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Climate Change and the Insurance Sector

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Climate change matters to the insurance sector. In terms of underwriting, on one scenario, the economic cost of weather losses could reach over 1 trillion USD in a single year by 2040. The impacts will be worse in developing countries. The private sector needs to work with the public sector, as part of a ''triple dividend'' approach that coordinates adaptation, disaster management and sustainable economic development. For asset management the indirect impacts are key. Greenhouse gas emissions have to drop by 60 per cent by 2050, which means transforming the energy economy. Finance for renewables will reach 100 billion USD a year soon. Political uncertainty is a serious blockage to market forces, and the re-evaluation of assets and project returns is happening too slowly. Finally, insurers have a duty as ubiquitous players in the economy and society to help to shape climate policies in a responsible and effective way.
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Introduction

In previous papers[1,2] the author discussed the scientific findings of the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), and then later the first study of climate change commissioned by the United Nations Environment Programme Finance Initiative (UNEPFI) after the Third IPCC Assessment Report. The key messages were that climate change has important implications in terms of risks and opportunities for the finance sector, including insurers, but that companies were not giving the issue sufficient attention. The present paper revisits the issues in the light of the Fourth Assessment Report of the IPCC, published in three parts in 2007,[3] and also of several CEO briefings by UNEP FI published between 2003 and 2006,[4] and covering different aspects of the way in which climate change impacts and policies will affect the financial sector.

Insurers play three key critical roles within the financial sector. They act as underwriters, accepting risks from clients and arranging reimbursement after claims have occurred. The premiums written in 2005 amounted to 3.4 trillion USD, split roughly 60/40 between life/non-life, making it the largest industry worldwide in terms of turnover.[5] Secondly, they invest their shareholders' stake in them as well as

[1] Dlugolecki (1997).
[2] Dlugolecki and Loster (2003).
[3] See website http://www.ipcc.ch/
[4] See website http://www.unepfi.org/
[5] Swiss Re (2006).

the considerable funds entrusted to them by their clients. In 2005, the figures stood at USD 16.6 trillion for insurance, USD 20.6 trillion for pension funds and USD 17.8 trillion for mutual funds.[6] Finally, they are important for the banking industry. Often, banking transactions depend on insurance to reduce the potential risk to a loan or investment. Also, there are now many financial conglomerates which possess both insurance and banking arms, for synergy.

Climate change affects insurers in two ways, through the impacts of changing weather patterns and environmental conditions on its clients and its own operations, and through regulations and other actions aimed at curbing the emissions of greenhouse gases. Strategies to deal with the first are referred to as *adaptation*, and those concerned with emissions reduction are called *mitigation*.

The first part of this paper considers some aspects of adaptation – how climate change is affecting Europe already, how quickly the probability of extreme events is changing, and what this means for insurers. It then looks at the global need for catastrophe insurance, and concludes by considering the issue of liability for damage caused by climate change. The second part concerns mitigation. Political uncertainty is a major obstacle to business decisions concerning investment that is energy-intensive, but the increasing urgency of strong action on emissions makes it very likely that a new low-carbon economy is imminent. This has important implications for investors.

However, the far-reaching nature of the changes, and the ubiquitous involvement of insurers in social and economic decisions, means that insurers have a responsibility to participate in formulating climate policies. The conclusions section draws these threads together, and offers comments on the way forward. The term ''insurers'' is used for brevity: most of the points are relevant to reinsurers, and many are pertinent to insurance intermediaries and other service providers.

Adaptation

Climate change is a global problem but to give some depth, the discussion here focusses on Europe where the data is well understood, and where at least some countries have quite comprehensive insurance systems that deal with weather losses.

Climate change in Europe

Across Europe the negative effects of climate change will be greatest in the south and east.[7] By 2070 rivers in southern Europe will be carrying half the water they do now while those in the north will be carrying half as much again. Even in drier regions, rainfall will be more concentrated. The risks of flooding will rise. Severe damage is already evident. The annual cost of climate disasters in the EU region has doubled to 8 billion euros in 20 years.[8] The number of major floods in Europe has risen from one per year between 1900 and 1974 to 15 a year between 1993 and 2001.[9]

[6] UNEP FI (2007).
[7] European Environment Agency (2004).
[8] Dlugolecki and Lafeld (2005).
[9] European Environment Agency (2004).

Good emergency warning systems mean that deaths from flooding are relatively low. However, the latest review of the extraordinary 2003 heatwave reports that it caused 71,000 deaths – many more than the original estimates.[10] Besides that there was massive social disruption, agriculture and inland shipping were badly hit, and the power supply was affected as nuclear power plants had to be shut down.[11] This was perhaps the hottest heatwave in a thousand years. One paper estimated that the likelihood is at least 75 per cent that the heatwave was due to human influence through greenhouse gases. The probability of similar heatwaves is projected to increase a hundredfold by mid-century.[12]

The burden of the changes will be uneven. Some industries such as construction might benefit from climate change, due to the increased need for reconstruction and more robust structures. Others, such as manufacturing, are climate-neutral in regard to impacts. Still others, such as agriculture, insurance, water and travel and tourism, are vulnerable. The impacts are not limited to the direct physical results; increasingly, businesses report unusual weather affecting profitability.

However, the most serious impacts for Europe may be those that occur elsewhere. One important risk is a potential surge in refugees from climatic impacts in North Africa, where drought is expected to be more frequent.[13] Another is that there could be supply chain disruption due to events in coastal regions of China; increasingly, Europe is dependent on manufacturing plants based in that region, which is vulnerable to typhoons, erratic river flow, and sea-level rise.[14]

All of the above impacts could affect insurers in two ways. Firstly, if weather-related costs are insured, then that will change claims costs. Secondly, companies or sectors that are affected by climate change will not generate the return on capital that investors like insurers are expecting. The next section considers how swiftly these changes are happening.

