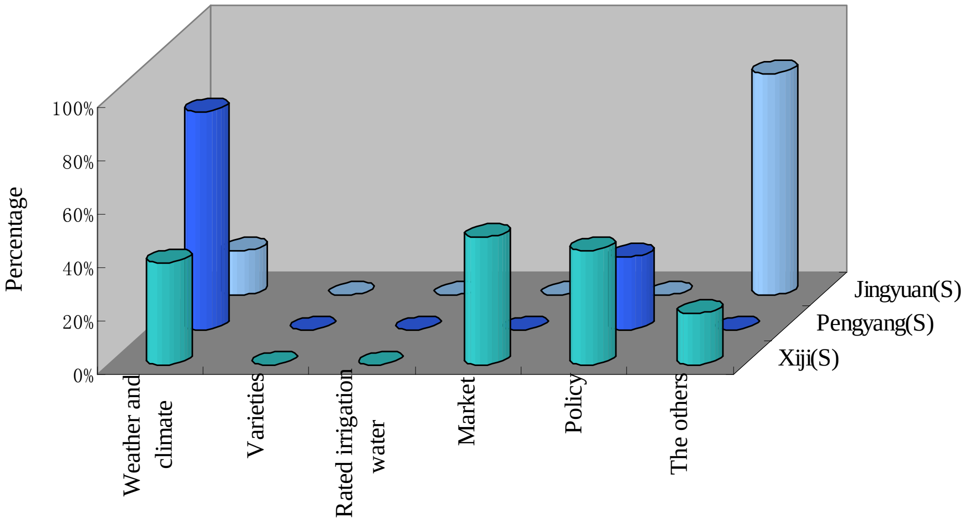
Figure 7: Causes of changes in crop composition (Question: What are your reasons for changing the crop composition?)



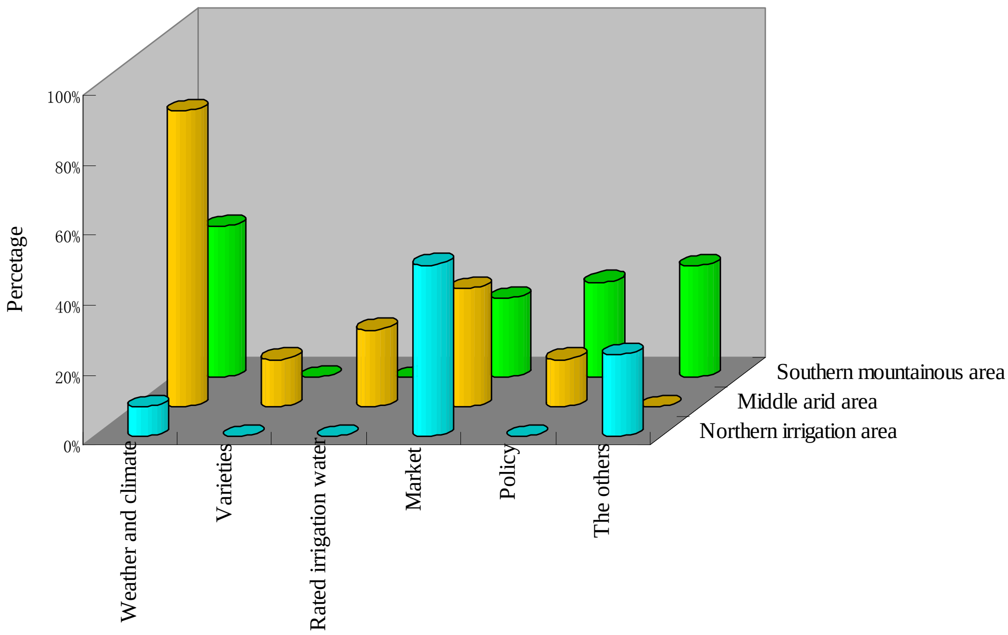
(a) The northern irrigation area



(b) The middle arid area



(c) The southern rainfed mountainous area



(d) The three agro-ecosystems in Ningxia

For the southern rainfed mountainous area, at least 60% of the respondents in Xiji County believe that they have changed their cropping composition. The same number of people in Jinyuan and Pengyang counties say that they have not changed cropping composition. This is a result of complicated reasons, though climate, policy, and market are the major influence factors (Fig. 8). Currently, rainfall conditions allow normal farming activities. As a result, people do record a large variation in cropping composition, except where the "Grain for Green" Programme has reduced the arable area. In Xiji, growing potato is encouraged by the local government for its high market price. The drought resistance of potato and its promising market price are the two major reasons for converting wheat and soybeans to potato.

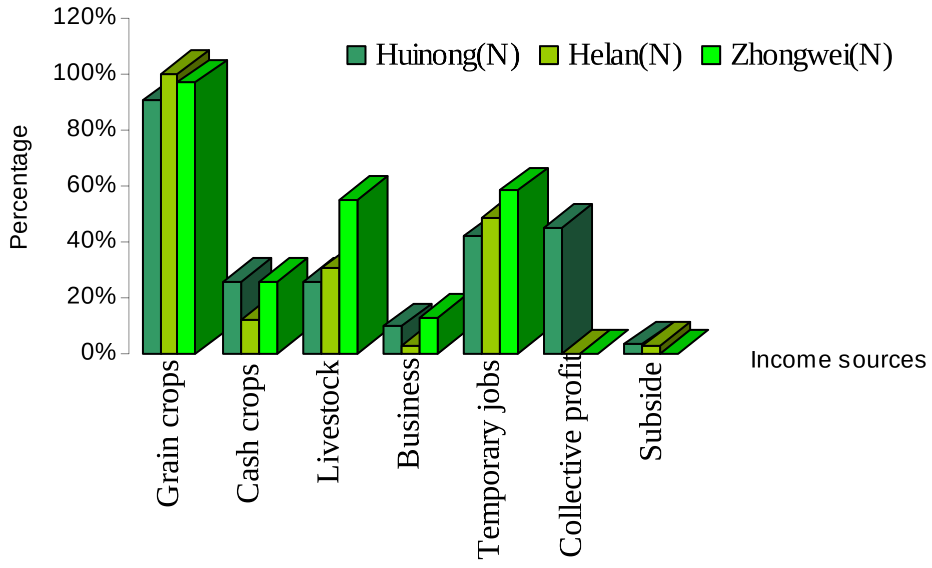
While witnessing changes in cropping composition, people have also seen changes in sowing area, though different in magnitude. The change in sowing area corresponds with the change of crop type, in a direction for more advantageous crops. The reason is the same:

climate variability and change is the key element, along with other lesser factors, such as change of market price and policy guidance. For example, Haiyuan has experienced a reduced rainfall in recent years, from 453mm in 2003 to 247mm in 2004, a decrease of 206mm. The reduced rainfall has also resulted in frequent occurrences of droughts with heavy damage. The local government has introduced watermelon as an adaptation to climate change. Covered with small stones to retain soil moisture, planting watermelon is drought resistant and a water saving practice. Growing watermelon in the locality creates a niche industry with a promising market perspective.

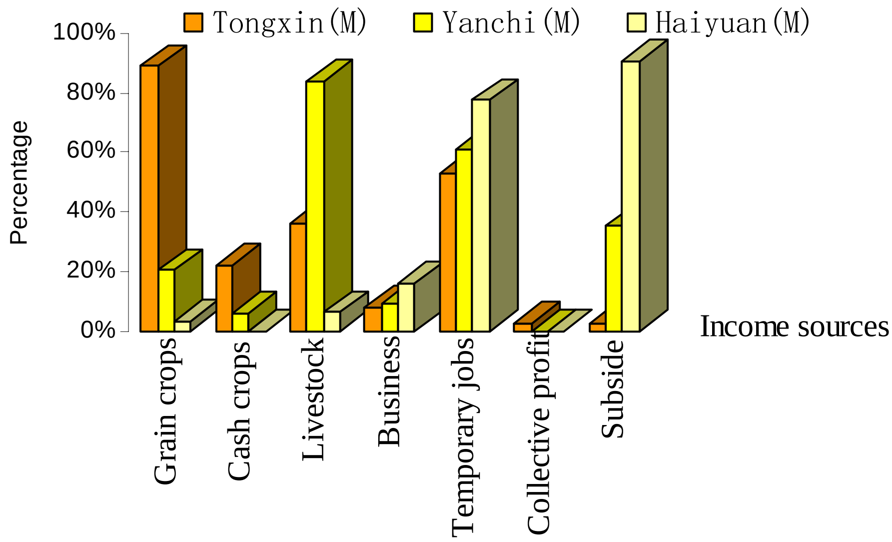
Impacts of Climate Variability on Income

Drought is shown to have a direct impact on the acquisition of drinking and irrigation water, affecting farmers' daily life and farming activities, which in turn affects farmers' income. Survey results have shown different income patterns for the farmers in the three different areas (Fig. 9). Farmers in the northern irrigation area earn their income mainly from growing cereals, working in the urban areas, local businesses, or from raising domestic animals, with limited income from growing cash crops. Farmers in the middle arid area make their income mainly from working in the urban areas, raising domestic animals, subsidies, and growing cash crops, except for Tongxin County where growing grain crops is an important income source because water is available. Farmers in the southern rainfed mountainous area earn their income mainly from subsidies, working in the urban areas, growing cereals and cash crops, with limited income from raising domestic animals and doing business.

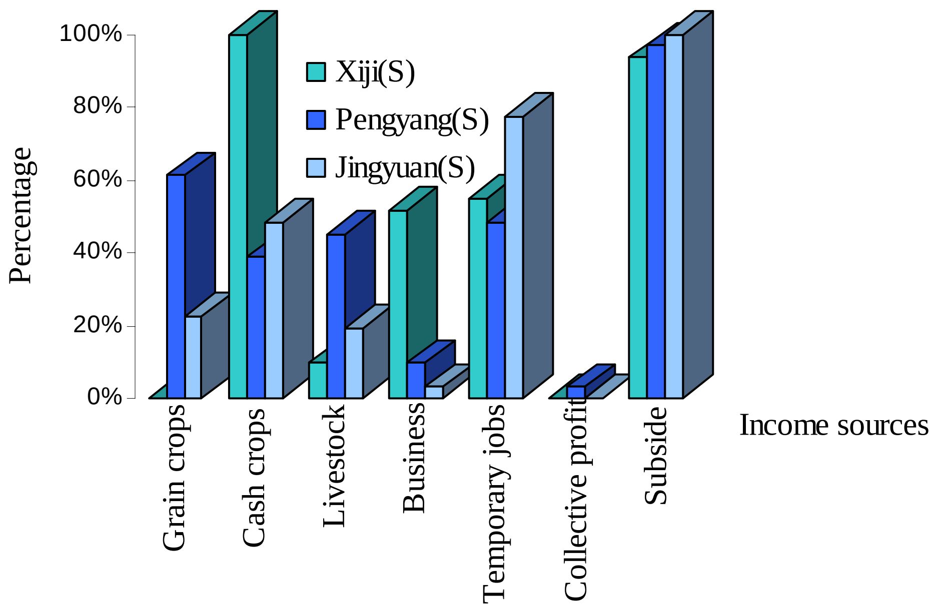
Figure 8: Income sources (Question: Which of these contribute to your income? Note: this was a multiple-choice question.)



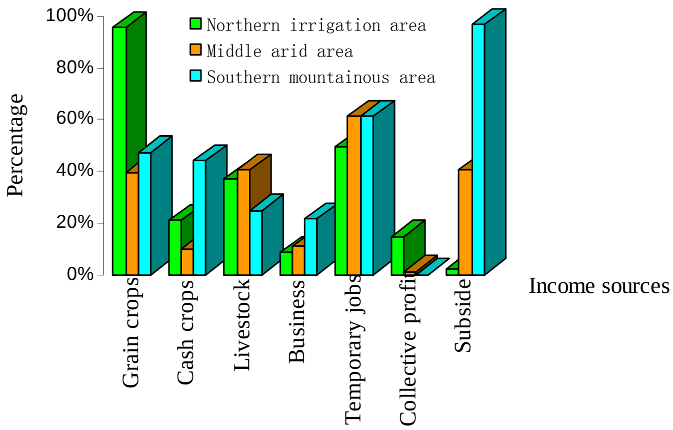
(a) The northern irrigation area



(b) The middle arid area



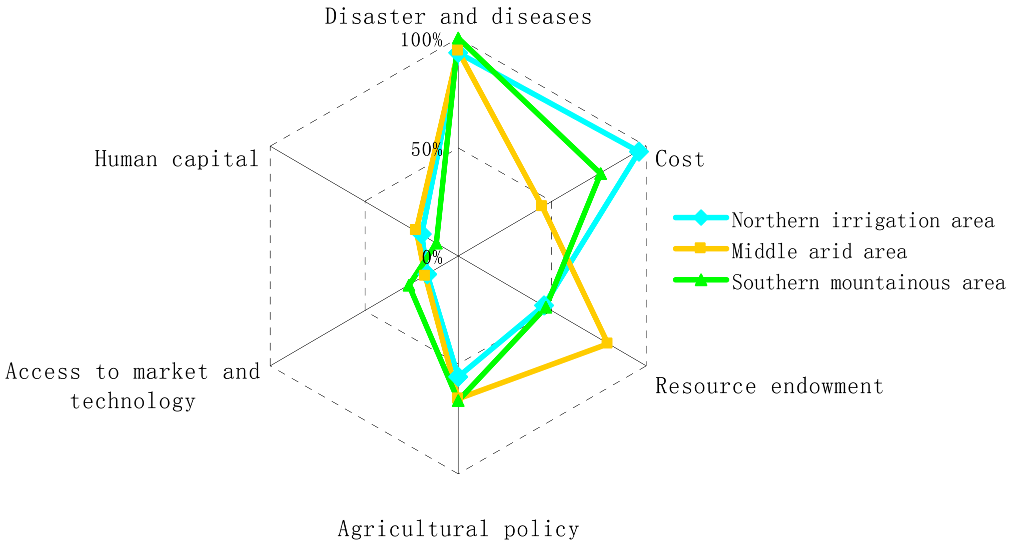
(c) The southern rainfed mountainous area



(d) Three agro-ecosystems in Ningxia

An analysis of the key factors affecting farmers' income (Fig. 10) reveals that both hazards (mainly meteorological ones) and diseases are the major factors affecting farmers' income. The fundamental causes, such as reduced rainfall and increased occurrences of droughts, have produced a large impact on local farming activities, resulted in water shortage, which in turn affects farmers' life.

Figure 9: Major factors affecting farmers' agricultural incomes (Question: Which factor has had an impact on your family's agricultural income over the last 10 years?)



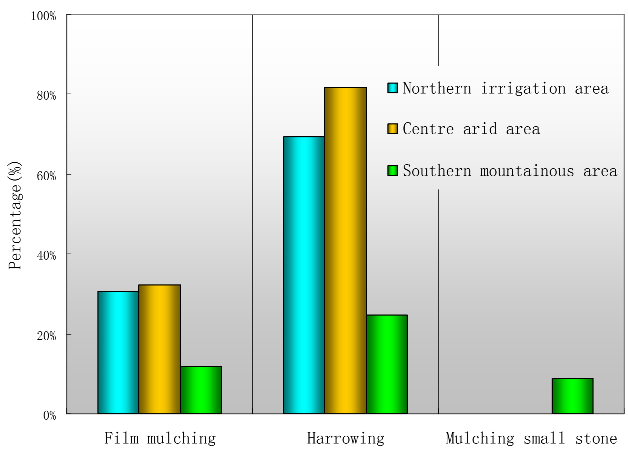
In addition, production expenditure, resources, and agricultural policies are the other factors mentioned by the respondents. Of these, the impact of production expenditure on income is felt most strongly in the northern irrigation area, which is associated with local farming and animal raising activities.

Farmer Adaptations to Climate, Climate Variability and Change

Measures to Cope With the Dry Climate, Drought and Maintenance of Soil Moisture

The perennially dry climate and limited availability of soil moisture undermines agricultural production in the region. This is greatly exacerbated by periodic reductions in moisture, related to the occurrence of droughts. Unsurprisingly, farmers use a wide range of measures to retain and enhance soil moisture (Fig. 11).

Figure 10: Measures to retain/enhance soil moisture (Question: What measures have your family taken to retain soil moisture?)



As is shown in Fig. 11, harrowing, film mulching, and sand cover are the most common measures used by farmers to maintain soil moisture. Harrowing is the most popular measure, most used in the southern area, and in Huinong and Helan of the northern irrigation area, at a cost between RMB35-50 per mu. The method can increases yields by around 40%. It is a common measure used by farmers across all the sites investigated. Other measures showed large differences by area. Film mulching is widely applied in Huinong, with a cost of RMB 90 per mu.[23]

Film mulching has different effects on crops, depending on the crop type. For example, successful dehydrated vegetable production depends on film mulching, whereas growing potato with film mulching may increase the yield by around 30% per mu.

Mulching with small stones is only applied in Haiyuan, and has become an effective measure for coping with droughts in the locality. Growing watermelon, as an adaptation measure, is costly, at some RMB 600 a mu, and farmers can earn net profit about 241.3 RMB per mu.[24] In this context, it needs capital support.

Rainwater Collection Measures

The three areas differ greatly in their using of rainwater collection measures. The northern irrigation area has relatively sufficient water resources, and uses almost no rainwater collecting measures. The middle arid area has a tradition of using the water collected by cellars for farming and domestic purposes. Each household generally has one or two water cellars. Costs for constructing a cellar are varied, depending on the volume, ranging between RMB 500-1000. The cellar construction is partially financed by the local government, in the form of cement and brick, with a 50% proprietary payment by local farmers.

In the southern rainfed mountainous area, there are no rainwater collection measures in Jinyuan County. In Pengyang County, farmers collect rainwater using catchment area[c] and water cellars, at a cost of RMB 2000 or so. The cost to build a water cellar also varies according to the size and material used, ranging from RMB 500 to 2000. The government provides cement for building the catchment ground and water cellar, with a 50% contribution to the locality. In Jixi County, farmers store water using water cellars. Drinking water is mainly from well water that has to be purchased. There is no rainwater collecting measures in the locality. Fortunately, with the support of a national project to combat drought, for the period of 1998-1999, farmers were encouraged to build terraced fields to collect rainwater, with 90% of the investment coming from the government, and 10% from individual farmers. It costs some RMB 200 to build a mu of terraced field. As the respondents mentioned, the terraced field produces a yield higher than that produced in sloppy ground with lower soil moisture by around 30-50%.

Water Saving Irrigation Measures

As most parts of the middle arid area do not have water available for irrigation, water saving irrigation measures are mainly applied in the northern irrigation area, with furrow irrigation being the most popular. Survey results show that only Huinong and Helan have taken measures. 52% and 33% of the respondents in Huinong and Helan report that they have used furrow irrigation in the past. Though believing it is an accepted water saving technique,

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[23] 1Mu=0.067 ha

[24] http://www.nxcpic.gov.cn/NewsInfoManageFPAction.do?flag=b&NEWS_ID=774

[25] Man-made open-air surfaces that are designed especially for rainwater harvesting. There are various materials that can be used on the catchment surface to reduce permeability, such as gravel-covered plastic sheeting, concrete, asphalt fibreglass. Compacted earth is commonly used and is also the cheapest catchment surfaces. (Tian Y, Li FM, Liu PH. (2003) Economic analysis of rainwater harvesting and irrigation methods, with an example from China. Agricultural Water Management. 60:217-226.)

farmers have not yet fully accepted furrow irrigation. The authorities concerned also believe that it is difficult to disseminate the technique.

Off-Farm Income Generation

Off-farm income generation is an important income source for the local farmers (Fig. 9). All three areas have income derived from working off-farm, with a percentage above 50%. Labour export in Ningxia is either government encouraged or a spontaneous action by farmers. In the middle area where the poor ecological environment dominates, both types of labour export are evident, which probably explains why the area had the highest percentage of respondents who marked ‘working outside’.

Except to the northern irrigation area, with has a better ecological environment, farmers in both the southern rainfed mountainous and middle arid areas are growing crops primarily for their own food needs, with few people able to sell their surpluses. These farmers are more vulnerable to the increased frequency of drought and other hazards such as hail. In this context, farmers who have the diversified income sources other than farming are less vulnerable to climate change.

Migration

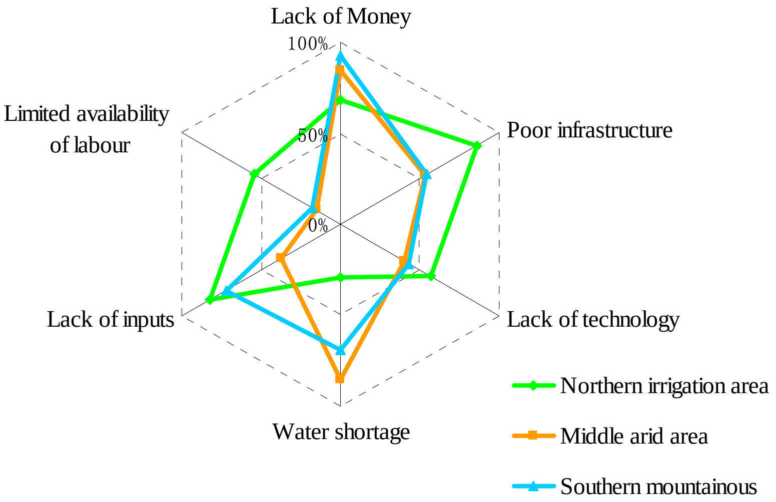
Migration is also called ‘Diaozhuang’[26] in Ningxia. In the area surveyed, most residents of Yanghetaozi Village in Tongxin County are the migrants. Their forefathers lived in a village called “crying for water” several decades ago, which is located deep in the deep mountains, with extremely tough living conditions. A national project to divert the water of the Yellow River has allowed the residents of the village to move to Yanghetaozi. This is an example of large-scale migration. Ningxia has developed much experience in moving people from poor to better environments. However, migration needs major support of capital funds and careful coordination and planning. The migrants in Tongxin County appear to have better livelihoods than before and compared to nearby villages that have no irrigation. They believe migration is a successful adaptation measure to climate hazards.

Factors Constraining Farmers’ Adaptation in Ningxia

Farmers spontaneously respond to environmental conditions and particular events. However, many factors influence their ability to do so. Fig. 12 shows that farmers have other difficulties other than available labour. For example, in the middle arid area, water shortages and insufficient capital are major constraints. In the northern irrigation area, farming activities produce major incomes for the local farmers. As a result, farmers believe that they need more capital investment in infrastructure and in their farming activities. Due to less available water for irrigation under drought conditions, timely irrigation cannot be ensured in northern irrigated area. In the southern rainfed mountainous area, money and water availability are the constraining factors. It is worth mentioning that in all three areas, 85% of the respondents believe that money is an important factor limiting their capacity to implement adaptation measures.

[26] Diaozhuang means that farmers migrate to other villages in the growing season, returning home in the winter with government help. The farmers settled down in the new village when they were used to local conditions.

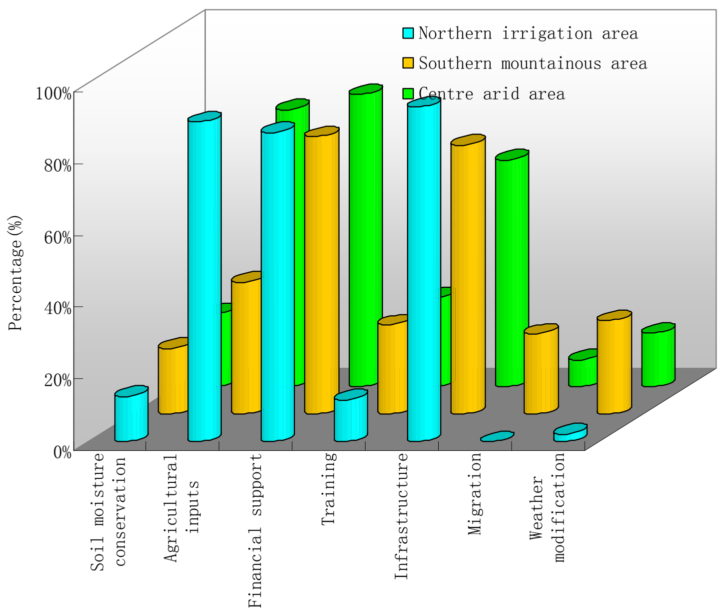
Figure 11: Major constraining factors (Question: What are the main barriers that prevent you from taking adaptation measures?)



Farmers' Expectations for Government Support and Policies

Farmers have encountered numerous difficulties in adapting to climate variability, and in dealing with climatic hazards. In addition to their own efforts, farmers hope that government will play a role, with an array of expectations as shown in Fig. 13. For example, farmers in the northern irrigation area hope that the government will provide strong support to the construction of infrastructure, and to secure more investment for farming activities. This wish is associated with the prevailing animal husbandry and small business activities in the locality. Farmers in the middle arid area would like strong support from the government, mostly in the form of cash, as farming activities in the locality have been seriously affected by droughts. They believe that the problem cannot be solved simply by having more irrigation systems, and by increasing investment in farming activities. They also need cash assistance from the government. Farmers in the southern rainfed mountainous area have the same wishes as their counterparts in the middle arid area, hoping for more money for farming activities.

Figure 113: Farmers' expectations of government (Question: What government programmes could help you to adapt to weather-related disasters?)



Conclusions

Meteorological observations show that since the 1950s Ningxia has experienced a warming trend in annual mean temperature, high rainfall variability, with a major drought during 2004-07, and some evidence for an increase in drought frequency/severity. These events have imposed impacts, though differing in magnitude, on all aspects of farmers' livelihoods, including accessibility to drinking and irrigation water, grain production, cropping composition, sowing area, and income.

1. All three areas in Ningxia are vulnerable to current climate variability and extremes, though differing in magnitude. The variation of rainfall and temperature, especially reduced rainfall and frequent occurrence of meteorological hazards (e.g. frost, hail, sandstorm), are felt across the three main agro-ecosystems of Ningxia.
2. Different areas differ in their vulnerability to the impacts of climate variability. For example, people in the middle arid and southern rainfed mountainous areas are more vulnerable, compared with their counterparts in the North, because irrigation in the north reduces exposure to variability and extremes and is associated with greater background levels of wealth and adaptive capacity.
3. Farmers who only rely more on agriculture tend to be poorer and more vulnerable than others. This can be explained by the ecological environment and agricultural development in the locality. For example, in both the southern and middle arid areas where natural conditions are poor and farming practices are traditional, farming is the predominant way in which farmers meet their food needs. Few people are able to make extra money from farming activities. These people are more vulnerable to the frequent occurrence of droughts and hailstorms. Haiyuan County in the Gaochuan District is a typical example.
4. Local farmers have adopted some adaptation measures, but these are not always enough; neither to cope successfully with existing hazards, nor changes in their frequency/magnitude in the future. The main measures adopted by farmers include soil moisture retention, efficient irrigation, labour export, and migration. Migration is a means to improve farmers' living environments, while soil moisture retention, efficient irrigation, and terraced fields are improvements in cropland management. Water cellars and rainwater catchment areas are widely used mainly to meet farmers' basic daily needs. Labour export[27] is an important income source for farmers. It can be seen that the measures adapting to climate change have covered many aspects of farmers' lives. At present, many farmers in Ningxia are living in very marginal conditions, and adaptation measures are constrained by a range of factors, including available water resources, capital, and infrastructure.
5. Location (relative to urban areas), background wealth levels, and education level appear to be key influencing factors on adaptive capacity. The northern irrigation area enjoys the existence of Yinchuan City, the capital of the autonomous region, with convenient accessibility, and a fast growing economy. The respondents in the northern area have an average education level of 5.8 years above the other two areas.

Response Strategies and Suggestions

Local farmers have adopted some adaptation measures to cope with climatic variability and extreme events. Meteorological extremes and longer term variability have affected every aspect of farmers' livelihoods. Their experiences and the support from local and regional level institutions can provide insights into suitable strategies and policies to enable and support more effectively these activities in the future. Because of the close alignment at the community and household level between adaptation (reducing vulnerability to climate change)

[27] Labour export includes hiring for other farming jobs and non-farming employment local or non-local.

and more generic individual and institutional aims for development there exists good potential to mainstream adaptation into development plans and poverty alleviation processes.

What are the main risks and opportunities that climate change represents to farmers in Ningxia? What strategies are most appropriate to reduce vulnerability to these changes, at local and regional levels?

Given the challenges, appropriate measures could consider some or all of the following:

I. Water-Saving Agricultural Practices and Technologies

1. **Soil moisture conservation and other agricultural technologies.** Measures include household-based, community-based, and government-based technologies and practices. Hoeing, plastic film mulching, mulching with crop residues, coarse sand and gravel mulching, field levelling, sowing in the furrow between film-covered ridges, sowing in the holes on film-covered ridges, selection of drought resistant varieties and crops, retaining stubble/low tillage and cellar can be adopted by individual farmers. Terracing and contour farming to prevent water and soil erosion can be adopted by farmers with the support of local government.
2. **Carry out water saving irrigation measures.** Measures include border and furrow irrigation, surface level plastic irrigation pipe, smaller plot irrigation, deficit irrigation. These technologies can be adopted by households. Measures can be applied by community-based and supported by local government including underground pipe systems, lined canals with cement, sprinkler system in southern region, root-zone drip irrigation and under mulch irrigation.
3. **Collect rainwater for supplementary irrigation.** Construction of catchment areas and cellars to collect rainwater, using collection farms can be adopted by community.

II. Adjustments to Infrastructure

1. Increase **irrigation area** through increase of water diversion from Yellow River to middle arid area and promotion of west line water diversion of South-North Water Diversion Project. It will be important to consider the wider implications of increasing water availability in the context of Ningxia and Yellow River water allocation potentially affecting the sustainability of supply.

III. Policy

1. **Integrate climate risk reduction and planning into poverty reduction programmes.** By developing infrastructure and technologies to improve adaptive capacity, and thereby increase resilience to climate change. These aims fit closely with Ningxia’s development goals and therefore represent good ‘no regrets’ opportunities to mainstream adaptation into regional development plans.

   Farmers’ perceptions of the main constraints they face and their expectations of government also vary across the region. However, they are consistent on major issues, namely farmers in all three areas have difficulties securing capital and infrastructure. Science and Technology advancement is a key area for promoting the development of productivity. In addition, farmers have expressed a strong need for monetary assistance from the government. Ongoing measures for poverty alleviation are the most appropriate delivery system for such needs but there is an argument for ensuring that these incorporate some level of climate risk assessment, to incorporate short-term exposure to extremes (e.g. improved drought forecasting and response) and longer-term shifts in climate conditions (planning for infrastructure, re-location/re-structuring of farming activities).

2. **Continue to support 'no regrets' measures.** Rural livelihoods in Ningxia are dynamic: Farmers already implement a range of climate risk reduction strategies to maximize their production in often marginal conditions, livelihoods are increasingly diverse, reducing exposure to climate related risks. Existing strategies should be reviewed against changing patterns of climate risk and, given other considerations, selected for support. There may be a case for targeting specific adaptation measures at poorer and more at risk communities.
3. **Support to develop new technologies and identify additional measures to deal with future climate change.** Climate change has multi-dimensional impacts. It is necessary for agencies to cooperate together in order to deal with climate change impacts. Government should support research on new technology development, such as breeding new varieties, water saving irrigation technologies, and diversifying agricultural activities. Water resource management should support rainwater harvesting, increase of water diversion from Yellow River to middle arid area and new water conservation measures to increase irrigation area (given larger-scale issues of water allocation and sustainability of supply). Ningxia Development and Reform Committee should finance the development of new technologies and identified measures.
4. **Enhance institutional awareness, capacity and cooperation.** Adaptation to climate change not only needs the concerted efforts of the international community, but also cooperation between and within countries and institutions. At the regional level climate adaptation will require horizontal coordination across institutions with different exposures and responsibilities in climate sensitive areas. Examples at the local level include coordinating agricultural support services with the meteorological bureau, at the regional level water management will be critical and should involve long-term strategic inputs from agriculture, water and development planning agencies. Strengthening capacity may be a necessary condition for success.
5. **Make plans for migration.** The government can coordinate farmers who live in unsuitable living places to move places with irrigation water or with more rainfall. Migration needs major support of capital funds and careful coordination and planning by government to avoid conflict on land and water resources.
6. **Conduct training programmes to help farmers achieve skills to develop off-farm activities (livelihood diversification).** Off-farm income generation is an important income source for the local farmers. Labour export in Ningxia is either government encouraged or a spontaneous action by farmers. The government can organize farmers and conduct training programs to help farmers achieve have some kind of skills. This can benefit farmers finding off-farm jobs.

IV. Science and Technology

1. **Strengthen assessments and information sharing for technical adaptations.** Effective technical adaptation measures need to be based on sound scientific assessment, and access to required information. Special attention needs to be paid to the areas where the impacts of climate change are greatest (in social and economic terms). In the areas where impacts of climate change are low, efforts should be made to identify measures to protect the existing situation, and prevent further deterioration.
2. **Develop new technologies and identify new measures to adapt harsher climate conditions in future.** From the survey, we can find that even though they have taken various countermeasures, farmers' livelihood have been affected by extreme climate event, climate variation and change. Current technologies and measures may not be enough to adapt to more difficult climate conditions in the future. Further technologies, such as

breeding drought and disease resistant varieties, and water saving technologies, need to be developed.

The opportunities listed above need to be set in the context of existing rural development programmes in Ningxia – local and regional expertise is essential to inform good decision-making. Decisions about particular options need to consider a range of factors, including considerations about the rate and magnitude of future climate change, but also other non-climatic factors such as cost efficiency, practicality (to farmers / implementing agencies), environmental sustainability and so on. Larger scale issues may also impinge on local level adaptation decisions, for example, securing reliable water supply to support new irrigation areas, land use planning in relation to land degradation (the ‘green for grain’ programme) and longer-term decisions about the sustainability of agricultural communities in some very marginal areas. Complementary reports from this project, such as the final regional report, will address these issues by proposing a flexible adaptation framework for Ningxia.

Ecological Localness and Legitimacy of Science Policy: Mapping Climate Issue in Research over China and Taiwan

Shih-Jung Chen[1]

Abstract

As science increasingly plays a vital role in global environmental governance, localness has become the focus in scientific interpretation of nature in terms of policy legitimacy and social communication. However, localness would not germinate until the issue of global change is linked locally, a social construction process which shapes the way of interpreting nature/society interaction and affects local ecological cognition. Localness thus indicates not only legitimacy but also an imperative for responsive actions in a society. It might be argued that although political consideration, with special respect to its stance in international negotiation, determines the extent to which national policy complies with environmental orders set by global regimes, local relevance established in domestic knowledge communication can facilitate policy adjustment. It is therefore crucial for further understanding the emerging and absence of the issues evolved in research agendas. This paper focuses on global warming issues in China and Taiwan for the purpose of mutual reference, and analyzes how ecological localness evolved in the problematization of climate science. Co-word analysis is employed to depict and evaluate the issue structure of the scientific domains and to highlight the relevant local issues which might be taken up by the local scientific community in order to fulfill its accountability as regards place-based communication.

1. Introduction

In the face of global environmental change with a high degree of abstraction and uncertainty as seen in the case of climate change, the relationship between science and society becomes critical. The role of science and technology in particular attracts a great deal of concern and attention(e.g. Haas, 1996; National Research Council, 1999; WGBU, 1996). This paper first articulates the role of "localness" in the communication function of science and highlights the accountability of scientific community in linking global change and local concerns. It then reviews the overall capacity building of climate research in China and Taiwan along with national climate policy, and analyzes empirically the extent to which they has addressed local ecological issues. To execute the assessment, co-word analysis is employed to depict and evaluate the issue structure of research problematization so as to draw out certain implication and suggestions to national science policy which is deemed to be critical as regards place-based communication.

2. Scientific Information and Local References

As far as global environment issues such as climate change are concerned, it is always the case that there is a cognitive gap between scientific interpretation of global threats and local public perception. One of the characteristics of the global environmental movement is that the achievement of creating a common image of earth runs parallel with many non-uniform images of environment based on "places" which people inhabit, along with their communities, lifestyles, and not least histories and memories (Jasanoff, 2004: 46). Scientific information with the appearance of global scale sometimes may appear alien to direct local concerns(Jasanoff & Martello, 2004). Contradictions in understanding between the global and

[1] Assistant Professor, Department of Administrative Management, Chinese Culture University, No. 55, Hwa-Kang Rd, Yang-Ming-Shan, Taipei 11114, Taiwan, email: csr@faculty.pccu.edu.tw.

local may occur, and these may even become severe when environmental issues are framed in a series of rules and orders set down by international regimes.

Localization of global change through domestic knowledge production is especially critical for developing countries(Jasanoff, 2004). There are at least two reasons for this. Firstly, due to the lack of sound scientific basis, research into global change in developing countries relies heavily on international patronages, which may lead to bias through the neglecting of locally unique nature/society interactions. As has been indicated, environmental research tends to miss the link between science and society owing to constraints in science enterprise, such as the interests of funding institutions (normally in countries of the North), the regulation of intellectual property and the specific local structures of innovation systems (Karlsson et al., 2007; Lahsen & Nobre, 2007: 66-70). The emphasis on localness in scientific research into global change serves a way of extending fact pursuance to include local relevant knowledge and concerns, which in turn enables the national scientific community to fulfill the accountability for the communication, translation, and mediation of knowledge (Cash et al., 2003; ICSU, 2002). Localization of global change in domestic knowledge production largely legitimizes public-funded research by introducing more focused scientific investigations, remedying the shortcomings that developing countries are always confronted by, such as an inadequate scientific basis, insufficient financial support, and manpower shortages. Moreover, the results of scientific research stressing on a place-based understanding of interactions between nature and society can enhance public communication and policy debates on global environmental change in a local setting where actions and responses are legitimized and hopefully resolved.

