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- Health systems
- Global economy
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Editor's Comment

The elephant in the room

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In South Africa, one of the major concerns of many people is a disintegrating public health system and an increasingly expensive private health system. Other national concerns are the failing education system, the level of corruption in government and general lack of delivery. But, while all of those are important, most of us are still too complacent about something that will alter our lives irrevocably – climate change.

If you read anything on geology and the history of our Earth, you will see that we are probably coming to the end of one of the most climatically stable eras in our planet's history. Climate change is inevitable and with it, massive changes in our way of life.

To my mind, having read extensively on the subject (wearing the hat of the scientist I was before I did medicine) I am convinced that there are major anthropogenic causes for the current global warming – which is shown conclusively by measurements going back hundreds of years. Along with this are ice cores showing the growing load of carbon dioxide in the atmosphere, far in excess of what is required for the greenhouse effect that keeps the Earth habitable. These massively rising levels of carbon dioxide and other greenhouse gases have come about since the 1950s when there was a massive surge in the use of fossil fuels in our industries, as well as the start of the rising consumerism that is part of the problem.

Most of these greenhouse gas emissions have come from the West – massive industries, a high standard of living which consumes relentlessly and produces a large carbon footprint. But, in Africa, South Africa plays the role of the West – our carbon footprint is large and, apart from our industries, is produced by a relatively small part of the population who are able to live the Western lifestyle. In the latest round of talks on climate change – unsatisfying as they were – countries such as South Africa, China, India and Brazil were no longer able to hide behind the label of 'developing world' and claim that they needed to continue to pollute in order to develop.

Climate change will affect every aspect of our lives. In the Western Cape we are already seeing a change in the seasons, with lower winter rainfall, later onset of summer and higher temperatures later into the year. This will affect agriculture – it already is – and those who are at subsistence level suffer the most. As with nearly all adverse man-made phenomena it is the poor who bear the brunt.

The overall effects on individual health – and population health – still remain fairly speculative, but it is almost certain that there will be an effect on health and well-being. The first effects are seen in people whose livelihoods have been taken away already – subsistence farmers in remote parts of the northern Cape and fishermen on the west coast. Doctors are educated people – and it is up to educated people to stand up and discuss the elephant in the room. We have already gone too far to prevent the 2°C rise in temperature that Kyoto was trying to prevent – we must come up with innovative ways to reduce the harms that this temperature rise will cause.

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Guest Editorial

Climate change, the threat of collapse and the opportunity for transformation

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Around the world there are many examples of previous human societies that have collapsed and disappeared. Societies that once flourished and seemed invincible, but which are now no more, include Great Zimbabwe in Africa, Easter Island in the Pacific Ocean, Mycenaean Greece and Minoan Crete in Europe and the Maya cities of Central America.[1] Professor Swilling, in the opening article of this issue of *CME*, presents us with a picture of global society that is breaching the absolute limits of environmental sustainability in several interconnected ways, of which climate change is only one. We face a global 'poly-crisis' that is already impacting on public health and which challenges us to revise our global economic system, approach to sustainable development and collective lifestyle. It is a planetary crisis that requires a transformative response on a global level, but which will impact individuals in communities on every continent.

Although awareness of climate change has increased, the likely impact on health has not been a central part of forecasting by the Intergovernmental Panel on Climate Change. In the second article Professor Myers discusses the likely impact on the burden of disease in South Africa. As I write this editorial South Africa has just finished hosting the 17th Conference of the Parties (COP17) in Durban. The contrast between the scientific 'red flags' and the slow political response at COP17 suggests our strategies may be 'too little, too late'.

When the problem faced by society 'takes the form of a slow trend concealed by wide-up-and-down fluctuations' it is much harder for people to see the trend and take it as a serious threat.[1] Much of the climate change skepticism, in the face of hard scientific data, feeds off these year-by-year fluctuations. The phenomenon of 'creeping normalcy' is also part of this as people's sense of normality shifts subtlety with time and longer-term changes are not perceived. The deforestation of Easter Island is thought to have been an example of this and the person who cut down the last tree may have had no sense of the immense environmental change.

However, even when societies perceive a problem to be real they often fail to act in time. Different groups or even countries may rather see the problem as a rational opportunity to advance their interests, even when this may cause harm to others or in the longer term to themselves.[1] A small and powerful group can successfully pursue rational self-interest when the harm is small in the short term, incremental and spread widely across society. Another known phenomenon is the 'tragedy of the commons' in which a group of consumers share a common resource. If the resource is not regulated fairly then people logically compete for their own share, so as not to lose out to someone else – the end result is depletion or disaster for the whole community.[1] The depletion of global fisheries is a good example of this. COP17 could also be understood as an attempt to get nations to agree to a fair share of the global atmospheric 'commons' and the amount of greenhouse gases that each country can fairly contribute. Dr Reynolds describes the concept of the carbon cycle in his 'More about…' article.

Ironically the health industry is a significant contributor to climate change at the same time as offering services to those impacted. Dr Louis Reynolds explores how the health industry can modify itself on an organisational level to be more congruent with its core business and mitigate climate change.

Climate change and its consequences are now inevitable and the focus is on limiting the extent of global warming to less than 2˚C. Drs Willems and Cameron explore how communities can adapt to climate change with the support of a primary healthcare approach.

An ecological model of health sees the impact of upstream and downstream factors on health. Upstream are the structural and societal factors discussed above and in the related articles. Downstream, however, are individual behavioural factors. Many of the behavioural changes that mitigate climate change at the level of the individual and family are also beneficial in terms of health. In the final article I discuss such lifestyle changes for health professionals and their patients.