Changes in return periods

For economic activity, what matters is not incremental changes in average temperatures or rainfall, but changes in climate extremes. Research shows that extreme temperatures and precipitation often behave differently from the way that average conditions will respond to climate change. For example, the average summer temperature in Prague will rise by 3°C, but heatwave temperatures could rise by 10°C. Similarly, the incidence of heavy rain there will increase by 20 per cent at the same time as overall rainfall declines by 20 per cent.[15]

The United Kingdom has the best data anywhere on historical temperature and rainfall. The data on monthly average temperatures in Central England starts in 1659. We can define different levels of historical extremes, and then explore whether recent

[10] Robine *et al.* (2007).
[11] Munich Re (2004).
[12] Stott *et al.* (2004).
[13] IPCC (2007).
[14] *Ibid.*
[15] Hadley Centre (2004).

experience is different. This paper takes the values that have only been exceeded 10 per cent of the time, for cold and for hot temperatures. Figure 1 displays what percentage of months have recorded temperatures above the historical 10-per cent upper or hot threshold, and how many have fallen below the historical 10-per cent lower or cold threshold. In the 1960s, for example, 8 per cent of months were warmer than the hot threshold, and 4 per cent were cooler than the cold threshold. It is quite clear that there are strong trends towards more frequent hot months, and less frequent cold months. In the current decade, the hot months are running at a 30 per cent frequency, compared to the expected 10 per cent. At the same time, cold months have vanished.

Figure 2 indicates how scientists expect summer temperatures to shift in the U.K. Over a 60-year period, the average summer temperature will rise by 1.6°C, which does

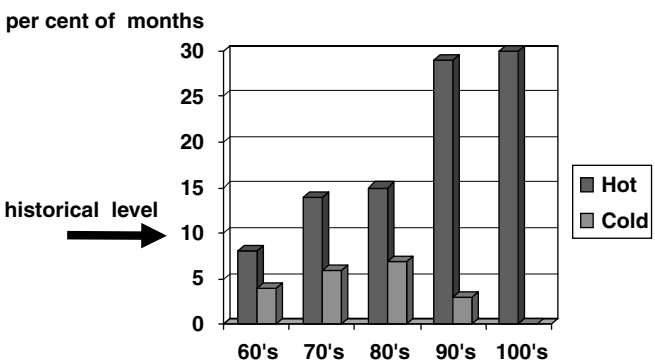

Figure 1. Recent trends in monthly temperatures in Central England 1960–2006.
Raw data from the Hadley Centre. Processed by Andrew Dlugolecki.

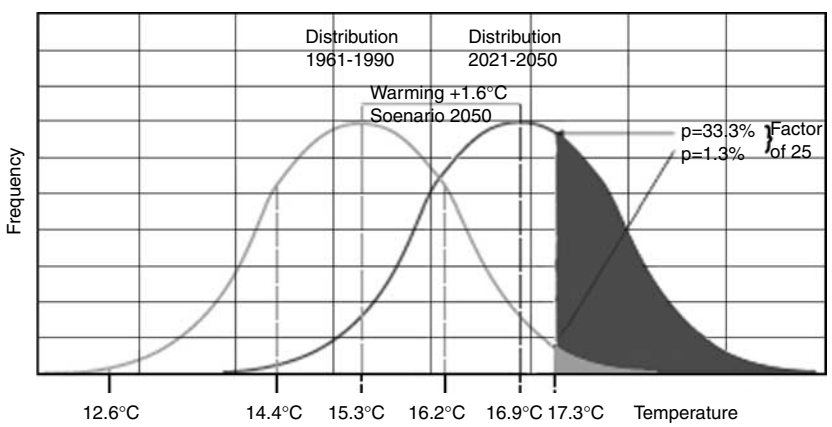

Figure 2. Predicted U.K. summer temperature extremes.
Source: CCIRG (1996). *Copyright, HMSO.*

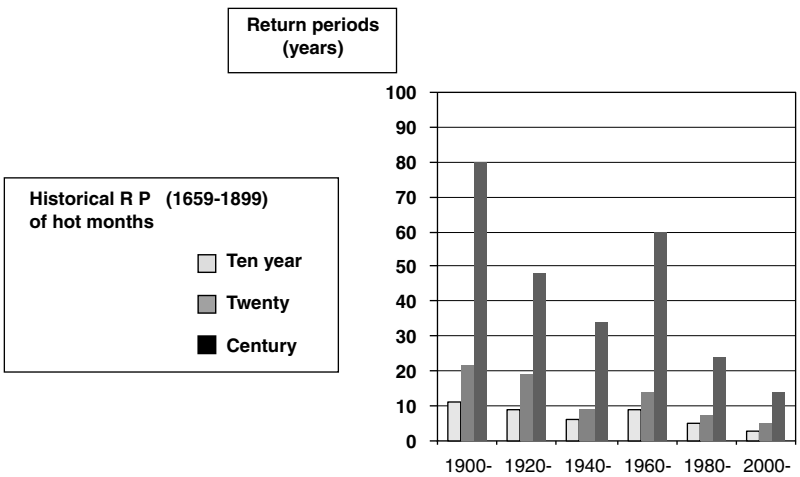

Figure 3. Actual Return Period for different levels of hot months in Central England.
Raw data from the Hadley Centre. Processed by Andrew Dlugolecki.

not sound serious. However, as the diagram shows, this will produce an enormous change in the frequency of extreme temperatures. The value of 17.3°C will move from a frequency of 1.3 per cent, to a new level of 33.3 per cent, that is, it will occur one year in three, not one year in 77. This means extreme temperatures will occur 25 times more often. From the shape of the probability distributions, it is clear that the more unusual the event, the greater will be the relative change in its frequency.