Secondly, in most countries of the South, global environmental agreements such as the Kyoto Protocol are the object of resistance owing to economic, political and cognitive factors. In the minds of some national policy makers and local stakeholders the impacts of new global orders may be just as serious as the impacts of climate change, as is illustrated by the case of the Kyoto Protocol, where the issue of global warming, focused on the reduction of greenhouse gas emissions, is a major political issue for individual political entities, especially in developing countries (Fogel, 2004; Pielke & Sarewitz, 2002). Challenges to the scientific community thus arise. Science is now demanded to contribute to the most heated agendas of global change in the domestic arena, where policy and action depend on a very different set of concerns, such as national interests, economic problems, institutional norms, life styles, beliefs, and so on (Mihelcic et al., 2003; Obasi, 2002: 12). Given the often state-central and economically orientated policy disposition in developing countries, policy-oriented research responding climate change is likely inclined to agendas that often center on increasing energy efficiency, upholding industrial reconstruction, and understanding overall impacts. Scientific information as such, which serves national needs to a significant degree, is characterized by conservatist and often disposed to passive responses or economic stabilization rather than active actions, since it delivers less tangible local references that can forester communication in public debate, social learning, and crisis perception. The lack of legitimacy and supports leads to failure or straddle in forming an active policy in responding climate change, which inevitably needs to make changes to lifestyle that people is accustomed to. An interpretation of nature based on the ecological localness helps to narrow the cognitive gap and stimulate constant debates about global environmental issues on the basis of local concerns. As has been pointed out by N. Luhmann (1989; 1995), scientific claim turns into “meaning” only when the ecological implications of the information are codified by the values and concerns of a given social system at a given moment. In other words, an ecological problem has no prior norm on its own. That is, an ecological problem becomes an ecological problem only through communicative construction and political disposition among various social systems. Researchers in many other fields have made similar observations regarding the communication and dissemination of knowledge (Carley & Newell, 1994; Knorr-Cetina, 1981). Use-inspired orientation and appropriate institutional autonomy built in scientific conducts helps to take non-traditional themes and indigenous knowledge into account which can widen research topics by spanning spatial scales and diverse phenomena to address problems that are locally concerned and therefore remedy the above mentioned unbalanced policy disposition and agendas array. The inclusion of ecological localness into research, thus, demands the prevalent norms, institutions, and practices in science to be transformed to arrow for greater involvement in the definition of research agendas (Clark, 2003: 6-7; Lahsen & Nobre, 2007: 67).

The paralleling images of the global and local characterize the sophisticated social mechanism of ecological communication between science and society. Scientific information interwoven with placed-based ecological concerns thus is essential to the process of public deliberation and consensus building for global environmental governance and local initiations. Drawn on the above concerns this paper focuses on research problematization, that is, to reveal how local ecological issues have been embedded in domestic knowledge production regarding climate change and how the issue constellations have been evolved and changed over time. Localness understood within the framework of the nature/society relationship as discussed so far refers to the criterion that the problematization of scientific research in the topic of global warming adopts issues that are locally and ecologically relevant. China and Taiwan are taken as cases of study here for not just comparative references but also mutual understanding and learning.

To detect ecological localness in national research, the content of scientific production becomes the focus in this study and an aggregate approach is needed for evaluation. Since the exact content of localness is constructed by scientific community through cumulated works of investigation, the accountability of information delivery is imposed upon scientific community as whole, rather than individual scientists or one particular project. As have been mentioned, the institutional context of knowledge production plays a part in the evolution of research poblematization. A brief description about the political and institutional context of climate issue in China and Taiwan is worthwhile before looking into the detail of the aggregate evaluation.

3. Context of Knowledge Production

Only considering the task of reduction of carbon dioxide emissions, both China and Taiwan face tremendous social costs and vast economic impacts. In 2004, China produces 5007.1 million tones of carbon dioxide, ranking it as world's second largest contributor of carbon dioxide(UNDP, 2007: 310-311). Although the figure in terms of per head of population remains relatively low, about a quarter of that in the US, the growing trend of carbon dioxide emission in China is unlikely to be altered due to its heavy dependence on coal in meeting the soaring demand of energy. A recent announcement already indicates that China has overtaken the United States as the world's biggest producer of carbon dioxide, reaching 6,200 million tonnes in 2006 (PBL, 2007).

As one of world's leading countries, China has developed its own strategies in response to climate change and new global orders. However, along the process of international negotiation, official statements and often-expressed view of Chinese leaders emphasize that the developed countries must take the main responsibility for past greenhouse gas (GHG) emissions while recognizing the duty to equally share the burden of environmental protection for common resources (Harris & Yu, 2005; Heggelund, 2007). Although the above "common but differentiated" approach is consistent with the UN Framework Convention on Climate Change, which launched the Kyoto process and recognized that economic development is "overriding priority" for developing countries, the stance often leads to an impression that

China will not take on full emission reduction commitment(Heggelund, 2007). The absence of compulsory cap on emission carbon dioxide in the newly initiated National Climate Change Program is seen by many as certification to those criticism and skepticism. Looking back the development of China's climate policy, China's fundamental position iterated by the common but differentiated approach was gradually manifested through the 1990s. This fundamental position certainly had affected the content of scientific investigation. What is not clear is the extent to which localness in domestic research is constructed and defined.

When China joined the International Geosphere-Biosphere Program (IGBP) in the late 1980s, Duzheng Ye, founder of Chinese atmospheric physics, insisted Chinese research on global change had a definite national focus(National Research Council, 1992: 23-24). That is, "global" change, from the Chinese viewpoint, was too large a scale for their needs and current scientific and financial capacities. Hence, from the beginning, China has concentrated on areas that are of practical importance for China and that are at the same time scientifically challenging. Apparently, Chinese global change research priorities focus on the question of what is the impact of global change on China and, among others, economic impact is the foremost concern(National Research Council, 1992: 24). Localness in this respect could be referred to a broad scope of domestic phenomena, or maintains a narrow intent to either pursue impact knowledge for wining academic prestige or serve industrial reconstruction by highlighting the applied purpose. The exact content of "national focus" of China are needed to be clarified.

Given the state-centered nature of Chinese politics, the emergence of ecological localness in climate-related investigation therefore contains profound meaning for social communication, and implies a relative autonomy of scientific community in defining research agendas and influencing policy. From this view, the National Climate Change Program of 2007 to some degree marks China's relatively active responses to climate change issues, reflecting the reorganization of China's top policy making structure and the recognition of serious domestic environmental deterioration with regards global warming (Ma, 2007; Melting Asia, 2008, June 5; NDRC, 2007). The nuance of transition underlying the new initiative signals not only a much clearer political resolution in dealing GHG abetment but also the cumulative performance of scientific endeavors in revealing the impacts of global change on China.

As to Taiwan, like other newly industrialized countries, it also faces problems in curbing the rapid increase of carbon dioxide emission. Its per capita carbon dioxide emission soars to 11.87 million tonnes in 2006, ranking Taiwan the 16th position around the world, with almost four times higher than the global average (IEA, 2008: II.167). Considering its small size and population, the total amount of carbon dioxide emission at 270.33 million tonnes certainly gives Taiwan a "notoriety" in the international community.

Although Taiwan did not sign the Kyoto protocol, the government promised to work on reducing carbon dioxide emission. In 1998, the Taiwanese government held its first National Energy Symposium in response to the Kyoto Protocol, but unfortunately it was not until 2005 that the second conference took place. The second conference even reversed the consensus at the first conference, which set a target of maintaining Taiwan's carbon dioxide emission at the level of the year 2000, approximately 223 million tons. Although the Ministry of Economic Affairs (MOEA) in 2005 tentatively considered imposing restrictions on emissions from Taiwan's top 200 energy consumption enterprises, including the Formosa Plastics Group and the China Petroleum Corporation, which cut carbon dioxide emissions by 170-million metric tons per year, the move was eventually abandoned and replaced with a moderate scheme based on voluntary. The legislative progress of GHG reduction continues to be sluggish, due to the strong resistance from industrial sectors, the performance of which is always the top priority on the political agenda. Thus, in the past ten years, climate policy has been almost inactive, despite the announcement of a “no-regret policy” by the former President Chen Shui-bian. It is interesting to note that the inertia in mitigation and adaptation policy has been severely and continuously criticized by scientific leaders and local environmental organization in Taiwan, albeit that their voices has been easily diluted by the heated political conflicts between the two major parties, Kuomintang (KMT) and Democratic Progress Party (DPP), as well as the ongoing economic downturn since year 1997 (Yue & Sun, 2003). Does this imply that in Taiwan scientific community have gained more autonomous in pondering and devoting the local ecological impacts of global warming? How does the less effectiveness of scientific advices in policy can be explained?

The systematic development of Taiwanese climate change research began with the involvement in the IGBP in 1989, and the IGBP Kuroshio-East China Sea Shelf Exchange Processes (KEEP-I) marked the start of Taiwanese climate change research. Later research extended to the Tropical Ocean Global Atmosphere program, the Climate and Air Quality Taiwan Station (CATS), the World Ocean Circulation Experiment (WOCE), Past Global Changes (PAGES), and so on. From the progress of Taiwanese research, it is clear that the local scientific community adopted the strategy of joining various international programs in order to develop research capacity, and it appears that research topics were discreetly chosen in terms of geographical connections with Taiwan, for the sake of legitimacy. Considering the still nascent stage of research capacity, this strategy is reasonable, though evidence has shown that Taiwanese scientific endeavors in the context of international programs tend to omit certain locally meaningful issues (Chen, 2007). Like other newly industrialized countries, energy efficiency probably is the most focused topics in policy-orientated investigation in Taiwan, for it perfectively fits the multiple national interests, such as economic, security, and environmental demands, but it may not be fully equivalent to the commitment of carbon reduction. How the ecological localness is addressed in scientific research needs to be further examined. In the last three years, the general public perception of climate issues has arisen dramatically in Taiwan, and KMT’s regaining power in 2008 brings out much clearer energy saving and carbon reduction policies. The results of the policy initiation are yet to be observed.

Assuming that the relative advances in national climate policy are associated with scientific information in a long run, it is reasonable to infer that the localness content in scientific investigation are accord with the tendency in political disposition. Thus, for better articulating the evolution of research priorities, this study demarcates the observation of data into three different time frames, respectively representing the formation of passive policy baseline in the 1990s, recognizing local impacts after 2000, and policy transition in the last three year. This time segmentation would also help to restrict word meaning in order to enhance analytic precision which is useful for co-word analysis and will be discussed further below.

4. Methodology and Data

To detect ecological localness in research at the national level, it is necessary to delineate the issue structure of relevant scientific research. There are many ways to illustrate the evolution of research agenda in which hieratical and ethnographic investigations are the most popular approaches (Cooper, 2003; Kwa, 2005). Data collected from interview, observation and documentation may reveal the nuance in the development of research priority, but in delineating contemporary evolution of science they would find themselves difficult to make a generalization given their heavy dependence on micro-level study. Analysis in this study aims to delineate the aggregate structure of research issues and hence turned to collect scientific papers published in academic journals which often represent the main body of science in a given field and constitute a vital part of modern scientific institution. Co-word analysis is therefore used to construct the issue structures of scientific papers in journals. The large number of words presents in papers' abstracts, titles, or key words make co-word analysis a particularly useful method to study and illustrate the issue structure of science domain, and to identify key concepts and themes of an entire discipline. Research has showed that co-occurrence words can be applied to mapping empirically the translation in the dynamics of science and technology in terms of the distribution and co-occurrence of words (Callon et al., 1986; Law & Lodge, 1984; Leydesdorff & Hellsten, 2005). Relying on words' distribution and co-occurrence and applying network analysis techniques to identify the embedded implications, co-word analysis arrows the investigation of research trends and priorities in a way that would be prohibitively time consuming or subject to human interventions with traditional tools of content analysis. The underlying logic of co-word analysis is based on communication theory that words are embedded in sentences and texts that provide them with meaning and special words can be regarded as carriers of meanings between science and society (Leydesdorff, 1997; 2001; Maasen & Weingart, 1995). Visualization and interpretation of co-word networks in the study are based on general concepts and techniques of social network analysis (Degenne & Forsé, 1994; Scott, 1991; Wasserman & Faust, 1994). Especial steps of analysis will be discussed below.

As regards scientific publications, data were retrieved from the online database of the Science Citation Index (SCI) as often applied in the field of scientometircs.[2] Although SCI database mainly collects publications written in English, which probably induces omission or biases in identifying the domestic evolution of knowledge production, articles collected from the SCI are often rigorous enough to gain recognition from scientific community therefore reflecting the creditable advance of scientific endeavors. By using *Global Warming* and *Climate Change* as the target terms and refining data though country code, 183 and 2133 articles published before the end of year 2008 were extracted from the SCI database which respectively represent the field of climate research in Taiwan and China (see Figure 1). From those extracted items, title words rather than key words or words in the abstract are set as the unit of analysis, since the precision of the title word in tracing topical concepts has been asserted (Leydesdorff, 1989). According to the discussion in the previous section, climate research as well as the content of localness in scientific problematization may be affected by domestic political disposition. Thus, for better describe the different stage of development of climate research in China and Taiwan and for better obtain word meanings in distinct periods of research evolution, the selected title words are segmented into three intervals of time, ranging the periods before 1999, between 2000-2005, and during 2006-2008. Because there are only 13 items of Taiwanese papers published before 1999, those 13 articles are discarded in view of the low communication function. After the data were retrieved, title words were processed and cleaned, and a set of title words were chosen with a frequency reaching the threshold beyond 50% of cumulative frequency of total words in each data set, with at least 2 times of occurrence (see Table 1). In the case of China, the numbers of selected words in the three time frames are 98, 139, and 149, while the Taiwan case has only two data sets as mentioned containing 123 and 144 selected words.

Those selected title words were then fed into Pajek software in order to map the issue networks.[3] The cosine for normalization was applied in order to obtain the vectors of the distribution of the words in the form of a network map (Salton & McGill, 1983: 121).[4]

[2] SCI Database is part of the ISI Web of Knowledge at http://portal.isiknowledge.com/.

[3] Pajek is a free, non-commercial software popular in the network analysis community. The Pajek web page can be found at: http://vlado.fmf.uni-lj.si/pub/networks/pajek/H.

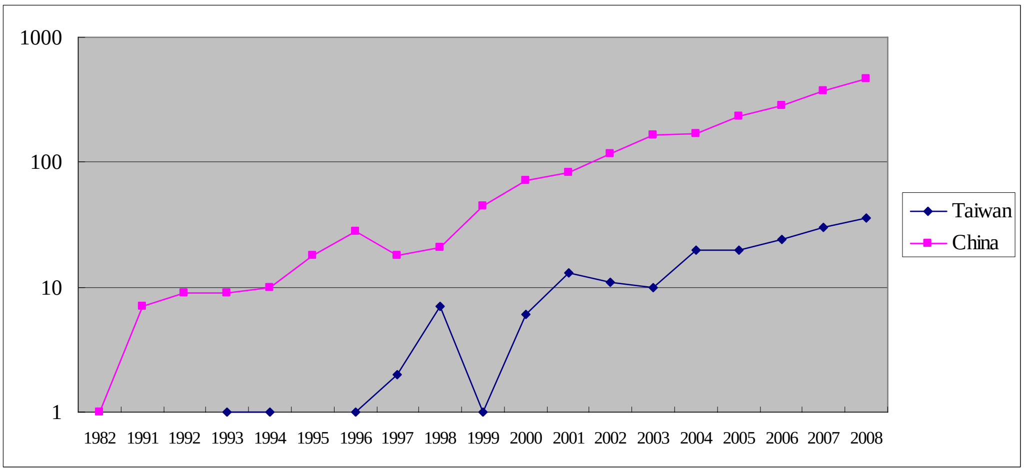


Figure 1. Distribution of articles of climate research in China and Taiwan
Notes: (1) Data are collected from SCI.
(2) Y-axis is based on logarithmic scale.

Table 1. Title words for analysis with thresholds

	Year	No of Articles	Total Words	Selected Words	Cumulated Freq.
China	1982-1999	166	635	98	53%
	2000-2005	840	1953	139	51.99%
	2006-2008	1127	2630	149	50.12%
Taiwan	2000-2005	80	485	123	53.11%
	2006-2008	90	554	144	55.39%

5. Issue Networks of Research

As sociologists have pointed out, the advance of science is based on a set of social institutions and norms, also referred to as "invisible colleges" (Crane, 1972; Merton, 1973). The self-organizational aspect of science thus allows one to depict the aggregate status of scientific production through individual publications. In this study, co-word analysis is used to construct the issue networks of title words so as to reveal the issue configuration of national climate research.

The main challenge of the study is to construct a unit of words that aggregately unfold the ecological localness in research publication over times. From the original issue networks of different time frames, the clusters of localness are extracted by employing the concept of "*k*-neighbors" to select a set of vertices centered on word *China* and *Taiwan* respectively with a direct link (*1*-neighbors). The clusters of localness represent title words of papers having a co-occurrence relationship with local geographic "metaphors" and thus allow one to closely exam the structure and evolution of research issues attending ecological localness. *China* and *Taiwan* here are seen as metaphors, meaning "messengers of meanings" across different subfields of climate research, and function as a punctuated tool to specify a localness cluster in terms of their symbolically spatial references (Leydesdorff et al., 2006: 233-235). To concentrate on "ecological" localness, the study in particular highlights the words connected with *China* and *Taiwan* which refer to the elements of ecosystem as tangible as possible,

[4] Salton's cosine is defined as the cosine of the angle enclosed between two vectors x and y as follows:

$$Cosine(x,\ y) = \frac{\sum_{i=1}^{n} x_i y_i}{\sqrt{\sum_{i=1}^{n} x_i^2}\sqrt{\sum_{i=1}^{n} y_i^2}} = \frac{\sum_{i=1}^{n} x_i y_i}{\sqrt{\left(\sum_{i=1}^{n} x_i^2\right) \times \left(\sum_{i=1}^{n} y_i^2\right)}}$$

including non-living and living components. What words can exactly be treated as having "ecological" references is left for subjective selection due to the fact that demands of information are determined by the lay people who search information by way of natural language not through academic jargons(Teil & Latour, 1995). It is worth noting that words with ecological references identified in the localness clusters are by no means subject to unrestricted interpretations. Although the bottom-up approach of aggregation arrows the subjective selection of words, the meanings of words however need to be judged in a structural view instead of an individual one in that the role of words in network is constituted by their co-occurrence relations. That is, the meaning and function of particular word in a co-word network are embedded and therefore constructed by others. For example, when *water* appear in a co-word network derived from article title of scientific publications, *water* itself cannot be arbitrarily interpreted as a specific kind of hydrological research in relation to climate change but in fact represents a bit of information regarding water which constitutes issue tendency with other words and therefore indicates an element of research problematization.

Based on the original issue networks and the clusters of localness within, the following section takes three further steps to execute network analysis:

1. to identify the presence and absence of vertices with ecological reference in the cluster of localness.
2. to compare the ratio of the word number of the localness clusters to the total words in the corresponding co-word map in different time frames, so as to distinguish the changing weight of the localness cluster against the overall research issues.
3. to compare the "relative closeness centrality" of words with ecological meanings in the localness cluster to reveal the strength of issues that occur in research across different time frames. The closeness centrality indicates the extent to which a vertex has central prestige in a network by measuring its accessibility to other vertices. When comparison across networks is needed, relative closeness centrality is applied.[5]

5.1 China's Climate Research Issues

By feeding the selected title words retrieved from SCI into Pajek, the co-word network of research issues of Chinese climate science are constructed. According to the three time frames as mentioned, the periods before 1999, after 2006 and in-between, three issues network are mapped, containing 98, 139, and 149 words respectively. A threshold cosine≧0.1 is applied to produce a "restricted discourses". Upon these original issue networks, 1-neiborhor clusters centered on *China* are further extracted and form the clusters of localness as show in Figure 2, 3, and 4, representing the three time frames respectively. The clusters of localness visualize the issue distributions of localness in China's climate research.

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[5] The index of vertex's closeness centrality is $C_C(n_i) = [\sum_{j=1}^{g} d(n_i, n_j)]^{-1}$, where $d(n_i, n_j)$ is the graph theoretic distance (length of shortest path) between vertices n_i and n_j, and g is set of all vertices; for the purpose of comparison across networks, relative closeness centrality is used and expressed as: $C'_C(n_i) = (g-1)C_C(n_i)$ (Wasserman & Faust, 1994: 184-185).

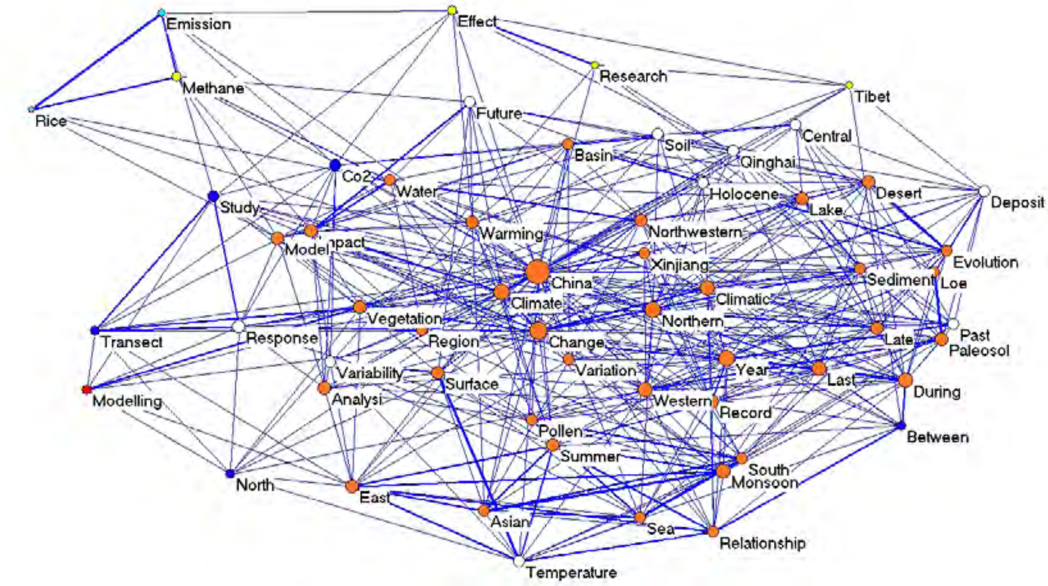

Figure 2. China's issue cluster of localness (59 words) in the period before 1999 at cosine ≧ 0.1, with illustration of 11-core sub-cluster

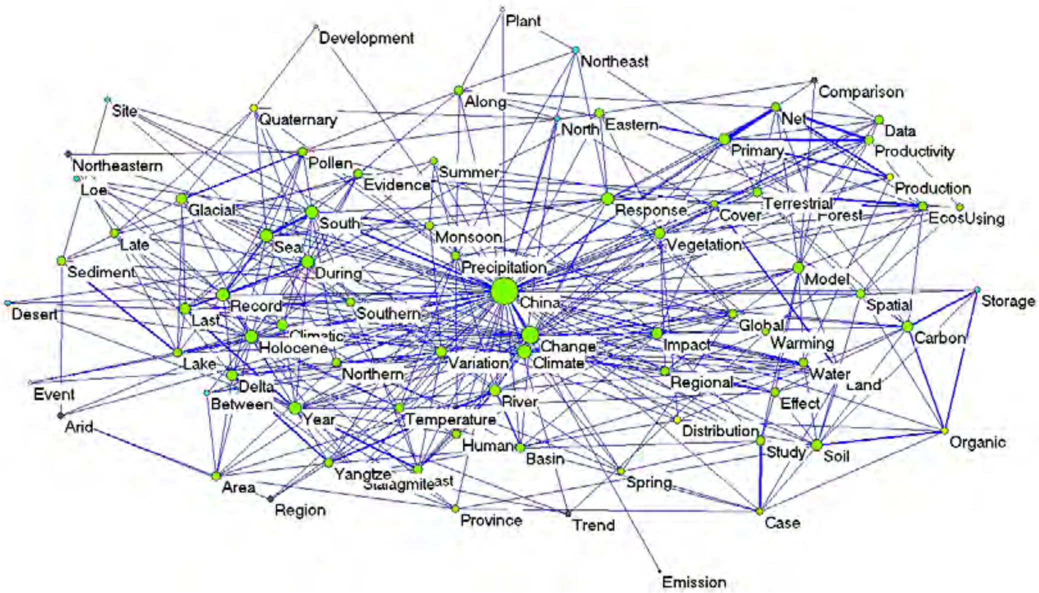

Figure 3. China's issue cluster of localness (80 words) during the period 2000-2005 at cosine ≧ 0.1, with illustration of 7-core sub-cluster

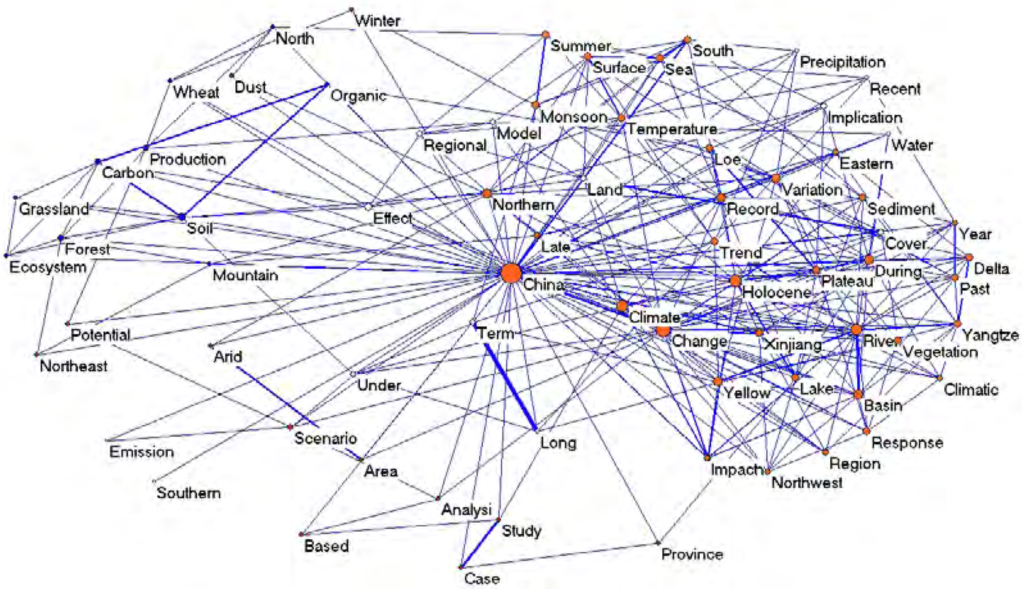

Figure 4 China's issue cluster of localness (70 words) during the period 2006-2008 at cosine ≧ 0.1, with illustration of 7-core sub-cluster

As expected, ecological references emerging in the research issues before 1999 are already various, including *Basin, Emission, Lake, Monsoon, Pollen, Rice, Sea, Soil, Summer, Temperature, Tibet, Vegetation, Water,* and *Xinjiang* (see Figure 2). The multiple issue distribution is somehow consistent with the local centered approach taken by Chinese scientific community in the initial stage of global change research in the 1990s and before. Interestingly, words in the cluster lack strong indicators suggesting the vigorous intervention of policy-oriented research, although this cannot infer an absolute autonomy of Chinese scientific community, which will be further discussed below. In the second time frame, between year 2000 and 2005, research issues embracing even much richer ecological implications, certain amount of which are newly emerging issues, comprising *Arid, Carbon, Desert, Ecosystem, Forest, Glacial, Human, Land, Organic, Plant, Precipitation, River, Spring, Terrestrial,* and *Yangtze* (see Figure 3). The large number of new research agendas with strong ecological references signifies that a variety of phenomena in relation to global change, including the extreme disasters as seen in floods and the extensively impacts such as dust storm, were rapidly explored by Chinese scientists with the build-up of their capacity through 1990s. Once the research manpower and capacity were expanded after 2000, knowledge gap was quickly filled up manifested by the increasing research agendas. This somehow illustrates the correspondence between the growing local knowledge and the active response regarding carbon reduction. With the increasing scientific information of climate change for the last twenty years, scientific evidences certainly attracts public attentions and constitutes policy learning and political pressures that push forward relevant policy actions.

The expanding trend of research topics has however relaxed in the last three years, while the emerging issues in the localness cluster are restricted to *Dust, Grassland, Plateau, Scenario, Wheat,* and *Winter* (see Figure 4). When examining the proportion of words in the localness cluster to the total words in the issue network, figures indicate a declining trend along the three time frames, running from 0.602, 0.576, to 0.469, suggesting the local-related issue are losing its weight while the research issues continuously increase. The rather contradictory trends demonstrate that the richness of localness in research may be attributed to the local-oriented science policy, but not imply a mature autonomy of scientific community. Thus, the expansion of research issues before 2005 simply represents the extreme want of understanding of the impacts of climate change, and the decline of weight of localness implies the emerging concerns in research has undergone a change and may be reoriented to maintain other types of interests, such as scientific prestige or economic benefits.

In recent years China has been eagerly seeking foreign partnership for collaboration in exploiting renewable energy (Asia Society, 2009; Delman & Chen, 2008). With the increasing strength of policy configuration in response to climate change, the state starts to tap scientific intelligence for economic benefits. As indicated above, the exploitation of energy efficiency may be a vital pillar for GHG cutting, but most often economic fallouts and energy security are at stake. Thus, it becomes a challenge for China's scientific information dissemination to balance the shifting focus from social awareness to economic profits. The network analysis has found that some words existing in earlier climate research, such as CO_2, *Methane, Paleosol, Qinghai,* and *Tibet,* are absent in the localness cluster after 2000. In terms of the value of relative closeness centrality, comparison of words with tangible ecological localness across the three time frames shows that their weights against overall research topics are declining. Figure 5 shows the results of the comparison which are focused on words like *Basin, Lake, Monsoon, Soil, Temperature, Vegetation, and Water.*

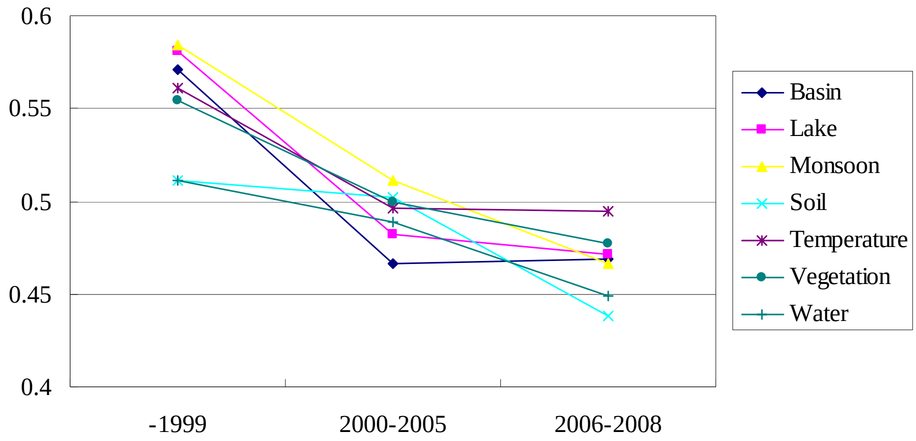

Figure 5. Comparison of relative closeness centrality of words with ecological relevance from China's issue cluster of localness across three time frames

5.2. Taiwan's Climate Research Issues

Due to the small number of items found in the 1990s, Taiwan's data in this period of time are discarded. As has been indicated, academic leaders in Taiwan play a vital role in the campaign of policy action in response to global warming. However, the small number of publications strongly implies that the domestic information of science did little to facilitate social communication of global change in Taiwan, although the scientific endeavors at the time would certainly paved the way for the further development of Taiwanese science basis for addressing global change in new millennium. Given the limited resources and manpower, for small nation like Taiwan the much focused research problematization is essential to bring out meaningful information for social communication.

Taiwan's localness cluster in the time frame 2000-2005 contains 44 words (see Figure 6). The localness cluster shows that words codified with obvious ecological relevance are *Asian, Crop, Dust, Energy, Gas, Pacific, Power, River, Spring, Summer, Water,* and *Yield,* manifesting a vivid and colorful problematization in research (see Figure 6). Among them, *Energy* however refers to scientific investigations targeting energy efficiency, which can be judged by its associated words and similarities.[6] Although research on energy efficiency may still fit to the criterion of localness, as indicated before it may facilitate technological upgrade rather than social learning. Similar suspicion is also manifested from other aspect. When looking back to the original issue network containing 123 words (not shown here for the purpose of succinctness), it is found that some words did have ecological relevance but are not included in the 44-word cluster of localness. Supposed we consider issues like *Hazard*, *Abatement*, *Precipitation*, *CO_2*, and *Risk* to be of importance to climatic information which can be found in the original issue network, we may be surprised to know that those issues are not associated with *Taiwan*, at least in the aggregate level. This means that some Taiwanese scientific investigations are ecological relevant but not related to *Taiwan*, a spatial indicator here. The ratio (0.357) of the node number in the localness cluster to the total amount of nodes in the issues network also suggests a relative law proportion of local relevance in overall research problematization. Considering the small scale of geographic features of Taiwan Island, unlike China, the link from global change to local impacts is a substantial challenge to scientific observation. The limited manpower and resources make a locally centered research even more critical. Judging from these factors, it may be inferred that Taiwan's climate research urgently stands in need of taking ecological localness into account.

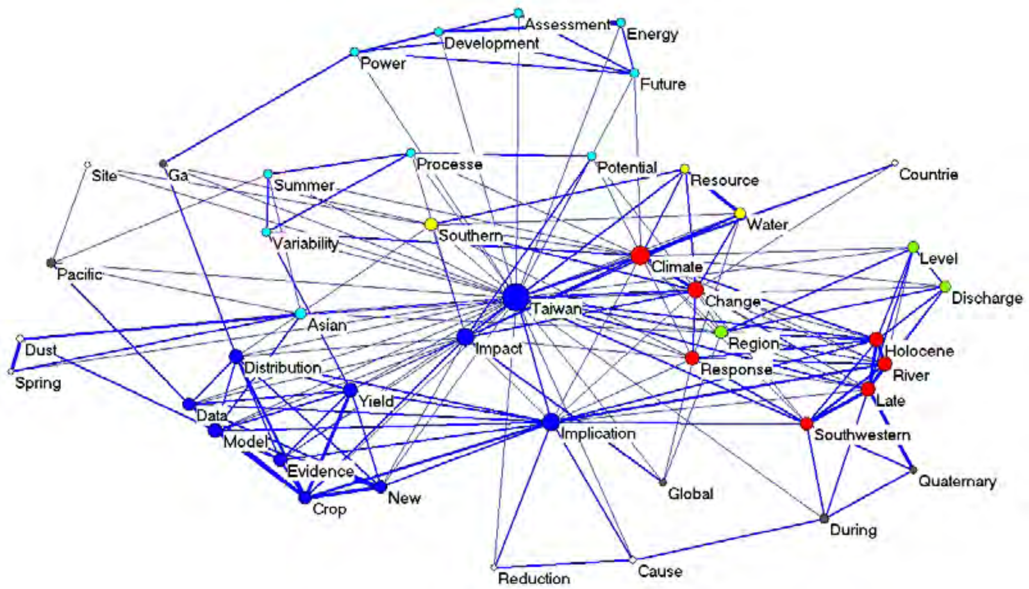

Figure 6. Taiwan's issue cluster of localness (44 words) during the period 2000-2005 at cosine ≧ 0.1, with illustration of 9-core sub-cluster

[6] The configuration of *Energy* clearly refers to energy efficiency research displayed by its co-word relations and in-between similarity as follow: *Assesment-0.333-Energy, Development-0.817-Energy, Efficient-0.817-Energy, Energy-0.418-Future, Energy-0.418-Power, Energy-0.817-Refrigerator, Eenergy-0.333-Study, Energy-0.126-Taiwan.*

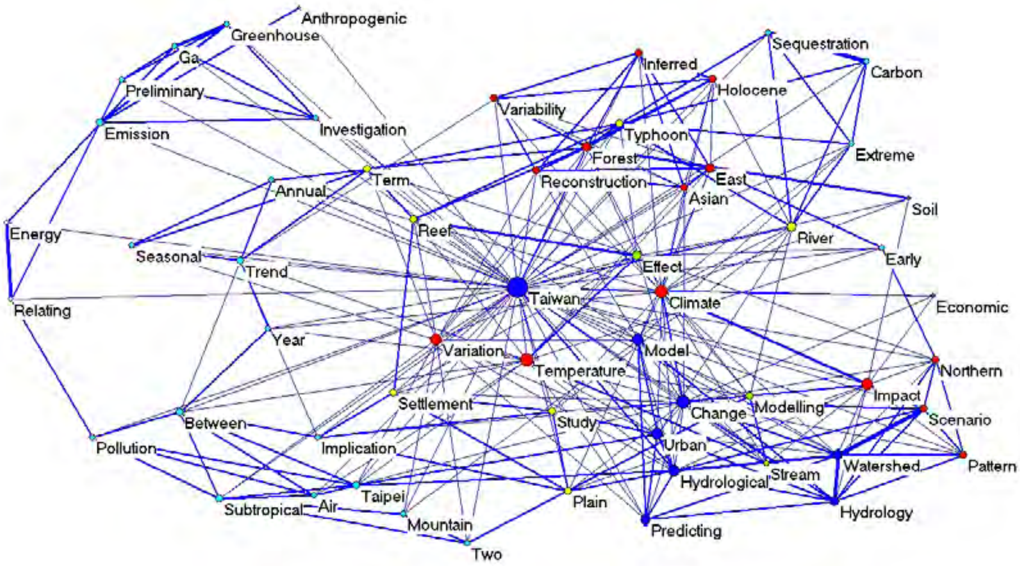

Figure 7. Taiwan's issue cluster of localness (60 words) during the period 2006-2008 at cosine ≧ 0.1, with illustration of 9-core sub-cluster

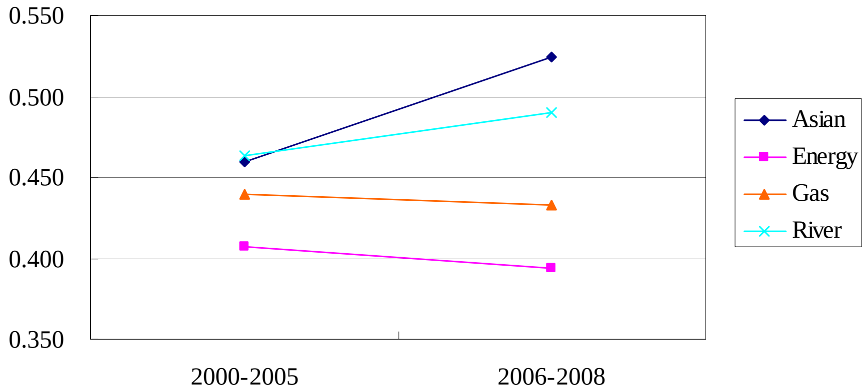

Figure 8. Comparison of relative closeness centrality of words with ecological relevance from Taiwan's issue cluster of localness across two time frames

Fortunately, after a decade of struggling, and alongside heated public discourse on carbon cutting, research issues in the past three year presented a transition of proliferation. In the 60-word cluster of localness extracted from the 144-word issue network representing data between 2006 and 2008, research priorities associated with local and ecological references increase and even cover new issues, such as *Air, Anthropogenic, Carbon, Economic, Emission, Forest, Greenhouse, Hydrology, Hydrological, Land, Plain, Pollution, Reef, Seasonal*, *Sequestration*, *Soil*, *Stream*, *Taipei*, *Temperature*, *Typhoon*, *Urban*, and *Watershed* (see Figure 7). These issues referring Taiwan's diverse natural and human phenomena have never been so saliently treated in the previous scientific productions. The proportion of words in the 60-word cluster to the total words is 0.416, higher than the previous value at 0.357, and suggests an increasing trend of research in addressing local relevance. This trend is correspondent to the initiative of climate policy of KMT administration in 2008.