The temperature data for Central England show that this is not just a theory, it is actually happening. Figure 3 presents the actual occurrence since 1900 of different levels of hot months. What was historically a 10-year event now occurs every 2.7 years, the 20-year event occurs every 4.3 years, and the return period for a 100-year event is just 12.5 years. The data does not allow us to observe the behaviour of the 1000-year event, but by applying the relationship seen in Figure 2, it is possible that the return period for a 1000-year event is now only 83 years. This is consistent with the extreme nature of the 2003 summer heatwave which affected much of Europe, and was the most extreme for at least 500 years.

It may be argued that extreme temperatures in themselves are not a severe property risk. However, high temperatures are correlated with a number of damaging phenomena – subsidence of clay soil causing damage to buildings,[16] great winter storms in Europe,[17] more intensive hail and convective storms,[18] and of course more intense tropical storms.[19] Furthermore, in almost every region, it is expected that precipitation will become more intense, even in those where the total amount of

[16] CII (2001).
[17] CII (1994).
[18] Munich Re (2003).
[19] IPCC (2007).

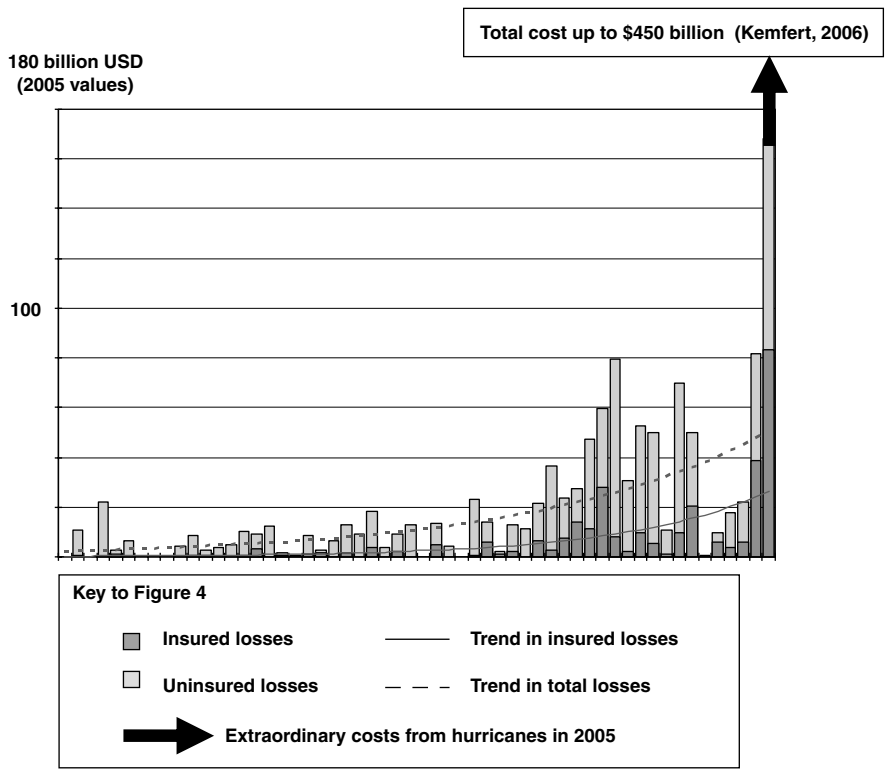

Figure 4. Great weather disasters: real cost 1950–2005, in 2005 USD.
Source: Munich Re. Indicator on 2005 inserted by A. Dlugolecki.

rainfall will decline.[20] That means that we can expect the return periods for flooding events to shrink also. Again, there are indications that it has already started to happen,[21] although the picture is complicated by changes in the date of spring thawing.[22]

With that background, it is not surprising that Munich Re has recorded a persistent rise in the real cost of great weather disasters since 1950 (see Figure 4) at about 6 per cent per year.[23] Much of this is due to socio-economic factors, like population growth, the growing use of more sensitive materials, and the drift to hazardous locations.[24] However, extensive analysis of data on weather losses in key regions suggests that there is a "climate change signal" within this trend, of about 2 per cent per year.[25]

[20] *Ibid.*
[21] Milly *et al.* (2002).
[22] IPCC (2007).
[23] UNEP FI (2006).
[24] IPCC (2007).
[25] Miller *et al.* (in press).

Implications for the insurance of extreme events

When return periods shrink, there are five important implications for insurers.

(a) Historical models of costs are inapplicable, because the scale and frequency of events move outside the zone of historical experience. This was found with the impact of hurricanes in 2004 and 2005. One estimate is that the new types of costs, such as higher energy prices due to disruption of drilling and refining in the Gulf of Mexico region, may have trebled the economic cost in 2005 to $450 billion USD, compared to the Munich Re database cost of $150 billion USD.[26] This is shown by the arrow marker inserted on Figure 4. Even within "normal" repairs, the costs rocketed due to unavailability of labour and material.
(b) Risks are incorrectly rated, because the probability of an extreme loss is assessed too low. Again, this was seen after the active hurricane seasons of 2004/05. Munich Re declared that it was recalculating its rates for such risks, in some cases by more than double, in part because the company believed that we have entered a period of higher hurricane activity, and partly because very extreme events are more costly than would be expected from simply extrapolating historical experience.[27]
(c) Exposures are too high, because the maximum probable loss is underestimated. One consequence of this is faulty reinsurance planning.
(d) Claims-handling capacity is too low, because the scale (extent and intensity) of destruction in new extreme events is beyond experience. This was seen after Hurricane Katrina in 2005, when New Orleans was evacuated, so that no damage assessment or repair work could be carried out for many weeks. Similarly, several times there have been multiple events in quick succession, which overwhelm the recovery capacity, as in Europe in 1990 and 1999 with storms, Florida with hurricanes in 2004, and U.K. with floods in 2007.
(e) Credit ratings are too generous, because the probability of a serious depletion of capital from a disaster is underestimated. This could expose investors to unexpected risk, and insurers to the possibility of unrecoverable reinsurance.

Innovation to meet new demands for climate insurance

Figure 4 shows that perhaps 75 per cent of the economic costs of great climatic disasters are uninsured. The entire capital of the global insurance industry is around 700 billion USD. Perhaps 200 billion USD is earmarked for catastrophe, including geo-hazards like earthquake,[28] or say 150 billion for climate risks alone. This provides security for only 25 per cent of today's economic losses from extreme events, so to fully fund disaster risk one would need around 600 billion USD. Allowing for economies of scale might reduce this by one-third, but still the gap is enormous: around *250 billion USD capital for extreme climatic events* (=400 required−150 current). This is certainly

[26] Kemfert (2006).
[27] Munich Re (2006).
[28] UNEP FI (2006).

not an excessive estimate; in 2005, economic losses from great disasters exceeded 165 billion USD, and such business always needs a safety margin.

Let us now consider the demand for "ground-up" cover, that is, including attritional losses, in 2030. The total level of damage at present is difficult to assess; the weather is highly variable, and the recording of costs is unsystematic.[29] From a variety of sources, it is estimated that the annual cost of weather damage on average is probably in the range 200–330 billion USD currently.[30] By 2030, this may rise to between 850 and 1,350 billion USD (in 2006 values). This does not make any allowance for more stringent risk management. On the other hand, it probably understates the scale of the problem in developing countries, and the costs of slow-onset risks like drought and sea-level rise.

This is a *four-fold increase* on today's level in real terms. Over the same period, world economic product is projected to grow by a factor of 2.5–3 in real growth. Allowing for further economies of scale due to the larger pool of losses, in broad terms therefore the demand for insurance capital will match the growth in the world economy up to 2030. Initially, the private sector's contribution would be principally through skills, but private capital would enter as local capacity builds and commercial viability is demonstrated.

Turning to slow-onset problems, to capitalise microfinance for the world's poorest billion would also require massive funds. Taking an average family of five, and an advance of 50 USD per family for agricultural purposes, would imply aggregate credit of 10 billion USD. Setting aside the issue of providing the capital (an amount of 200 million USD at a reserve ratio of 2 per cent), what about insuring the loans against such risks as drought? If we assume a premium rate of 4.0 per cent of the sums insured, and a solvency margin requirement of 25 per cent of premiums written, that implies *a capital requirement of at least 100 million USD for insuring slow onset events in the rural sector*. Again, we can expect that to grow in real terms.

The major types of risk that have not been insured are agricultural or public sector, and also flood risks. Penetration of insurance is also weaker in poorer social segments. There are many reasons for such market failures. On the supply side, key ones are climatic variability, the lack of good data, regulatory restrictions or apathy, and high administrative costs. On the demand side, the main barriers are lack of awareness, price, and attitudes about cross-subsidies. To overcome them requires strong public/private collaboration. In some cases the private sector might not be willing to accept risk in the classical insurance mode, but it could still provide a rich array of other services and skills to support a publicly funded insurance system.

Already there are many promising examples of private sector involvement in finding novel solutions to climate risk in developing countries. These include catastrophe bonds, weather derivatives, and microinsurance. What is needed now is a determined political will to address the issues in a coordinated way, integrating economic development, adaptation, and disaster management to gain a "triple dividend". A key enabling strategy is the generation of better quality information on risks and exposure.

[29] Guha-Sapir and Below (2002).
[30] Dlugolecki (2007).

The needs of different sectors require different solutions, from traditional insurance to microinsurance to catastrophe bonds and weather derivatives, but international pooling of risks is a crucial part of the answer. One final part of the jigsaw could be a move to encourage long-term contracts with a favourable tax regime. That would benefit everyone by providing a more stable market.

Liability for climate damage

Two basic types of liability case are possible. In the first, the defendant exposes a plaintiff to whom he has a contractual or other direct relationship, to an increased level of weather losses by supplying goods or services that are defective, for example, a poor quality of flood defence. Climate change may enter into such cases, because it is now clear that historical weather conditions cannot be taken as the best guide to future experience. In this first category, the defendant is not being held liable for climate change, but for failing to account for it in his transactions. The volume of such actions will grow, until climate change is "mainstreamed" into business, professional, and administrative practice. Such claims could affect insurers through a variety of liability products, and underwriters should revise their risk assessment to incorporate climate change as a risk factor, for example, for professional indemnity cover for consulting engineers.