While the proliferation of issues in Taiwan's climate research is evident, some issues existing in the previous time frame however lose their momentum in attracting researchers and disappear in the localness cluster of the last time frame, such as *Crop, Dust, Pacific,* *Power, Spring, Summer, Water,* and *Yield*. In addition, few words with ecological localness can actually sustain across different time frames. Only *Asian, Energy, Gas,* and *River* exist in both data. The implication and directions resulted from the large scale of replacement of research problematization is still not clear. A further study is needed to pin down the effects. Similarly, the uncertain trend is also showed in figure 8, presenting an inconsistent patent of relative closeness centrality of words that survive through the two time frames. It might be judged at this stage that Taiwanese climate research has come to a critical time to focus on much use-inspired and action-oriented topics so as to contribute to social learning and communication. In network analysis, a *k*-core partition can be applied to identify the most efficient sub-cluster where a closer interaction among vertices are arrowed since any single vertex within the sub-cluster has at least *k* neighbors. Using *k*-core technique, it finds that only five words in Figure 7, including *Hydrology, Hydrological, land, Urban,* and *Watershed*, belong to the highest 9-core sub-cluster (signified by blue color). The limited number of words in the 9-core sub-cluster implies that the scientific community is in need of better agendas setting both in depth and width to facilitate social communication.

6. Conclusion

This study evaluates the content of China's and Taiwan's climate research at an aggregate level in order to reveal how far knowledge production has responded to locally relevant issues. The purpose of the study echoes the recently emerging concerns about the link between science and society, while understanding scientific activity may has multiple functions. To evaluate the content of scientific information and to meet the challenge of empirical study, co-word network analysis, a rather new way of text exploration of science, is employed for a better delineation of the structure and evolution of scientific problematiation over different time frames.

It begins by assessing the notion of ecological localness, and finds that there is a need to evaluate the structure of scientific problemization at national lever for better understanding current function of science in social communication. Aiming the issues of *Global Warming* and *Climate Change*, data are retrieved from SCI and Pajek software is used to conduct and visualize the co-word network analysis. Although having its limitations in micro-level depiction, co-word network analysis offers a feasible approach to surmount the challenge in apprehending main themes in an entire discipline of science, and allows one to explore the trend of research issues in terms of a bit of information decomposed from title words of journal articles, a developed method in science studies and information science.

The results of the study manifest that both China and Taiwan are in an increasing trend of building their own identifiable ecological localness, although two regimes have taken different approaches in research to address the localization of global warming. Differences are partially determined by different political disposition and scientific institution, which is beyond the scope of the study here. However, the co-word analysis do showed the proliferation of ecological localness embraced in research is correspond with the development of national policy in addressing climate change. Thus, the study empirically validates the value of ecological localness, under the concept of which research into global change are expected to be intertwined with meaning attachment in terms of local culture, ecology and lifestyles, aside from economic and political preferences. Based on the scientific information with ecological relevance, actions and policies are likely to gain legitimacy and hopefully to be brought out in practice.

The evolution of research derived the co-word analysis reveals that China's research agendas contain rather rich ecologic localness from the start and especially after year 2000. The richness and diversity of ecological localness may be attributed to its local-centered approach in science planning and therefore contribute to the transition of national climate policy in general, but underneath the diversity of research agenda, “richness” itself implies tremendous and continuous demands for more scientific information in view of China’s extensive territory, diverse natural conditions, large population, and complex anthropogenic impacts. Evidences derived from this study has revealed that along with China’s development in both policy and science domain, research topics related to ecological localness have declined its weights against overall climate science. China’s scientists now have to cope with challenge in balancing information dissemination, a problem often seen in developing countries that knowledge production is either distorted by policy-oriented applied research or dominated by pure fact pursuance.

As to Taiwan, it takes almost 15 year to build up its scientific capacity and then gradually shift its scientific priority in attending ecological localness. Although the aggregate analysis here is unable to judge the link from the limited scientific information to policy inertia during the 1990s, this study does show that although Taiwan has witnessed the proliferation of research issues after year 2000, the ecological localness in research problemization still fall short of saliency and momentum. Especially, during the recent years, scientific endeavors in offering information with ecological localness are losing focus and present tendencies of inconsistency and contingency, which of course will damp the function of science in facilitating social communication. The direction and effect of these tendencies need further investigation. Due to the small scale of geographic coverage and the economic vulnerability, conducting and transferring useful and meaningful scientific information are both a challenges to and accountability of Taiwanese scientific community for consolidating the link between knowledge and action.

Based on the findings of the study, it is concluded that ecological localness may realize its ideas more profoundly by setting itself up as one element of the constant negotiation between nature and society, the global and the local, and the international regime and the nation state. The assessment of China and Taiwan in this study suggests that communication between science and society is based on the unique local setting, in which constraints and opportunities are always mixed, and that this is particularly the case when dealing with global environmental issues. Programmatic initiatives aside, constant scrutiny and evaluation are necessary to create an alternative platform for communication between nature and society, and the purpose of this study itself is simply to play a part in the negotiation process.

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Climate Change and Heatwaves: China's Responsibility Before The Poor Elderly

José Azoh Barry[1]

Abstract

OBJECTIVE: To address the extent of China's obligation toward the elderly – a growing segment of the population -- as more vulnerable to heat waves.

METHOD: Data handled are secondary and derived from a non-exhaustive review of a specialized scientific literature. The search for relevant publications was conducted from a multidisciplinary perspective.

RESULTS: Of the various sources of human influences on climate, two major ones related to heat waves appear to be urban designs and greenhouse gas emissions. The urban heat islands effects as local anthropogenic impacts on climate increase the need for air conditioning and demand for power consumption which in turn, has repercussions on the global emission of greenhouse gases. Carbon dioxide (CO2) and other greenhouse gases have increasingly displayed atmospheric concentrations involved in the rise of cardiovascular and respiratory diseases. Increases in temperature resulting from anthropogenic "negative synergies" and vicious circles, pose a serious threat to the lives of the poor and the elderly less likely to access acclimatization and more susceptible to heat waves-related mortality.

CONCLUSION: Indeed, China as one of the main sources of emissions of CO2 and other greenhouse gases contributes to global warming and has obligations towards protecting the health of its elderly and in poorer countries as well. Their resilience and adaptation to heat waves are dependent on environmental friendly health, housing, urban and economic development policies. A way of being pro-active rather than reactive would consist of targeting the sources of global warming in addition to implementing rapid warning system along with other social and health care interventions whose .effectiveness has been proved not only in some European countries (France and Italy), but also is Shanghai, China. Reducing the effects of urban heat islands, power stations and motor vehicles emissions requires a genuine commitment to achieve international fairness in an aging world.

Introduction

Climate change and global warming are recurrent themes in both scientific and non-scientific arenas associated with threats, mitigation, adaptation strategies and related calls for urgent and effective actions. Their well documented effects are various and likely to have differential impacts on a range of systems, with some being more or less affected than others. Human societies are confronted with the climate change challenge, whilst having components with differing coping capacities.

With the exception of a few countries, demographic aging is a worldwide trend. According to the United Nations, developing countries and countries with emerging economies have younger populations, but will experience a fastest population aging (United Nations, 2006). China, under the confluence of a decrease in fertility and a rising longevity, is part of them.

In China, the percentage of people aged 65 and over is increasing steadily. In 2000, they accounted for 7% of the total population, and five years later they reached 8%. Adults aged 60 and over are currently representing 11% of the population and are projected to reach

[1] Investigación & Acción, AC, Cerro de la Popa, 110, Col. Riveras de Girasoles, General Escobedo, N.L., Mexico, email: jhazcool@yahoo.com

28% by the year 2040. In absolute numbers, it implies 397 millions of Chinese elders, a speedy aging compared to European countries and the United States of America (Zeng et al, 2009; Jackson &Howe, 2006).

It has been abundantly documented that owing to the normal process of aging, the aged populations experience more chronic and degenerative diseases. Aside from bio-social differentiation that put them at disadvantage, climate change may contribute to jeopardize them especially when extreme events occur. Among risk factors known to increase vulnerability to summer heat stress are cardiovascular diseases, a health condition noticeable in contexts of demographic and health transitions.

The use of climate models to project the impact of global warming on heat-related mortality provides alarming data such as an increase in summer heat-related deaths in Lisbon, Portugal, by up to six times by the 2050s (Dessai, 2003). In another continent, a 75% increase in annual heat-related mortality among people 65 years and older was projected by 2050 in six temperate cities of Australia (McMichael, 2002).

As part of a pattern of increased climate variability due to climate change, natural hazards have differing impacts on human health. Responses to disasters can make significant differences in morbidity and mortality and are the reflection of how the protection of the most vulnerable members of a population is ensured. Climate protection efforts represent a translation of countries' policy regarding the mitigation of the effects of climate change.

China's climate policy has been considered positive and praised for its willingness to cutting energy consumption (Zhang, 2006). In its first national climate change plan, it is clearly expressed that the need for development must be reconciled with the need for environmental protection (Watts, 2007).

However, taking action to curb the high levels of carbon dioxide (CO2) emissions was eluded. Therefore, the progressive perceived policy appears less interesting without a commitment to lower targeted emissions. Also, it appears less impressive in light of external data.

As a matter of fact, data recently provided by the International Energy Agency (IEA) on CO2 emissions indicate that in 2009, China will become the world's biggest emitter with a release of 5.8 billion tons of the greenhouse gases. As such, China would leave the United States of America behind (Zhang, 2006). Although this estimate could be less high, there is mounting evidence on China moving backward.

According to the climate change performance index (CCPI), a measure linked to a mechanism for transparency and comparability into international climate policy, China did not achieve any progress. If in 2006 the country ranked 29 out of 53 countries, in 2007 it dropped to 54 out of 56 countries. This is attributed to its rising CO2 emissions (World Watch, 2006)

Carbon dioxide and other emissions of greenhouse gases such as sulphur dioxide (SO2), methane (CH4), nitrous oxide (N2O) have increasingly displayed atmospheric concentrations. Most are recurrently said to be of critical importance to climate change. China as one of the main sources of emissions of carbon and other greenhouse gases contributes to global warming. Besides the United States of America (USA), other countries from Europe and the Third World (India, Brazil, etc) are involved. So, China is not the only major country emitter.

However, the concern is about the unwillingness of the Chinese government to join biding international commitments in order to reduce its share of gas emissions. It does so by shifting the blame and responsibility for a long-time atmospheric pollution and global warming on wealthier nations. Therefore, the question of how to reconcile it with china's growing greenhouse gas emissions is relevant and worthy of being addressed from various perspectives after the Kyoto protocol adopted in 1997 in Japan.

Reluctance toward the reduction of greenhouse gas emissions, whilst efforts at reaching a related consensus are underway, not only may leave China in a situation of marginalization, but also raises an issue of values. Bearing in mind that societies are judged on how they treat their weakest elements, China has to face its responsibility for the health and well-being of the elderly as a component of the population more vulnerable to extreme weather events and heat waves in particular.

The objective of this paper is to address the extent of China's obligation toward the elderly as susceptible to heat waves and vulnerable to such kind of abnormal weather, especially in urban areas. In doing so, it handles secondary data derived from a non-exhaustive review of a specialized scientific literature. The search for relevant publications was performed from a multidisciplinary perspective, using relevant keywords. Engines were used to locate and retrieve articles from specialized databases.

Information available from websites of organizations dedicated to global change, environmental, energy and public health issues, and the press were also taken into account. The results presented here are discussed simultaneously to highlight sound evidence needed to properly inform policy making and thus, support mitigating actions relevant to the health and well-being of the elderly in an aging world.

Results

Heatwaves: A Window to Climate Relationships to Human Health Conceptual Aspects

There is no absolute specific definition of heat waves which are described as periods of abnormally hot, and often humid, weather (EPA, 2009). There is also a tendency to consider maxima temperatures above 35 degrees Celsius (35°C) during several days. Despite the lack of unanimous definition of heat waves, a common ground is that they cause discomfort and are health damaging.

However, there is a definition of a heat wave considered the most adopted (Souch & Grimmond, 2004). It is the one provided by Robinson (2001), describing a heat wave as an extended period of unusually high atmosphere-related heat stress, causing temporary modification of lifestyles and likely to have adverse consequences on the health of the affected population.

It has been suggested that the notion of a heat wave is relative on an interregional scale, and is dependent upon the frequency of a given maximum temperature (Kalkstein & Davis, 1989). In two Asian cities, Tokyo, Japan and Nanjing, China, a threshold of daily maximum temperatures was established at 32°C and 36°C degrees Celsius respectively. Above this threshold, a direct impact of heat on human health could be observed (Ando et al., 1997).

When China was hit by unprecedented heat waves in 2003, temperatures ranging from 39 to 41 degrees Celsius were the highest daily ones registered in the south of the Yangtze River (Tong, 2003). Actually, human thresholds to heat are heterogeneous, but the negative impact of heat waves on humans, especially on their health is notable.

Heat-Related Mortality

Conflicting data over the decline versus increase of heat waves do not elude the magnitude of heat-related mortality. Its toll of more than 8,000 premature deaths over two decades (1979-1999) in the USA for instance, is estimated to exceed the number of mortalities resulting from hurricanes, lightning, tornadoes, floods, and earthquakes combined (CDC, 2004).

In Europe, France was heavily affected by the heat waves that hit many countries in 2003 and kill mostly elderly people. An unusual increase of deaths in the capital city Paris by 140% and an excess death of 14, 800 solely in the month of August, challenged the protection of public health in an industrialized country (Vandentorren et al., 2004; Institut de Veille Sanitaire, 2003).

If the association of hot weather extremes with mortality among humans is commonly taken for granted, it is also noteworthy to mention documented discordant situations in the scientific literature. In southern USA, the cities of Dallas, Atlanta, New Orleans, Oklahoma City, and Phoenix offer examples of little change in mortality during the hottest weather in summer.

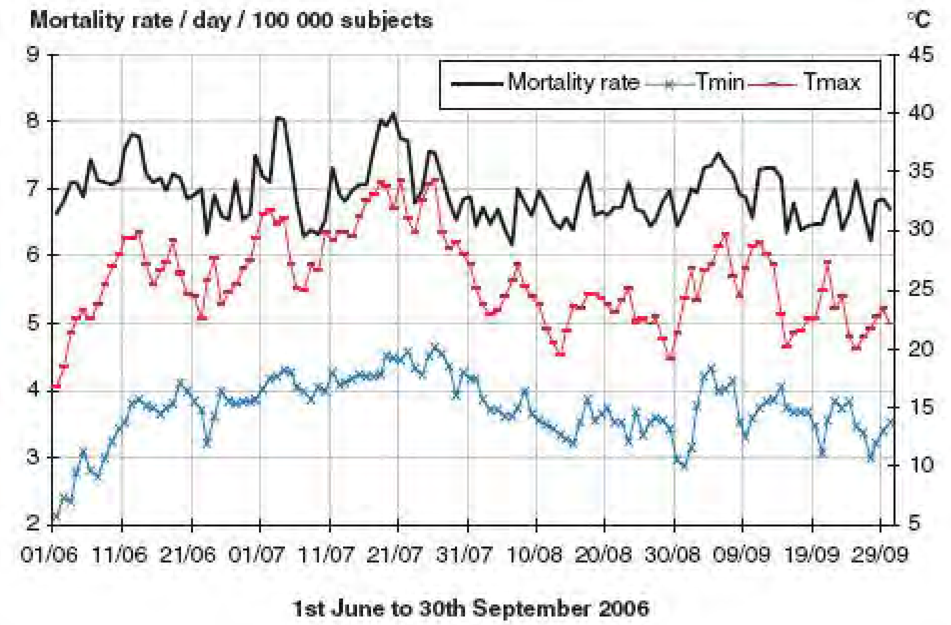
In China, a comparison of day-to-day variation in mortality between the city of Guangzhou with a warm summer climate similar to New Orleans (USA), and Shanghai located at a higher latitude (Tan, 1991), shows a lesser trend in the former. As such, it raises the difficulty of defining threshold temperatures.

However, most findings on heat-related mortality demonstrated that many cities in the northeastern and Midwestern United States show a sharp rise in total mortality during unusually hot weather conditions. In some cases, daily mortality can be more than double baseline levels when the weather is oppressive (Kalkstein, 1989).

In a recent European study on heat waves by Fouillet et al., (2008), a consistent link between temperature and mortality was found and can be observed in figure 1 below.

Six years ago, approximately 35,000 people were killed by a heat wave that occurred during summer 2003 and has been said to probably be the hottest summer since 1500 in Europe (Schar et al., 2004; Luterbacher et al., 2004**).**

Figure 1. Observed daily mortality rate (deaths per 100,000 subjects; black line), maximum (red) and minimum (blue) temperatures (°C) in France in June–September, 2006.



Source: Fouillet et al., 2006

Heatwaves and the Elderly

The elderly vulnerability to heat-related mortality is more accepted than contentious among researchers. There is considerable research work indicating age and socioeconomic status as more significant factors than gender and race (Huynen et al. 2001; O'Neill, Zanobetti & Schwartz, 2005). Although heat waves are not exclusive to urban areas, highest heat-related mortality is often associated with relatively high levels of urbanization (Smoyer et al., 2000).

According to Kalkstein (1992), the fact that mortality rates during heat waves increase with age, has been documented since the 70’s and is still supported. It has been explained by impaired physiological responses, insufficient cardiac output during extremely hot weather, decreases in sweating efficiency, and an increased sensitivity to the heat under the effect of many medications (Oechsli & Buechley, 1970; Jones et al., 1982).

In a recent state-of –the-art, the elderly vulnerability to heat is attributed to a range of factors such as: intrinsic changes in the regulatory system; interference of some medications with normal homeostasis; a relatively high percentage of people with illnesses, disabilities, and a lower socioeconomic status among them (Tan, 2008).

Heatwaves and Hospitalization

In Italy, data have been collected on heat waves and hospitalizations among people age 75 and older during two consecutive years (2002 and 2003) in the Veneto Region. They show that dehydration, heat stroke and kidney failure were the heat-related conditions for which hospitalisation among elders duplicated (Mastrangelo, 2007).

Under the occurrence of five heat waves, researchers could observe associations between their duration (at least four days) and the even effects of a combination of high temperatures and humidity as the summer progressed. A study on the effects of heat waves on the health of the elderly in Seville, Spain, concluded that low relative humidity enhances the effects of high temperatures, particularly through the effects of ozone (Diaz et al., 2002).

Such findings in the context of Europe (Italy and Spain) do not support previous ones derived from studies conducted in the USA in the 70's. Humidity and wind were found insignificant in contrast to high temperature as a single factor having a very dramatic effect on mortality (Kalkstein, 1992).

The effects of the duration of heat waves were also observed in China. A study conducted on the impacts of heat waves mortality in Shanghai, found that for heat waves in both summers (1998 and 2003), mortality was strongly associated with the duration of the heat waves (Tan et al., 2006).

In the Italian study by Mastrangelo et al., (2007) which examined hospital discharge records, and a similar one carried out in Australia with a focus on extreme heat and the health of the mentally ill (Hansen et al., 2008), the link to hospitalization is clearly established. In the context of China, such link does not seem to obviously reflect the real situation of the elderly.

Data on hospital admissions in Adelaide, Australia, revealed that deaths attributed to mental and behavioural disorders increased during heat waves in the 65- to 74- year age group and in persons with schizophrenia, schizotypal, and delusional disorders. Dementia deaths increased in those up to 65 years of age (Hansen et al., 2008). Rather, in many developing countries, dementias are overlooked while age is a risk factor for Alzheimer disease for example.

Accuracy on heat-related mortalities may not be applicable to the Chinese elderly in the same extent. As a matter of fact, in the context of China, some data highlight the greater disadvantage of the elderly, in the sense of their lower hospital admission rate. This is attributable to socioeconomic factors.

In their study of the trend of hospitalization among the elderly in urban China, Gao et al., (2007) found that financial difficulties were the most common reasons for not accessing inpatient care and affected the low-income elderly, without health insurance and women in particular. Worthy of being mentioned, is the dramatic increased in 1993 from 12% to 134% in 2003 among the low-income elderly not using inpatient services.

Other analyses performed by Chinese experts revealed that the high cost of medical treatment has become a biggest barrier to proper medical care for the population. The state sponsored health care systems in the cities have been confronted with cuts in spending.

Therefore, the cost of medical services increased from 1993 to 1998 at rate two to three times higher than the rate of the increase of the average wage (CASS ketizu, 2000).

Heat Acclimatization: Scope and Limitations

People's vulnerability to heat depends on climatic factors (eg. the frequency of heat waves), poorer-quality housing, and lack of air-conditioning among many others (Tan, 2009; Semenza et al., 1996). Comparing the levels of human mortality during two heat waves in Shanghai, China, for the years 1998 and 2003, led researchers to conclude that some actions interplayed in the differences they observed.

They stated the following:

> "Finally, since the meteorological conditions and pollution levels for the two heat waves were alike, we conclude that improvements in living conditions in Shanghai, such as increased use of air conditioning, larger living areas, and increased urban green space, along with higher levels of heat awareness and the implementation of a heat warning system, were responsible for the lower levels of human mortality in 2003 compared to 1998." (Tan et al., 2006)

On the other side of the medal, the use of air conditioner may have negative health repercussions in addition to soaring demands for electricity. In the city of Shanghai, China, where a heat wave was experienced in the summer of the year 2004, and the number of days with high-temperature outnumbered officials' predictions, the following was reported:

> "Most of the illnesses are caused because these little babies cannot adapt to air-conditioners or take improper food….In addition, people who suffered fever, heatstroke, and related acute diseases caused by frequent air-conditioner use have doubled, especially for senior citizens… The heat has also worsened the serious power shortage in the city…. Electric generators have been kept running near maximum load so as to meet the surging power demand of households while 5,000 industrial producers have been co-ordinated to shift their working hours to reduce the pressure." (Xiuzhen & Xiaoyi, 2004)

In the USA, a study seeking to anticipate the future effects of climate change on ambient temperatures and associated mortality, the positive impacts of acclimatization through modelling (eg. increased use of air conditioning, gradual physiological adaptation) on summer heat-related premature deaths indicated a reduction of about 25% in New York and its outskirts (Knowlton et al., 2007).

Also, these authors acknowledged in their conclusions the uncertainty which surrounds climate forecasts and future health vulnerability, and raised the limitations of acclimatization in completely mitigating the effects of climate change by mid-century. Accordingly, their projections suggest an overall net increase in heat-related premature mortality in the New York City metropolitan region.

If acclimatization has its own limitations, increased use of air conditioning and refrigeration -- one of its aspects – is also involved in global warming during summers and contributes to a vicious circle likely to affect human health in a context of urban heat islands.

The Urban Heat Islands and Their Ramifications

In their typology, scientists distinguish between atmospheric and surface urban heat islands. According to them, urban heat islands are the results of the combination of many forces leading to the replacement of natural land covers in cities with human-made surfaces (pavement and building made of concrete, asphalt, metal) that absorb incident sunlight during the day and re-radiated it at night as heat (EPA, 2009; Knowlton et al., 2007; West, 2009).

Consequently, urban areas tend to have higher surface and near-surface air temperatures than surrounding suburban and rural areas. According to experts (EPA, 2009), night time temperatures are oppressive and may be more significant than high maximum daytime temperatures. They found a strong correlation between the lack of night time relief in air temperatures and increased mortality during heat waves (Kalkstein, 1991).

The effects of urban heat islands are exacerbated by an urban design consisting of tall buildings, narrow streets where the air trapped is heated by waste derived from air conditioners, cars and factories (West, 2009). Urban heat islands also exacerbate the impact of heat waves and in some densely populated urban centers, vulnerability to heat increases (EPA, 2009; O'Neill, Zanobetti & Schwartz, 2003; CDC, 2002).

In addition to altering local weather (e.g. wind patterns, clouds and fog, lightning strikes, rates of precipitation), urban heat islands contribute to global warming and affect human health due to the increased use of air conditioning and refrigeration needed to cool indoor spaces, which in turn results in the release of more of the heat-trapping greenhouses gases known to cause global warming (West, 2009).

In the United Kingdom, a 250% increase in annual heat-related deaths is projected by the 2050s across four greenhouse gas scenarios according to a global climate model (Donaldson et al., 2006). In the vein of their modeled impacts on global climate, emissions along with warming trends are not expected to cease (Solomon et al., 2007). Since it has been found that the urban heat island exacerbates regional temperature increases (Solecki et al., 2005), a related prediction is that a city like New York may be at particular risk for climate change (Knowlton et al., 2007).

In China, the study of historic trends in climate change detection show what happened in the past half century. The mean summertime temperature has increased, with warmer nights than days. The number of extremely hot and humid days has increased, as well as heat waves lasting several days (Wang & Gaffen, 2001).

In their study using a regional climate model focused on California, Bell, Sloan & Snyder (2004) found that increases in daily temperature lead to increases in prolonged heat waves. Besides, they demonstrated that statistically significant increases in daily minimum and maximum temperatures occur with a doubling of atmospheric carbon dioxide concentration. China ranks high as far as greenhouse gas emissions which contribute to global climate change are concerned. It is important to mention its willingness to tackle the adverse health effects of heat waves.

Good Intentions Against the Adverse Health Effects of Heatwaves in China

China announced its project on Climate Change Adaptation to Protect Human Health in collaboration with international health, development and environmental agencies (WHO/UNDP-GEF Global Project, 2009). The World Health Organization is in favour of the implementation of effective mitigation policies relating to the consequences of climate change on health (Bertolini, 2008).

China specified the objective of the project and described what will be established accordingly. The expected outcomes encompass a series of initiatives to be implemented at both national and international levels.

Objective of the project

To strengthen the national capacity to respond to the increased health risks due to heat waves to in China.

Summary of the expected outcomes

-. Enhanced capacity of emergency medical services and establishing emergency medical plans drafted at each locality based on information on high risk population in the community for increased cases during heat wave periods.

-. Early warning system linked to weather and ambient temperature forecast, in order to inform the public of potential health risks. At-risk people will be warned about heat waves in a timely fashion.

-. Enhanced ability of public self-protection by providing health advisory and education.

-. Availability of community health consulting services. Therefore, a regular health examination and surveillance of people at risk.

-. Enhanced community awareness of individual actions and also among decision-makers.

-. Effective local and national inter-sectoral collaboration (environmental protection, health and meteorological services), and international cooperation as well.

(Own adaptation)

The People's Republic of China
Project on Climate Change Adaptation to Protect Human Health

Such a national plan not only acknowledges the increased threat to human health that heat waves represent, but also gives an idea of the preparedness needed to empower the at-risk population for heat-related stress. Adaptation is paramount for those who do not count with the conditions that may play a protective role.

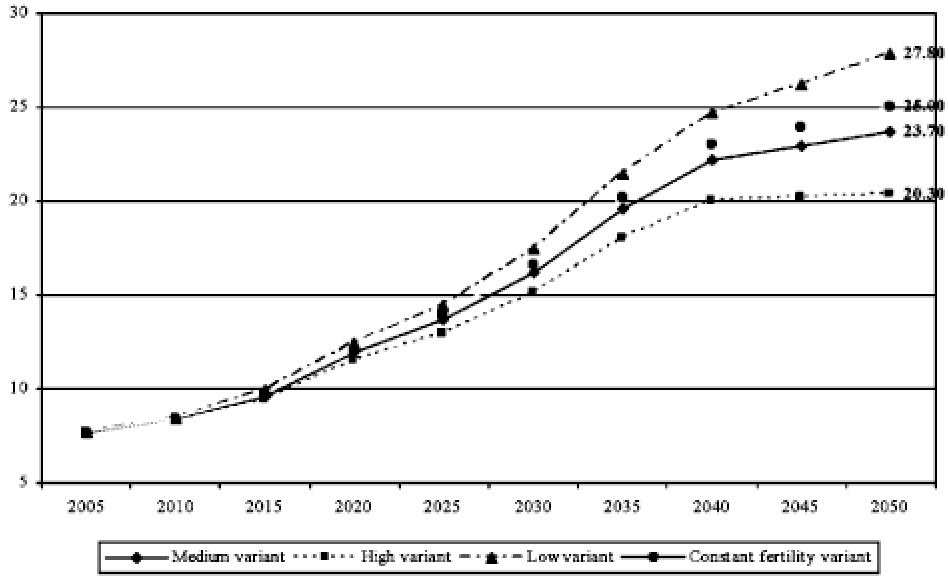
Social Conditions and Health Status in Old Age

Social conditions and health status that put the elderly and the poor at risk for heat-related illnesses and deaths encompass the characteristics of their homes, social isolation and physical health according to the EPA (2009). Besides the reduced ability of their bodies to handle heat stress, the profile appears as follows: a low income elderly, living on the upper floor of a typical row home, made of brick construction, with extreme temperatures, a dark roof, and windows on only two sides, often lacking air conditioning and/or available, but not in use for fear of high utility bills.

According to the same source, social isolation contributes to their vulnerability to extreme heat events in situations where: a) they live by themselves and are unemployed; b) neither family members nor friends live nearby; c) they do not have neighbours to rely upon and d) they fail to hear news or other warnings and recommendations regarding heat waves.

In China, the old dependency ratio is predicted to rise according to several scenarios by experts. As it can be appreciated in the figure provided below, the value of the total dependency ratio will be pulled up by the value of the old component (Stranges, 2008). Disproportions in the composition of the population will likely also be reflected in a shrinking social network versus an extended one.

Figure 2: Demographic forecasts of the percentage of population aged 65 and more in China under four different scenarios



Source: own elaborations on United Nations, 2006 by Stranges, 2008

The issue of social isolation at an advanced age needs to be examined and apprehended in relation to the structural imbalances in China's population. This is the result of family policies implemented decades ago, especially the restrictive one-child policy, in order to achieve a decline in population growth.

Demographers have well described one of the effects of the demographic transition for the Chinese social system in terms of burden of care of the elderly. The "4-2-1- model" is used to explain a reversed system with a family strain, where only one child will be available to care for two adults (parents) and four elderly (grandparents) (Booth, 2008).

Such a responsibility becomes challenging in a context where the social and welfare system is different from the existing ones in more industrialized countries. In the latter, the elderly may benefit from a rise in transfers derived from retirement pension schemes and social insurance programs with a wider coverage.

In China, less than 30% of the aged have any pension, and their access to medical insurance is limited. The pension and health care systems are conducive to further reliance on intergenerational support provided by children and grandchildren (Banister, 2009). ***Actually, it is estimated that two-thirds of people aged over 65 live with their children and one per cent of those over 80 are in nursing homes (Willett, 2005).*** Therefore, a failure to provide for the older relatives and house them like in a "feedback family model", contributes to their exposure to social isolation.

The would-be elderly are likely to be faced with more demand for a less available family support. In addition to the living arrangements issues, poverty still persists and wealth is said to lag behind old age: "*wei-fu-xian-lao*" meaning in Mandarin getting old before getting rich (Yang, 2009). So, addressing climate change in relation to health and well-being in later life puts in presence a constellation of factors with an unfinished agenda on poverty reduction at the national level, into which the rate for the elderly has been slower.

Conclusion

As already stated in the present article, China, an important contributor to CO2 emissions and other greenhouse gases, is undergoing demographic changes (lower birth rate and a greater increase in life expectancy). Its population will age very fast and it is known that older adults, and among them persons with existing health conditions, are at particular risk for extreme events and vulnerable to heat waves, while not necessarily being among the better-off.

Humans' vulnerability to heat depends on climatic factors (such as the frequency of heat waves) among many others ranging from individual, medical, behavioural to environmental factors. Adaptation measures exist along with findings about the difference acclimatization could make in heat-related mortality. In addressing global climate change and protecting human health, national heat waves response systems are as important as other strategies to mitigate the effects of urban heat islands.

It is true that human societies have the potential to provide mitigating responses to the negative effects of climate change and global warming. In China for example, rain is artificially created and high temperatures are cooled through the manipulation of clouds to ease the oppressive action of heat on humans and pressure on the cities' power generators as well.

Also true is that members of human societies belong to differing social strata and age groups, and do not have the same coping capacity. Although praised, access to acclimatization cannot be taken for granted among the elderly due to a number of factors.

On the other hand, authoritative researchers pointed out the limitations of acclimatization in terms of its sustainability. Also, by releasing more heat-trapping greenhouse gases responsible for global warning, increased indoor use of air conditioning and refrigeration in summer time, may appear to act as a double sided ally.

It cannot be eluded that heat-related stress has variable thresholds on the one hand. On the other hand, all extreme temperatures do not necessarily lead to higher morbidity and mortality. Social isolation per se does not appear to have potential adverse effects, as long as the elderly people who live alone are able to take care of themselves properly.

Also, global change models are not exempt from criticism regarding their limitations in simulating heat waves. However, a thorough review of the scientific literature does not provide support for inaction or delayed actions.

China has significantly reduced poverty along with illiteracy since the end of a central planning era. Nonetheless, consistent data on unemployment and a diminished purchase power at an older age, the burden of care of the elderly, mounting unmet needs among the have-not, a growing power demand and the consequences of an over consumption must be taken seriously.

The emphasis put on individual responsibility as far as the prevention of heat-related illnesses and deaths is concerned, is reflected in what is usually recommended by experts. They are focused on the home environment and lifestyle and convey behaviours such as staying indoors in an air-conditioned space and drinking plenty of fluids. Although useful to some extent, and a luxury for some, such preventative measures appear to be insufficient.

As already clearly stated by an international health authority such as the World Health Organization, responsibility must be directly taken by the health sector since adaptation to climate change and the protection of public health go hand in hand. So, in terms of policy implications, public health interventions need to be implemented. How to implement them is important as well. It should be done in a pro-active rather than reactive manner.

A way of doing so should involve a real commitment to minimizing (with concrete reduction targets) the sources of global warming and investing in renewable energy sources. It implies a strong political will and a huge responsibility not only toward a growing segment of the population sensitive to the health impacts of global climate change, but also further awareness of the burden of their family caretakers.

Going completely carbon neutral would be unrealistic during the process of protecting public health. However, the potential to restore international fairness and a genuine protection of the atmospheric commons exists.

We should bear in mind that demographic aging in China and other countries is accompanied by a shrinking support received from the state and social networks. Therefore, further emphasis on a holistic environmental protection rather than on individual responsibility for ill-health and lifestyle, would help in properly addressing the threats to human health posed by climate change and global warming.

Adhering to the legally binding commitments for greenhouse gases reduction as established by the Kyoto Protocol, would surely contribute to make environmental friendliness inevitable and beneficial for all. This would be fair and is pressing in a connected world with aging populations.

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Land Use and Climate Change: Effects and Solutions at The Local Level

Mark Henderson, Ph.D.[1]

Introduction

China is likely already seeing the effects of climate change. Further effects in the form of increased temperatures, changing precipitation patterns, and rising sea levels could be catastrophic, making action at all levels an urgent priority. While much attention is rightfully paid to reducing carbon emissions from fossil fuels, land management practices account for as much as a quarter of the net increase in greenhouse gasses. In China, urbanization is the most important and tractable phenomenon affecting the landscape, reducing carbon sequestration, as well as locking in transportation patterns that assume increasing fossil fuel use into the future. Developing systems for carbon-negative land management will have benefits at the local and global scales, serving as an insurance policy against the increasingly negative consequences of climate change.

In this paper, I review the linkage between land use patterns and climate change. In China, central government policies aimed at curbing urban expansion and preserving agricultural land have faced difficulties in implementation, as local officials respond to other policy signals and economic incentives. A review of the local effects of climate change on some of China's most prosperous regions suggests that, if these were properly accounted for, many local leaders could see net benefits from investing in carbon-negative land management. I conclude by considering some policy reforms that can be taken by local and central governments to promote beneficial practices at multiple levels.

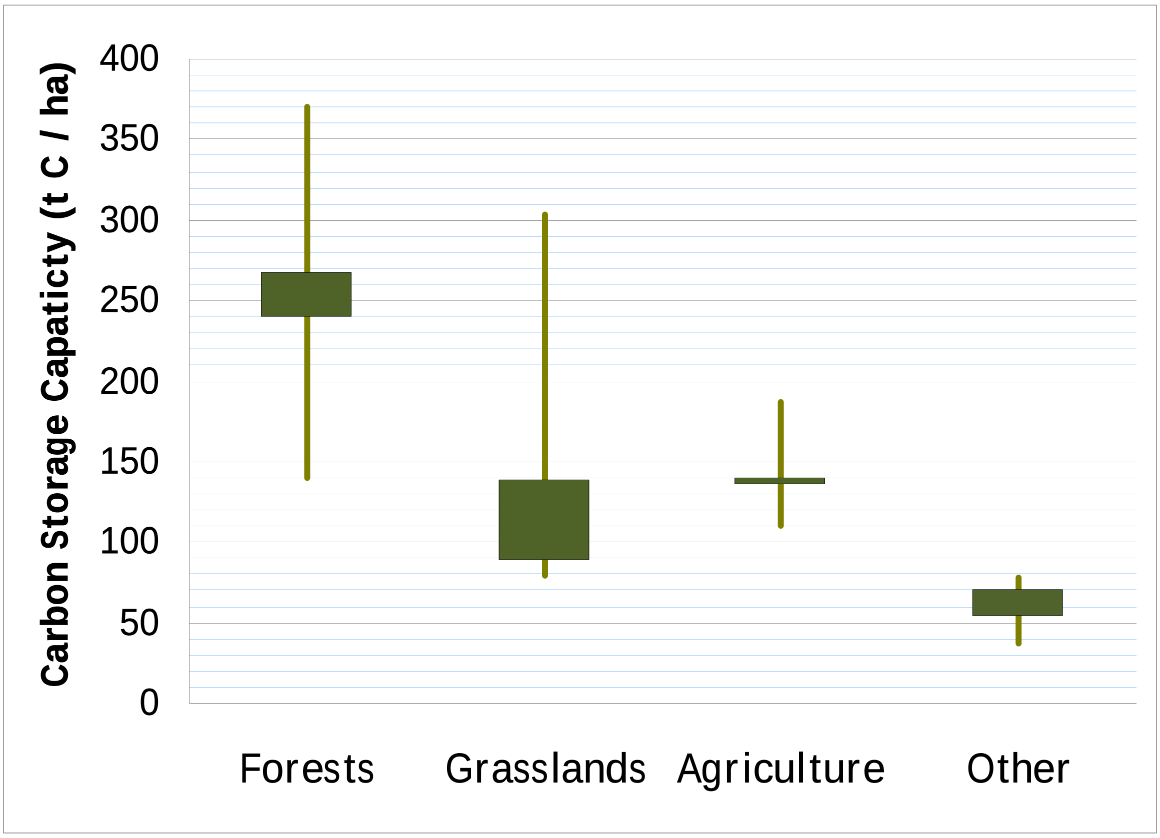
Land Use and Climate Change

Anthropogenic climate change has emerged as the foremost environmental challenge of our time. The increase of atmospheric carbon dioxide (CO_2, the dominant greenhouse gas) has been linked directly to the rise in fossil fuel use as the Industrial Revolution has spread around the world. As such, the greatest amount of attention has been given to efforts to limit new carbon emissions through political, economic, and technical means (Fleming 1998; Houghton, Jenkins, and Ephraums 1990; Watson 2001; Depledge and Lamb 2003). But the absorption of carbon from the atmosphere by vegetation—completing the "carbon cycle"—is attracting increasing attention, with proposals that land use management practices may be key to meeting the challenge posed by global warming.