The second type concerns cases where a plaintiff alleges that a defendant has, by causing the release of greenhouse gases, altered the climate to the detriment of the plaintiff. There is no direct relationship between the two parties. Several cases have been lodged on this basis, mainly in the U.S.A.[31] In general, their aim is not to seek financial remedies, but to establish the principle that greenhouse gases are potentially harmful and need to be reduced. However, there has been an underlying element of seeking compensation, which started with the Association of Small Island States (AOSIS) campaign for a fund to deal with sea level rise.[32] Some believe that using financial liability as a tactic would make governments and corporations tackle the problem of global warming faster.[33]

I disagree strongly for several reasons. The scientific state of knowledge is not advanced enough to discriminate between natural variability and anthropogenic causes of extreme events. The delays and uncertainty in the legal process are such that we would lose the battle against climate change during the process. (The duration of the process to establish tobacco liability is telling, and that is a much clearer case involving willful liability). The serious damage from climate change lies decades ahead, so it is impossible to say who the victims will be and how much loss they will suffer. Nor is it possible to compensate financially for the loss of unique assets like natural species. Finally, it seems unfair to select only a few emitters for blame, when we are all "guilty" of emitting carbon dioxide, including developing countries like China and India.[34]

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[31] ABI (2004).
[32] Silver and Dlugolecki (2007).
[33] Allen (2005).
[34] Dlugolecki (2005).

For these reasons, the prospect of "global warming liability" is remote as a problem for insurers, and most likely current pollution exclusions would be effective anyway.[35] Nevertheless, defending actions against liability could be costly in terms of management time and legal expenses. Swiss Re has for some time stated that its underwriting practice on Directors and Officers cover is to review whether the company concerned has a responsible attitude towards climate change. For large companies, one of their reference sources is the Carbon Disclosure Project – a database for investors that holds details of corporate strategies and performance on climate change (see later).

Mitigation

Mitigation, or the reduction of greenhouse gas emissions, is relevant to insurers for two reasons. Firstly, it will affect them as investors, because of the enormous changes that will occur in the economy. Secondly, as underwriters they will be faced with new products and processes that require insurance.

The economics of business in the greenhouse

Mitigation policies potentially alter costs for those sectors and companies that depend on producing, using or consuming large quantities of fossil fuel, because the policies are intended to encourage more efficient usage, or a switch to alternatives.[36] Analysis shows that companies are unevenly affected, even within the same sector, due to such factors as product mix, proportion of unregulated markets, and R&D capability.[37] For oil companies, the effect of mitigation policies might range between neutral for one company, to an 11 per cent decline in profitability for another;[38] for car manufacturers the spread was wider, from a 10 per cent gain for Toyota, to a 14 per cent decline for Ford.[39]

Some businesses like Exxon have emphasised the uncertainties of climate science, and campaigned against "premature" mitigation. Others like BP and Allianz have welcomed it as a necessary precaution, noting that it may be cost-effective to reduce energy consumption anyway, and that a concern for the environment helps employees to identify with the company. For businesses, uncertainty about policy is the greatest problem.[40] On the one hand, there is a grave danger that major investments could be "stranded" after a sudden shift of policy. On the other hand, passing up major investments because of uncertainty may concede markets to competitors.

[35] Simpson, Thacher and Bartlett (2007).
[36] Mansley and Dlugolecki (2001).
[37] CERES (2005).
[38] WRI (2002).
[39] WRI (2003).
[40] UNEP FI (2005b).

Political uncertainty

The Kyoto Protocol (KP) is the first international agreement to tackle climate change, with target limits on greenhouse gas emissions for the industrialised countries (the so-called Annex 1), and a variety of other measures. Although it was formulated in 1997, it did not enter into force until 2005, and its provisions on emissions terminate in 2012. This is well inside the financial planning horizon for major projects now, and so is of little help to investors or businesses. Besides that, two of the largest Annex 1 nations declined to ratify the treaty (U.S.A. and Australia), and a third, Canada, looks unlikely to fulfil its commitments. There has even been an attempt to instigate a rival arrangement to KP, called the Asia-Pacific Economic Cooperation (APEC). An additional difficulty for the business community is that the KP introduces "flexible mechanisms" like the Clean Development Mechanism (CDM) and Emissions Trading to facilitate the flow of funds to low-carbon technologies, but these have proved cumbersome in operation.[41] The early experience of emissions trading has been disappointing. The first, "pre-Kyoto" phase of the EU system was effectively "gamed" by the industrial lobby, resulting in over-allocation of emissions permits, and a collapse in the carbon price. This has undermined investor confidence.

However, there are signs that this malaise will not last much longer. The allowances for the second phase of the EU emissions trading system that will run in parallel with the KP system look much tougher. Within KP itself, the operation of the CDM is being refined. In the U.S.A., there are increasingly vociferous calls for mitigation policies, and it looks like whichever candidate wins the 2008 Presidential election will be committed to tackling climate change in a meaningful way. Australia, one of the members of the APEC, has announced that it will introduce emissions trading in 2012. This is largely due to the strong popular disquiet about severe drought conditions there, which have been linked to climate change.

The new low carbon economy

The changes to the economy that are required to achieve a transition to a safe emissions path are enormous (see Figure 5). In the year 2000, worldwide emissions of carbon dioxide from human activity alone contained over 6 billion tones of carbon, roughly one tonne *per capita* globally. If we continue on a business-as-usual path, this will increase by more than half, to nearly 10 billion tonnes by 2030.[42] On the other hand the EU's stated policy is to aim for a reduction of emissions of 50 per cent by 2050, relative to 1990. Applying this to global emissions, and allowing for an acceleration after 2030 as the transition gathers momentum, that means that emissions still need to fall by nearly a third by 2030. In other words, by 2030 we need to create only a half of the emissions expected!

Technically this is perfectly feasible, although it means that energy prices will have to rise to pay for "clean energy".[43] From the asset management viewpoint, the stakes

[41] UNEP FI (2005a).
[42] IEA (2005).
[43] IPCC (2007).

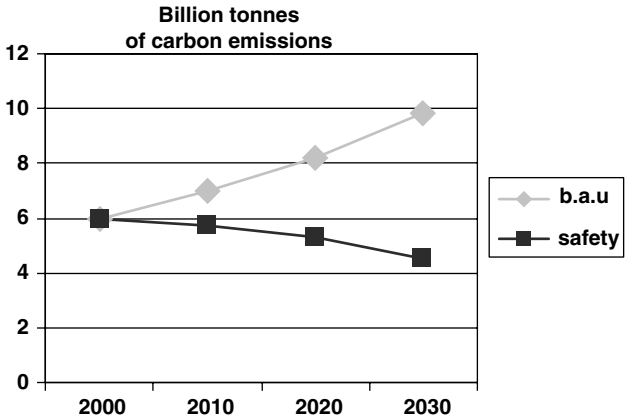

Figure 5. The Fork in the Emissions Path. Business-as-usual (b.a.u.) vs. a precautionary (safety-first) path.

are huge. It is estimated that the value of new and replacement energy infrastructure will be 20 trillion USD over the next 30 years.[44] In addition, measures like emissions standards for cars and buildings could generate annual revenues of 230 billion USD in clean-technology markets by 2016.[45]

To achieve a cut of 50 per cent in emissions from business as usual by 2030 there will need to be a number of strategies. The top two are retaining existing forests and a step change in energy efficiency, in conversion and end-use processes.[46] There may be some scope for investors like pension funds to "sponsor" forests, if a way can be found to monetise ecosystem services, and we already identified that more efficient products and processes are potentially an attractive market.

However, the introduction of renewable energy (RE) on a large scale is also a key feature in cutting emissions, and here insurers could play an important role. There are many energy policy difficulties in blending renewables into a conventional energy system, but there are also significant difficulties in getting insurance cover for RE projects.[47] Four obstacles have been identified where insurance might assist.[48]

(a) Lack of a "renewable" resource in the operational phase, for example, calm conditions for wind turbines, or drought for hydropower. Weather derivatives could be a solution.
(b) Late construction, resulting in loss of revenue for the project. Advanced loss of profits cover would be advantageous to developers.
(c) Biomass, that is, energy supplied from crops, in general has problems due to the difficulty of maintaining the quality and volume of supplies. This is an agricultural

[44] IEA (2005).
[45] Clean Edge (2007).
[46] Stern (2006).
[47] UNEP FI (2004).
[48] SEFI (2004).

risk, which is often difficult to insure, but again, perhaps weather derivatives could provide a partial solution.

(d) Performance risk where the equipment underperforms or fails, due to unforeseen weaknesses in novel technology, or extreme weather conditions. Absence of cover means manufacturers must carry warranty reserves on their balance sheets, to reassure clients that they have the resources to deal with such problems. At first sight this is an unattractive proposition for underwriters, since the manufacturer may be presumed to know more about the risk than the insurer. However, this is the sort of risk that specialist engineering insurers tackle.

The question of how to deal with risks from innovatory processes and technology can be addressed systematically.[49] First, insurers need to get involved earlier in technology development, because at the upstream stages of innovation changes can be made relatively easily to reduce risks, whereas later on, features may be "locked in". Second, new technical knowledge and risk management approaches such as "fault-tree analysis" are required to assess the risks of technology before it becomes operational, since there is no data for the conventional actuarial techniques based on historical performance or experience. Third, a determined effort must be made to acquire new skills through recruitment of technical experts, and networking with centres of expertise.

Corporate social responsibility

Finally, there is the question of what role insurers should play in formulating policy about climate change. Many leading scientists are now very concerned that climate change may become uncontrollable, as it could lead to irreversible changes in the Earth's climate system. There are many possible ways in which a breakdown could occur (see Figure 6). Four are singled out here for examination.

- *Ice sheet collapse*: The eventual sea level rise would be 7 m and 4.6 m for the deglaciation of Greenland and West Antarctica, respectively. Our ability to adapt would depend crucially on the rate of deglaciation, which is estimated as ranging from rapid (a few centuries) to slow (a few millennia). Recent observations indicate acceleration in the rate of sea level rise,[50] the danger is that by mid-21st century it may be impossible to save the ice-caps.
- *NATHC* (North Atlantic ThermoHaline Current, i.e. the Gulf Stream): A slowdown of NATHC is likely to occur during the 21st century, but subsequent behaviour is unclear. If the flow stopped, the impacts would be global. IPCC views this possibility as remote. However, the very latest observations challenge this comforting position: the NATHC appears to have weakened by 30 per cent in recent decades.[51] As we cannot explain it, this surprising result indicates the need for caution.

[49] Dahlstrom *et al.* (2003).
[50] Rahmstorf *et al.* (2007).
[51] Bryden *et al.* (2005).