Land resources can act as either sources or "sinks" of carbon. Forests are one oft-given example: growing trees take in carbon from the atmosphere, sequestering it until they are burned or decomposed. Agricultural crops also sequester carbon during the growing season (see Figure 1). Changes in land use can affect the flow of carbon: forests cleared by burning release their carbon back into the atmosphere, while land taken out of agricultural production is no longer able to play its role in the cycle. As climatic variation affects vegetation growth patterns, climate change and land use change are intertwined in a feedback loop, each affecting and being affected by the carbon cycle (Adger and Brown 1994: 5-9; Matthews et al. 2000).

[1] Mills College, Oakland, California USA, email: mhenderson@mills.edu.

Figure1. Carbon Storage Capacity of Land Cover Types. After Matthews et al. 2000.



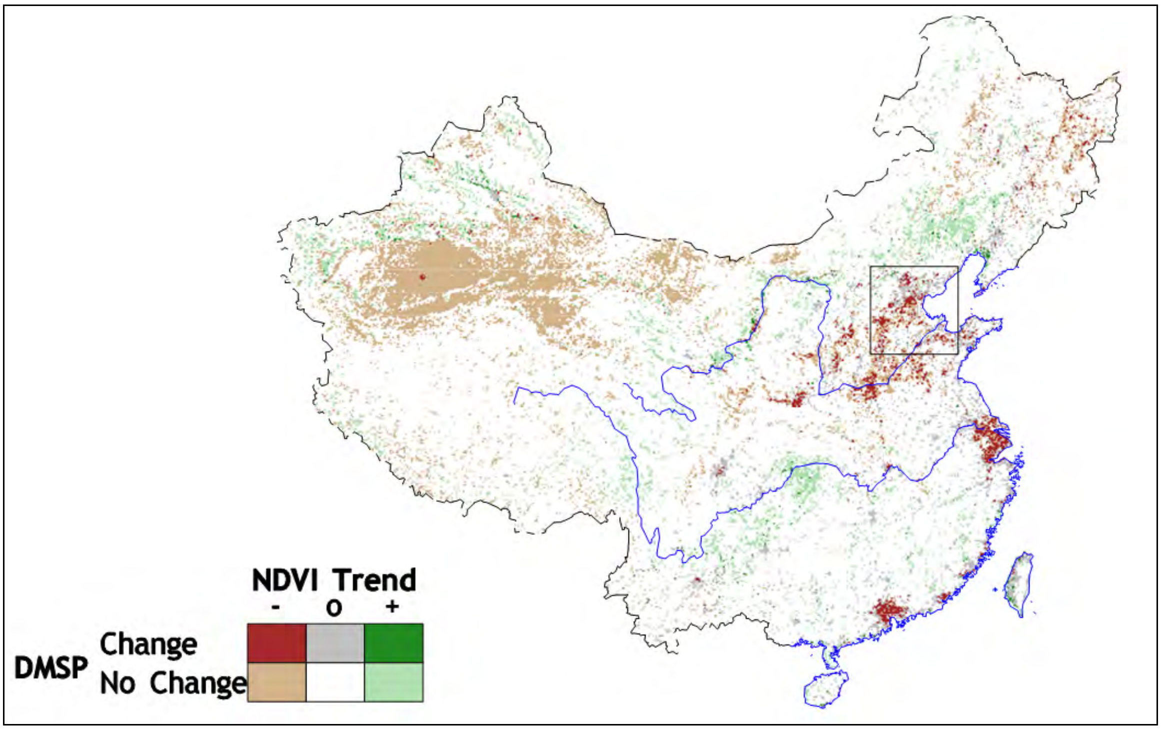
Governments and international organizations are already considering how land management practices that sequester carbon can be encouraged, and perhaps credited against a country's share of global carbon emissions. The Kyoto Protocol included provisions to account for afforestation efforts, although it should be pointed out that new forests do not always enhance carbon sequestration if they replace other well adapted land cover types, such as grasslands or peat bogs (Watson et al. 2000: 16; Adger and Brown 1994: 49-54). True carbon-negative land management systems in any environmental setting would be designed to enhance cyclical and secular carbon sequestration, as well as incorporating urban design features that minimize transportation-related carbon emissions.

In China, with its recent history of rapid development and its billion-plus population seeing living standards rise, emissions from industry and a booming transport sector have risen sharply to surpass those of the United States (Energy Information Administration 2009). Meanwhile, land use change in China is also expected to reduce carbon sequestration, further contributing to atmospheric carbon dioxide concentrations. Researchers of the Harvard University Committee on the Environment's China project have estimated that the growth of net carbon emissions from China could offset the reductions proposed by all of the other countries in the world, combined (McElroy 1997; McElroy and Nielsen 1997).

The greatest effects of China's land use change on the global carbon cycle may have already happened. Reconstructing a three hundred-year history of forest cover, Woods Hole Research Center scientists estimated that 180 million hectares of forest land have been lost since 1700, releasing 17 to 33 Pg (billion metric tons) of carbon into the atmosphere. The annual average emissions of up to 110 million tons over three centuries was far exceeded in the Maoist era, when mass campaigns promoted accelerated clearing, with emissions perhaps reaching 500 million metric tons in peak years. But expanded afforestation drives since the 1990s suggest a reversal of China's net carbon flux, making China's remaining forest lands an important sink for atmospheric carbon (Houghton and Hackler 2003; see also Shapiro 2001, chapter 2).

China's agricultural lands, which sequester only one-third to one-fourth as much carbon per hectare as growing forests, have come to occupy a greater share of China's landscape. And agricultural lands are under greater threat from urban expansion. An analysis of night time satellite imagery found that China's city lights had increased in area by over half, from 4.40% of the country's land area in 1992-93 to 7.03% in 2000. Seen by day, those same areas were nearly twice as likely to see declines in vegetation (Henderson 2004: 9-12, see Figure 2). In terms of carbon storage, the conversion of that much cropland to urban areas could result in a reduction of 300 million tons annually—around twice the carbon sequestration capacity of the forests of the United States (Adger and Brown 1994: 49; Myneni et al. 2001: 14788).

Figure2. Land Cover Change: Urban (DMSP) and Vegetation (NDVI) dimensions, 1992-93 to 2000. Source: Henderson 2004.



Nearly one-fifth of China's agricultural lands fall within 8 km of expanding urban areas. Though the total land area affected by urban expansion is a relatively small share of China's territory, such areas have a disproportionate effect on the overall trend of decreasing vegetation. Typically, labor and fertilizer inputs have made farmland close to urban settlements the most productive, and these are the lands most likely to have seen both urban expansion and decline in vegetation.

Land use change must be considered not only for its immediate effects on the carbon cycle, but also for the long-term patterns of future emissions that are locked in place by choices about land development and, especially, transportation. The development of urban forms that emphasize reliance on the automobile, energy-intensive buildings, and external resources will produce greater carbon emissions. The energy and resources required to maintain complex urban systems must be drawn from an even wider swath of the landscape, what some have called the "ecological footprint" (Lin 2001; Qi et al. 2004). Together, the expanding physical and ecological footprints of cities have become the most significant forces reshaping China's landscape (Watson et al. 1997: n.p.).

Climate Change and Land Policy: Tension between Central and Local Goals

There are signs that the Chinese central government recognizes the importance of combating climate change in order to live up to its aspirations as a leader in the international community as well as to avoid further domestic consequences. Top leaders have begun to attach greater importance to "environmental security" *(huánjìng ānquán)*, listing global climate change among their major concerns (Guojia Huanjing Baohu Zongju 2002). While the Chinese negotiating posture leading up to the 2009 Copenhagen climate talks calls for highly aggressive cuts in carbon emissions by developed nations in advance of any mandatory limits for China and other developing countries, within its borders the government has taken significant steps to promote more environmentally friendly technologies and public works projects—far surpassing the "green" stimulus spending of any other country (Yang and Oster 2009; Qi 2009; Jacobs 2009).

Still, there are limits to the central government's capacity to carry out "green" reforms even if there were a political consensus to do so. Although conservation of agricultural lands has returned as a key issue in national policy (Rozelle and Rosegrant 1997), the central government cannot act alone to control land use in the thousands of towns and villages across China. It must rely on agents at the local level to monitor land uses and enforce conservation policies. Under China's system of collective land ownership, most rural households' rights to use land is subject to the control of local officials, who retain the authority to allocate and reallocate land (Christiansen 1986: 21-3). These officials, situated at the nexus of state power and local interests, often have divided interests—their responsibilities to higher authorities may conflict with community pressures and incentives for personal gain (Brown 1995: 922).

At the village level, almost all economic and political motivations favor industrial development over the preservation of agricultural land. Every peasant farmer knows that factories, not farms, are the key to rapid wealth. Besides filling the pockets of their constituents, village leaders have another incentive to divert land to industrial development: factory profits are subject to a different taxation system than agriculture, leaving more in local coffers and sending less to the central government (Oi 1992; Whiting 2000). Not surprisingly in this context, compliance with land conservation policies has historically been low.

Another major challenge to the central government's attempt to regulate land conversion has been the lack of reliable, detailed statistics on local land management. Land use statistics, produced unreliably at the township level, were filtered and aggregated as they were reported up the bureaucratic hierarchy, resulting in an undercount of at least 40 percent (Smil 1995: 805; Crook 1993; Ash and Edmonds 1998: 845; Smil 1999; Cartier 2001; U.S. Embassy Beijing 1997a, 1998; Lin and Ho 2003). Without private property rights to land, government officials at the township level or above did not systematically track who held and exercised land use rights; a national land registration system only went into effect in 2008 (Shandong interview 2001, Asia Pulse 2008).

Turning to satellite surveys of land use and urban growth as an independent source of data, in the late 1990s China's State Council launched a nationwide campaign to protect land resources. Directives called on "the whole nation to pay more attention to the protection of arable lands" and banned unauthorized conversions of forest and agricultural land (Xinhua 1997b, 1997a, 1998; Zhang et al. 2000; Xu, Qi, and Gong 2000). A mounting sense of crisis prompted central officials to invoke a "broad-brush" policy that left little room for adaptation to local conditions.

Meanwhile, the desire to jump-start local economies stalled by the Asian financial slowdown prompted a resurgence in the creation of local economic development zones, with some six thousand such zones opened from 2000 to 2003 (Cartier 2001; Zhang 2004). These zones made use of a loophole in the 1998 Land Administration Law that allowed cities to requisition surrounding farmland for planned urban expansion (Skinner, Kuhn, and Joseph 2001). In the past decade, such land requisitions have become a common source of friction between local officials and displaced farmers, resulting in protests and thousands of lawsuits nationwide.

Faced with discontented farmers, reports of profiteering by local officials, and renewed concern about food security, top leaders again confronted the question of agricultural land conservation with two important policy changes. First, the State Council's Document Number 1 in early 2004 reiterated the policy of "strictly protecting farmland," requiring provincial or higher-level approval for conversions (Associated Press 2004). Secondly, the principle of compensation for land appropriation was formalized as part of a set of amendments to the national constitution (Xinhua 2004). Accompanying regulations specified how compensation could be assessed for displaced farmers, their village collectives, and local governments; these costs can amount to RMB ¥160,000 per hectare (Zhang 2004). By 2008, satellite imagery indicated that the pace of unauthorized land conversions had slowed, but some 31,000 suspected violations remained under investigation (Xinhua 2008a, 2008b)

While the policy of requiring no net loss of farmland continues, regulations are vague about *where* compensatory land may be reclaimed. Fresh vegetables for the city of Beijing are now being shipped in from farmland hundreds of kilometers away, rather than being produced locally as was true just a decade or two ago (Skinner 1985; Qi et al. 2004). Perhaps influenced by the ongoing *xībù dà kāifā* (Great Development of the West) campaign, developers in Dalian have invested in land reclamation in Xinjiang, some three thousand kilometers to the west (Zhang 2004). Indeed, Xinjiang, Ningxia, and the Tibetan Autonomous Region in the far west of the country accounted for most of the reclaimed farmland reported in recent years (Wang 2000: 652-3; 2001: 706-7). Such remote land reclamation projects do nothing to achieve the stated goal of balanced land use within provinces, to say nothing of the increased carbon emissions from transporting food from more distant sources.

Localized Effects of Climate Change

A growing understanding among national leaders of the potential consequences to China of global climate change may have contributed to the decision to sign the Kyoto Protocol, as well as to take other measures on this issue (U.S. Embassy Beijing 1997b; Chen 2002). Several analysts have shown how interactions among Chinese and international scientists have helped develop this understanding within the Chinese bureaucracy, along with the technical capacity to predict potential consequences and implement beneficial policies (Henderson 1994; Ross 1998; Economy 1999).

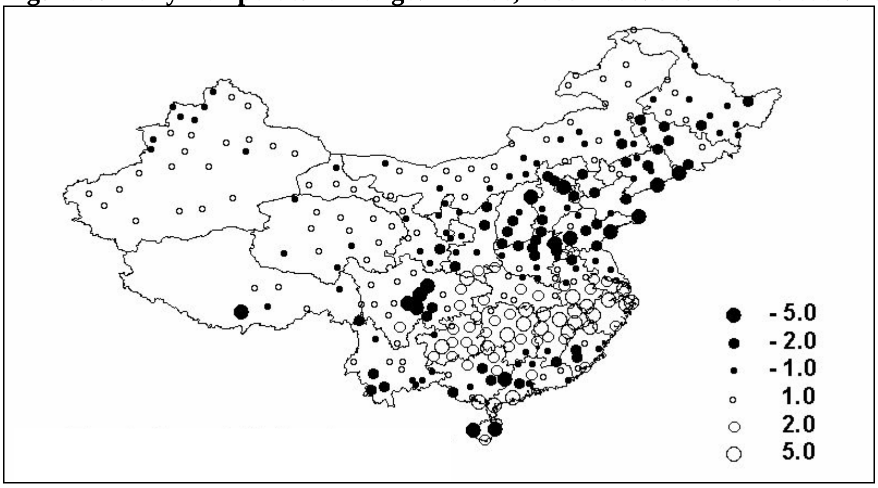
Given the importance of local enforcement to ensure the success of any policies to combat climate change, especially policies related to land use, consideration needs to be made of the motivations of local officials. While normative exhortations and bureaucratic enforcement will both have their place (Skinner and Winckler 1969; Ross 1988), I suggest that attention to the incentive structures under which these officials operate will have the most immediate and long-lasting results.

Appeals to localities' own self-interests—producing "win-win" situations—should be made wherever possible. Co-benefits to the local economy and environmental conditions must be emphasized. While this is difficult in the case of global climate change, where effects are often far displaced from the sources of the problem, some local effects of carbon emissions can be pointed out. As it happens, some of the most prosperous localities in China (and those with the highest carbon emissions) also face some of the greatest risks under future climate scenarios; as such, these regions have both the wherewithal and the incentive to invest in emissions-reducing land management practices.

According to the United Nations Intergovernmental Panel on Climate Change, "three subregions in north China appear to be especially sensitive to climate change because of potential increases in the soil moisture deficit." Climate models indicate that areas of the North China Plain can expect "more frequent and severe spring droughts" and changes in seasonal temperature patterns that will "make it difficult to maintain current crop patterns … limiting the present practice of double-cropping in succession" (Watson et al. 1997, chapter 10)

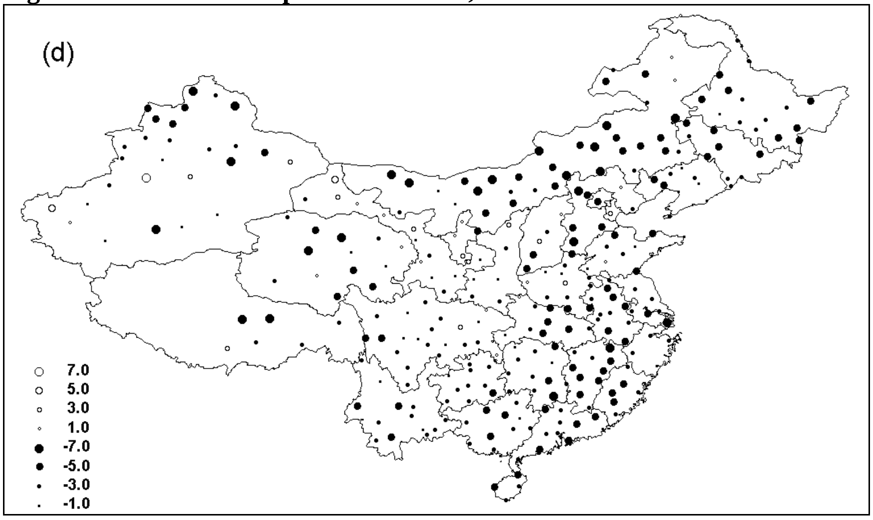
Such climate changes have already begun to appear, revealed in weather station data collected by Chinese authorities over the past half-century. Liu et al. (2003) found statistically significant warming trends across China, especially in the north (see figure 3). As night time low temperatures have increased faster than daytime highs, the daily temperature range has decreased—a fact of importance to cropping patterns. To give one example, rising temperatures trimmed 2.4 percent from growth in wheat yields between 1979 and 2000 (Fang and Yang 2008: 272). For the 300 million residents of the region, warmer nights bring less relief in heat waves, linked to increased mortality. For those who can afford it, this climate trend spurs the demand for air conditioning—and for electric power from coal-fired power plants, further contributing to anthropogenic climate change.

Figure 3. Daily Temperature Range: Trends, 1955-2000. Source: Liu et al. 2004.



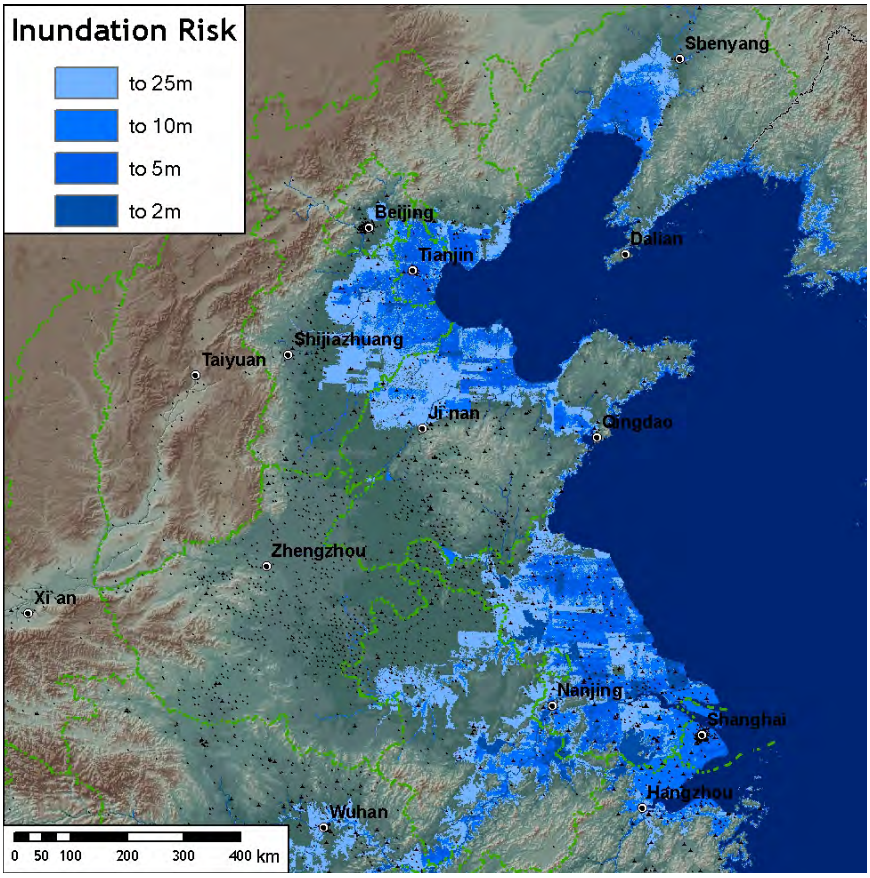
Total precipitation in all seasons, especially the summer rainy season, has also decreased across northern China while increasing in the flood-prone Yangzi River basin (see figure 4). Of even greater concern, the *frequency* of precipitation events has decreased at a greater rate in all regions and seasons, meaning that even if there is less total precipitation, it comes in more intense storms, with implications for soil erosion and flooding (Liu et al. 2005). Many other climatic variables show similar spatial and temporal trends, with turning points toward less favorable conditions from around 1978–1990.

Figure 4. Summer Precipitation: Trends, 1960-2000. Source: Liu et al. 2005.



Of all of the projected effects of global climate change, rising sea levels are among the most alarming and contentious. A minimum increase of around 1 meter is expected in the coming century due to the expansion of ocean water under warmer global temperatures, with some substantial variations around the world's coastlines (IPCC Working Group 2007). Substantial additional increases—to 10, 20 meters or more in the long term—are expected as the Greenland and Antarctic ice sheets recede. Recent reports indicate this may be happening faster than previously acknowledged by the IPCC (Hansen 2007; Kerr 2008).

Figure 5. Population Centers in Relation to Elevation above Current Sea Level. Source: Township Population Census of China, 2000; GTOPO30 Digital Elevation Model.



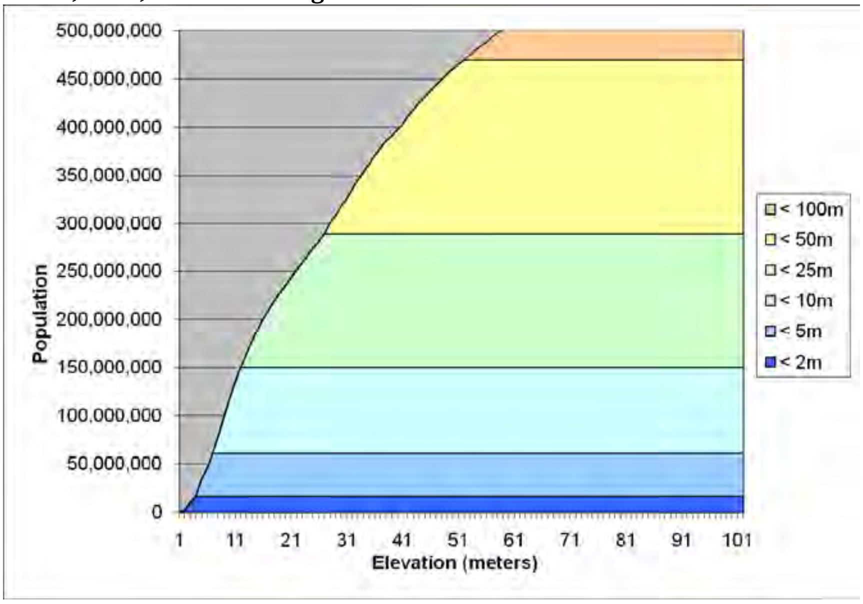
In China, where large areas of land has been reclaimed from the sea over centuries (Elvin 1993; Marks 1997) and where an increasing population has been drawn to new economic opportunities in coastal cities, sea level rise could have catastrophic consequences. While a 1-meter rise in sea levels may sound minor, coupled with increasing storm surges it would require a major engineering effort to protect heavily developed coastlines (Revkin 2009). As shown in Figure 5, large tracks of Jiangsu province and much of the North China Plain are very close to sea level; the Pearl River Delta around Guangzhou and Hong Kong is similarly situated. Nationwide, up to 16 million people live within 2 meters of sea level and, with gradually rising sea levels, will require increasingly expensive protective measures, or decisions to relocate.

Even as seas rise, low-lying areas in the North China Plain are experiencing land subsidence related to groundwater depletion. Considering areas currently up to 5 meters above sea level, there are 45 million more people potentially affected by seawater incursions, including most of the major metropolises of Tianjin and Shanghai.

Should the Greenland or West Antarctic Ice Sheets collapse, as some fear, either could add up to 10 meters to current sea levels worldwide; in China, another 90 million people would be affected—including nearly all of Jiangsu province. While the collapse of the East Antarctic Ice Sheet is considered the least likely, it could raise sea levels 25 meters or more, with another 138 million people affected in China. Under such a scenario, presently landlocked Shenyang and Ji'nan would face typhoon storm surges, and tidal flows would reach up the Changjiang to Wuhan.

In short, depending on which level of risk you want to consider, sea level rise could affect the homes and livelihoods of around 300 million people in China—approximately equal to the entire population of the United States (see figure 6). Because the regions at risk include some of the most developed in China, the value of the infrastructural investments potentially in harm's way—water control structures, ports, highways and railroads, urban developments, and improved agricultural lands—could exceed more than one-third of the country's total.

Figure 6. Population by Elevation above Current Sea Level. Source: Township Population Census of China, 2000; GTOPO30 Digital Elevation Model.



Engineering solutions to protect against these risks would require enormous expenditures. Attempted on a piecemeal basis under crisis conditions, construction of new water control structures could only defend the most valuable urban centers. With sufficient advance planning more land could saved behind seawalls, levees, and locks, but displacement of many people and industries would be unavoidable. Estimation of these costs, even under conservative estimates of possible harm, are needed so that they can be weighed against proposed measures to mitigate these consequences of global climate change.

A "win-win" alternative to these dire projections would involve adapting land management practices in these areas to promote carbon sequestration and reduce transportation-related carbon emissions. Local jurisdictions at risk of negative consequences from climate change, whether in terms of rising temperatures, water shortages, or flooding, can view investments in carbon-negative land management systems as an insurance policy that will have benefits whether or not the worst predictions come to pass.

There is some evidence that communities that are more prosperous are more willing to make expenditures or forego some economic growth in order to achieve environmental aims. The hypothesized "Environmental Kuznets Curve" suggests that "smokestack" industries and loss of biodiversity are seen as the necessary price of progress as societies industrialize, but that beyond a certain point societies place an increasing value on environmental amenities like clean air and open space. A recent study suggests that China's coastal provinces may have passed that point, showing declines in sulfur dioxide, an air pollutant of local and regional concern (Fang and Yang 2008: 237; see also Auffhammer and Carson 2007). If true, and if local leaders can be provided with sufficient information to assess the current and prospective costs of climate change, we may look to these more developed communities to lead progress on carbon-negative land management systems.

Policies for Carbon-Negative Land Management at The Local Level

Some of the most promising political developments on global climate change since the 1997 Kyoto Protocol have come from local governments and communities worldwide. Even in the United States, where the Federal government failed to ratify the protocol, numerous localities adopted their own "climate action plans" to reduce carbon emissions. Localities on Taiwan, too, have been successful in making progress on climate issues without being a Kyoto signatory. In these cases, local officials were often swayed by members of civic environmental organizations. China too has seen a notable rise in environmental NGOs, often focused on protecting local natural resources. If given the political space to become informed about the effects of global climate change on local environments, these domestic environmentalists may help shape and implement carbon-negative land management practices in key areas of China.

There is no time to lose in setting China's urbanization and land conservation policies on a more sustainable footing. Land conservation policies must be carried out at the local level by officials who are faced with other conflicting political and economic signals. While the central government is increasingly stressing the importance of agricultural land conservation, most local officials will still be swayed—short of a campaign on the order of the One Child policy—by other signals in the political and economic environment. These include policies of the central government itself that have countervailing effects, as well as issues that have been a source of recurring tension between central and local interests.

Development of the Transportation Infrastructure

From the Grand Canal to railroads and most recently superhighways, the construction of transportation infrastructure has always hastened urbanization. New roads literally pave the way for more labor intensive and higher value industries. The mode of transportation access may have long-lasting effects on the form of urbanization that takes place. Railroads have the benefit of requiring relatively little land; their effect on land use is concentrated around stations and spurs through industrial districts, and, especially if electrified, they are relatively benign in terms of energy efficiency and pollution. Since 1990, the North China rail network has grown from three long-distance lines to more of a grid, linking every regional city and a growing number of lower-order settlements. With the anticipated addition of high-speed links between metropolises, this network can be the basis of a sustainable transportation system for passengers and freight.

The new long-distance superhighways, though, promote another source of urban expansion altogether. They require significantly more land for the roadways and interchanges, not to mention the accompanying infrastructure of feeder routes, gas stations, parking lots, and the other accoutrements of the automobile society. The Chinese government's stated goal of producing 10 million cars annually, much of which are to be sold domestically (People's Daily 2003) is indirectly a land use policy, because it promotes a vision of automobile-oriented development as China's future. With China now the world's third largest oil importer (Xinhua 2003), concerns about national security may join air pollution and land management as reasons to shift course. Putting greater priority on developing local roads—building connections within regional city systems—while favoring rail for long-distance connections would be an improvement.

Reform of Economic Development Zones

As noted above, development zones have been promoted by locales eager to attract outside investment—and to skirt rules for converting agricultural land within zone boundaries. Much has been written on the proliferation of these zones and the central government's periodic campaigns to revoke thousands of zone designations made by local authorities (Chung 1997: 148; Cartier 2001). In the present economic environment, the proliferation of development zones across the landscape makes little sense from the national perspective, especially when such zones are concentrated in areas that already have the economic advantages of convenient transport and bureaucratic infrastructure.

To break the cycle of establishing and abolishing development zones, one approach would be to overhaul the complex land permitting and taxation system, with infinite local variations, that has evolved over the past quarter-century. With a more uniform system, locales would compete for investment on the basis of the structural advantages, rather than with creative loopholes. With the shift back from "letting some regions get rich first" to the promotion of more spatially balanced development, subsidies should be available for regions falling behind the national average.

Priority Farmland Zones and Ecological Services

Another kind of zone designation that has spread rapidly across the landscape putatively reserves highly productive land for agricultural use in perpetuity, or at least requires greater scrutiny at higher levels (and higher costs for would-be developers) before conversion can take place. Surveys to identify and post signs around these zones have been seen in prefectures from Dalian to Lhasa. At a higher scale, entire counties have been labeled "national grain bases." Clear signals from authorities about the permitted future uses of land are to be welcomed, as contrasted with the "give it today, take it back tomorrow" approach to land use rights that has been seen too often over the past half-century (Grinspoon 2002: 27). But there remains the implication that communities consigned to the agricultural sector will be excluded from the benefits of economic development and urbanization.

In these circumstances, transfer payments for "ecological services" provided by these communities should be considered. International economic incentives for tree-planting and other beneficial land management practices are already being tested as part of the international negotiations on climate change. If widely adopted, these could provide a legal framework for transferring funds to regions that continue to provide important ecological services (Daily 1997; Prugh, Costanza, and Daly 2000). Farmers and foresters would receive a greater share of the economic benefits that they provide to society at large from participating in carbon-negative land management systems.

Conclusion

Some of these policy recommendations echo directives that are already being put into effect in China; others will require greater coordination between central and local officials or structural changes to be effective. All will depend on more widespread understanding of the likely local consequences of failure to act on global climate change. While any local actions on this global issue are subject to fears about free-riding by communities that would reap benefits without sharing the costs, China's local leaders have, in aggregate, the resources to affect a phenomenon of planetary scale. In the words attributed to Benjamin Franklin, "we must all hang together, or we will assuredly hang separately."

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Sustainable Consumption and Production as Climate Change Mitigation Strategy for China

Patrick Schroeder[1]

Abstract

China's greenhouse gas emissions currently stem mainly from sources related to industrial production and electricity generation. With accelerating speed of urbanisation and economic policies which aim to increase domestic consumption, over the next decade a major share of China's emissions will be resulting from consumption related activities. This paper will discuss the current status of consumption in China and options of the integrated approach of sustainable consumption and production (SCP) for reducing emissions from the three consumption demand areas housing, mobility and food. In this context it discusses consumption trends and the growth of the global consumer class in China, the circular economy approach, and the potential of current government stimulus spending and policies to create sustainable urban infrastructures and consumption patterns from the outset.

Introducing Sustainable Consumption and Production (SCP)

The approach of sustainable consumption and production (SCP) can be distinguished according to three aspects: First, it is an integrative analytical perspective which helps to understand the complex interrelationship between economic activity, human well-being and environmental degradation. Secondly, it is a set of practical solutions or 'tools' to address social, economic and environmental problems arising from unsustainable production and consumption patterns. Finally, it is a political agenda to promote and support policies necessary for the systemic transition towards sustainable consumption and production patterns.

SCP as an integrative analytical perspective is based on the realisation that consumption and production are not separated from each other, but are inextricably connected and need to be considered as a coupled system (Lebel and Lorek, 2008). However, the SCP perspective is, for conceptual simplification, still often separated into the production side and the consumption side, with consumption and production referred to as 'two sides of the same sustainability coin' (UNEP-DTIE, 2009; De Ruyt, 2008). Some related concepts which are relevant and supportive of the SCP perspective are, amongst others, Factor 4 and 'dematerialisation' (v. Weizsäcker, Lovins & Lovins, 1997) and ecological footprint analysis (Wackernagel and Rees, 1996). The most important analytical tool of the SCP perspective is life-cycle thinking through which it is possible to consider all stages of the life-cycle of goods and services from resource extraction to end-of-life phase, thereby making the 'world behind the product' visible. Conceptually, life cycle thinking offers huge untapped potential for providing comprehensive information and data about products and the associated environmental impacts. There is currently still a gap between the life-cycle information already generated and comprehensive practical applications which address environmental issues based on life cycle thinking (Mont & Bleischwitz, 2007).

Similarly, the SCP concept has been discussed since the early 1990s, however, tools and methodologies for practical implementation are still evolving. SCP as a practical approach developed out of the Cleaner Production approach which, according to the formal definition by UNEP and UNIDO (UNEP-DTIE website), "is the continuous application of an

[1] UNEP/Wuppertal Institute Collaborating, Centre on Sustainable Consumption and Production (CSCP)
Hagenauer Straße 30, 42107 Wuppertal | Germany, Phone | +49.202.45 95 8.10, Fax | +49.202.45 95 8.31
www.scp-centre.org, email : patrick.schroeder@scp-centre.org

integrated, preventive environmental strategy towards processes, products and services in order to increase overall efficiency and reduce damage and risks for humans and the environment." Born out of the realisation that Cleaner Production alone will not be sufficient to achieve the necessary reduction in environmental impacts (Mont & Plepys, 2008), and that overall increases in consumption can offset efficiency improvements on the production side through so-called rebound effects (Sorrell, 2007), the cleaner production approach was extended by adding the 'consumption side' - thereby creating the integrated SCP approach. SCP offers a 'toolbox' containing range of practices and solutions which are being used to address unsustainable consumption and production patterns. Some of these SCP practices are technical and managerial, seeking to improve product properties and manufacturing processes, i.e. make them more energy and resource efficient, reduce the content of toxic substances and the output of industrial waste products. Examples of this type are the above mentioned cleaner production practices, technological innovation and green supply chain management.

Other practices are used to effectively communicate relevant information about products or companies' performance to stakeholders, such as policymakers and consumers. Such information sharing and communication practices include among others eco-labelling, sustainability reporting, product information disclosure and consumer awareness raising. Further practices can be classified as demand side management approaches which go beyond simply providing better information, but actively influencing consumption behaviour towards becoming more sustainable. Examples here include product choice editing by retailers and regulators, or green public procurement undertaken by local and national government bodies. All these different practices described above are often closely related and mutually supportive, thereby can be combined as a package for a more comprehensive strategy to deal with the environmental, social and economic impacts of consumption and production systems, including climate change (Tuncer and Schroeder, 2009).

In addition to being a conceptual perspective and practical approach, SCP is also a global political agenda and process. The political SCP agenda first gained momentum at the World Summit for Sustainable Development (WSSD) in 2002 where it was stated that "…all countries should promote sustainable consumption and production patterns, with the developed countries taking the lead and with all countries benefiting from the process…" (WSSD Plan of Implementation, 2002).

Responding to the call of the WSSD Johannesburg Plan of Implementation, UNEP and UN DESA initiated a global action plan to promote sustainable consumption and production in June 2003, the so-called Marrakech Process. It is a global multi-stakeholder process (including national governments, private sector and civil society) to promote SCP and to work towards a 'Global Framework for Action on SCP', a 10-year framework of programmes on SCP to support regional and national initiatives promoting the shift towards SCP patterns. The Commission on Sustainable Development (CSD) will review the theme of SCP during its 2010/11 two-year cycle (UNEP DTIE/UN DESA, 2007; UNEP, 2009). One of the main goals of the Marrakech Process is the development of non-prescriptive guidelines to support the implementation of national SCP programmes and action plans which requires the active participation of national governments (Clark, 2007). One example of such a national action plan is the *Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan* by the European Union which was adopted on 4 December 2008 (Council of the European Union, 2008). While this action plan is currently the most elaborate plan globally available, it has been criticised by different stakeholders for its lack of proposed action and measures. An alternative 'blueprint' has been launched as recently as May 2009 and proposes how the current EU action plan should be improved to make significant progress towards realising SCP in Europe (EEB, 2009).

SCP and Climate Change

How does the pressing issue of climate change relate to the SCP perspective, SCP approaches and related political processes? From the SCP perspective climate change can be said to be the result of currently unsustainable consumption and production patterns. Whilst climate change is often perceived as mainly an energy issue, through the SCP perspective it becomes clear that many more economic sectors and activities need to be considered, including among others forestry, agriculture, and waste management.

The application of life-cycle thinking and detailed analysis of a wide range of products shows that current efforts to reduce greenhouse gases do not focus on the 'hot-spots' responsible for the main share of emissions. Huge potentials for reduction exist 'upstream' in the value chain, the resource extraction phase and early stages of raw material processing, as well as 'downstream' in the value chain, during the use phases of goods and services (see Figure 1).

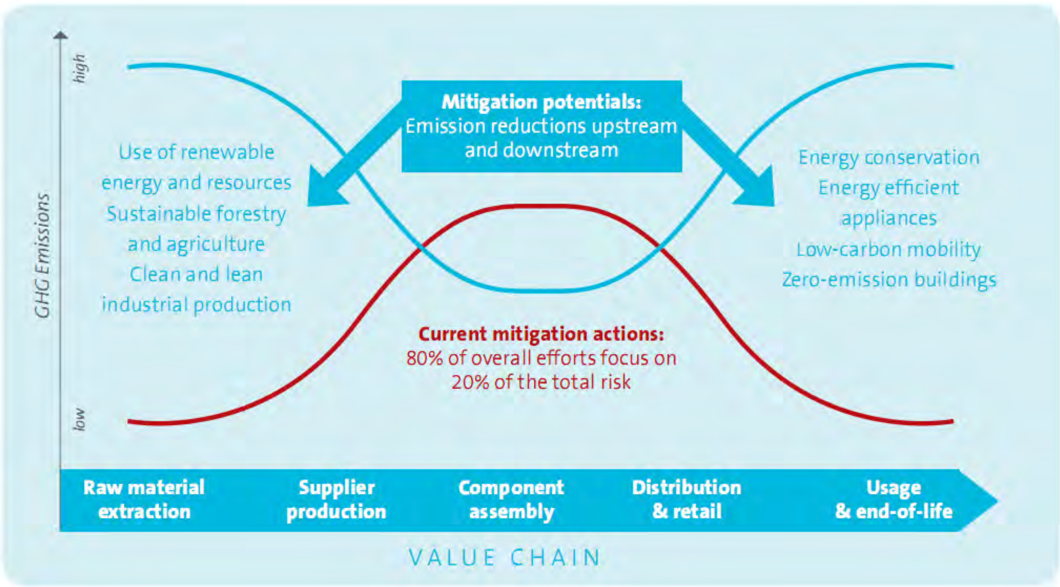

Figure 1: Opportunities for emission reductions along the value chain (Source: Tuncer and Schroeder, 2009).

Currently, the main global, bi-lateral and local initiatives to reduce greenhouse gas emissions, such as the Kyoto Protocol under the UNFCCC, or the Asia Pacific Partnership, focus mostly on the production side, i.e. technical improvements in electricity generation infrastructures and industrial manufacturing equipment. While acknowledging the importance of these actions, the SCP perspective also shows that a variety of social issues need to be considered to understand the underlying causes of climate change and find possible solutions to climate change. The most crucial contribution of the SCP approach to climate change is the realisation that in addition to technical solutions other non-technical issues and options for change on the consumption side need to be considered and supported, particularly for the reduction of emissions through behaviour and lifestyle changes.

This proposition by the SCP approach is supported by growing scientific evidence that not only technological and industrial transformation towards renewable energy technologies such as wind or solar, energy efficient manufacturing processes and new technological innovations are required to successfully mitigate climate change, but issues relating to consumer behavior and life styles are keys in finding a solution. For instance, in the Synthesis Report of the IPCC's Fourth Assessment Report it is stated that "there is also high agreement and medium evidence that changes in lifestyle and behaviour patterns can contribute to climate change mitigation across all sectors. Management practices can also have a positive role." (IPCC, 2007: 59).

Looking more specifically at which type of consumption patterns and lifestyles have climate change impacts, a comprehensive study about end-consumption related activities in the EU-25 has shown that there are currently three consumption sectors, also called demand areas, responsible for about 70-80% of the overall environmental impact of human consumption and production systems (EIPRO Study, 2006). These demand areas are housing, mobility and food and they are also thought to be the causes for about 70% of the global warming potential in the European Union (ETC/RWM NAMEA data base). Applying life cycle thinking shows that by addressing these three demand areas significant reductions in environmental impacts, including greenhouse gas emissions and climate change mitigation, can be achieved. For instance, more than 80% of greenhouse gas emissions over the life cycle of a private passenger vehicle occur during the consumption phase, i.e. while driving the car (WWF-UK, 2008). Similarly, the use phase of a computer is responsible for three times more greenhouse gas emissions than the emissions resulting from the manufacturing of the computer (UNEP, 2008).

Examples of SCP practices which are currently trying to address climate change issues in these three consumption demand areas are, for example, energy labeling for buildings and electric appliances, carbon labeling for food products or emission standards for private vehicles. Most of the SCP practices simultaneously address other environmental, social and economic issues also. Labeling for buildings encourages better insulation for energy efficiency in housing, which not only reduces energy consumption for heating or cooling, it also helps households save money in the long run. Using low-carbon or even zero-carbon transportation contributes to improving air quality in cities and has significant health benefits for inhabitants. Finally, in the demand area of food, consumer awareness raising can support efforts to reduce the intake of red meat, particularly beef, which can not only significantly lessen greenhouse gas emissions from agriculture and deforestation, but also has positive health effects reducing the risk of cancer (Cross et al., 2007).

SCP in Asia and China

The adoption of the SCP perspective in Asia for the analysis of environmental issues has so far not been without complications. While the awareness about ‘production side’ issues and the need to reduce industrial pollution is widely acknowledged, the sustainable consumption part of SCP has at times been an almost controversial topic for Asian developing countries, including China. The reason behind this controversy are considerations of global equity and historic responsibility of the industrialised economies of Europe, North America and Japan, which house only 20% of the world population, but are currently responsible for almost 80% of the life-cycle impacts of consumption, therefore are still the ‘prime culprits’ of modern consumption patterns (Tukker et al. 2008: 1219; Schor, 2005).

Current trends in global consumption patterns, including Asia and in China, pose a dilemma because of two seemingly contradictory traits: patterns of over-consumption and under-consumption existing side by side. Consumption levels in Asia, and particularly in China, have increased dramatically over the last three decades since the opening-up economic reforms under Deng Xiaoping. At the same time, millions of people are still not consuming enough to meet their basic needs for water, food, shelter or energy services and, increasingly, suffer from the environmental problems associated with industrial pollution. Why should China and other Asian developing countries, which often are still struggling with issues of poverty reduction, should restrict or change their consumption levels when western industrialised countries are responsible for the largest share of current and historical levels of resource consumption and associated industrial pollution and resource depletion? Why should Asian developing countries realise sustainable consumption while western consumption patterns are still highly unsustainable? The SCP debate shows close parallels to the international discussions on climate change, per capita emissions and commitments for emission reductions by developing countries, above all China. The sensitivities about historical responsibility and global equity are important issues to be resolved, not only for climate change, and the concept of sustainable consumption being a key issue in the debate.

Another barrier to the acceptance of the sustainable consumption concept, in Asia as much as in Europe, is the perception that sustainable consumption is automatically a restriction in consumption and of reduction in quality of life. In this respect, the challenges of promoting sustainable consumption in Asia's newly industrialising economies are similar to those in Europe and North America. The first test is to make stakeholders such as policymakers, consumers, business and researchers understand that the concept of sustainable consumption is not necessarily about less consumption, but about efficient consumption. While it might entail a reduction in the *quantity* of resources consumed, it also means improving the *quality* of consumption, thereby contributing to increases in quality of life.

Regarding SCP as a practical approach, it is important to recognise that economies of different countries have significant differences in their consumption and production patterns due to their different stages of economic development. Hence, a one size fits all SCP approach is not feasible. Practices that have been successful in Europe, the US or Japan might only be to some extend replicable in China and other Asian countries. In practice, the 'production side' practices such as cleaner production for industrial resource efficiency, phase-out of outdated industrial equipment or technological innovation approaches have been taken up relatively quickly by policy and business in Asia and China and show first success.

In contrast, the SCP practices addressing the 'consumption side' for consumption behaviour and life-styles have so far received little attention, and require possibly more complex and integrative practices involving a larger range of stakeholders than conventional production side practices. The reason is that consumption is not only an activity to fulfill basic needs for food, clothing and shelter, but increasingly driven by a complex set of forces rooted in different psychological, social, cultural and institutional settings (Mont and Plepys, 2008:536), which can be quite different within the Asian context. Therefore, understanding and addressing consumption issues in Asia and China possibly requires different approaches than those applied in Europe.

Several international initiatives are currently underway trying to promote the SCP agenda in the Asia Pacific region. The main new message of these initiatives is that pollution control alone is not enough to reduce environmental damage and mitigate climate change, and that demand side management approaches to control consumption will become increasingly critical in the future.

The 3R (reduce, reuse, recycle) concept and initiative from Japan can be seen as an early SCP approach as it is also based on life-cycle thinking. Currently, the Japanese government and the Institute for Global Environmental Strategies (IGES) are working towards bringing the two concepts and approaches of 3Rs and SCP together. The Green Growth Initiative, funded by the Korea International Cooperation Agency (KOICA), is a policy focus for Asia that emphasizes ecologically sustainable economic progress. Next to initiatives for promotion of green taxation and sustainable infrastructure, Green Growth also includes a component on demand side management through SCP. Several project-based initiatives have also been funded by the European Commission, such as under AsiaProEco and most recently under the SWTICH Asia Programme. These projects involve small and medium sized enterprises and are carried out by a range of different organisations. In addition to greening industries these programmes have the strategic goal and make attempts to give the concept and approach of SCP more prominence in Asian policymaking.

In China, the national action plan for SCP is currently being promoted and realised through the 'circular economy' concept – promoting closed-loop industrial processes where waste products are reused and recycled as opposed to a linear one-way cradle to grave straight-out production and consumption processes. On a theoretical level, the circular economy concept is closely related to ecological modernisation concepts and aims for simultaneous positive outcomes for the Chinese economy, society, and the environment. On a practical level, the circular economy model is mainly a cleaner production approach that aims to ensure that industrial facilities' waste product outputs (including heat, water, materials) are other facilities' resource inputs. By preventing waste at the source as well as turning waste into a resource, the circular economy concept aims to reduce both waste to be treated and levels of resource consumption of the industry (NRDC, 2006). Despite these efforts by Chinese government agencies and industries, the knowledge of existing circular economy best practices in China is still somewhat inadequate, especially with regard to the effectiveness, efficiency and appropriateness of best practices for the differing contexts of Chinese economy (Geng et al, 2008). The law is extremely important in terms of announcing China's intent to pursue a more sustainable model of industrial development, but to move from only being a comprehensive policy statement to implementation requires further specification. Efforts to implement circular economy currently focus mainly of large state owned enterprises. To make the circular economy a common industrial practice, more attention is required to improve the environmental performance of small and medium sized enterprises which constitute about 99% of all companies in China and generate about 60% of the industrial output value (Ho, 2005). From the SCP perspective, the circular economy approach is still too much focused on the production side and not sufficiently considers consumption side issues.

Consumption Trends and Climate Change in China

As mentioned above, fast developing emerging economies display a wide range of different consumption and production patterns. In countries like China, India and Brazil stark differences exist between regions and social classes where poverty and western high-impact life-styles often exist side by side. As the societies in emerging economies are in flux and the momentum of rapid economic development will continue despite global financial crises and economic downturn, over the next two to three decades 80% or more of their future infrastructures will still be built. This is as much a worrying trend as much as it is an opportunity! Decisive action towards setting up sustainable consumption and production systems in the early stages of development can be realised before the societies are locked-in though unsustainable infrastructures, institutions and behaviour.

This is exemplified through Asian urbanisation trends which are major drivers for economic development and social change, resulting in massive changes of consumption and production patterns. In Asia, by around 2035 the urban population will have grown by 70% to more than 2.6 billion people (ADB, 2006). More than half the construction going on in the world is currently taking place in China and by 2030 this one country is expected to have more than 200 cities with populations of over one million people each (McKinsey Global Institute, 2008). Urbanisation is not only driving construction, but further a driver for new mobility patterns. At present, with only about 2% of the population in China owning a motor vehicle, private car ownership is still low compared with 40-50% in Europe and North America, but this level is expected to rise steeply, and estimates put the number of private passenger cars in China at 190 million by 2035 (ADB, 2006).

Finally, it is particularly urban consumers that belong to the emerging so-called "global consumer class" which totaled about 1.7 billion people in 2004 – of which almost 40% are in Asia (Worldwatch Institute, 2004). Global consumers share certain elements of a lifestyle of conspicuous consumption regardless of their cultural background or nationality – they are likely to live in modern apartments equipped with electronic appliances and gadgets, have access to information technologies and global luxury brands, own their own cars, travel by air, etc. This consumer class in Asia is now estimated at around 600 million people, already more than the total populations of Europe and North America combined. In China, rapid growth in economic activity and incomes has revolutionised access to modern consumer goods and services. The country has in the last three decades not only become a global manufacturing hub, but it is now home to an emerging consumer class. It is estimated that by 2020 about 700 million Chinese will be part of this global consumer class, compared with less than 100 million today. In terms of spending, this increase in consumer numbers equals a five-fold increase in urban consumer spending over the next 20 years to $2.3 trillion per year (McKinsey Global Institute, 2006:17)

While the consumption patterns of millions of urban consumers in the newly industrialised countries of the Asia-Pacific region are converging with those of western industrialised countries – especially within the younger generations – there are still stark differences between rural and urban consumption patterns in many of these countries. One commonly used tool to measure and compare the environmental impact of consumption patterns is the environmental footprint analysis. In China ecological footprint analysis shows that there are large differences between rural and urban footprints. The rural ecological footprint is between 0.8 to1.2 ha per inhabitant, while the urban footprint can be as high as 3 to 6 ha per inhabitant (Salat, 2008), the latter being comparable to the average urban European footprint. Looking only at China’s mean ecological footprint of 1.6 ha per inhabitant, which is still below the global average of 2.2 (CCICED & WWF, 2008), is therefore not giving the complete picture of the situation. Furthermore, the comparison of different Chinese and global cities’ footprints shows that Beijing and Tokyo have similar ecological footprints (about 4 ha per inhabitant), and Shanghai and London’s inhabitants have a footprint of about 5.5 ha per person (Salat, 2008). This shows that urban consumer lifestyles of people living in Chinese metropolis are equal in terms of environmental impact to those in industrialised countries of Europe and Japan.

The high urban ecological footprint is closely related to per capita emissions and carbon footprints which are becoming relevant in the global climate change debate. While China’s average per capita emissions are currently still below 6 tonnes per year, it can be expected that there is a significant different between rural per capita emissions and urban per capita emissions in China. For example, Beijing has annual per capita greenhouse gas emissions of 6.9 tonnes and Shanghai 8.2 tonnes (Vaughn, 2009) while the per capita emissions of rural Chinese are significantly lower than the national average. This stands in contrast to industrialised countries where the highest share of carbon emissions can be attributed to people living in sub-urban and rural areas and urban consumers often have up to 50% lower carbon footprints. Comparing the per capita emissions of different global cities, the inhabitants of Beijing and Shanghai have significantly higher footprints than their counterparts living in Tokyo (4.8 tonnes), Seoul (3.8 tonnes) or Barcelona (3.4 tonnes) (Vaughn, 2009). This difference is mainly due to public transport infrastructure and building densities reducing the need for motorized personal transport in those cities (see figure 2).

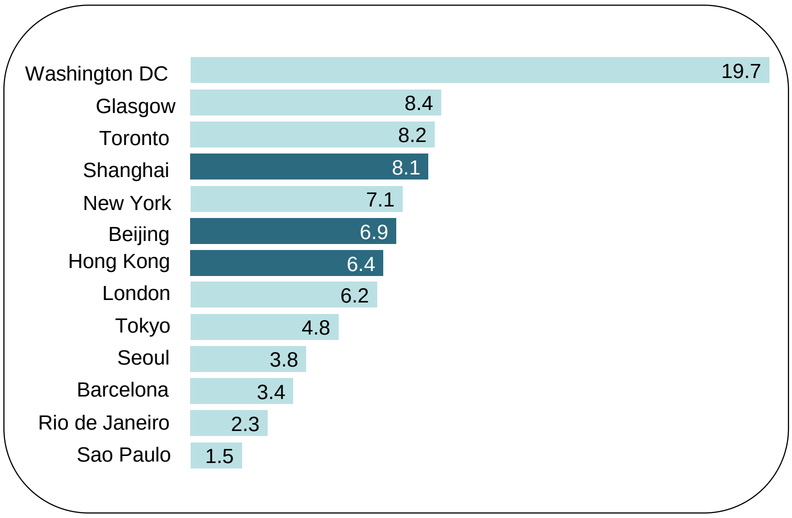

Figure 2: GHG emissions per capita (tonnes of CO2 equivalent). (Source: Vaughn/IIED 2009)

Realising Low-Carbon Lifestyles Through Sustainable Consumption in China

The hot-spots identified above show that urban consumption patterns in China's mega cities need to be addressed first to reduce increases in emissions from consumption. In the area of personal mobility, often regarded as the main problem area for many Chinese cities, positive developments towards sustainable consumption patterns can be observed in the uptake of electric scooters and bicycles. Over the last decade these electric two-wheelers have made strong advances in quality, and the diffusion and commercialization has accelerated dramatically since the early 2000s. Electric two-wheelers emerged from virtual non-existence in the 1990s. Then, in 2000 about 300,000 electric bikes were sold and the number of bikes sold increased to 10 million in 2005 and 20 million in 2006 (Weinert et al., 2008).

Electric two-wheelers have significantly reduced environmental impacts compared to other personal urban travel options. The average electric bicycle uses only 1.5 kWh electricity per 100 km. Compared to the average of 3 litres petrol used by a motorcycle and 10 litres petrol by a passenger car in urban city traffic, the environmental impact reduction is considerable, even if electricity is generated through coal. It also is also a more cost effective mobility option. Given 10,000 km travelled per year, the total electricity cost would amount to about 90 to 100 Yuan, which is about 15 times lower than that of a motorcycle and more than 40 times lower than of a car. (Feng, Jiang and Chen, 2007)

How can Chinese urban consumers make progress towards realising low-carbon lifestyles in other consumption related demand areas? While on the one hand Chinese urban consumption patterns and life-styles are converging with those in Europe, Japan and North America, on the other hand personal consumption in China is a socially, culturally and politically embedded and idiosyncratic activity affected by society and institutions, which can be quite different than those in western industrialised countries. A number of relationships shape values of Chinese consumers, including notions of utility and need. Currently, material consumption in China increasingly is perceived to contribute to self-satisfaction, social position and serves as an indicator of a good, successful und modern life. Initiatives that aim to enable SCP and emission reductions in China must therefore deal with both 'hard' technical details of industrial production processes, as is currently the main focus, as well as 'soft' issues such as how consumption is practiced, perceived and circumscribed by Chinese society.

One the one hand, wealthy urban consumers have significantly larger environmental footprints and higher carbon emissions than their less well-off fellow citizens. This is true for western industrialised countries as much as for China. Therefore, wealthy consumers with high-impact lifestyles carry a larger share of the responsibility for contributing to global environmental changes such as climate change. On the other hand, wealthy consumers can be agents of change supporting the transition towards sustainable consumption and production patterns. Through their buying power they can take up their responsibility and support ‘green’ and low-carbon products, such as organic food and natural cosmetics, living in modern low-carbon buildings that use environmental technologies and sustainable building materials, organic fashion made from natural fibres and dyes, and make use of low-carbon vehicles such as hybrid cars. While often perceived as such, these green products are in fact *not* bottom-end products of low-quality and low-price, but luxury products for the wealthy that the average consumer in many cases cannot afford.

As for China's nouveau riche, consumption is not any longer about meeting basic daily needs, but has entered a stage of conspicuous consumption, an "Enjoy Now" phase where higher-end purchases are no longer out of reach. According to Merrill Lynch’s Asia Pacific Wealth Report, an estimated 415,000 Chinese had more than $1 million in disposable assets in 2007, more than any other country (Merrill Lynch and Capgemini, 2008). Up to 170 million people, or 13 percent of the population, can afford luxury brands and the number is predicted to reach 250 million by 2010. They are mostly aged between 25 and 40 and live in urban developed coastal regions of China. They are fashionable and passionate about lifestyle and quality. With a growth of 20 to 35 percent in the next five years the Chinese Ministry of Commerce predicts the country will become the world's largest luxury market by 2014, accounting for 23 percent of global business (Battered luxury brands eye Chinese market, 2009).

As Chinese consumers increasingly spend their money on luxury goods, there should be no apparent contradiction between a luxury life-style and sustainable consumption of high quality green products. However, at this stage green and sustainable products are not particularly considered to be luxury goods and product quality is often not satisfactory. An additional issue is that eco-labels, important tool for the identification of green and sustainable products, have low credibility and are not trusted by Chinese consumers. A shift in consumer thinking, together with increased awareness about environmental and health issues, and quality improvements can give green products a new face and image. With these barriers overcome, green sustainable products have the potential to become new status symbols and a creative means of displaying wealth and success. Furthermore, it can be a way of generating positive emotions and satisfaction from consumption that cannot be gained through unsustainable wasteful or unethical consumption practices which can often even be accompanied by feelings of guilt.

This trend towards green high-end lifestyles can already be observed in the lifestyle concept of LOHAS (Lifestyle Of Health And Sustainability) which is becoming an ever more important high-end market segment in North America, Europe and Japan. Even in China the LOHAS concept (*lehuo*) is beginning to become known and is used as marketing strategy by forward-looking, innovative businesses. Through buying green luxury products such as organic food or cosmetics, the market share of such niche products can be increased and be made available for mainstream consumers. However, green consumerism is probably not the final answer, the greening of markets and improving the quality of green products has rather to be seen as a step into the direction of sustainable consumption.

In addition to making green products ‘cool’ and trendy, traditional Chinese culture and values have the potential to positively influence consumption behaviour. All three Chinese cultural traditions, Buddhism, Daoism and Confucianism, are currently experiencing a renaissance in China. Long before current discussions about unsustainable consumption behaviour these traditions have dealt with issues relating to conspicuous consumption. With their emphasis on simplicity, contentment, moderation, frugality and harmony between humans and nature they are still relevant today and influence personal consumption behaviour. Furthermore, these traditions emphasise the relationship between the individual, society, the Earth and Universe as one, therefore appropriate personal behaviour is crucial for global well-being. While ‘back to nature’ in the proper sense of the phrase is not possible, these traditional cultural values can support awareness about the need of balancing economic growth through industrialisation and environmental protection, including the global atmosphere (Angsuvat, 2006).

Addressing unsustainable individual and institutional consumption behaviour is also increasingly becoming an area of activity for Chinese NGOs and civil society. Environmental awareness of Chinese consumers’ is increasing, often through the efforts of NGO environmental activism and campaigns. In the area of climate change the “26-degree campaign”, which was initiated during 2004 and 2005 jointly by several NGOs including Global Village of Beijing, World Wide Foundation for Nature in China, China Association for NGO Cooperation, Friends of Nature, Institute of Environment and Development and Green Earth Volunteers, has been very successful. Following this campaign, in 2007 the State Council officially announced that all governmental agencies and state enterprises are obliged to set air conditioner to a minimum of 26 degrees, which shows that civil society is beginning to have an impact on national environmental policy making (Xie, 2009).

Furthermore, consumption of sustainable products are not only options for wealthy urban consumers, but can also be made available for China’s poor in rural areas of Western China. Examples are solar PV home systems for renewable energy generation. China’s solar water heater market is already the largest in the world. Through the adoption of solar PV home systems, many people in rural areas who have never been connected to the electricity grid can leapfrog towards a sustainable energy future without going through the process of grid connected unsustainable energy supply through coal fired power generation. Over the last decade, through a range of government sponsored programmes, several million people in Western rural China have been supplied with solar home systems, local industries have been built up contributing to social and economic development in the region. Electricity provision further is the basis for other economic activities and social development.

In addition to greening markets other efforts are likely to be necessary to achieve systemic solutions. Examples are the development of product-service systems that can be realised through increasingly closer partnerships and collaboration between stakeholders (Morelli, 2007). The SCP approaches developed and practiced in western industrialised countries can be replicated and offer potential solutions also for addressing challenges arising from Chinese consumption patterns and lifestyles. In addition, particular SCP practices and strategies based on the native cultural as well as political contexts need to be considered for realisation of SCP in China (Leong, 2008).

Particularly China’s policies for demand side management and changing consumer behaviour based on a tradition of central planning can show very different approaches and results compared to those implemented in Western countries, where market-based mechanisms are preferred over top-down command and control mechanisms. A case in point are the Beijing measures to reduce traffic congestions and improve air quality during and after the Olympics. The effects on traffic reduction can be to some degree compared with the effects of congestion charges in the London inner city. Which approach is better or more effective is difficult to assess and should be considered according to the socio-political situation and local conditions. While an imposed Beijing-style “five-day regulations” would very likely be met with resistance in most European cities, implementation of congestion charges would be likely to face other difficulties in Chinese cities.

In the context of global financial crisis and economic downturn, China’s policymakers face both challenges and opportunities. China has in the last three decades largely been a production-focused economy, with most products destined for overseas export markets and consumption in the countries of Europe and North America. As the recent financial crisis has shown, this model was unsustainable not only from an environmental perspective, but also from financial and economic perspectives. China’s economic policy is now stimulating the increase of national domestic consumption to prevent large-scale unemployment in the manufacturing sector. The government’s stimulus package with more than US$200 billion allocated for green spending (HSBC, 2009), in comparison to other countries’ spending the highest amount allocated for green industries, is an example how government can stimulate economic development towards sustainability. In times of economic and financial crisis China now has also the opportunity to change its economic structure from one that only produced low-value-added products and relied on external markets to an economy based on sustainable consumption and production systems.

Conclusion

Emissions from coal-fired power stations for electricity generation are generally still being perceived as the main contribution to climate change from China. While in the past China’s environmental problems and greenhouse gas emissions can indeed be largely contributed to electricity generation and resource and emission intensive industrial production, within the next decade the focus will very likely shift towards more consumption related impacts. As a result of increasing incomes and urbanisation the share of emissions from the consumption areas of private mobility, housing and food are going to increase and will account for one of the largest shares of China’s emissions in the future.

The conceptual and practical approaches of SCP offer a good opportunity for China to address the issues of rising urban per capita ecological footprints and greenhouse gas emissions simultaneously, and contribute to the creation of a resource efficient and low-carbon economy and society. Currently in China, SCP is mainly being promoted through the circular economy approach, which has a strong focus on cleaner and leaner production processes, waste minimization and recycling. It does, however, not explicitly include the issue of sustainable consumption. While the circular economy is an important legislation to improve environmental performance of industry sectors, a comprehensive SCP approach will also need to consider the growing impact associated with new consumption patterns, particularly in respect to growing greenhouse gas emissions.

Addressing unsustainable consumption patterns in China requires the active participation of China’s wealthy consumers who have the power to support a market shift towards greening products and markets. Increasing awareness among Chinese consumers about environmental and health related issues is an important first step in any transition to sustainable consumption patterns. However, as increased awareness does not automatically lead to behavioural changes, further SCP practices and measures addressing consumer behaviour are required. These SCP practices can to some degree be taken from Europe and other countries, but for replication in China will have to be tailored according to the specific Chinese cultural, political and social conditions.

Finally, the Chinese government has included the expansion of domestic consumption as a key goal to overcome the financial crisis and global economic downturn. The government is allocating large amounts for financial stimulus spending towards important sectors such as railway systems, public transportation and energy efficient buildings. While there are doubts how ‘green’ China’s stimulus package actually will be, this type of green spending offers opportunities to establish sustainable urban infrastructures, including low-energy housing and sophisticated public transport systems from the outset. This effort has the potential to support medium-sized second-tier cities, where most future construction will take place, to avoid becoming locked into unsustainable infrastructure, making the transition for Chinese citizens towards sustainable consumption and production patterns significantly easier, thereby pre-emptying high-carbon urban lifestyles.

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Public Initiatives and Local Practices in China's Response to Climate Change

Lei Xie[1]

Abstract

China is facing increasing environmental pressure, among which climate change is the most serious one. As many areas are still under development, the country's vulnerability to the adverse impacts of climate change lies not only in its ecological aspect but also its social aspect. In particular, the country's increasing energy demand has posed serious problem, as the country strongly relies on fossil-fuels. Dilemmas exist between development and increasing level of pollution. Local government, to realize its political credibility often permits environmental pollution happen and has been ineffective in local environmental governance.

Chinese environmental non-governmental organizations (ENGO), led by journalists, scientists and key environmentalists, have emerged since early 1990s. They begin to play an increasingly significant role in China's dealing climate change. Although still in its early stage of development, domestic ENGOs are greatly influenced by International ENGOs in their strategies, organizational development and accessing scientific knowledge. Chinese ENGOs have become successful in assisting local communities dealing with key issues of climate change, including energy, agriculture pattern and changes of lifestyles in cosmopolitans.

Illustrated by case studies, this paper discusses the role that Chinese environmentalists play in local communities' dealing with climate change issues. It examines ENGOs' the characteristics, strategies, knowledge and technology transfer in their organizational development and promotion of social changes. In particular, this paper explores the interaction between ENGOs, INGOs, local governments and local communities in looking for solutions of climate change.

This paper contributes to the understanding of China's growing civil society and local practices in mitigating climate change's impact, which have significant influence to local and national environmental governance. It also deepens our understanding of the impact of globalization to the country.

Introduction

China, a country whose role on the global stage has changed profoundly, has received significant attention from the world. Although the country has experienced fast economic growth, a high price has been paid by the environment, which has been seriously degraded. Climate change has posed serious environmental problems including accelerated deforestation, threats to human health, increasing levels of outdoor and indoor air pollution and negative effects to coastal zones and freshwater ecosystems and so on.

China is faced with mounting pressure in dealing with climate-related issues. Domestically, owing to its ecological and geographical conditions, China is highly vulnerable to climate change. This factor, along with China's growing regional inequality pose serious problems to sustainable economic and political development. Driven by extreme weather events, health and pollution crises, social unrests surge in China.[2] Growing protests emerge against forced relocation by energy development and unequal exposition to environmental risks. Therefore, the impact of climate and environmental change is one issue that has strong implications to political stability (Wiener, 2008).

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[1] Email: Xie.Lei.1@city.ac.uk

[2] Elizabeth Economy notes that in 2006, the Chinese government reported 1,000 environmental protests per week. Elizabeth C. Economy, *The Great Leap Backward?*, FOREIGN AFF., Sept./Oct. 2007

China is also being challenged to bear climate-related issues with greater responsibility from various stakeholders in international community. External pressures generated by international negotiations on climate change have placed the issue of global warming on China's domestic agenda and forced the country to respond. Climate negotiations have become an important element in its foreign dialogues with countries that have strong commitment in global climate governance, such as the European Union. Equally important, concerns have been raised toward China's overseas investment and the country's environmental footprints abroad. In Africa, China's resource security centred approach has been criticised for neglecting the environmental impacts and damaging natural resources in the continent (see Taylor, 2007; Bosshard, 2008).

Under this background, certain space is found available for the Chinese public to get involved and respond to climate change with individual actions. Since early 1990s, Chinese citizens have shown an increasing level of environmental awareness, which is evident in the development of environmental activism and symbolized by the organization of environmental non-governmental organizations (ENGOs) and voluntary groups. During the globalization process, the international environmental events, organizations and NGOs (INGOs) have had a strong impact on the country. The Chinese NGOs' perspectives are broadened and intensified understandings of global climate change are achieved after participating international events, such as the 2002 World Summit on Sustainable Development, the UN Framework Convention on Climate Change Conference since 2005. They have successfully built public consensus on local and regional environmental issues. In recent years, many ENGOs have began to be involved in mitigating the impact of climate change in China, assisting local communities adaptation capacity, promoting energy efficiency and energy saving and so on.

This article examines the development of public initiatives in China's response to climate change. The following questions will be addressed: what are the main forms of actions, on what issues the public's climate actions are, how are public's interests articulated and what impact has been produced? The second part provides a literature review on the role of NGOs in global environmental governance. The third part explores political opportunities that are found in China's political structure. Through case studies, the fourth part illustrates the main domains of NGOs' initiatives and the significance of such activities. The last section concludes the role that the non-state actors play in China and discusses the implications of public participation to China's climate capacities.

Literature Review

Increasing scholarly interests have been shown on the significance of nongovernmental actors' in global environmental governance. Literature includes the development of international environmental activism, forms of action and the nature and extent of its influence globally.

International environmental organizations are the largest transnational social organizations in number (Bandy and Smith, 2005). Its population has almost doubled as a percentage of all transnational social movement organizations (Johnson and McCarthy, 2005; Frank et al. 2000). Two factors contribute to such development in environmental movement, one the globalization of environmental problems and solution strategies) (van der Heijden, 2006). Second, the characteristics of global environmental governance also require the incorporation of NGOs, who act as potential force to provide arrangements beyond state (see Arts, 2006).

One of the key areas of debate is developed on the role of NGOs in international environmental politics (Bestill and Corell, 2001; 2007). Two categories can be found: a small group of scholars puts strong emphasis on the national and subnational context of ENGOs (Dalton, 1994; Pickvance, 1998; Szasz, 1994); while a larger group takes on a transnational focus and emphasizes the emergence of transnational advocacy network (O'Neill, 2009; Della Porta and Tarrow, 2005). Both agree that although environmental NGOs are rooted in national context (Bandy and Smith, 2005; Faber, 2005; Rootes, 2005), they have broader policy impact at the state, national and international levels (Faber and McCarthy, 2001).

Heated debate is developed on the significance of transnational environmental activities. Such activities are characterized by two natures: networking and cooperation. Transnational advocacy networks are found to be linked by horizontal or vertical connections (Khagram et al. 2002) or loose and informal networks that have spread across borders (see Adamson, 2005). Environmental NGOs cooperate by sharing common purposes, values, environmental information and resources (Wapner, 1996; Dalton et al., 2003; Della Porta and Tarrow, 2005). However, issues are raised on the coalition efforts. Murphy's work suggests that coalition presence is a double-edged sword. While greater numbers of coalitions suggest movement expansion, empirical evidence suggests that this rise makes the foundings of new organizations less likely (Murphy, 2005). Additionally, no universal frame exists for global environmentalism (Mol, 2003), therefore conflicting ideologies and goals exist among environmental networks and can cause tensions and affect the patterns of international cooperation (Keck and Sikking, 1998).

Regarding the influence of transnational networks and their activities, they are found to be of significance in global environmental politics. Dryzek (2003) suggests it as part of the "transnational public spheres". At global level, advocacy networks are suggested to be functional in the following two aspects.

First, ENGOs participate in the process of international environmental negotiations (Arts, 1998; O'Neill, 2009). They serve as the "conscience-keepers", highlighting the moral and ethical imperatives to solve global environmental problems (Yamin, 2001), and in some occasions have successfully brought problems to the attention of the international community (Wapner, 1996). However, ENGOs' role in international environmental negotiations is found to be constrained by domestic politics. In climate politics, governments may assume that new international rules to impose policy changes upon them and therefore not want NGOs to co-determine the outcome of international negotiations (Arts, 1998). Certain states are found to have had tried to reduce, or even marginalize altogether the degree of NGO input into policy debates, for instance, Egypt, Saudi Arabia, Argentina and Mexico (Newell, 2000). The significance of ENGO's political influence is also suspected. By closely examining NGOs' political influence on the Climate Change and Biological Diversity conventions, Arts argued that NGOs have only some or indirect effects on both of the provisions, which were far less than representatives claim they could have (Arts, 1998).

Another main role of NGOs is their involvement in advancing the creation of formal accountability mechanisms for global governance (Scholte, 2004; O'Neill, 2009). In environmental governance, NGOs, as one distinct form of non-state actors (NSAs), have been noted for imposing substantial regulatory power (Arts, 2006). They offer the strongest regulation and potential to socially embed global markets 'an array of voluntary, self-regulatory, shared governance, and private arrangements', which are beginning to fill the policy void (Howlett, 2000; Haufler 2001; Gunningham et al. 2003; Ruggie 2004; Hay et al. 2005). In the climate arena, self-regulation proposed by civic-business partnerships, certification programs, labeling and standards for climate neutrality are regarded as 'new' modes of governance that is transformed from conventional hierarchical governance. (Bäckstrand, 2008).

However, turning to green activism in newly industrializing countries, where the capacities and resources to articulate environmentalism are relatively low, the environmental movement is often found weak at national level and is only poorly integrated in global networks (Mol, 2003). Current literature suggests that organizational development has been one major reason that attributes to the lacking of significance in environmental movements. Securing funds to survive is of priority to ENGOs in developing countries, where finance mostly comes from foreign donors. Lacking resources proves to be an important factor to explain why the Mexican NGOs put priority on local environmental issues and not engage in climate issues (Pulver, 2006). Additionally, distinct environmental identities are another important factor that affects ENGOs' influence when interacting with foreign donors in developing countries. Lacking connection with local communities, Russian's ENGOs are found to be inefficient in promoting civil society and influencing environmental policy, despite the fact that Russian ENGOs' increasingly developed into professional bodies (Henry, 2001). Furthermore, with relatively weak organizational development, ENGOs in newly industrializing countries are found to remain in an unequal position within global environmental networks (see Rohrschneider and Dalton, 2008). Northern ENGOs provide aid to groups from the South and may frame environmental campaigns using their own goals instead of the indigenous groups (Rohrschneider and Dalton, 2008). Therefore, grassroots organizations' own strategies and resources available at the local level influence the relationships that emerge between local and transnational environmental organizations and compose key variables in determining movement outcomes (Della Porta and Tarrow, 2005; Rodrigues,2004).

China's Climate Governance and Political Opportunities for Public Participation

In general, the Chinese authorities are not keen on encouraging organized efforts from the public, which is often associated with political dissent. However, it seems that political regulations is less repressive in the field of environmental protection, which has been one of the fields that certain space is provided by the state for NGOs to establish (Saich, 2000). This can be explained by several factors, the evolution of Chinese environmental governance structure, improved legal regulations on public participation and the challenge of the complexity of climate policy implementation in local level.

China's climate-relevant policies are found to be rather limited, domestically as well as internationally (Richerzhagen and Scholz, 2007; Koehn, 2008). They can be broadly divided into three policy fields: energy, transport, and environment. Energy policy is central for economic growth, and at the same time, energy generation is the main source of Chinese GHG emissions. Transport sector is one of the sectors that have the fastest growing greenhouse gas emissions. However, these two sectors have been weakly incorporated to climate policies. Only environmental policy has connections with the other two sectors' policies and holds strong potential for synergies between mitigation policies and specific environmental programmes (Richerzhagen and Scholz, 2007). Hence, mechanisms and measurements utilized in environmental policies may have strong implications to the design and implementation of comprehensive climate policies. Evidence has been shown that in environmental policies the Chinese political authority is experiencing transformation (Mol and Carter, 2006). In industrial pollution control, NGOs have been involved in industrial pollution control (Han and Zhang, 2006). Such facilitative attitude may lead political elites to integrate civil society in other climate-relevant policies.

Recognizing that demands exist for public environmental participation, the state has established several legal frameworks and regulatory measurements to allow the public to be involved in policymaking processes and decisions. The Environmental Impact Assessment Act promulgated in 2003 confirms the right of public participation in environmental policies, but in practice the law is seldom followed. This legal framework is complemented by 'Environmental Protection Administrative Licensing Hearings Provisional Measures' (2004) and 'Provisional Measures for Public Participation in Environmental Impact Assessment' (2006). Both legal documents delineated the measures for citizens' participation in environmental impact assessment. These legal documents provide institutional arrangement for public participation, for NGOs to act as an independent monitoring force in controlling environmental pollution, the completion of environmental impact assessment that many large-scaled energy skipped under protection of local government.