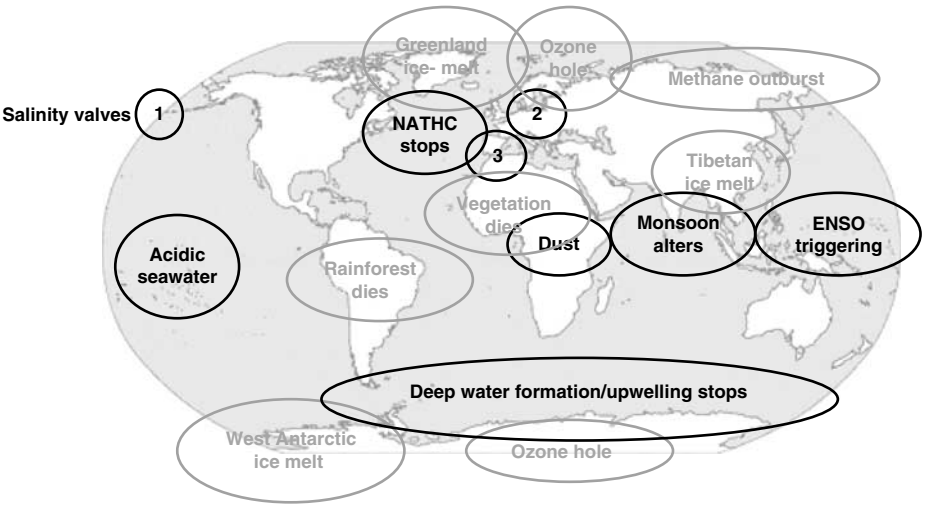

Figure 6. Vulnerable points in the climate system. Adapted from Schellnhuber's diagram presented in Kemp, 2005.
Key: NATHC North Atlantic Thermo Haline Current=Gulf Stream. ENSO El Nino Southern Oscillation= fluctuations in regional temperature of Pacific Ocean. For a fuller explanation see original article.

- *Destruction of Amazonia*: The Brazilian rainforest is "the lungs of the planet". It is a critical part of the carbon recycling system. Yet, Hadley Centre predicts that it could die back under water stress by 2060, due to lack or rainfall and heatwaves.[52]
- *Ocean acidity*: The acidity of the oceans is increasing as it warms and is able to absorb more atmospheric carbon dioxide. This is damaging for shellfish and other marine organisms, because their shells are sensitive to the acid content of the ambient water. Since these organisms are a major sink for carbon dioxide, this could accelerate climate change, and lead to a collapse of the marine food-chain.[53]

Despite the gravity of the threats, the will to act is weak. There are powerful lobbies ranged against mitigation.[54] The chain of accountability in asset management is confused and priorities are short-term.[55] Politicians fear to act, because making energy dearer, or constraining consumerism are potentially vote-losing. Insurers themselves have been reluctant to become involved.

In the face of scientific uncertainty and political antagonism, American insurers have been very reluctant to commit themselves[56] (see Box 1), though recently both

[52] Hadley Centre (2004).
[53] Orr *et al.* (2005).
[54] Leggett (1999).
[55] Dlugolecki and Mansley (2005).
[56] FotE (2005).

Box 1 Insurance Company SEC Filings and Climate Change

Friends of the Earth reviewed the 2004 Securities and Exchange Commission (SEC) filings of 106 publicly traded property/casualty insurers in the U.S.A. Only three companies specifically mentioned climate change as a risk factor: Allianz, Aspen, and Millea (Tokyo Marine). Another two (Chubb and Cincinnatti FC) said they continue to "explore and analyze credible scientific data" (the wording was identical).
Aspen stated that "climate change may increase the frequency of severe weather events". Coupled with increases in values and concentrations this could mean that "a single catastrophic event could affect multiple geographic zones, or the frequency or severity of catastrophic events could exceed our estimates" with an adverse affect on financial performance.

AIG and Allianz, through its U.S.A. subsidiaries,[57] have declared that global warming is a problem that needs urgent attention. Swiss Re and CERES have also attempted to mobilise U.S. insurers with reports on the likely hazards. The U.S. National Association of Insurance Commissioners has placed the issue on its agenda, but is reluctant to approve rate rises based on expectation rather than experience.

There are some collective initiatives concerned with climate change that include insurers as supporters or members. Two significant ones are the Carbon Disclosure Project and UNEP FI.

- *CDP* is an international NGO, based in London. Its purpose is to improve disclosure of corporate exposure to climate change, through an annual questionnaire to listed companies, on behalf of institutional investors. It is now finishing its fifth cycle, and on 1 February 2007, it stood at 284 institutional investors with assets of $41 trillion under management. CDP started by writing to the biggest 500 companies in the world, ranked by listed capital (FT500), and has now expanded to seek data from 2,400 quoted companies, organised with local partners in a number of surveys focussed on geographical markets or sectors, like power utilities. The standard of disclosure has improved, but it remains inadequate, and the initiative lacks "follow-through" from the institutional backers to target companies that are lagging on reporting or performance. Insurers are certainly not a driving force here.

- *UNEP FI* is a global partnership between the *United Nations Environment Programme (UNEP)* and the private financial sector, currently represented by over *160 financial institutions* who are signatories to the *UNEP FI Statements of Principle*. Its goal is to develop and promote linkages between the environment, sustainability and financial performance through *regional activities* like training, and a comprehensive programme of working groups that research and communicate information on key sustainability issues. The focal point for global warming is the Climate Change Working Group (CCWG), which has produced a stream of excellent papers on climate change since 2002. These have addressed a wide range

[57] Allianz and WWF (2006).

of issues from the financial perspective, and are frequently used as reference documents. However, if one considers active membership, and engagement with policymakers, then the situation is not so impressive. The CCWG has 15 members, of which six are global insurers. And when UNEP FI issued its *Declaration on Climate Change by the Financial Services Sector* at the time of the 2007 G8 Meeting, only 23 members signed, of which only four were insurers. (This number of signatories is similar to other business declarations, but the gap between active and passive membership is wide, and does not accord with the fact that insurers are meant to be experts on risk management.) In its most recent report on mitigation,[58] CCWG stated that the most immediate business issue is to ensure continuity in the regime beyond 2012, with clear, reliable targets for emission levels up to 2025 at least, supported by consistent policies. However, the paper did not propose any level, nor how it should be shared between countries. In its companion briefing on adaptation,[59] CCWG suggested that the annual cost of extreme weather events might exceed one trillion USD (in 2006 values) at least once before 2040. The paper proposed more systematic planning for such events, by mainstreaming climate change into all significant policies and operations in various ways. Again, no proposal was made concerning a prudent atmospheric concentration of emissions.