China is in great need of climate efforts at local level. As suggested by Wilbanks and Kates (1999), 'the human activities that can lead to climate change are very local', there is growing awareness that any global response to climate change must involve local action. Despite enormous efforts to improve the state of the environment, implementation on the local level of the actions proposed is weak due to lack of incentives and conflicting interests, which result in neglect of environmental activities. Lacking of financial resources in environmental protection lead to weak administration, and produces an obstacle that restrains the Environmental Protection Bureau (EPB)'s capabilities (Xie, 2009a). Human resources also are not sufficient to undertake climate-specific actions, in climate-relevant sectors such as energy, transport, agriculture, forestry, industry and research and Development. Therefore, the design and implementation of climate policies and measures are largely constrained. This factor provides strong incentive for NGOs' participation in climate-related activities. Those whose interests are at risk are very likely to participate in environmental movement and have their interests articulated by ENGOs (Xie and van der Heijden, *forthcoming*). When the political output structure is found weak in adapting to climate change, the public is likely to initiate such activities themselves.

Main Actors in the Third Sector

Among the efforts of public organized activities, INGOs, ENGOs, and GONGOs are the important forces. Each has its own advantages, which lead them to adopt different strategies to conduct activities responding to climate change.

International Actors

China sees an increasing number of international actors actively involved in mitigating effects of climate change in China. During the globalization process, international environmental events, organizations and NGOs (INGOs) have had a strong impact on the country. After the UN's Fourth World Conference on Women in 1995, an increasing number of international NGOs arrived in China. These groups account for a majority of INGOs that have entered China since 1978.[3]

A vast number of international environmental NGOs are currently working in China on climate and environmental change. Some of the areas they are working include: climate change (WWF), biodiversity protection (Conservation International, Wildlife Conservation Society); Watershed management (Oxfam America) and ecotourism, promotion of clean energy (Natural Resources Defense Council; The Nature Conservancy).

INGOs have proven to be a strong force in fostering the development of Chinese ENGOs, especially when the latter were just established in the early stages of NGO development (Xie, 2009a). They bring significant funding to help Chinese groups, which constitute the major source of revenue to Chinese ENGOs (Fu, 2004; Yang, 2005). Although enjoying certain degree of freedom, it should be noted that INGOs are very cautious in working with and joining domestic advocacy activities, because of the repressive political conditions in China.[4] Collaboration between domestic ENGOs and International NGOs are built mainly through their chapters in China. Large international environmental NGOs - such

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[3] Ma, Q., 2006, Globalization, International Non governmental organizations and China's Non governmental organizations' development. *Open Times.* Issue 2.

[4] See for instance a talk made by Lo, SzePing, campaign director of Greenpeace China. http://www.wilsoncenter.org/index.cfm?topic_id=1421&fuseaction=topics.event_summary&event_id=274600

as Greenpeace and WWF China - have their own staff and offices in China and operate relatively independently from their headquarters. They have more chances to cooperate with Chinese partners. After two decades of presence in China, WWF has built good working relationship with state government. It has been committed to seeking solutions for China's low carbon development and is carrying out a "low carbon city" project with 2 pilot cities. Some others prefer to work alone, for instance Greenpeace. Smaller organizations can hardly establish an office and choose to build partnerships with local environmental groups, thus relying mainly on the latter in their collaborative projects and the collaboration lasts only for a short period of time (see Xie, 2009a).

In recent years, foreign NGOs and social groups have also been brought in the country by its climate cooperation with Northern countries including those from EU, the US, Canada and Japan and so on. NGOs can apply for financial sources provided by official development assistance grants and act as implementing partners in multilateral environmental agreements (MEA) from China's partner countries.

Domestic Environmental NGOs

The past few years have seen rapid growth of ENGOs. By October 2008, 3,539 environmental groups had been registered with the Ministry of Civil Affairs or its local bureaus.[5] However, unregistered environmental NGOs are not included in this number and neither are web-based organizations or ENGOs registered as business organizations[6]. According to estimates the total number of unregistered environmental organizations is over 2,000.[7]

The Chinese ENGOs participation in climate related issues is, contrastingly, relatively new. In late 1990s and early few years after 2000, most Chinese ENGOs engage in rising environmental awareness among citizens and officials, in disseminating information to the wider public and in clean-up actions in streets and parks (Xie, 2009a). The past several years have seen an increasing amount of ENGOs engaging themselves in climate change issues, including providing education on climate change, promoting energy saving and efficiency and helping farming communities to shift to renewable energy sources. It is estimated that almost 60% are involved in energy saving and emissions reductions. This excludes those that promote other issues on deforestation, sustainable agriculture development and consumers' behavior change.

Regarding the professionalization, the Chinese social organizations and voluntary groups have also been more capable to secure funds through domestic charity and foundations, with legal document that provides higher incentive to private donations.[8] With their fund secured, NGOs can focus on global environmental issues instead of local or regional ones that have immediate effects to their lives. However, China's ENGOs have seen a low level of institutionalization and formalization, which is identified by a weak membership system, informal internal institutions and very few systematic mechanisms that have been developed for decision-making. Individual key members or leaders dominate organizational life, and determine these organizations' agendas. Despite this, indigenous environmental identities have been developed in different localities, which are supported by

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[5] All-China Environmental Foundation, 2008, '*Report on environmental NGOs*', unpublished internal report.

[6] This survey was taken by a GONGO—ACEF, which may have had difficulties trying to reach unregistered grassroots ENGOs that do not have legal status.

[7] Economy, E., 7 February 2005, China's environmental movement, testimony before the Congressional Executive Commission on China Roundtable on Environmental NGOs in China: Encouraging Action and Addressing Public Grievances, from U.S. Government's Council on Foreign Relations. Available HTTP: <http://www.cfr.org/publication/7770/> (accessed 03/02/ 2006).

[8] The government is discussing to promulgate the first Charity Law, which will provide higher tax deduction rate for private donations to charity activities.

the country's cultural heritage and traditional moral education. It strongly strengthens the mobilization of masses and resources, and helps to preserve the movement's autonomy from international NGOs as their funding organizations (Xie, 2009b).

GONGO

One special type of NGOs that is of increasing importance in China is government organized NGOs (GONGOs). They were initiated by government agencies or institutions. Examples of GONGOs that are committed to energy saving and renewable energies include Chinese Renewable Energy Industries Association (CREIA) (established in 2000), the All-China Environmental Federation (ACEF) (established in 2005), China Energy Conservation Association (CECA) (established in 1984).

GONGOs' involvement in climate activities is boosted by international climate cooperation between China and the world. The multiple structure of global climate increasingly requires the participation of NGOs and industrial associations as partners in collective global climate efforts (see O'Neill, 2009). As non-state actors, they are regarded as important representative of the industries and community interests. Additionally, the Chinese government partner is often concerned for lacking transparency in project implementation (see Wu, 2002). For example in German government's cooperation with China on energy saving and the promotion of renewable energies, industrial associations become partners for implementation as well as state agencies. Moreover, GONGOs have acquired certain level of independence and began to play leading role in setting professional standards and norms and decision making process. Empirical case study on CREIA indicates that it has expanded its activities as merely implementing project and has become an influential actor in national and provincial renewable energy policy making (Wu, 2002).

Additionally, GONGOs also foster coalitions and networks among NGOs and groups that work on climate change issue. Established in 2007, China Civil Climate Action Network (CCAN) is a network that is co-organized by China Association for NGO Cooperation (CANGO). Major members include Chinese ENGOs, industrial associations and international NGOs, such as WWF Beijing Office, Environment Defense China. Aside from strengthening Chinese NGOs' knowledge and capacity working on climate change issues, CCAN also bridges Chinese NGO actors with international NGOs' activities on climate change, including 2007 UNFCCC in Bali.

Raise Individuals' Awareness

Educating the public and affecting consumers' behaviour have been the main focuses of NGOs' involvement in reducing China's greenhouse gas emission. Based on their rich experiences in conducting environmental education, a coalition of ENGOs mobilised a national campaign to promote energy saving.

Seeing the urgency to keep the climate change in check and the potential to save more energy in the summer months when air conditioners run full power to cool hotels, offices and private homes, Beijing's 6 ENGOs collectively initiated the "26 Degree Campaign" during the summers of 2004 and 2005[9]. Their goal was to raise consumers' awareness of climate change and change their behaviors when consuming energy. Public and private enterprises as well as individuals were asked to set their air conditioners to a minimum of 26 degrees. Led by Global Village Beijing and WWF China, systematic campaigns were organized including a variety of promotional activities. Experts were organized to provide profound knowledge

[9] In 2004, Global Village Beijing, Friends of Nature, Green EarthVolunteers, Institute of Environment and Development, WWF China and China Association for NGO Cooperation collaborated. In the second year, another 3 ENGOs joined, including SEPA China Environmental Culture Promotion Association, Friends of Earth (HK) and Conservation International.

and data on Beijing's energy crisis and scientific investigation was conducted to affirm the possibilities of saving energy by controlling the use of air conditioners.

This initiative was also welcomed by local ENGOs through their connections with major ENGOs in Beijing. Across the country in 16 provinces, various promotional activities including exhibitions, participatory education and lectures were organized to disseminate methods of energy saving and to educate the public on global warming. Target audiences were composed of communities, schools and universities. Newspapers as well as the Internet were also used to generate social influence. Innovative methods were utilized to educate the youth through a music concert.[10] This campaign also saw new groups join: prestige GONGOs such as All-China Environmental Foundation (ACEF) and CANGO. Their presence boosted the influence of the campaign and smoothed the implementation in cities where the size of ENGO community is small.

The public's efforts have had significant results. Within the first year of the campaign starting, according to the calculation of NGOs, about 350,000 to 550,000 tons of carbon dioxide emissions were avoided. After two years of advocacy activities, the campaigns had also successfully influenced state agencies located in Beijing, as they began to take actions to set minimum requirements for public buildings. In June 2007, the State council issued a document formally regulating all governmental agencies and state enterprises to set their air conditioners to a minimum of 26 degrees. Such efforts have also indirectly led to the state government adopting strict quantified targets in reducing environmental and climate pressures in the 11th Five-Year Plan. This calls for a 20 percent nationwide improvement in energy intensity by 2010, and is one of the few strict quantified targets that were adopted to preserve the environment.

Greening the Media and Better Inform the Public on Climate Change

The Chinese news media has been enjoying increasing freedom in environmental reporting. Although most newspapers and their regional offices are still owned by Communist Party Committees at various levels, the decline of financial subsidies from the state means that the mass media have to survive in the developing market economy. Even the Communist Party's newspapers and publications are transforming, by establishing supplements that increase their freedom to discuss news and public affairs.

Mass media is often used deliberately by environmental movements to mobilize resources, support as well as to alert political figures on environmental issues (Dalton et al., 2003) In China, the media has been found to work closely with Chinese environmental movement, the two actors often cooperating in building public consensus and generating social impact (Xie, 2009a; Yang, 2005). In fact, many NGO leaders are journalists themselves, making them very familiar in utilizing media campaigns to promote environmental concerns. Faced with the country's growing demand for energy, ENGOs and the media have raised strong concerns on the construction of dams and development of hydro power in Southwest China, where water resources are rich. Media discourse was built on the ecological perspective as well as rights of the local inhabitants (Xie and Mol, 2006), therefore raising the issue of social costs that is associated with dam construction.

Regarding climate change-related issues, the public has not been well informed in many places of the world. According to study, in both Germany and US, important disparities have been found between the media's reporting and communications in the fields of science and politics (Weingart and Pansegrau, 2000); even the prestige press have produced biased coverage of global warming and resultant actions (Boykoff and Boykoff, 2004). This may have affected the public's understanding regarding the causes of global warming, and hence

[10] http://www.conservation.org/newsroom/pressreleases/Pages/121207.aspx

might have attributed to the finding that the American citizens' knowledge about global warming was ranked middle among fifteen countries (including developing countries) surveyed in 2001, even lower than Cuba (Brechin, 2003).

As for Chinese reporters, they are faced with challenges in producing accurate and effective climate reporting. For a developing country like China, the public's levels of activism is relatively low (Xie, 2009a). The public's perception of specific environmental problems is rather limited, evident in the knowledge they have on specific environmental issues (Minsheng Bank, 2005; Hong, 2005). The most distressing environmental issues include noise pollution, and air and water quality (Minsheng Bank, 2005), probably as they concern day-to-day living. In comparison, the public's concern on regional and global environmental issues is relatively low. According to a survey conducted among 20, 000 urban youth between 16-35 years old, only 25% are certain that they have clear idea of how to deal with the impact of climate change, although 75% feel that it is a threat and already underway. Among them, 92% have received university education. Media and NGOs are thus obliged to develop close links to assist with the gathering and dissemination of environmental and climate-related information and improve public awareness.

In addition, the green reporters have also been active in raising their capacity to produce effective climate reports. Assisted by ENGOs, contacts and networks are built between reporters, scientists and experts. Workshops and seminars have been organized to train reporters in effectively reporting on climate change, and guidance has been written to direct reporting. Such activities are especially prominent in Beijing, which hosts a majority of national newspapers. A climate change journalist club has been formed, funded by British Council, on a "Climate Cool" project. State-owned media groups, particularly at the national level, are the most influential in the industry, and are the main source to which local newspapers and news agencies refer when determining what approaches and attitudes to adopt when reporting local stories. It is therefore essential that reporters from prestige national newspapers communicate with relevant experts to ensure scientifically accurate reporting.

Promote Shift to Clean Energy Sources and Eco-Economic Sustainability in Rural Areas

Using biogas presents an opportunity to address many of the problems plaguing the countryside, among which the most serious is energy supply in rural areas. People traditionally forage for fuel wood in forests, which also serves as safe fertilizer supplier. Currently, China relies heavily on nitrogen-based fertilizers, which are produced from petroleum. These fertilizers deplete the quality of soil over years of reuse in a way that organic fertilizer does not. Additionally, over-applied nitrogen-based fertilizers are a major contributor to eutrophication and algae blooms in China. Biogas digesters also stand as a solution to increasing production of methane emissions, which accounted for an estimated 3 percent in total methane emissions in the country in 2005.

Biogas technology is not new to China and is mainly used for cooking, lighting and heating by individual farm households. However, difficulties exist in the shift to biogas as an energy source in rural areas, primarily in financing the installation of biogas digesters.[11] Additionally, the income level of households proves an important factor in determining fuel usage, and the consumption of firewood declines as incomes reach relatively high levels (Zetriffi and Pan, 2008). Poverty therefore proves a constraint lies is therefore often synonymous with pollution levels that impede rural areas' ability to mitigate climate impact.

[11] Difficulties with distribution drive up marginal coast. Since consumption is lower, the fixed costs end up being divided between fewer units of energy sold.

ENGOs have succeeded in introducing this efficient energy source to rural areas and in two cases have received active support and participation from local communities. In Hubei, through preliminary investigation, Beijing-based ENGO Green Cross (GC) discovered that villages in Wushan County could very easily be transformed into an ecological village. They initiated an experimental project that aimed to reconstruct the village in an ecological way, establishing clean energy (biogas), improving the local living environment, recycling rubbish, recycling telluric water and promoting ecological food and ecological tourism. Working directly with local ENGO Green Han River, GC successfully gained trust from three levels of local governments (city government, county government and Villagers' Committee). In particular, the leader of the group built good personal connections with county government officials. This proved an important factor, as the county government provided half of the funding to build a digester in pilot villages.

The biogas system provides methane gas that farmers can use as a fuel source for cooking, heating and electricity. Farmers use the slurry left over from the fermentation process as an organic fertilizer in local agriculture to plant tea or greenhouses. Local tourism is developed because the recycling rubbish and recycling telluric water greatly improves the villages' hygiene conditions and attracts city dwellers to stay at village homes. Villagers' ecological economy was raised by 15% on per capita basis. The successful pilot has now been expanded: another 15,000 households (15.2% of total households in the county) and 167 villages (62.5% of the total number of villages) have set up biogas digesters and a number of them have also established wastewater treatment plants—using the energy generated by biogas.

In Tibet, the Global Environmental Institute (GEI)-a Beijing based NGO, also implemented a biogas program in Wujinmai village, Tibet. Based on its rich project experiences in Yunnan, GEI educated and trained farmers to manage and maintain biogas systems that employ simple technology to provide one or two households with heating and cooking fuel year-round. Animal manure, a potential groundwater pollutant, is composted into biogas for energy and fertilizer for growing organic crops. Realising Tibet's temperature and sunshine compose ideal conditions for organic agriculture production. GEI helped the villages to establish greenhouses that are greatly facilitated by the biogas tanks. The clean, renewable and free source of energy solves Tibetans' animal waste problems and reliance on wood for fuel. Impressed by the pilot village's success, the Tibetan political authority who initially suspected the plausibility of GEI's project began to promote extensive usage of biogas systems in combination with greenhouses. Tibet's Development and Reform Commission evaluated the villagers' understanding and use of the biogas system and have replicated the project in 12 counties since 2007, with more than 2,000 biogas systems built.

To make the programme profitable and financially sustainable, GEI also assisted villagers to establish a local company as a vehicle to connect the farmers to outside markets. Capacity building and skills training are provided to help the farmers learn to better manage their new businesses selling surplus organic vegetables. The organic product can be sold for profits that allow them to engage competitively in the market economy.

Both cases illustrated that ENGOs have played an active and innovative role in promoting rural energy shift and contributing to greenhouse gases reduction. Two factors greatly contributed to the success of these innovational experiments: First, NGOs can easily gain trust from local communities, which facilitated their work; second and most important, they incorporated poverty relieving as an important goal in projects and assisted the local communities' sustainability economically as well as ecologically. The latter reason also explains why the initial successes were expanded to more communities.

Watchdog on industrial behavior

Being a main driver of economic growth, Chinese industries are also a principal source of greenhouse gas emission. They also cause serious environmental deterioration in China; more than half of the river pollution and 90% of air pollution come from industries.

NGOs play a crucial role in improving pollution regulation and controlling severe pollution. Monitoring and curbing domestic enterprises' pollutions has been one of the main focuses of Chinese ENGOs. At subnational level, local governments face a conflict between economic and environmental aims and usually give priority to the economic development of their region, postponing environmental recovery. When polluting industries compose an important part of the local economy, they are often protected by local governments. As an independent force, NGOs thus play an active role in disseminating information to the public through mass media and the Internet. One polluting factory's discharge caused cancer to villagers from Zhaiwan, a Hubei village that borders to Henan province. Green Han River, a local NGO from Xiangfan (located in Hubei province) mobilized public consensus and collaborated with an influential group, Green Volunteer Beijing, to publish the news on national and provincial newspapers. Henan provincial officials were alerted and ordered the polluting factories closed. Aside from building the media campaign, NGOs also helped citizens launch civil lawsuits against polluting enterprises to seek legal redress through the courts. The Center for Legal Assistance for Pollution Victims (CLAPV) helped citizens sue enterprises. However, the citizens are likely to disagree about how to manage the compensation received, as happened in one case in which 1721 litigants were involved.[12]

In recent years, the Chinese ENGOs have also become watchdogs on international enterprises for their environmental behaviours. Advocacy networks have been built between Chinese local and national ENGOs and international ENGOs, such as Greenpeace and WWF through their local offices. One such campaign was initiated by Greenpeace toward Yunnan's illegal logging operations of Asia Pulp & Paper (APP), a subsidiary of Sinar Mas Group, the largest Indonesian pulp producer. From Green Watershed, a Yunnan-based NGO that commits to protection of natural resources, Greenpeace learned that APP's illegal operation in Yunnan had been secretly permitted by Yunnan government. It then gathered evidence of the company cutting trees in natural forests and planting non-native eucalyptus trees, which are then used by to produce paper and pulp. Greenpeace, collaborating with another 5 influential Chinese ENGOs, sent a letter to the Department of Pollution Control, Ministry of Environmental Protection.[13] Such collaborative actions have caught the media's attention and have affected APP's public image, as the company was suspected to have breached the law by demolishing natural forest in China and was under investigation by central government.

Another important role of NGOs is their involvement in facilitating the Clean Development Mechanism (CDM) and its potential in China. The mechanism, developed under the Kyoto Protocol, has been an impetus to reduce greenhouse gases and promote the green technology market in China, where huge potential for CDM projects exist. However, the implementation of this mechanism has posed difficulties to Chinese private business, as knowledge, capacity and the understanding of CDM markets are rather low. The Chinese research institute GEI, collaborating with partners from Europe, organized "CDM Capacity Building". Through training and editing a handbook on CDM practice in China, it improved

[12] See *Benjamin van Rooij, 2008,* The People vs. Pollution: Understanding Citizen Action against Pollution in China, discussion paper, Colloquium, "Environmental politics in China", University of Manchester, 3 Dec, 2008.

[13] Among the 5 ENGOs, except Greenwatershed, which is a local ENGO from Yunnan, another 4 are all national ones, including Green Village Beijing, Friends of Nature, Green Environmental Volunteers and Shouwang Jiayuan.

enterprises' understanding of CDM project activities and related carbon trading concepts and indirectly contributed to the mobilization of increasing resources through market mechanisms to support energy efficiency.

Discussion and Remarks

Illustrated by the cases of ENGOs' role in the four areas, it is found that the public has been participating to China's response to climate change. The success is mostly based on their previous experiences in environmental education, campaigning and monitoring activities. The shift on climate-related issues at a crucial time when such efforts are mostly needed should be regarded as one progress Chinese ENGOs have made. In comparison to new industrializing countries, the Chinese proves to be one of the few countries that see public involvement in climate policies.[14] This is based on increasing public awareness about climate-related issues as well as the organizational development of green groups and NGOs in China. Environmental groups are capable to secure funds and can focus on global environmental issues such as climate change, instead of local or regional ones that have immediate effects to their lives. In this regard, it has to be noted that Beijing's environmental activism has been at the forefront of the country's environmental movements, probably because it is the origin of the Chinese environmentalism and in comparison to other regions in China, closer interactions have been made between local environmental groups and branches of international NGOs that conduct the large amount of climate-related campaigns in the country.

Additionally, the cases illustrate that existing connections and networks between these nonprofit actors proves to be useful to facilitate cooperation. Each brings own advantages in collaborations: international NGOs provide NGOs and GONGOs with the updated global climate efforts and linkages to relevant international actors; GONGOs can provide access to policy-makers and state and economic institutions; they also facilitate project implementation through administrative structures that GONGOs can use (Zhao, 2004). ENGOs act quickly and are representatives of local communities because they know their needs best. They are also efficient in mobilizing volunteers and expertise in environmental education. Through cooperation, the three actors complement each other and can succeed in improving environmental capacity of the state and local authorities.

Viewing from NGOs' activities in responding to climate change, it is found that initiatives and operations are taken mostly on energy, environmental protection including deforestation and pollution control. Sporadic initiatives are implemented in the adaptation of climate change. This indicates that NGOs' involvement in climate policies is still in an early stage. They have yet to develop sufficient knowledge and expertise in providing specific actions on strengthening local climate capacities.

Although ENGOs' work in climate-related activities has just begun, innovative ways to adapt to different communities have been brought out, based on ENGOs' past experiences and rich understanding of China's current socio-economic development. Take the example of energy saving promotions, different focuses are developed in urban and rural areas, where environmental awareness levels differ. In cities where consumption is higher, energy saving is educated with the perception of low-carbon life style raised. In rural areas, the primary goal is to ensure that local communities' sustainability in economically as well as ecologically. Regarding the fact that China is in great need of local climate efforts, the joining of nonprofit organizations provides a potential solution to the strengthening of the Chinese state's climate capacity and mitigating adverse impact of climate change.

[14] In country such as Brazil

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Climate Change, The Traditional Chinese Calendar and Modernity

Dr. Rey Tiquia PhD[1]

Abstract

This era of unpredictable and at times colossal global climactic weather changes place tremendous pressure upon the human internal environment to adapt to these dire changes in the external environment. It places tremendous pressure upon our inner Guardian Qi wei *qi* as well as the air or atmosphere *da qi* (which the Chinese Martial artist Lu Ji Tang refers to metaphorically as similar to our inner Guardian Qi).

In premodern China, climate change is always contingent upon time and the seasons i.e. the twelve two-hour periods, lunar month, seventy two pentads, twenty four solar periods, the four seasons, the year and the sixty temporal units *Jia Zi*.

The cosmic yin and yang energies of heaven and earth ascend and descend and climate weather conditions during the four seasons resonate with these changes. Humanity must harmonize and adapt to these changes as well.

However, the current dominance of modernistic temporal systems by way of the Gregorian calendar and the Greenwich Mean Time has led to the effacement of local and traditional temporal systems such as the Chinese astrocalendrical system. This has led to the spatio-temporal desynchronisation of humanity with the natural flow of the seasons/time *shi*. This is clearly demonstrated in the practice of Chinese medicine in the southern hemispherical region of Australia and New Zealand where the flow and movement of our Qi is out of synchronization with the occurrence and flow of the seasons/time.

To help harmonize our Qi and our health with the nature's temporal order I have constructed a north-south hemispherical lunisolar calendar, which may contribute towards the synchronization of our respective spatial locales with nature's motion of temporality.

氣候 *Qi hou* Climate/Weather

A modern definition of the English word 'climate' refers to " the weather conditions prevailing in an area in general or over a long period". [2]Please note the absence of the role of 'seasons' in the definition. Having this definition in mind, can we use the word 'climate' to translate into English the ancient Chinese word 氣候 qi *hou*? As an example, the *ABC Chinese-English Dictionary* compiled by John DeFrancis translates *qi hou* into 'climate' (Defrancis, 1996, p. 477). Other similar dictionaries have done similar things. To clarify the matter, I investigated the etymology of the Chinese word *qi hou*.

The Etymology of the Chinese Word 辭源 defines *qi hou* as "changes in the *qi xiang* 氣象 or *jie ling* 節令. [Commercial Press Editorial Board, *Ci Yuan*, Vol. II, p.1705]. *Jie ling* 節令 is defined as "Climate and other natural phenomena of a season" by the electronic dictionary "Learning is so Easy" 快譯通, *Chinese to English, English To Chinese Dictionary,* Taiwan, 2004. It also defines *qi xiang* 氣象，as the "natural landscape, the natural phenomenon" 自然界的景色，現象。[*Ci Yuan*, Vol II, p.1706]. Hence, we can say that *Qi hou, is* similar in meaning to *Qi xiang* in the sense that both refer to changes involving the *jie ling*. We can say that *Qi hou* is *Qi xiang*. Both mean changes and transformation in the climate and in other natural phenomenon of a season. Hence, I do not think we can simply translate the Chinese word *qi hou* into the English word 'climate. It is more appropriate to define *Qi Hou* as the "constantly changing state of the climate and other natural phenomenon of a season/sub-seasonal phase." Subseasonal phase or 'subseasonal Qi is my English

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[1] Email: rtiquia@bigpond.net.au.

[2] This is a definition of the word 'climate provided by the *Oxford American Dictionary* (2005) embedded in my Apple Mac computer.

translation of the Chinese ancient terminology *jie qi* 節氣. Other Chinese language scholars translate this Chinese word into English as ‘solar qi’ or ‘solar periods’.

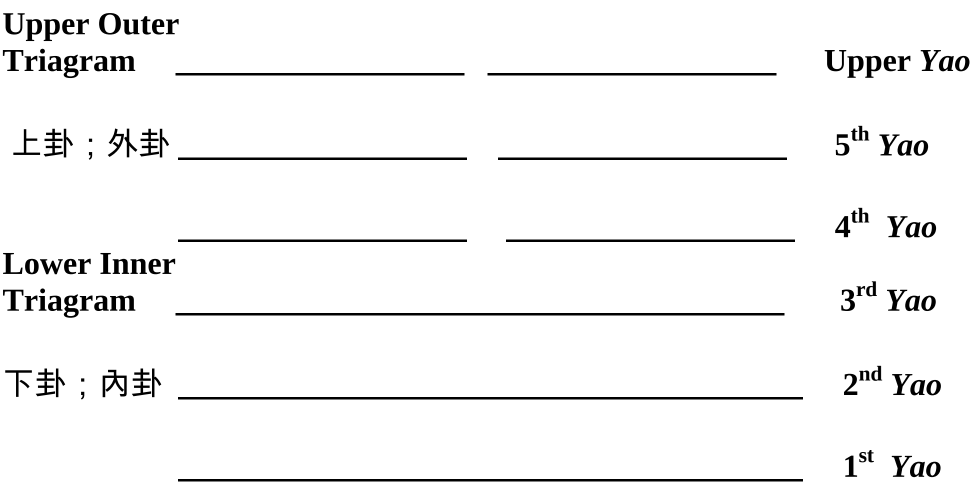
變易 *Bian Yi* ‘Change’

DeFrancis translates 變易 Bian *Yi* into English as to ‘change’ or to ‘alter’ (Defrancis, 1996, p. 33). *Yi* 易 is the second Chinese word of the title of one of the oldest book in human history: *The Book of Changes* 易經 *Yi Jing.*

In his introduction to the use of the *Book of Changes*, the late German Sinologist Richard Wilhelm views the eight triagrams 八掛 as symbols[3] which stands for changing transitional states. They are images, which are constantly undergoing change. The system of the eight triagrams centres not on things in their state of beings as it is chiefly used in the West, but rather upon the movement of things in their changes. Wilhelm sees the eight triagrams not as representation of things as such but rather of their tendencies in movements [*Yi Ching*, Wilhelm (Trans.), 2003, p. 25], that is in their re-presentation.

In early antiquity, China used the eight triagrams 八卦 *Zhen* 震 , *Li* 離, *Dui* 兑 and *Kan* 坎 to represent spring, autumn, summer and the winter seasons respectively. Since every hexagram has six *Yao* 爻, hence these four *Gua* 卦 would have twenty-four *yao*s which represent the twenty-four ‘solar Qi’ 二十四個節氣. The east and the spring season are categorized under triagram zhen 震 and the element ‘wood’ 木. The south and summer season is categorized under the triagram *Li* 離 and the element ‘fire’ 火. The west and autumn season are categorized under the triagram *dui* 兑 and the element ‘metal’ 金. The north and the winter season are categorized under the triagram *Kan* 坎 and the element ‘water’ 水. The triagrams *zhen, Li, Dui* and *Dui* correlates with the ‘four seasons' 四季. Every hexagram has six *yao*s; and every *yao* 爻’manages’ 管 fifteen days. Hence, every hexagram (which has 6 *yaos* 爻) altogether ‘manages’ ninety days. And the four hexagrams in total manages 360 days (China Nurturing Life, 2004, p. 11]

The Structure of the Hexagram *Tai* 泰



(China Nurturing Life, 2004, p. 146]

[3] “…a word or picture is symbolic if it contains more than can be grasped at first glance” (C.G. Jung *Man and his Symbols* , London, 1964) [Eberhard, 2003, p. 8].

In this way, subtracting the four triagrams (Zhen, Li, Dui and *Kan)* from the sixty four hexagrams we are left with sixty hexagrams left with 360 *yao*s 爻. Every *yao* 爻 represents a day. However, each year has 365.25 days. Hence, there are 5.25 days, which have no *Yi jing gua* to pair with. Hence, 5.25 days are equally distributed to the 60 hexagrams. If each day is apportioned 80 points each, then 5.25 days will come to 420 points. Then distribute 420 points equally to the 60 hexagrams. Every hexagram will then get 7 points. Because one *yao* 爻 generates one day and one hexagrams 'manages' 主 6 days, and then add to this the average 6 points, hence one hexagram is paired with 6 days and 7 points. This is what is referred to as the '6 days 7 points' 六日七分法 methodology developed by the famous *Yi Jing* scholar Meng Xi. Because the ancient Chinese consider 5 days in each solar Qi (subseasonal Qi or phase) constitute one *hou* 候 (pentad), hence in one year there are 12 months, 24 solar Qi 节气 and 72 pentads.七十二候 [China Nurturing Life Culture Research Centre, *Chun, ershisi jie Qi yang sheng jing* (China Nurturing Life, 2004, p. 11].

Seasons, Subseasonal Phases and the Seventy-Two Pentads

The premodern Chinese lunisolar calendar 農曆 is a very complex but very reliable spatio-temporal map, which aids us to "calculate our position in time, space and the universe" (Dalby, 2007, p. xix). It affords one the opportunity to experience the universe (that is the continua of space-time) in both the Northern and Southern hemispheres of the globe. It is a time tested reference tool in "comprehending the rhythms of the earth and the seasons" (Dalby, 2007, p. xix).

In premodern Chinese medicine, being mindful of the correct season means 'determining or diagnosing the disease correctly' 決病法. The 'Fourth Exemplar' of the *Treatise on Febrile Diseases Caused by Cold Meteorological Influence '* 傷寒例第四 outlines the ' temporality-related methodologies for diagnosing seasonal diseases' *jue bing fa* These methods are 'the four seasons' 四時, 'eight solar nodes' 八節, 'the twenty four Qi' 二十四氣and 'the seventy-two pentads' 七十二候.

The 'four seasons' are spring, summer, autumn and winter seasons. The 'eight solar nodes' *ba jie* are the eight time-segments into which the four seasons are further subdivided into eight subseasonal phases, which are

1. Spring Begins 立春
2. Spring Equinox 春分
3. Summer Begins 立夏
4. Summer Solstice 夏至
5. Autumn Begins 立秋
6. Autumn Equinox 秋分
7. Winter Begins 立冬
8. Winter Solstice 冬至

The 'eight solar nodes' *ba jie* above *are* differentiated on the basis of the ascension, descent, separation and coming together of the Yin and Yang (Qi).

The twenty-four subseasonal Qi (subseasonal phases) is further subdivided into the twelve (lunar) monthly nodes 十二月節 and 'twelve middle of the month Qi' 十二中氣 (Please refer to table). The 'monthly nodes' are the 'starting Qi' 起始之氣 in every month, while the 'middle of the month Qi' 中氣 is the Qi in the middle of the month. For example, the subseasonal phase Spring Begins is a 'node' of the first month 立春爲正月節; while 'Rain Water' 雨水 is the 'Qi (subseasonal phase) of the middle of the first lunar month month' 正月氣 of the Chinese calendar.

Let us further subdivide *hou* 候. Five days constitute one *hou*. In one year, there are seventy-two *hou*s, which make up three hundred sixty days in one year. The very meticulous differentiation made here is the result of the combination of traditional Chinese astronomy 天文 and the calendar 曆法 by the ancient sages who observed the influence of weather changes 天候衍變 upon the natural world, animals, plants, and humans. This paper is exploring the effects of weather changes upon humans.

Month	1	2	3	4	5	6	7	8	9	10	11	12
Node	Spring Begins	Waking little critters	Clear & Bright	Summer Begins	Grain in Ears	Little Heat	Autumn Begins	White Dew	Cold Dew	Winter Begins	Great Snow	Little Cold
Qi	Rain Water	Spring Equinox	Grain Rain	Little Fullness	Summer Solstice	Great Heat	End of Heat	Autumn Equinox	Frost Descends	Little Snow	Winter Solstice	Great Cold

Table 1 Twenty-four Subseasonal Qi in one Year

Among the twenty-four subseasonal phases, the 'four beginnings' 四立 (Spring Begins, Summer Begins, Autumn Begins and Winter Begins) are the starting points of the four seasons *si shi*. The 'two solstices' *er zhi* and 'two equinoxes' *er fen* represent the process of the rise and fall *shuai wang* of the two Yin Qi and Yang Qi between heaven and earth tian *di*. The rest represent the 'phenological signs'[4] 徵候, which all-living things in the universe generate. Each of the names of these two sets of subseasonal phases comes from marked changes being performed by these living things. For example, 'Rain Water' is the subseasonal phase when 'the spring wind melts the ice' *chun feng jie dong*. Waking little Critters' represents the subseasonal phases when 'critters' (tiny creatures) 蟄蟲 begin to be active. (Lai Peng Ju et. al. (2003. Pp. 15-16)

The Subseasonal Phases 節氣 *jie Qi*[5]

Jie Qi generally refers to *jie ling* or seasonal changes. From the subseasonal phase of Spring Begins *li chun* up to the subseasonal phase of the 'Severely Cold ' *da han* there are all in all twenty four *jie Qi* or subseasonal phases. These subseasonal phases represent the interrelationships between astronomy 天文, the seasons' 季節, climate 氣候 and agricultural production 農業生產. It is a cultural legacy from ancient China. As an integrated agricultural climate/weather calendar, it has played a major role in agricultural production in China and still in use up to the present time.

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[4] The *New Shorter Oxford English Dictionary Vol 2 (*l993) defines phenology as "The field of study that deals with the cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life." (Brown, 1993, p. 2184).
"Vegetation dynamics like growth, reproduction, winter rest, competition for nutrients, water, and light are strongly influenced and determined by climate variables. A change in climate will result in a change of these dynamics. A scientific discipline , which is able to link vegetation dynamics with climate variable is PHENOLOGY. Phenology is the study of the timing of recurrent biological processes such as flowering, budburst, insect hatching, birdnesting, fruit ripening and leaf fall (so called PHENOPHASES)."
[International Society of Biometeorology, 2009].

[5] The following segment is a linguistic translation of the theme on 'The Twenty Four *Jie Qi*' from the on-line version of the *Complete Chinese Encyclopaedia* 中國大百科全書 http://wordpedia,pidc.org.tw/content.asp?ID=14057&query=1

During the early history of civilization in China, the notion of spring sowing 春種, the growth of crops during summer 夏長, the harvesting of crops during autumn 秋收 and the storing of crops in winter 冬藏 evolved in response to the needs of seasonality patterns in agricultural production.

At the time of the Spring and Autumn and Warring States period, with the emergence of iron agricultural implements, seasonality requirements in agricultural production has become much higher resulting to the gradual evolution of the concept of *jie Qi.* During this time, the ancient Chinese sundials 土圭 was put into use to 'measure the sun's shadow' and thus fix the subseasonal phases. In the beginning, there were only the subseasonal phases of the 'Winter solstice' 冬至 and 'Summer Solstice' 夏至. Subsequently the subseasonal phases of the 'Spring Equinox' 春分; 'Autumn Equinox' 秋分; ' Spring Begins' 立春; 'Summer Begins' 立夏; 'Beginning of Autumn' 立秋 and 'Beginning of Winter' 立冬 were added. During the Western Han Dynasty, the whole twenty-four subseasonal phases were recorded in the Chinese philosophical text *Huainanzi* (ca.180-122 B.C.E.). The direction where the handle of the Big Dipper is pointing was used to fix the temporal beginning of each of the twenty-four subseasonal phases. The 'Beginning of Spring' was fixed on the first subseasonal phase of the First month of the lunar calendar 正月節 （節氣）; while the start of the subseasonal phase of 'Rain Water' 雨水 was fixed at the middle of the first lunar month. In one year, there were twelve *jie Qi* and twelve zhong *Qi* 'middle of the month Qi'. Later in history, the two were collectively referred to as *jie Qi.* Astronomically speaking 天文上, the twenty-four subseasonal phases represent the twenty-four (apparent) positions of the sun along the ecliptic 視太陽在黃道上的位置 as the earth rotates around the former. When the sun is on 0 degrees on the ecliptic, it is the 'Spring Begins' **立春**. From this position, the succeeding subseasonal phases follows in 15° intervals until the whole cycle of 360 degrees of the ecliptic is covered. In each month of the Gregorian calendar 公曆上, the two days are set for the two of the subseasonal phases.

The twenty-four subseasonal phases evolved in the regions surrounding the lower reaches of the Yellow River basin in China. Hence the designated names and their meanings of these reflect the specific, local characteristics *hour* 侯 corresponds with specific phenological phenomena of agricultural production there, its seasons as well as the local climate of the region.

The Seventy Two Pentads 七十二候

The content of the temporal system of the seventy two pentads was recorded in the classical Chinese book *The Complete Classical Text on Leisurely Living,"* Chapter on Instructions on the Flow of the Seasons" 《逸周書・時訓解》which was compiled in 2 BC. Each pentad 候 corresponds to a phenological phenomena 物候现象, which is referred to as a 'resonating pentad' 候应. The sequential changes in each of the seventy-two resonating pentads reflect the changes in the *qi hou* (constantly changing state of the climate and other natural phenomenon of a season/sub-seasonal phase) *each* year. In the case of botanical resonating pentads 植物候应, we have first the sprouting of the buds 萌芽萌动; then the flower blooms 开花; and then the bearing of fruits 结实. While in the case of the zoological resonating pentads 动物候应 we have firstly, the ' first vibration' 始振, the first cry 始鸣, and the mating 交配；mobility 迁徙. As for examples of resonating pentads of inanimate things 非

生物, we can point to phenomena of ‘beginning to freeze’ 始冻 ; ‘melts the ice’ 解冻; ‘thunder sings’ 雷始发生 etc. [<http://www.wiki.cn/wiki 七十二候>

The Four Seasons, 24 Subseasonal Phases and The Seventy-Two Pentads

I SPRING

Spring Begin

1. East wind melts the ice — August 7 through 12th, 2009
2. Dormant creatures start to twitch — August 12th through 17th
3. Fish swim upstream break ice — August 17th through 23rd

Rain Water 雨水

4. River otters sacrifice fish — August 23rd throughAugust 27th
5. Wild geese head north — August 27th through September 1st
6. Grasses & trees sprout — September 1st throughSeptember 7t

Waking little critters 驚蟄

7. Peach blossoms open — September 7th through 12th
8. Golden orioles sing — September 12th through 17th
9. Hawks become doves — September 17th through 23rd

Spring Equinox 春分

10. Swallows return — September 23 through 28th
11. Thunder sings — September 28th through October 2
12. First lightning — October 2 through 8th

Clear & Bright 清明

13. Paulownia blooms — October 8 through13th
14. Moles become quails — October 13 through 18th
15. Rainbows appear — October 18 through 23rd

Grain Rain 穀雨

16. Floating weeds appear — October 23 through 28th
17. Pigeons flap their wings — October 28 throughNovember 2nd
18. The hoopoe alights in the mulberry — November 2 through 7th

II SUMMER

Summer begins 立夏

19. Little frog peeps — November 7 through 12th
20. Worms come forth — November 12 trough 17th
21. Cucurbit flourishes — November 17 through 22nd

Grain full 小滿

22. Bitter herbs grow tall — November 22 through 27th
23. Waving grasses wither — November 27 through Dec. 2nd
24. Autumn wheat ripens — Dec. 2 through Dec. 6th

Grain in ear 芒種

25. Mantids hatch — December 6 through 11th
26. The shrike begins to shriek — December 11 through 16th
27. The mockingbird loses its voice — December 16 through 21st

Summer Solstice 夏至

28. Deer break antlers — December 21 through 26th
29. Cicadas sing — December 26 through 31st
30. Crowdipper plant flourishes — December 31 through Jan. 5th

Slightly hot 小暑

31. Hot winds arrive — January 5 through 10th
32. Crickets comes into the walls — January10 through16th
33. The hawk studies and learn — January 16 through 20th

Severely hot 大暑

34. Rotted weeds turn into fireflies — January 20 through 26th
35. The earth is steaming wet — January 26 through 31s
36. Great rain sweeps through — January 31 through February 3rd

III AUTUMN

Autumn Begins

37. Cool wind arrives — February 3 through 8th
38. White dew descends — February 8 through 13th
39. The cold cicada chirps — February 13 through 18th

Limit of Heat 處

40. The raptor sacrifices birds — February 18 through 23rd
41. Heaven & earth turn strict — February 23 through 28
42. Millet ripens — February 28 through March 5th

White dew 白露

43. Wild geese come — March 5 through 10th
44. Swallows leave — March 10 through 15th
45. Flocksof births gather grain — March 15 through 20th

Autumn Equinox 秋分

46. Thunder pipes down — March. 20 through 25tt
47. Beetles wall up their burrows — March20 through
48. Waters dry up — March 30 through Apr. 4th

Cold Dew 寒露

49. Wild geese come as guests — April .4 through 9th
50. Sparrows enter water and turn into clams — April . 9 through 14th
51. Chrysanthemums are tinged yellow — April 14 through 20th

Frost Descends 霜降

52 The wolf sacrifices the beasts — April 20 through 25th
53. Leaves turn yellow and fall — April 25 through 30th
54. Insects tuck themselves away — April 25 through May 5th

IV WINTER

Winter Begins 立冬

55. Water begins to freeze — May 5 through 10th
56. Earth begins to freeze — May 10 through 15th
57. Pheasants enter the water and turn into monster clams — May 15 through 21st

Slight Snow 小雪

58.Rainbows hide — May 21 through 26th
59. Heaven’s Qi rises Earth’s Qi sinks — May2 through31st
60. Walled up and closed, winter takes hold — May 31 through June 5th

Heavy Snow 大雪

61. The copper pheasant is silent — June 5 through 10th
62. Tigers begin to mate — June 10 through 15th
63. The Iris Pallassii sprouts — June 15 through 21st

Winter Solstice 冬至

64. Earthworms twist — June 21 through 26th
65. Elk sheds antlers — June 26 through July 1st
66. Spring waters move — July 1 through 7th

Slightly Cold 小寒

67. Wild geese return to their northern home — July 7 through 12th
68. Magpies nest — July 12 through 17th
69. The pheasant cock calls its mate — July 17 through 22nd

Severely Cold 大寒

70. Pheasant hens brook — July 22 through 27th
71. The vulture flies stern and swift — July 27 through Aug. 1st
72. Streams and marshes are frozen solid — Aug.1 through 5th

English entries of 72 pentads are from Lisa Dalby’s book: *East Wind Melts the Ice: A Memoir through the Seasons*, 2007.

The Cyclical Flow of the Sixty-Gan *zhi* 干支 Temporal Units

"Time for the (premodern) Chinese is forever flowing without beginning or end, " noted Thome' H. Fang. And " it is customary for the Chinese people to use the *kan-Chih* (*gan zhi)* 干支" [Shu-Hsien Liu, 1974, 145-153] to mark the passage of time. There are ten heavenly stems (*gan*) and twelve Earthly Branches (*zhi)*, an alternating and sequential combination of the two makes a cycle of sixty " years, months, days and two-hour periods *shi Chen* 时辰 in a day.

Each lunar year is represented by a pair of one celestial stem and one earthly branch. The celestial stem is at the top while the earthly branch is below (please see table below). In accordance with the succession and order 順序依次 of the each (celestial) stem 干 and (earthly) branch 支, the pair of temporal symbols are arrayed with the first of the stem like *jia* 甲 being paired with the first branch Zi 子 which forms jia-*zi* 甲子. *Jia Zi* is the first among the cycle of temporal units, while *Gui Hai* 癸亥 is the last of the 60-temporal units.

With regards the tracking down of the 60-year temporal units, please refer to the table below. Beginning from *jia-zi* 甲子, one stem and branch are paired in sequential succession. Every year ends up with a different stem and branch combination. For example, the year 2039, is the *ji-wei* year 己未. The succeeding year is the *Geng-Shen* year 庚申, which falls on the year 2040. The following year is the year 2041, which is the xin-*you* year 辛酉. 2042 is the *ren-xu* year 壬戌. etc. Because there are 10 celestial stems and 12 earthly branches, hence, the celestial stems are arrayed back and forth six times. 10X6=60. On the other hand, the earthly branches are arrayed back and forth 5 times. 12X5=60. After pairing the stems and branches in this way, the 60th year is reached and the temporal cycle then goes back to the first *jia-zi* 甲子 year with one stem and one branch combination. Hence 60 years is referred to as one cycle or as one stem-branch or *gan zhi* cycle. However, the stem-branch *gan zhi* 60-units cycle can also be used to track down diurnal time (two-hour period 时辰), days in a lunar month as well as the twelve lunar months in a year [Yang Yi Ya 扬医亚, 1985, pp. 182-183].

The sixty *gan zhi* temporal cycle is very important in the practice of Chinese medicine. More specifically, it is an important temporal tool in the acupuncture practice of *zi wu liu zhu* 子午流注 which is a method of choosing and using acupuncture points in dealing with a specific clinical pattern 症候 in accordance with the patient's temporal clotting and flow of his/her Qi and blood .

The Cyclical 60-Year, Months, Days, Two-Hour Periods

Stem Branch Year Zodiac	*Jia* 甲 *Zi* 子 1984 1.Rat	*Yi*乙 *Chou*丑 1985 2.Ox	*Bing*丙 *Yin* 寅 1986 3Tiger	*Ding*丁 *Mao*卯 1987 4.Rabbit	*Wu* 戊 *Chen* 辰 1988 5.Dragon	*Ji* 己 *Si* 巳 1989 6.Snake	*Geng*庚 *Wu* 午 1990 7.Horse	*Xin* 辛 *Wei* 未 1991 8.Sheep	*Ren*壬 *Shen* 申 1992 9.Monkey	*Gui*癸 *You*酉 1993 10.Rooster
Stem Branch Year Zodiac	*Jia*甲 *Xu*戌 1994 11.Dog	*Yi* 乙*Hai* 亥 1995 12.Boar	*Bing*丙 *Zi* 子 1996 13.Rat	*Ding*丁 *Chou*丑 1997 14.Ox	*Wu* 戊 *Yin* 寅 1998 15.Tiger	*Ji* 己 *Mao* 卯 1999 16.Rabbit	*Geng* 庚 *Chen* 辰 2000 17Dragon	*Xin* 辛 *Si* 巳 2001 18.Snake	*Ren* 壬 *Wu* 午 2002 19 Horse	*Gui* 癸 *Wei* 未 2003 20.Sheep
Stem Branch Year Zodiac	*Jia* 甲 *Shen*申 2004 21Monkey	*Yi* 乙 *You* 酉 2005 22Rooster	*Bing*丙 *Xu* 戌 2006 23 Dog	*Ding* 丁 *Hai* 亥 2007 24.Boar	*Wu* 戊 *Zi* 子 2008 25. Rat	*Ji* 己 *Chou*丑 2009 26. Ox	*Geng* 庚 *Yin* 寅 2010 27 Tiger	*Xin* 辛 *Mao* 卯 2011 28Rabbit	*Ren* 壬 *Chen* 辰 2012 29Dragon	*Gui* 癸 *Si* 巳 2013 30 Snake
Stem Branch Year Zodiac	*Jia* 甲 *Wu* 午 2014 31Horse	*Yi* 乙 *Wei* 未 2015 32Sheep	*Bing*丙 *Shen*申 2016 Monkey	*Ding* 丁 *You* 酉 2017 34Rooster	*Wu* 戊 *Xu* 戌 2018 35. Dog	*Ji* 己 *Hai* 亥 2019 36.Boar	*Geng* 庚 *Zi* 子 2020 37. Rat	*Xin* 辛 *Chou*丑 2021 38。Ox	*Ren* 壬 *Yin* 寅 2022 39 Tiger	*Gui* 癸 *Mao* 卯 2023 40Rabbit
Stem Branch Year Zodiac	*Jia* 甲 *Chen*辰 2024 41Dragon	*Yi* 乙 *Si* 巳 2025 42Snake	*Bing*丙 *Wu* 午 2026 43Horse	*Ding* 丁 *Wei* 未 2027 44 Sheep	*Wu* 戊 *Shen*申 2028 45Monkey	*Ji* 己 *You* 酉 2029 46Rooster	*Geng*庚 *Xu* 戌 2030 47.Dog	*Xin* 辛 *Hai* 亥 2031 48.Boar	*Ren* 壬 *Zi* 子 2032 49.Rat	*Gui* 癸 *Chou* 丑 2033 50. Ox
Srem Branch Year Zodiac	*Jia* 甲 *Yin* 寅 2034 51 Tiger	*Yi* 乙 *Mao* 卯 2035 52 Rabbit	*Bing*丙 *Chen*辰 2036 53Dragon	*Ding* 丁 *Si* 巳 2037 54 Snake	*Wu* 戊 *Wu* 午 2038 55 Horse	*Ji* 己 *Wei* 未 2039 56 Sheep	*Geng* 庚 *Shen* 申 2040 57Monkey	*Xin* 辛 *You* 酉 2041 Rooster	*Ren* 壬 *Xu* 戌 2042 59. Dog	*Gui* 癸 *Hai* 亥 2043 60 Boar

Modernity, Climate Change and the Time/Seasons

Modernity is a historical epoch characterize by the emergence of capitalism, industrialism, ratio-legal bureaucracies, and state control of military power and surveillance. Its cultural dimensions include discourses of rationality, scientism, and progress through economic development [Connor & Geoffrey, 2000, p. 7]. In his book *Cosmopolis the Hidden Agenda of Modernity*, Stephen Toulmin aptly describes the cosmology of 'High Modernity' as one "which saw nature and humanity as distinct and separate"[6], and pointed out as early as a decade before the end of the last millennium the sure signs of the dismantling of this 'modern scaffolding' and saw modern society moving towards the current unfolding epoch of 'humanist modernity' which "reintegrates nature and humanity, and puts the local, circumstantial arguments of ecology [7]on a scientific footing with universal arguments of electromagnetism and other physical theories." and where "scientists no longer separate nature from society" .

We are at currently at the threshold of a humanist, modern and globalised era which is characterized by a growing "disbelief in the meta-narratives of science, rationality and objectivity, in which lived lives, the diverse, the complex, the unique" [Chan, Jonathan &. Chan, Julienne E, 2000, p. 332-33] are favoured. More importantly there is a trend towards the *local*, which also "acknowledges individuality, complexity and the subjectivity of

[6] Stephen Toulmin described 'High Modernity' as an age "which saw nature and humanity as distinct and separate' giving way to an epoch of 'humanized Modernity' or postmodernity "which reintegrates nature and humanity" [Toulmin, 1990 ,pp. 182-183].

[7] 'By now, people understand that 'nature' is not a source of neutral resources to be exploited for our benefit; quite as much, it is *our terrestrial home*. In political and social debate, therefore, questions about "ecology" – the Greek rots of this word mean "the science of household management" –have irreversibly moved to the center of the practical stage." (Toulmin, 1990, p. 182).

personal experience" [Chan, Jonathan &. Chan, Julienne E, 2000, p. 332-33], as well as the organic unity of man (humanity) and heaven (nature)[8] [Liu. & Wei, 1970, p. 8]; that is, as expressed by Chen Dingsan, the fact that the nature world and the human world are organically "of one Qi" *tian ren tong Qi* 天人同氣 [Chen Dingsan, 1986, p. 16].

Climate Change *Qihou Bianyi* -The Constantly Changing State of The Climate and Other Natural Phenomenon of a Season/ Subseasonal Phase

Hence, at this present postmodern era, climate change *qi hou bian yi* 气候变易 is seen as contingent upon *shi* 時 (time and season)[9], *shi chen* (twelve two-hour period), *ri* (day), *yue* (month), *qi shi er hou* (seventy two climactic weather pentads), *er shi si ge jie Qi* (twenty four subseasonal phases), *si shi* (four seasons), *liu Qi* or *liu jing* (the Six Ecological Seasonal Qi or Six Divisions), nian (year), and *jia zi* (sixty temporal units). As the premodern TCM scholar/practitioner Yang Ru Hou (1861-1928) stated (paraphrasing and further developing this concept from the *Yellow Emperor's Manual of Corporeal Medicine*, 'Chapter on the Regulation and Nurturing of the four Qi' 內經素問。四氣調攝):

The cosmic yin and yang energies of heaven and earth ascend and descend and climactic/weather changes 氣候 during the course of the four seasons resonate with these changes. And humanity must conform and resonate (harmonize) with it 順應 with it as well. During spring and summer, one must nurture the cosmic Yang energy. While during autumn and winter one must nurture the cosmic Yin energy 春夏養陽；秋冬養陰. In this way, unusual diseases will never afflict one. Those who dare goes against it will certainly be afflicted with severe illness. Whichever acutract the fierce and toxic Qi decides to 'remain', one will get that illness 毒烈之氣 ，留在何經，則發何病.

When one is 'injured' by the cold meteorological influence 傷於寒 in winter one will certainly get the warm factor disease 溫病 in spring. When one is damaged by the wind meteorological influence in spring, one will certainly get dinnertime 'leak' 飧泄 in summer.

When one is 'injured' by the heat meteorological influence in summer 暑, one will certainly be afflicted with a condition known as 痎瘧 (a type of malaria). When one is injured' by humidity meteorological influence during autumn one will be afflicted by a coughing disease 咳唆.

The above are cases of illnesses one gets when one is 'injured' by the changing *qi hou* i.e. changes in the climate and other natural phenomenon of a season/ subseasonal phases unfolding between heaven and earth. However, there are times when the *qi hou* do not occur in synchronicity with nature's temporal order (seasons) 亦有與時不應者. Hence, in the

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[8] In discussing the history of Chinese thought, James T.C. Liu and Wei Ming Tu quoted the contemporary Chinese philosopher Wing Tsit Chan as stating that:

> If one word could characterize the entire history of Chinese philosophy, that word Would be humanism—not the humanism that denies or slights a Supreme power, But one that professes the unity of man and Heaven. In this sense, humanism has Dominated Chinese thought from the dawn of its history. [Liu, James T. C. & Wei Ming Tu , 1970, p. 8]

[9] The Chinese character 時 *shi* is written with the radical *ri* 日 (the sun) and the phonetic component *si* 寺 which stands for a temple where the 'temporal' law is applied constantly'. A more ancient form of writing the script conveys the meaning of the time when plants sprout under the influence of the sun or the continuity of the flow of the subseasonal phases.[G.D. Wilder ,1974, p. 47-48].

classics 經 there is this discussion on whether or not people gets afflicted by an illness when the *qi hou* has arrived or not **未至**至而至者病**論**. When nature's temporal order has arrived 有至 and is in harmony with the cycle of the changing *qi hou* then there will be tranquility 而**和**則**平**. However, when nature's temporal order has arrived and the *qi hou* is quite severe, then people gets ill 至而甚則病. Or, it has arrived but the *qi hou* is the reverse to what it should be **反**, then, people also fall ill. If the temporal order should have arrived and it turns out that it has not, then people falls ill. When the temporal order should have not arrived and it turns out that it has arrived, and then people also fall ill.

These are situations wherein a specific qi *hou* is 'occurring wrongly' at a specific subseasonal phase 非節之氣候. This will certainly generate illnesses 必生病也. An example is when it should be warm in winter but instead it is 'ragingly warm' 暴暖. Hence, winter warm factor diseases occurs 冬溫. When it should be warm during spring and summer but instead it is 'ragingly cold' 暴寒. Hence, winter pestilence 寒疫之類 of sorts will emerge.

Above are the correlations between the principles of illnesses 病理 and the *qi hou* **氣候**. This is to show that the study of the astrocalendar 曆學 and medicine 醫學 is mutually related. Although Western medicine 西醫 does not talk about the methodology of the study of the astrocalendar, however they observe the prevalence of infectious diseases and intestinal and stomach diseases during the summer season; the prevalence of respiratory diseases during the winter seasons and thus are reluctant to abandon the *qihou* factors 氣候 in discussing about pathology 病理. As to accounting for *qi hou* changes 夫氣候之變遷, there is the difference between the direct and slanting way the light of the sun reaches us. The sun and the moon passes through in heaven which has not changed even since the beginning of antiquity …Humanity is in the midst of this Qi between heaven and earth and is closely and interactively connected with the Qi transformation unfolding between heaven and earth 天的之氣化息息相通. As medical practitioners harmonizing with the temporal order and surveying Qi 候時測氣, how can we ignore these things? [Yang Ruhou, 1985, pp. 293-295]

Practicing the Tradition of Chinese Medicine As Local Knowledge In a Globalised World

The practice of *bian zheng lun zhi* 辨证论治 i.e. the practice of proposing treatment principles in accordance with the pattern of clinical phenomena (Tiquia, 1996) is a body of knowledge that is anchored on local conditions. It is an ancient traditional medical practice, which emerged and became systematized from the local health contingencies in ancient China and then extended in time and space to other locales in China, Japan, Korea, Asia, Europe, America and Australia. It is a set of medical practices that "adapt to different local circumstances, to meet the heterogeneity 混雜性 of the local requirements of the system... (plasticity 可塑性) and the capacity… to incorporate many local circumstances and still retain a recognizable identity (coherence 條理性)" , as the contemporary American feminist philosopher of science Susan Leigh Star would put it. Plasticity and coherence are the two factors, which make a system of knowledge 'robust' 健狀的 according to Star [Star, 1989, pp. 15-16].

On this question of the transmission of knowledge from one locale to another, the Chinese has an equivalent set of phrases which goes: *yin di zhi yi* 因地制宜*; yin ren zhi yi* 因人製宜*; yin shi zhi yi* 因時製宜 which I translate into English as 'doing things which are appropriate to the locality; the culture of the local people and local temporality (local time and seasons).' With the practice of *bian zheng lun zhi* i.e. differentiating clinical patterns and associating *yao* [Tiquia, 2004, p. 101] not only can emergent clinical phenomena 症候 be holistically differentiated in detail, but at the same time they can also be dealt with dynamically in their various stages of development." [Zu Xing, 2007, p. 44]. In this way, illnesses can be simultaneously dealt with spatially 在空间上 as well as temporally 在时间上。

Practising TCM in the northern hemispherical region of China follows local temporality 时, spatiality 空间 and human culture 人文 (humanities) . Historically, the practice of bian *zheng lun zhi* 辨证论治 followed and continues to follow the circularity 圆 of time (continuous cycle of the past, present and future cycle of the seasons) as well as the quadratic 方 nature of space (the sky above, the earth below and the directional locale of the east, south, west and north) with humanity occupying the central spatio-temporal position.

In the Southern Hemispherical region of Australia and New Zealand, deploying a syncretic 'double insider' methodology of standing outside both the analytic tradition of contemporary science studies and inside contemporary TCM practice and analysis, I connect with the *theory* of local knowledge developed by contemporary philosophers of science such as Susan Leigh Star, Joseph Rouse, Bruno Latour, Helen Verran and David Turnbull, who have been at the forefront of de-colonizing traditional and indigenous knowledge systems from the Trojan horse of scientific theories. [Tiquia,2009 http://arts.monash.edu.au/mai/asaa/proceedings.php]. From this stance, I have reconstituted the practice of TCM as *bian zheng lun yao* 辨證論藥 i.e. differentiating clinical patterns and associating *yao.* I see 'yao' as routine therapeutic practices that move the patient's Qi which includes acupuncture, traditional Chinese massage, food therapy, prescribing materia medica, emotional counter therapy, Qi exercises, Tai ji quan etc. In TCM clinical encounters, Qi is performed as *differentiating clinical patterns and associating yao* [Tiquia, 2004, p. 101].

Living in our contemporary world dominated by abstract, universalizing and modernistic temporal systems such as the Gregorian calendar (with its northern hemispherical bias) and Greenwich Mean time (with its de-localizing bias of universal time) presents huge challenges for those of us living in the southern hemisphere, who wish to follow health practices according to the principles of living in harmony with local space, local time and local culture.

Furthermore, for those of us living in the southern hemisphere, there is the added challenge of practicing TCM according to the foundation principle of *bian zheng lun yao* (differentiating clinical patterns and associating *yao)*. This is a practice based on highly specific prescribed health practices and treatment principles dispensed in accordance with clearly defined complex temporal phases and periods set on the basis of the ancient northern Hemispherical Chinese lunisolar calendar. In the absence of such an adaptation of this calendar for the southern hemisphere, it is almost an impossibility to practice *bian zheng lun yao*.

To address this problem, I researched the ancient traditional Chinese calendar and adapted its core principles to produce a Chinese Medical & Agricultural Lunisolar Calendar (Northern & Southern Hemispheres) relevant to Australia's southern hemispherical local conditions. This will now make it possible to follow best practice in TCM by utilizing such a calendar to harmonize the flow of our Qi with the flow of the seasons here in the southern hemisphere. In addition, with this calendrical tool, we can 'reverse' the clinical activities of 'differentiating clinical patterns and associating *yao in* accordance with the flow of the seasons here. For example, by using this calendar, it is now possible to forecast, prevent and clinically manage 'seasonal diseases' *shi bing* 时病 brought about by external factors *wai gan bing* (influenza type conditions like the ' severe warm factor epidemics 大瘟病 [Lai Peng Ju, 2003]) as the calendar will indicate the likely spatio-temporality of this condition's genesis, its prevention, and specific, effective diurnal time periods in which to treat this condition.

Examination of the Characteristics of the Traditional Chinese Calendar

The traditional Chinese calendar with its northern hemispherical bias is ironically found and used in many TCM practices, Chinese restaurants and homes in Australia. On examining a copy of such a calendar for the year 2007 (the Year of the Pig ding *hai nian* 丁亥年 published by the *Chinois for Living*), for one who cannot read Chinese characters, it is just like any ordinary Gregorian calendar with the twelve months of January, February, and March etc. complete with the Arabic numerals from 1- 31. However, for one literate in the Chinese language, one can see that aspects of the traditional Chinese Farmer calendar *nong li* 農曆 or *yin li* 阴历 blended with the days and months of the Western Gregorian calendar. Thus we have the 'Chinese lunisolar calendar', which evolved after the adoption of the Gregorian calendar in 1911and syncretised with aspects of the traditional Chinese calendar.

As we are all aware, we celebrated the arrival of the 'Ox Year' *Ji Chou nian* 己丑年 last January 26, 2009 of the Gregorian calendar, which falls on the 'first day of the first month of the traditional calendar' i.e. *Ji Chou nian* 己丑年, *zheng yue chu yi ri* 正月初一日. The first day of the traditional Chinese calendar month is the day on which the astronomical new moon (i.e. conjunction) is calculated to occur" [Doggett, L.E. Calendars, 2004 <http://astro.nmsu.edu/~lhuber/leaphist.html>]. However, the 26th of January in the northern hemisphere (in China) is just nine days before the subseasonal phase 节气 *of* the "Beginning of Spring" *li chun* 立春 [< http://www.nongli.com/item3/index.asp>]. However, here in the southern hemisphere, the 26th of January 2009 is just the end of the summer season and the start of autumn. From these, we can see that the flow of the seasons in the southern hemispherical region of Australia runs in the opposite direction to that of China and regions in the northern hemisphere.

Locating the Year and First Days of the First Lunar Month in the Southern Hemisphere

According to the rules followed by Purple Mountain Observatory (1984) in Nanjing, China, in constructing the Chinese traditional calendar, 'the first day of the month is the day on which the New Moon occurs [Doggett, L.E. Calendars, 2004 <http://astro.nmsu.edu/~lhuber/leaphist.html>]. On this basis, I calculated the first days of the lunar month in the Australia/New Zealand, from a table of the various phases of the moon in the southern hemisphere for the years 2006-2010, in *Easy Organic Gardening* 2006 by Lyn Bagnall. I then proceeded to set the first day *chu yi* 初一 of the first month zheng *yue* **正月** of the year of the of the Ox Year, *Ji Chou Nian* 己丑年on the 2009 Gregorian calendar. In order to do this, I first located and then superimposed the exact dates of the twenty-four subseasonal phases 节气 onto each month of Gregorian calendar (2008- 2009). I then aligned them with the seventy-two pentads *qi shi er hou* 七十二候. Using a Chinese language calendrical table, which converts the 60-temporal *gan-zhi* units of years, months, days and 2-hour periods into the Gregorian calendarical years, months and days [Ou Yang Shan Ren, 2007] , I tallied the days and months for the years 2008-2009. I then superimposed the Chinese *gan-zhi* (combination of the celestial stems and earthly branches) onto the days and months of the 2008-2009 Gregorian calendar.

August 20th 2009 -The ‘ Chinese Spring Festival’ of the Year of the Tiger in the Southern Hemispherical Region of Australia

After executing the above, I was able to establish the first day of the first month of the Southern Hemispherical Chinese Medical & Agricultural Lunisolar Calendar: August 20, 2009. In doing so, I also discovered that our ‘spring festival’ or *chun jie* or Lunar New Year’s Day fell on the New Moon of August 20th 2009, some six months ahead of the Chinese New Year Date in the Northern hemisphere. Hence, on the 20th of August 2009, we will begin the ‘Year of the Tiger’ *Geng Yin nian* 庚寅年. The first Chinese Medical & Agricultural Lunisolar Calendar (for both northern and southern hemispheres) was thus constructed. Enclosed (fig. 1) is a copy of the Chinese Medical & Agricultural Lunisolar Calendar (Southern Hemisphere) for August 2009 (the beginning of the Tiger year) which features the reversed flow of the twenty four subseasonal phases 节气, seventy two pentads 七十二侯 as well as the days of the months both in the Gregorian calendar and the traditional Chinese calendar. It also features the specific dates of the sixty *gan zhi* 干支 *temporal* units for the year 年, month 月 and days 日 of the Chinese lunar calendar.

This calendrical tool, a practical critique of modernity which restores and breathes new life into an ancient Chinese spatio-temporal tradition will hopefully bring human life into close rhythm with the organic flow of all forms of natural life in this universe 宇宙. It will help us align the performance of our Qi with the occurrence and flow of the seasons in the Southern hemisphere. More specifically, it will facilitate the choice of acupuncture points and acutracts in accordance with the flow and clotting of our patient Qi and blood 子午流注. In this way, we can properly execute seasonally appropriate ‘nurturing life’ exercises 养生 and adopt lifestyles that promote health, longevity and prevent diseases. At the same time, this Chinese Medical & Agricultural Lunisolar Calendar (Southern Hemisphere) can facilitate the ‘translation’ of the ancient Chinese northern hemispherical concept of ‘the circulating five phases and six climactic influences [Qi]’ 五运六气 into the Australian southern hemispherical locale. In doing so, the occurrence of exogenous seasonal diseases 时病 like epidemic influenza 流感 can be traditionally and properly diagnosed and their future health risks may be ascertained and managed.

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Climate Protection in The People's Republic of China

Bartosz Rakoczy[1]

Abstract

Climate protection is one of the basic problems in the modern world. It is also a problem which should be solved in an all-world scale and not by each state separately. It does not mean, however, that individual states could not regulate issues concerning climate protection in their own legislation. Constitutional regulations play an important role in climate protection.

Climate protection in the constitution of the People's Republic Of China is carried out on several plains. First, climate is protected as an environmental element to the use of which all citizens have the right. Public authorities ensure climate protection. Second, climate protection occurs within the protection of rights and freedoms of an individual. An individual / citizen has the right to use environment, and also climate. Third, climate is protected as an element of environment on the basis of the regulations concerning environment as the good of the whole nation.

In the first place it should be noticed which duties public authorities have when it comes to climate protection. It is about presenting their duties concerning this notion. Climate is protected first due to the fact that it is an element of environment which public authorities should protect and, second, climate as an environmental element is the common good of a nation.

Later constitutional position of an individual concerning climate protection will be presented. In particular, the duty of an individual to protect climate will be characterized as well as the rights of an individual to use environment.

The summary will contain proposed solutions which could be accepted in the Constitution in the future in order to protect climate in a better way by the People's Republic Of China.

The environmental protection, in particular climate protection, is a challenge for the modern world. As W. Skrzydło points out "the environmental protection has been one of the principal issues of the modern society and state"[2]. In consequence, the modern legislator faces the challenge connected with legal regulations concerning the environmental protection. Among notions referring to the environmental protection one should also take into account intensity with which one should protect particular environmental components without forgetting about the fact that we should protect the environment (as a whole) despite everything.

At present the most important challenge connected with the environmental protection of the contemporary state is the climate protection. It is connected with the scale of climate violation as well as the scale of the results of such violations. The climate protection is a challenge not only for biologists, economists, ecologists but also for legislators. That protection should be carried out both on the level of international public law, regional law (eg. the European Union law) and the national law[3].

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[1]Manager, Environmental Protection Law, Nicholas Copernicus University in Toruń – Poland, and Professor, department of the Public Economic Law and the Environmental Protection, Gdańsk University – Poland, email: bartoszrakoczy@wp.pl

[2]W. Skrzydło, Konstytucja Rzeczypospolitej Polskiej, ed. 5, Warszawa 2007, p. 81.

[3]see in: The role of the laws in the protection of the climate, Climate Change, Global Risk, Challenges & Decisions. Abstract books, Copenhagen 2009 IOP Conf. Series: Earth and Environmental Science 2009, z. 6, 112036.

From the point of view of national law one should recognize as the most important the regulations concerning the environmental protection including the climate protection in the constitutional regulations. The Constitution of the People's Republic of China has the highest authority in the legal system so it plays the role of the most important and superior legal act.[4] At the same time the People's Republic of China is considered as the state where dictatorship of the proletariat lies at the basis[5].

The report covers discussing legal regulations concerning the climate protection n the Constitution of the People's Republic of China dated 4 December 1982[6]. The aforementioned report stresses above all tasks of the state, issued connected with international aspects of the climate protection as well as the legal situation of individuals concerning the climate and its protection.

The Constitution of the People's Republic of China, as well as other constitutions of the world, does not contain the definition of climate. Such an important act should not contain definitions since it is the act of a general and abstract character. Moreover one should notice that generally in legal sciences it is difficult to define such a not legal notion as climate. It may be assumed that in legal sciences "the notion of climate has not been precisely defined in accordance with legal regulations. […] The climate is defined as the characteristic system of phenomena and atmospheric processes occurring on a particular area which develops under the influence of physical and geographical properties of that area. The climate is also defined as an average state of weather on a given area, characterized on the basis of measurements carried out in the period of at least 30 years since measurement of climate components is necessary[7].

The analysis of the regulation concerning the climate protection in the Constitution of the People's Republic of China one should start from the preamble. J. Rowiński and W. Jakubiec claim that "the bases of the constitutional system of the state [i.e. China – author's note] are regulated by the preamble and regulations contained in the first chapter.[8]" The preamble to the Constitution of China contains a sentence saying " The future of China is closely linked to the future of the World"

That sentence from the last part of preamble has a very important meaning since it expresses the connection between the world's history and its future. It means that the People's Republic of China undertakes international cooperation also regarding the climate protection for that is one of the most important challenges for the modern world.

International cooperation, as it arises from the preamble, is to be connected with the future of the world. It means that the People's Republic of China not only undertakes such a cooperation but also does that by taking the world's future into account. It seems that the climate protection is the best example of the kind of actions taken into considerations. Not only does it require international cooperation but also it is future-oriented because global actions undertaken today are going to produce effects only in the future. Climate is protected not only for contemporary generations but first of all for the future ones.

Notions connected with the environmental protection including the climate protection appear also in the next parts of the Constitution of China. Art. 9 may be treated as the constitutional basis of the climate protection „All mineral resources, waters, forests, mountains, grassland, unreclaimed land, beaches, and other natural resources are owned by

[4] Wang Gniguo, John Mo, Chinese Law, London Boston 1999, p. 26

[5] W. M. Bezczastnyj i inni, Konstytucyjne prawo innych państw, Kiev 2008, p. 426.

[6] Further referred as the Constitution of China

[7] M. Kistowski, [in:] J. Ciechanowicz – McLean (ed.), M. Kistowski, B. Rakoczy, D. Trzcińska, K. Klenowska, Leksykon ochrony środowiska, Warszawa 2009, p. 92.

[8] J. Rowiński, W. Jakóbiec, System konstytucyjny Chińskiej Republiki Ludowej, Warszawa 2006, p. 37.

the state, that is by the whole people, with the exception of the forest, mountains, grassland, unreclaimed land and beaches that are owned by collective in accordance with the law.

The state ensures the rational use of natural resources and protects rare animal and plants. Appropriation or damaging of natural resources by any organization or individual by whatever means is prohibited”.

The aforementioned regulation is contained in the first chapter of the Constitution of the People’s Republic of China called „General Principles”. That chapter covers the basic constitutional and political principles of the People’s Republic of China. Within the general principles the constitutional legislator shall regulate the basic values that the constitution should protect.

Natural resources should be treated as such without any doubt but their protection is connected first of all with the role that the aforementioned resources play in the functioning of the state and society. They are to serve the common good and all the people what arises from the art 9 of the Constitution of the People’s Republic of China. „The state is responsible for assuring the national use of these natural resources and for protecting the same resources against exploitation”[9]

From the analyzed point of view, important is the fact that the components enumerated in the art. 9 of the Constitution of the People’s Republic of China make up the notion of the environment. They are also the environmental components. Their rational acquiring, use and management is supposed to aim at the environmental protection. It is worthy noticing that the art. 9 of the Constitution of the People’s Republic of China mentions plants as environmental components deserving protection. Flora protection, regardless of the fact if the plants are rare, protected or common has the great significance in the climate protection. The state of flora serves the stability of climate and in consequence leads to its protection.

The art. 20 of the Constitution of China that states „The state promotes the development of the natural and social sciences, disseminates knowledge of science and technology, and commends and rewards achievements In scientific research as well as technological innovation and invention” is also counted among the constitutional bases of the climate protection.

The aforementioned regulation has a general meaning and refers not only to issues concerning the environmental protection. Yet this article may also be used for issues connected with the environment and its protection since it imposes the duty on the state to promote and develop natural and social sciences, deepening knowledge and supporting the development of technical and technological innovations.

It is interesting that the Constitution of the People’s Republic of China imposes the duty to promote and develop natural and social sciences. The development of these sciences is naturally connected with aiming at obtaining funds necessary for the environmental protection including the climate protection. In case of the environmental protection, including the climate protection, one can clearly notice how nature and social sciences may serve a common goal since the climate protection is not possible without involving both natural and social sciences. Natural sciences allow to understand the mechanisms that rule the nature and climate. They also allow to gain proper means for the climate protection[10].