This "vacuum" is dangerous, because it fosters delay. Insurers have a unique capacity to speak out in this area. On the one hand, they are experts in assessing physical risks and managing their consequences. On the other hand, they are long-term custodians of trillions of dollars on behalf of clients and beneficiaries – assets at risk to global warming. The tactics of negotiating near-term targets can be left to the political process. What we need are a long-term, "safe" goal and an allocation method that is easily understood and will guide near-term policies and actions.

From a risk management perspective, the costs of being too lax about emissions could be very high, due to a breakdown in the climate system. It therefore makes sense to aim for tough limits, which can be relaxed later if appropriate. There is ample guidance from scientific sources on this.[60] Many scientists believe that an atmospheric level of 450 ppmv (parts per million by volume) of carbon dioxide should be the initial target for prudence; already we are at 380. For long-term allocation, the "Contraction and Convergence" model (C&C) seems appropriate (see Figure 7). This consists in choosing (1) a "safe" global annual emissions level and (2) a date at which it will be shared out globally on a *per capita* basis. The other element is (3) a start date from which time the actual, unequal *per capita* emissions start to move towards their final, equal *per capita* levels. The name C&C reflects the facts that the annual emissions *contract* to a safe level, and the per capita shares *converge* to become equal.

[58] UNEP FI (2005b).
[59] UNEP FI (2006).
[60] IPCC (2007).

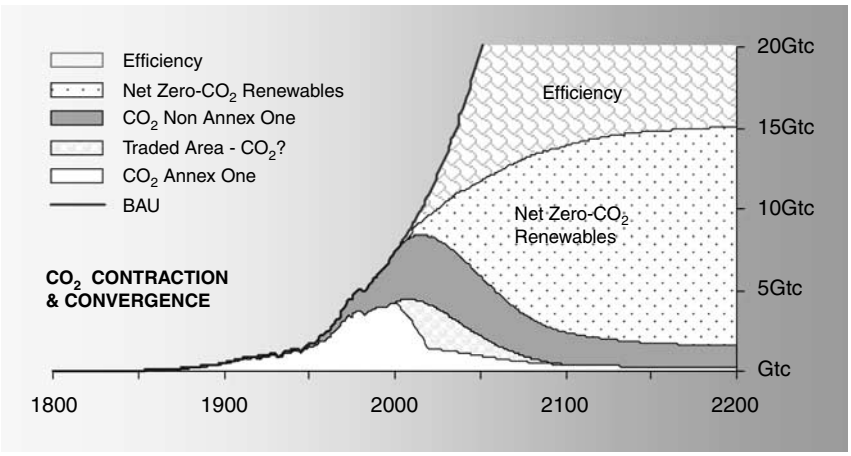

Figure 7. Contraction and Convergence (C&C). *Source: Global Commons Institute*
Key: Vertical axis is billions of tonnes of carbon emitted annually. Horizontal axis is the year. *Operation* The solid line (BAU) shows the path that emissions will follow on historical patterns. The "CO_2" segments of the chart show how actual emissions could develop under C&C. The gap between BAU and actual emissions would be solved by energy efficiency and RE. In the short run, since the C&C emissions allocation is based on equal per capita allowances, that gives the developing world something to trade, as they have lower per capita emissions generally.

Conclusion

This paper has shown that climate change is a crucial issue for the insurance sector, because of the direct impacts from the altered climate system, and the indirect ones from policies to reduce emissions or prevent damage. Already the impacts in Europe are growing serious. At the global level, the economic cost of weather damage could reach over 1 trillion USD in a single year by 2040. The impacts will be worse in developing countries.

A key aspect of climate change is the rapidity with which return periods are shrinking. Data on U.K. temperatures allow us to see that this is a real phenomenon already. This has serious implications for underwriters: catastrophe models are wrongly calibrated; premiums are too low; exposures are too high; claim-handling capacity is inadequate; and credit ratings are too generous.

On the other hand, this analysis shows that there is a huge unfulfilled need for insurance. At present, to service that gap would require additional capital of around 250 billion USD for extreme events, and perhaps 100 billion for slow onset ones, like drought. These "markets" will grow by a factor of four in real terms by 2030. There is a clear opportunity for the private sector to work with the public sector in this area as part of a "triple dividend" approach that coordinates adaptation, disaster management and sustainable economic development.

For asset management the indirect impacts are more important. To avoid run-away climate change, greenhouse gas emissions have to drop by 50 per cent by 2050, which means transforming the energy economy. Finance for renewables will reach 100 billion

USD a year soon. However, political uncertainty is a serious blockage to market forces, and the re-evaluation of assets and project returns is happening too slowly.

Insurers have a duty as ubiquitous players in the economy and society to help to shape climate policies in a responsible and effective way. With their expertise in risk management, and their responsibilities as custodians of future wealth they are uniquely placed, but in general they have been dilatory in this task. It is time for them to speak out strongly for specific measures: a target for atmospheric CO_2 of 450 parts per million, and adoption of the Contraction and Convergence model as a method of allocating emissions.

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