Social sciences also play an important role in the climate protection. Economics is important as well for it allows to figure out the costs of climatic changes as well as the law which allows to assure the best efficient means and instruments for the climate protection

[9] Wang Chenguang, Zhang Xianchu, Introduction to Chinese law, Hong Kong Singapore 1997, p. 456.
[10] The greenhouse effect which is the reason of climate disturbance is drawn up first of all by physicists and chemists and not by sociologists or lawyers since they are capable of working out effective means of the climate protection.

including sanctions and sociology describing social consequences of climatic changes and allowing to forecast future effects.

The national authorities have the duty to support and develop new techniques and technologies. Such a situation is in favour of gaining new ways of development and as a consequence the climate protection because such technical and technological solutions taking the need to protect the climate into account may be consciously suggested.

Another provision of the Constitution of the People's Republic of China that is connected with the climate protection is the art. 26 which stipulates that. The state protects and improves the environment in which people live and the ecological environment. It prevents and controls pollution and other public hazards. The state organizes and encourages afforestation and the protection of forests.

The aforementioned provision should be treated as the basic one when it comes to the climate protection. Similarly as in the case of former provisions the legislator does not clearly point out that they mean only climate. The legislator refers to the notion of the environment and not the climate.

Yet it stems from that provision that it says also about the climate which is an important environmental component. The contents of that provision is wide.

The aforementioned provision imposes on the state the obligation to protect the environment, including the climate. That duty should be understood widely. It can be assumed that the state is obliged to undertake all the actions aiming at preserving and improving the state of the environment. The duties connected with the environmental protection may be realized on four planes – constituting laws, organizing activities connected with the environmental protection, assuring funds and carrying out ecological education. The constitutional obligation of the state concerning the environmental protection is set out on these four planes.

When it comes to the first of the aforementioned planes it should be pointed out that the state has duties concerning constituting the law favourable to the environment what can be done both directly and indirectly. Direct method consists in constituting legal acts aiming directly at the environmental protection, while indirect method consists in constituting other standards (eg. tax standards) that are to aim at different purposes but at the same time it is possible to reach a fiscal goal[11].

The state also has the duty to organize the environmental protection. It occurs first by indicating which organs are competent for the issues concerning the environmental protection and what are their competences. The state may constitute specialized bodies, entrust already working bodies with performing the tasks or accept a mixed model consisting in part of the competences being performed by specialized bodies and another part by not specialized[12].

The next task of the state is assuring financial means for the environmental protection. The state is obligated to finance the environmental protection either through the national budget or specialized funds. The lack of sufficient funds for the environmental protection is the basic reason of ineffectiveness of protective measures.

The last task should be ecological education on all the stages beginning from kindergartens to adult education. The state should assure proper educational content in school curricula, including studies.

The aforementioned solutions will also refer to issues concerning the climate protection.

[11] Eg. through exemptions or tax reliefs

[12] See in: B. Rakoczy, Prawo ochrony przyrody, Warszawa 2009, p. 34.

First, the state should constitute the regulations that either directly or indirectly are favourable to the climate protection. Thereby it is forbidden to constitute regulations that may lead to violating the climate.

The state should also organize the climate protection by designating competent organs which might deal in climatic issues under their own tasks. Then the state could entrust these bodies with specific competences.

The state should also assure financial means for the environmental protection and directly bear the costs of the climate protection (financing technologies favourable to the climate protection).

The state's duty consists also in carrying out education concerning the climate protection both for children and adults. The education is first of all connected with making the society aware of the importance of the climate and indicating the need of its protection.

It results from the art. 26 of the Constitution of China that the state has an obligation to protect the environment, including the climate, on account of people. The Chinese legislator indicates clearly that it concerns the environment in which people live. One can clearly see the connection between the environmental protection and individual's legal situation, including the connection with its laws. The Chinese legislator also proves that the protection of human life and health is the basic motive of the environmental protection in the Chinese legislation. The following question occurs - can the right of humans to live in the favourable environment be deduced from the art. 26 of the Chinese Constitution?

In spite of the fact that the regulation refers to human life and health as the basic values, it is hard to deduce that every human being has the right to live in the favourable environment and the state is obliged to assure that.

First of all, the regulation is not to be found in the second chapter of the Constitution of China – the basic rights and duties of citizens, so the legislator's intention was not to refer to the rights and freedoms and even duties of citizens but only indicating one of the basic duties of the state.

Secondly, human life and the environment favourable to humans are only indicated as a standard in that regulation at achieving of which the state should aim, and not the value itself.

One should also make the demand de lege ferenda that such a right of an individual to live in the favourable environment should be expressed in the future.[13]

From the analyzed point of view one should also treat duties of the state concerning protecting the environment against pollutions as very important. It is a very important and at the same time a very courageous declaration of the state taking the form of an obligation. The danger of pollution is now treated as one of the most dangerous challenges for the environment in China.[14]

The state committed itself to preventing pollutions and the risk of such pollutions. It seems that the obligation refers to the very climate protection. Modern problems concerning the environmental pollution first of all refer to the air, and as a consequence to the climate. So the state is obliged to prevent air pollution, including the pollution which may result in climate violation. It does not only concern the fact that the state alone refrains itself from polluting the air but also leads to such a situation when other subjects also refrain themselves from such an activity.

The state has an obligation to prevent the risk of pollution as well which means referring to the universally accepted prevention principle in the modern environmental

[13] The same problem refers also to many other constitutions, eg. The Constitution of the Republic of Poland dated 2 April 1997

[14] E. Chien, Working towards environmental quality in the 21st century, Pekin 1991, p. 19.

protection law. The mentioned principle first of all assumes refraining from unlawful violation of the environment at the same time accepting the fact that the environmental impact is necessary. That principle constitutes the basis of the European environmental protection law.

Prevention requires from the state creating proper legal instruments aimed at its realization, in particular by specifying the limits, standards and indicating in which situations it is necessary to obtain the environmental permit.

The state has an obligation not only to prevent pollution but also to control it. It means that the state must constitute proper procedures of control and register the results under the monitoring system.

Another important regulation is forest protection stemming from the art. 26 of the Constitution of China. As it has been pointed out above, the People's Republic of China protects the forests and prevents their violation. The forest protection occurs again in the regulation. The following question occurs – to what purpose the Chinese legislator referred twice to the forest protection? In the first case mentioned before forest protection concerned natural environmental reserves, while the art. 26 of the Constitution of China refers to the forest protection in the context of preventing the environment violation. Also protection against pollution is important which forests are able to assure. Also solutions accepted in the art. 26 should be treated as important from the point of view of the environment in that context. The constitutional legislator draws our attention to the forests as a natural means of protecting the environment against pollution. On the other hand however, the legislator seems to be aware of the significance of forests for the environmental protection, in particular the climate.

Solutions concerning the environmental protection, in particular the ones referring to the climate protection in the Constitution of the People's Republic of China should be accepted with satisfaction. The most important drawback, apart from the lack of clear reference to the rights of an individual to live in favourable conditions, is the lack of reference to the sustainable development principle on any grounds. The Chinese legislator never refers to that principle in the Constitution of China. It seems that it is difficult to protect the environment without referring to the sustainable development principle in the modern state. Reference to that principle strengthens the constitutional bases of the environmental protection. It also makes them more universal and connected with global means of the environmental protection which has the fundamental significance in case of the climate protection.

The art. 5 of the Constitution of the Republic of Poland may be cited as an example. It says that "The Republic of Poland shall safeguard the independence and integrity of its territory and ensure the freedoms and rights of persons and citizens, the security of the citizens, safeguard the national heritage and shall ensure the protection of the natural environment pursuant to the principles of sustainable development."

Reference to that clause could strengthen the climate protection in the Constitution of China all the more so because the legislator realizes the necessity to cooperate with other countries to the extent of challenges that the modern world poses. Therefore the sustainable development principle should be made de lege ferenda the basic principle of the Chinese environmental protection law. Also direct reference to the concept of sustainable development would be legitimate.

Summing up, the solutions adopted in the Constitution of the People's Republic of China referring directly to the climate protection are good ones. The legislator treats the environmental protection, including the climate protection as the constitutional value which is important in itself. Also wide regulation of notions concerning the environmental protection, including the climate protection, is justified. The basic duties concerning the climate protection are imposed on the state by the constitutional legislator. The very state is responsible for the environmental state and its protection. Therefore the state should constitute regulations favourable to the environmental protection both aiming at that directly or indirectly. The state should also assure financial means for organizing the environmental protection and ecological education.

The state should assure the proper level of the environment due to the protection of health or life of an individual and prevent the environmental pollution, including the risk of its violation.

The lack of direct regulation of individuals' right to the life in favourable environment as well as the lack of reference to the sustainable development principle are drawbacks of the Constitution of the People's Republic of China. In the future constitutional regulations should be supplemented with these elements.

Embedding Climate Change in The Curriculum

John Willott[1]

Abstract

Climate change presents significant scientific, technical, ethical and political challenges. Attitudes to climate change are a function of tradition and culture, and the prevailing discourses in society and the media. Educators have a key role in understanding these attitudes and promoting behavioural changes. However, the transdisciplinary nature of the issues can present a problem for staff and students alike. While it is relevant to many, or most, areas of the curriculum, traditional discipline and organisational boundaries, and the knowledge, skills and educational history of both staff and students, can prevent engagement. Examples include teaching the concepts in non-science courses, engaging science disciplines with the political and ethical issues, and developing the understanding of responsibility and its relevance in vocational, business-related courses.

In this paper I describe a review of courses across a higher education institution to understand how climate change is incorporated into the curriculum, and the development of teaching and materials for use across disciplines. Examples and discussion will be contextualised to China and its role and position in global climate change issues.

Introduction

Climate change is the greatest environmental challenge facing the world today. To meet this challenge, the world needs minds capable of creating new possibilities for meeting our basic needs such as energy, water, shelter and food; minds that can transform our daily experiences into ones that allow a sustainable development, safeguarding our opportunities and the environment for future generations.

The higher education sector is where these minds are trained and developed. Therefore, it is crucial that the sector contributes strongly to sustainable development. It can do so by training and expanding these young minds; researching answers to challenges and informing public policy; showing its own understanding and commitment through careful campus management; and by being a responsible employer and active member of the business and local community. Professor Lord Stern of Brentford, Foreword in HEFCE (2009)

These words illustrate the growing concern at policy level in the UK of the impacts of climate change, and the role of universities, both as organisations and teaching institutions, in responding to the threats. The role identified for universities here, way beyond that of researching the problems, poses a significant challenge to our understanding of higher education – what it is for, how it operates, and how curricula can be developed across the different disciplines which encompass the range of issues implicit in the statement. I shall show there are difficulties and tensions, but significant opportunities to respond to the challenge which can no longer be avoided.

Role of Higher Education

Views on the purpose and role of higher education vary across the world (Gough & Scott 2007), but the discourse and policy in the UK has been largely shaped in recent years by what

[1] School of Applied Global Ethics; Leeds Metropolitan University, UK, e-mail: j.willott@leedsmet.ac.uk

has become known as the Dearing Report (Dearing 1997). In this, four main purposes are identified:

- *to inspire and enable individuals to develop their capabilities to the highest potential levels throughout life, so that they grow intellectually, are well equipped for work, can contribute effectively to society and achieve personal fulfilment;*
- *to increase knowledge and understanding for their own sake and to foster their application to the benefit of the economy and society;*
- *to serve the needs of an adaptable, sustainable, knowledge-based economy at local, regional and national levels;*
- *to play a major role in shaping a democratic, civilised, inclusive society.*
  (Dearing 1997, Chapter 5)

These ideas have recently been explored and expanded in the context of sustainable development by Gough & Scott (2007). These authors discuss the tensions between the roles of higher education producing the skills base to serve society and the economy, and its contribution to personal development and the intellectual and moral improvement of the human condition - the so-called “real world” or “ivory tower” views. Added to contested notions of how sustainable development is actually defined, these tensions have perhaps held back the incorporation of sustainability principles within higher education.

Ward (2007a, b) has critiqued the role of higher education in the UK and its (lack of) engagement with climate change problems. He sees the fundamental problem being due to the influence of capitalism and consumerism, mediated through government policy, on education generally, and on universities in particular. He argues that universities may be compromised by their pursuit of research funding, including that of major corporations and the petroleum and energy industries. With particular reference to the curriculum, he concludes:

Our current education system at all levels, with its discrete, economically justified curricula, designed for the knowledge based economy, lacks any element for holistic approaches to global problems such as environmental degradation (Ward 2007b, p.15).

Contribution of Higher Education to Climate Change

In the UK, the Climate Change Act (2008) established a legally binding target of at least an 80% cut in greenhouse gas emissions by 2050, and a reduction in CO_2 emissions of at least 26% by 2020, both targets against a 1990 baseline. This imposes a Carbon Reduction Commitment (CRC) (Defra 2009) on large organisations which consume more than 6,000 MWh of energy per year. This includes many universities. At present this only includes energy consumed on site, but in future is likely to incorporate emissions related to travel and waste. The CRC is a cap and trade system, so organisations purchase carbon credits, with a price currently set at £12 per tonne of CO_2 for the first year of the scheme (2010 – 2011). Companies receive a rebate the following year, based on the cost of the credits ± 10% in the first year, with this rising to ± 50% in the fifth year. The variation is based on the company’s position in a league table of environmental performance. Initially this will be determined by actions such as the number of sub-meters installed and certification to the Carbon Trust Standard[2], but will eventually be judged mainly on emissions reductions. So there are now strong financial incentives and penalties for universities to address their carbon emissions, and any actions will need engagement with staff and students.

[2] See www.carbontruststandard.co.uk/

This wider legislative framework also informs the policy of the Higher Education Funding Council for England (HEFCE) and its counterparts in Scotland, Wales and Northern Ireland. HEFCE distributes core funding for students, learning, teaching and research, and provides capital funding for universities. Earlier policies and actions of HEFCE (e.g. HEFCE 2005) were criticised by Ward (2007a) for failing to address climate change at all, despite the rhetoric around sustainability. However, its more recent publications are now more explicit. The policy on sustainable development in higher education (HEFCE 2009) notes that English universities have energy bills totalling £250 million a year, resulting in around 1.6 million tonnes of CO_2 emissions. The same report also notes (p.18) that the sector spends over £8 billion per year in non-pay costs, so how and where that money is spent can have a significant social and environmental impact. Although there is wide variation across institutions in their consumption of resources and emissions, there does seem to be some evidence of improvement (Table 1).

Table 1 Energy and water consumption and waste indicators for English HEIs, 2006-07 (source, HEFCE 2009)

	Lower quartile	Median	Upper quartile
Energy consumption per student FTE*	2,288 kWh	3,201 kWh	6,449 kWh
Percentage change 2004-05 to 2006-07	*-7%*	*-7%*	*-11%*
Water consumption per student FTE*	7.6 m^3	11.5 m^3	25.0 m^3
Percentage change 2004-05 to 2006-07	*4%*	*1%*	*2%*
CO_2 emissions per student FTE*	643 kg	863 kg	1,593 kg
Percentage change 2004-05 to 2006-07	*-4%*	*-12%*	*-15%*

* FTE: full-time equivalent

While the precise details of calculations are not explicit in either publication, these figures for UK universities would appear to be lower than for many in the USA. In a sample of 13 institutions, Rappaport & Creighton (2007, Table 2.2, p.24) record per capita emissions of between 360 – 9950 kg CO_2. For an individual institution, Rappaport & Creighton (2007) provide a detailed case study of approaches to reduce the climate change impact of Tufts University in the USA which could be used as a template for other institutions. It is interesting to note in their analysis that the wealthiest universities (as measured by their endowment funds) tend to have the greatest per capita emissions (Chapter 2, p.22), mirroring the relationship between wealth and emissions of countries. They suggest that less well-off institutions may have been quicker to embrace routine energy saving measures than their wealthier counterparts.

A voluntary scheme exists in the USA for universities and colleges to monitor and report actions to combat climate change. Recent data are summarised in Table 2. While recognising that the sector in the USA is larger, more diverse and does not have the centralised policy and control of that in the UK, it is nevertheless disappointing to see that as many as 20 – 30% (of those who reported) do not even have policies to reduce energy consumption through more efficient buildings or purchasing – two areas that would seem to make economic sense even if responsible development was not the key driver.

Table 2. Measures to reduce greenhouse gas emissions at some universities and colleges in the USA. Data accessed from http://acupcc.aashe.org/statistics-tangible.php on 5 June 2009.

Action	**Schools Committed (Total = 514)**
1. Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.	368 (72%)
2. Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist.	412 (80%)
3. Establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by our institution.	46 (9%)
4. Encourage use of and provide access to public transportation for all faculty, staff, students and visitors at our institution.	323 (63%)
5. Within one year of signing this document, begin purchasing or producing at least 15% of our institution's electricity consumption from renewable sources.	181 (35%)
6. Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where our institution's endowment is invested.	45 (9%)
7. Participate in the Waste Minimization component of the national RecycleMania competition, and adopt 3 or more associated measures to reduce waste.	297 (58%)

It is perhaps not surprising to see that air travel and investment policies are the least well developed, as the former would be an additional cost, even if travel were restricted (which would itself raise questions about how the institution operates), and the latter would raise fears that the institution might see lower returns on investments. Both of these measures which carry immediate cost implications may be further affected because as has been widely reported, for example in The New York Times (2009), the value of university endowments has fallen significantly since the onset of the current global financial crisis. The actions of UK universities are being discussed in June 2009 at a roundtable debate organised by Times Higher Education and the Carbon Trust entitled ‘UK HEIs are home to some of the world’s experts on climate change and sustainability but are they putting their own house in order?’. We shall see.

Education for Sustainable Development (ESD)

Climate change could be considered as a topic under the broader heading of education for sustainable development. There is a considerable literature on this, from compulsory school-age education through to universities. A consistent theme is that sustainable development education, as distinct from environmental education, is highly complex and interdisciplinary, and consequently requires the development of high level skills in both teachers and students (e.g. Dale & Newman 2005). This has had implications for its incorporation into school educational programmes across the world, for example in Australia (Tilbury 2004) and the USA (Fortner 2001). Some authors have argued that the school education system actively mitigates against incorporating such a subject which is holistic, co-operative and interdisciplinary (Stevenson 2007). Comparable concerns exist in higher education, with staff largely supportive of its inclusion in the curriculum, but voicing concerns about the complexity, fit with subject areas, and how it could be taught (Cotton et al 2007), although there are examples of highly creative ways of engaging students, albeit those on a geography programme who might be expected to be motivated, skilled and engaged with the issue (Rebich & Gautier 2005). Nevertheless, policy drivers, in the UK at least as evidenced in my introduction, are pointing towards its inclusion across the curriculum, perhaps catching up with those who have been advocating it for some time:

What is particularly missing is the study of global warming in the curricula. It should, without doubt, be present across almost the entire spectrum of university teaching. No other educational opportunity like this presents itself. Before these students depart to their careers in whichever field they have chosen, it is fundamental that they realise what that role that field plays in humankind's contribution towards the changing of the planet's climate. Ward (2007a, p.178).

Case Study: Leeds Metropolitan University

Leeds Metropolitan University arose through the amalgamation of several smaller specialist colleges during the 20th century. It became Leeds Polytechnic in 1970, and Leeds Metropolitan University in 1992, and currently has around 52,000 students. Buildings are divided between the city centre and a campus approximately 5 km away. The city buildings were mainly 1960s tower blocks, which are gradually being replaced by modern, more energy-efficient units. The separate campus largely comprises older, listed buildings; that is they are protected by law because of their historical and architectural significance. The nature of the estate, and the fact that having two separate campuses means significant inter-campus travel, poses significant challenges to sustainability strategies. Nevertheless, in 2003, it became the first university in England to achieve the ISO 14001 international standard for environmental management. In 2008 it ranked in the top 50 Sunday Times Best Green Companies League, being the highest placed university. Contributory factors included the fact that 85% of energy comes from renewable sources, the university employs full-time environmental co-ordinators and regularly consults and informs staff on green issues, and there are travel, recycling & purchasing policies in place. The University has also been awarded Fairtrade status.

The project on 'Embedding Climate Change in the Curriculum' was conceived in late 2007 in response to the feeling that there was no knowledge of the extent to which climate change and related issues of sustainability were addressed in teaching and learning across the institution, and since they cut across the curriculum a university perspective was necessary. Our impression from colleagues was that climate change (and related issues) was not always incorporated into the curriculum where it could be, and colleagues may have been working in isolation or duplicating effort. As the subject is so wide-ranging and interdisciplinary, and requires both technical knowledge and high level skills in systems analysis (Dale & Newman 2005) we were concerned that individuals working in relative isolation would not be dealing with the subject in a holistic manner (if at all). With no obvious focus for broad climate change research and teaching within the institution (i.e. no earth or environmental sciences) our goal was to create a network of individuals across faculties and disciplines to help embed this subject across the curriculum, share the expertise and good practice of staff, develop shared teaching materials and enhance the student learning experience as a result. Given that the university has been recognised as having taken a lead on environmental issues, it was also fundamental to the project that the Sustainability Manager and team were involved. Case study materials will have immediate relevance to students, and will illustrate the framework within which the university operates, and tensions between some of its areas of operation. Being so close to home we predict that this kind of case study is likely to have a greater impact in changing student behaviour (e.g. switching off electrical appliances) or expectations.

Thinking of the nature of the institution and subjects taught within it, these were some of our *a priori* ideas of how climate change could relate to curricular areas:

- Politics, social sciences – political and social policy
- Business, economics, law – corporate social responsibility; consumer behaviour; costs of mitigation and adaptation; economic models of development and growth; notions of discount rates; legislation to reduce emissions
- Ethics and development – spatial and temporal components of responsibility and justice; water resources; population movements; millennium development goals
- Tourism, hospitality, events – impact the industries have, e.g. carbon emissions of flights, and the consequences of climate change for destinations and related businesses; responsible tourism, event and hospitality management
- Health – changing patterns of disease and vectors; mortality from heat stress
- Built environment, architecture & landscape design – energy efficient buildings; planning issues; urban design; consequences for the landscape
- Arts – cultural consequences; artists' responses
- Education – education for sustainable development agenda; curriculum & pedagogy
- IT/Computing – resource use, recycling, green computing, role of ICT in sustainable development and lowering emissions

The survey of actual practice gave the overall impression that although there were some centres of activity and good practice, and many staff were interested at a personal level, there was no evidence of broader inclusion across the curriculum, even in areas where it might be expected. It is not my intention here to highlight the gaps, but to briefly illustrate some activities across diverse areas.

Two research and teaching centres have climate change issues explicitly at their core. The Centre for the Built Environment[3] works on emissions and energy efficient buildings, and produces a range of teaching materials, including online and virtual simulations. The International Centre for Responsible Tourism[4] works extensively on areas of pro-poor tourism, sustainability, conservation and protected areas, with Masters courses for professionals in the sector. Elsewhere, recent curriculum developments have included an MSc Green Computing[5] which identifies that 'green' issues are a major concern in terms of their business, social and environmental impact in the 21st century. With the almost universal adoption of ICT, this industry has a significant carbon footprint and students investigate green ICT technologies, assess the environmental impact of ICT and look at how companies can streamline their systems, increase sustainability and save energy costs.

Sector-specific reports and initiatives on climate change can influence curriculum content within highly vocational degrees. The course team of the BSc Entertainment

[3] See www.leedsmet.ac.uk/as/cebe/build.htm
[4] See www.icrtourism.org/
[5] See www.leedsmet.ac.uk/inn/courses_msc_green_computing.htm

Management have developed a new module on Responsible Entertainment, and updated the curriculum within a module entitled Contemporary Issues, partly in response to a report on carbon emissions by the London theatre industry. This is currently estimated at 50,000 tonnes CO_2 per year, with an additional 35,000 tonnes due to audience travel, and strategies are suggested for reducing them (Greater London Authority 2008). Such a clear drive from the sector for more sustainable practice is clearly a strong driver for the incorporation of materials on climate change, emissions and sustainability into the curricula of degree schemes for which it might, on the face of it, appear to have little relevance. This notion of tailoring information to make it directly relevant to peoples' concerns (in this case their chosen profession) is one of the suggestions for breaking down barriers to engagement suggested by Lorenzoni et al (2007).

Other opportunities for engaging with the sustainability agenda in courses that have not traditionally been involved can come through shared teaching sessions. In one example, students on the MA Peace and Development course were taught together with those on the BA Managing International Hospitality. Though a simplistic exaggeration, these courses could be considered to be in different places along the spectrum of vocational and academic courses, or the 'real world' and 'ivory tower' dichotomy of Gough and Scott (2007). Together they studied a module entitled 'Working as a Global Citizen', which covers ideas of responsibility and ethics in the workplace, including sustainability and climate change. The dynamics of two groups of students who would not normally interact (indeed, would normally be on different campuses) allowed the development of understanding of others' positions; education where learners are challenged by the experiences and perceptions of others, rather than direct personal experience (Gough & Scott 2007, Chapter 15).

These few examples illustrate pockets of activity and expertise across a wide range of disciplines and faculties, and that given individual and institutional will to develop and share resources, the lack of an obvious centre is no barrier to climate change being incorporated across different curriculum areas. Our next challenge is to roll out materials for wider use.

Tensions Within Academia

I am not suggesting it will be straightforward to embed climate change and sustainability across a university's operations. There are a number of structural and attitudinal barriers to greater engagement, not least of which are the behavioural norms of academics themselves (Feltham 2007), and a hands-off approach is entrenched in policy:

We have not yet revised the action plan in the light of the strong concerns that HEFCE should do more to support the educator role. This is a challenging and sensitive area and we do not wish to do anything that might infringe, or be perceived as infringing, institutional autonomy. HEFCE (2009, p.6)

An illustration of an area displaying an apparent mismatch between institutional policy to reduce emissions and its educational mission is provided by international students. These are a significant source of income for many universities worldwide, they add to the cultural diversity of campuses and enhance the educational experience of fellow students. Internationalisation is a key agenda for many universities, and even though an important component of this is greater internationalisation of the curriculum through materials and examples from other countries and cultures, there is still considerable emphasis placed on international students and student mobility through educational exchange schemes. An unavoidable consequence of this are the associated greenhouse gas emissions. For example, consider the approximately 49,000 Chinese students studying in the UK in 2007/2008 (Table

3). Let us assume for the sake of illustration an average of one return air fare per year from Hong Kong to London for each individual, producing approximately 4.5 tonnes CO_2[6]. On this basis, emissions from these journeys alone exceed 220,000 tonnes CO_2 per year, and this crude averaging does not include in-country travel. This tension between the benefits and costs of internationalisation is likely to become a key issue for higher education institutions worldwide, both in terms of the ethics of increased air travel in an age of climate change, and particularly if these emissions are included in any future calculations of an institutions' total output of greenhouse gases. Of course, if air travel becomes prohibitively expensive for students owing to peak oil or carbon taxes or other disincentives (or a combination of both), then the financial model and student experience of many universities will have to be re-appraised.

Table 3. Subject of study and country of origin of students studying in UK universities in 2007 – 2008. Source: UK Higher Education Statistics Agency (www.hesa.ac.uk)

	UK		**Other EU**		**China**		**Rest of world**	
		%		*%*		*%*		*%*
Medicine & dentistry	52875	*2.7*	2420	*2.2*	255	*0.5*	6260	*3.5*
Subjects allied to medicine	267280	*13.6*	7560	*6.7*	620	*1.3*	11665	*6.5*
Biological sciences	146205	*7.4*	7375	*6.6*	905	*1.8*	7110	*3.9*
Veterinary science	4200	*0.2*	175	*0.2*	0	*0.0*	475	*0.3*
Agriculture & related subjects	15385	*0.8*	930	*0.8*	235	*0.5*	1125	*0.6*
Physical sciences	71765	*3.7*	4110	*3.7*	1095	*2.2*	5160	*2.9*
Mathematical sciences	27975	*1.4*	1805	*1.6*	1890	*3.9*	2450	*1.4*
Computer science	76080	*3.9*	5140	*4.6*	2655	*5.4*	11700	*6.5*
Engineering & technology	96920	*4.9*	11550	*10.3*	6645	*13.5*	24320	*13.5*
Architecture, building & planning	53870	*2.7*	3380	*3.0*	1260	*2.6*	4575	*2.5*
Social studies	169645	*8.6*	10285	*9.2*	3755	*7.6*	15190	*8.4*
Law	72740	*3.7*	4955	*4.4*	990	*2.0*	10560	*5.8*
Business & administrative studies	219690	*11.2*	22730	*20.3*	21015	*42.8*	47020	*26.0*
Mass communications & documentation	40860	*2.1*	2960	*2.6*	1110	*2.3*	3040	*1.7*
Languages	115210	*5.9*	9050	*8.1*	3710	*7.6*	8085	*4.5*
Historical & philosophical studies	88520	*4.5*	3260	*2.9*	210	*0.4*	4635	*2.6*
Creative arts & design	140340	*7.1*	8250	*7.4*	1360	*2.8*	8935	*4.9*
Education	191020	*9.7*	4360	*3.9*	980	*2.0*	5945	*3.3*
Combined	113735	*5.8*	1860	*1.7*	400	*0.8*	2310	*1.3*
Total	1964315		112150		49090		180550	

[6] Emissions calculated using www.carbonbalanced.org/calculator/flights.asp

The importance of academics engaging with the problems of climate change across all disciplines, including arts, humanities and social sciences has been stressed by Sir David King, the former Chief Scientific Adviser to the UK Government:

"[climate change] is also a problem that needs to be looked at from the social science point of view, economic point of view and political point of view, and universities need to address these problems in an interdisciplinary mode" (Times Higher Education, 24 January 2008)

The comments of Sir David were made in the context of interdisciplinary research, but the data in Table 3 emphasise the need the need to extend this argument to teaching. Table 3 shows the numbers of students in the UK studying different disciplines and their country of origin. Climate change research is likely to be concentrated in the disciplines of physical and biological sciences, and perhaps engineering and technology. (There will of course be individuals or small groups of academics with these interests in other areas, but my contention is that they are likely to be in the minority). Assuming patterns of teaching and curriculum content follow these research foci, it is clear that there are potentially large numbers of students passing through university without engaging with the issues as part of their curriculum. This is unintentionally reinforced by some of the professional associations in UK academia. The Higher Education Academy[7] supports good practice and sharing resources in teaching and learning across UK universities, and is arranged in Subject Groups. Resources related to climate change tend to be within the Geography, Earth & Environmental Sciences (GEES[8]) Subject Group, but many of these are technical and could only be readily understood by others within the discipline. It is also evident that some websites of faculties or departments engaged in climate change science have resources and activities available for schools and children. While this is laudable and should be encouraged further as part of universities' responsibility to engage with society, what of resources for non-specialist academics and students within their own institution?

For many of the more vocational undergraduate and postgraduate courses, curriculum content is strongly determined by the associated professional body. Examples at Leeds Met include nursing, physiotherapy, law, accountancy and architecture among others. In order to retain the accreditation of the professional body, and so attract fee-paying students, course designers need to meet the professional standards. In what may already be a full curriculum, negotiating where issues like climate change and sustainability fit in (and, crucially, dealing with real or perceived fears of what may therefore need to be left out) is a significant issue. Aside from courses with professional bodies, there are strong traditions of autonomy within higher education when it comes to designing and delivering a curriculum, and this continues to be articulated by the responsible public body:

HEFCE recognises that it is not within its role to influence the curriculum. However, we can support universities and colleges in producing graduates with the values, skills and knowledge to address sustainable development. This is important for all graduates, not just those engaged in fields directly connected to sustainability. Many will, for example, be managing or leading businesses or services where they will need to make decisions that impact on social justice or the environment.

Equally, we recognise the danger of bolting what some might see as the latest fad onto courses; doing so is more likely to create resentment than real change. So we will support

[7] See www.heacademy.ac.uk/

[8] See www.gees.ac.uk/index.htm

shared curriculum ideas, content and assessment methods that help to develop teaching and learning. Different institutions will have different approaches. We want to encourage and incentivise engagement (including through our Strategic Development Fund) but recognise that there will be those who find it hard to engage because of their discipline base, the focus of their mission or the size or level of student interest. Our approach is therefore one of encouragement and support. HEFCE (2009, p.13)

While the newer policy on sustainable development is undoubtedly a step forward, the above extracts do not entirely remove some of the frustrations with earlier documents discussed by Ward (2007a). If the principal body responsible for policy and funding of higher education in England regards sustainable development as '*important for all graduates*' (my emphasis), why do they not feel they can influence curriculum, and can only offer 'support' for those institutions? The curriculum is already influenced in that there are strong drivers to incorporate employability, enterprise and personal development planning into all courses. Discipline base, mission, size and (perceived) level of student interest are no excuse for lack of action. As I showed earlier in the example of Leeds Metropolitan University, there are few, if any, disciplines to which it is not relevant, and it is certainly now relevant to every individual and organisation across the globe. It is the case though that many academics will not see the relevance to their subject or will be concerned about unbalanced or politicised teaching (e.g. see Cotton et al 2007). Nor would I argue that climate change should be developed in the curriculum uncritically. There are debates (however well- or ill-informed) about the nature of the evidence, the veracity and reliability of predictions, the extent to which any changes are human-induced, what, if anything, our response should be, and responsibility for and nature of actions to mitigate and adapt to changes. So aside from the subject of climate change *per se*, it is a highly valuable and topical tool for students to develop skills in critical analysis and balancing arguments, risks and uncertainties. This fits with universities' responsibility to prepare students to face the challenges of the twenty-first century world in their professional lives and as citizens. Broader concepts of ethics, justice and fairness can readily be addressed through climate change (e.g. Adger et al 2007; Garvey 2008).

It would be naïve to assume that incorporation of materials across the curriculum would instantly produce results. Education is a necessary but on its own insufficient condition to promote the necessary changes in behaviour – the gap between knowledge and pro-environmental behaviour is well known (see Kollmuss & Agyeman 2002). But without it no change is likely.

China

The capacity of the environment in China to cope with the growing pressures of population, development and economic growth is being stretched (Kitzes et al 2008). Unsurprisingly, there is wide regional variation in the causes and consequences of the issues. For a densely populated and highly developed area such as Hong Kong, its ecological footprint is largely a consequence of its importing of natural resources from other regions and the global commons, and carbon emissions released into the atmosphere as a consequence of power generation and transport (Niazi et al 2008). Summarising China's environmental problems, MacBean (2007) argues that while there are a range of policies and laws in place aimed at addressing them, their impact is limited owing to lack of compliance and conflicting pressures for economic growth and employment.

In 2007, the National Development and Reform Commission produced China's National Climate Change Programme (Anonymous 2007). As with any such document, there are issues with the scenarios and targets because of the time lag in collecting, publishing or reviewing data in such rapidly changing circumstances (e.g. see Anderson & Bows 2008). There is also China's stance, contested by some, that developed countries should take the lead in reducing emissions because of past activities. Liu (2009) offers a recent and succinct critique on climate and energy issues in China, encompassing the National Climate Change Programme. While noting some considerable achievements, like MacBean (2007) she comments on the disjunction between state policy and local buy-in:

Unfortunately, the state-led efforts have not sparked much enthusiasm from local governments and industries because of a lack of incentives. And the annual energy efficiency targets are rather arbitrary, with few considerations of the time frame needed by industries for such changes. As a result, the targets were not reached in 2006 or 2007. The policies and regulations do, however, indicate the central government's political will, and they have cleared many obstacles for optimal market functioning. (Liu 2009, p.86)

For the purposes of this paper, I do not intend to comment further on general climate change issues or policies within China, but will focus on those aspects of the policy which relate to higher education. Key sections of the document are:

Strengthening Education, Training and Public Awareness on Climate Change
The Government of China always attaches importance to education, training and public awareness on climate change. The Program of Action for Sustainable Development in China in the Early 21st Century states that China will vigorously develop all forms of education at all levels, to enhance the public awareness on sustainable development and enhance their scientific and cultural capacity for their participation in the sustainable development by reinforcing personnel training. In recent years, China has intensified its efforts to promote education, training and public awareness on climate change by organizing various kinds of lectures on climate change basic knowledge, conducting climate change training courses for policy makers at central and provincial levels, and organizing conferences such as Climate Change and Ecological Environment, as well as setting up an official bilingual website on climate change (China Climate Change Info-Net http://www.ccchina.gov.cn) in Chinese and English to provide comprehensive information on climate change. Commendable results have been achieved accordingly.(p.13)

Reinforcing the publicity, education and training on climate change. Measures in this regard include: making full use of mass media such as books, newspapers, periodicals, audio and video products to disseminate knowledge of climate change to stakeholders in all walks of life; advocating sustainable life style including electricity-saving, water-saving, garbage classification, reduction, recycling and reuse; incorporating climate change publicity and education into the framework of basic education, adult education and higher education as an important component of China's overall quality education; holding various thematic training seminars targeting at different audiences and organizing different workshops on both popular and professional climate change science; (p.55)

Public awareness. Capacity building needs for public awareness include developing medium-and-long term program and policy to enhance public awareness of climate change, establishing professional publicity and education network and institutions in line with international standards, training people working in media and climate change education, launching public campaigns for stakeholders from different regions and groups to disseminate the knowledge of climate change, and guiding the public consumption patterns in favor of the protection of global climate system. (p.62)

While many of these goals are laudable, there is a lack of indication of who is to take responsibility for the actions and how they are to achieve them. Higher education in China has changed rapidly in recent years, and this process is continuing (Ma 2003). There is still a strong rhetoric of centralised control and a proscriptive curriculum (e.g. Ministry of Education of PRC 2008a), and this approach can take away the flexibility and incorporation of locality-specific materials with which to engage students. These can include case studies of their own university as I have indicated earlier, and include specific examples of impacts if localised scenarios are available (e.g. Tracy et al 2006). In common with other countries, many of the specialist higher education institutions might not regard climate change as relevant to them. The latest data I have seen show that by 2002, 15% of young people were progressing to higher education in China, equating to 16 million people in over 2000 institutions (Ministry of Education of PRC 2008b). These are likely to be the future managers and leaders of society, and as Ma (2003) notes:

What specific missions and roles will higher education play in independent judgment, development of cultural and ethical values of society, besides economic development?

Conclusions

Universities have a key role to play in responding to the challenges of global climate change. They are the site of much research into our understanding of the science behind climate change, and are working with businesses, governments and non-government organisations on projects to develop technologies and actions for mitigation and adaptation. However, there is evidence that teaching in these areas is not always extending beyond the core areas of geography, earth and environmental sciences and some engineering. This lack of interdisciplinary working is hampering wider engagement and means that many students are passing through university without any critical engagement with climate change issues within their curriculum. This need not be the case. Universities also tend to be large organisations, playing a significant role in the city or region they are located. Through better management of their estate and energy use, and initiatives aimed at staff and students, such as transport, purchasing and recycling policies, they can demonstrate leadership to their communities and stakeholders, both internally and externally, and these can generate valuable teaching tools with which to engage students.

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