I hope that this edition of *CME* may practically impact on your lifestyle, health promotion activities and organisation of your practice. I also hope, as outlined in the 'More about' article by Professor Coetzee, that it will encourage you and the health profession to show leadership on this issue and advocate for the necessary transformation of structures and society.

1. Diamond J. Collapse: How Societies Choose to Fail or Succeed. New York: Penguin Books, 2005.

So what is so unsustainable about the global economy?

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

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In 1987 the World Commission on Environment and Development published *Our Common Future*.[1] This report attempted to reconcile the ecological 'limits to growth', articulated by the northern green movement since the early 1970s, with the need for growth to eliminate poverty, as articulated by developing countries in the south, many of whom had recently broken free from colonial control. The most frequently quoted definition of sustainable development originated in this report: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' Although this is a definition that is highly contested,[2-4] this extremely influential report provided the strategic foundation for the 1992 Earth Summit in Rio, the World Summit on Sustainable Development, which took place in Johannesburg in 2002, and numerous international sectoral policy conferences between 1972 and 2002.[5] These global events put in place the fragile multilateral, global governance system, which is all we have today to face our collective global 'polycrisis'. Since the release of *Our Common Future* we have learnt much about the challenges we face: numerous crises that were predicted – but little done to avoid – are starting to be noticed by mainstream centres across many nations in the developed and developing world.[6-9] This has given rise to a new literature on sustainability/sustainable development, and the emergence of a field formally designated as 'sustainability science'.[3,4,10-15] The first synthesis of a southern African perspective on sustainability science has also recently been published.[16]

The second Copernican revolution

Seven globally significant, mainstream documents will, in one way or another, shape the way our generation sees the world which we need to change. These are as follows:

- **Ecosystem degradation.** The United Nations (UN) *Millennium Ecosystem Assessment*, compiled by 1 360 scientists from 95 countries and released in 2005 (with virtually no impact beyond the environmental sciences), has confirmed for the first time that 60% of the ecosystems upon which human systems depend for survival are degraded.[7]

These global events put in place the fragile, multilateral, global governance system, which is all we have today to face our collective global 'polycrisis'.

- **Global warming.** The broadly accepted reports of the Intergovernmental Panel on Climate Change confirm that global warming is taking place due to release into the atmosphere of greenhouse gases caused by, among other things, the burning of fossil fuels, and that if average temperatures increase by 2˚C or more this is going to lead to major ecological and socio-economic changes, most of them for the worse, and the world's poor will experience the most destructive consequences.[17]
- **Oil peak.** The *2008 World Energy Outlook*, published by the International Energy Agency, declared the 'end of cheap oil'.[18] Although there is still some dispute over whether we have hit peak oil production or not, the fact remains that mainstream perspectives now broadly agree with the once vilified 'peak oil' perspective (see www.peakoil.net). Even the major oil companies now agree that oil prices are going to rise and alternatives to oil must be found sooner rather than later. Oil accounts for over 60% of the global economy's energy needs. Our cities and global economy depend on cheap oil and changing this means a fundamental rethink of the assumptions underpinning nearly a century of urban planning dogma.
- **Inequality.** According to the UN *Human Development Report* for 1998, 20% of the global population who live in the richest countries account for 86% of total private consumption expenditure, whereas the poorest 20% account for 1.3%.[19] Only the most callous still ignore the significance of inequality as a driver of many threats to social cohesion and a decent quality of life for all.
- **Urban majority.** According to generally accepted UN reports, the majority (i.e. just over 50%) of the world's population was living in urban areas by 2007.[6] According to the UN habitat report entitled *The Challenge of Slums*, one billion of the six billion people who live on the planet live in slums or, put differently, one-third of the world's total urban population (rising to over 75% in the least developed countries) live in slums or what we refer to in South Africa as informal settlements.[20]
- **Food insecurity.** The International Assessment of Agricultural Science and

Technology for Development[21] is the most thorough global assessment of the state of agricultural science and practice that has ever been conducted. According to this report, modern industrial, chemical-intensive agriculture has caused significant ecological degradation which, in turn, will threaten food security in a world in which access to food is already highly unequal and demand is fast outstripping supply. Significantly, this report confirmed that '23% of all used land is degraded to some degree'.[21]

- **Material flows.** According to a 2011 report by the International Resource Panel (http://www.unep.org/resourcepanel), by 2005 the global economy depended on 60 billion tonnes of primary resources (biomass, fossil fuels, metals and industrial and construction minerals) and 500 exajoules of energy, an increase of 36% since 1980.[22]

The above trends combine to conjure up a picture of a highly unequal urbanised world, dependent on rapidly degrading ecosystem services, with looming threats triggered by climate change, high oil prices, food insecurities and resource depletion. This is what the mainstream literature on unsustainable development is worried about. This marks what is now increasingly referred to as the *Anthropocene* – the era in which humans have become the primary force of historico-geophysical evolution.[23]

Significantly, although these seven documents are in the policy domain they reflect the outcomes of many years of much deeper research on global change by scientists and researchers working across disciplines and diverse contexts on all continents. Although this process of scientific inquiry leading to policy change is most dramatic with respect to climate science,[24] it is also true for the life sciences that fed into the outcomes expressed in the *Millennium Ecosystem Assessment,* the resource economics that has slowly established the significance of rising oil prices and, most recently, of all the rise of material flow analysis (more on these later). The rise of our ability to 'see the planet' has given rise to what Clark *et al.* have appropriately called the 'second Copernican revolution'.[25] The first, of course, goes back to the publication of *De Revolutionibus Orbium Coelestium* by Copernicus in 1530, but only 'proven' a century later by Galileo, who established by observation that Copernicus was correct when he claimed that the sun rather than Earth was the centre of the universe. This brilliant act of defining the planetary system through observation was a – perhaps *the* – defining moment that paved the way for the Enlightenment and the industrial epoch that followed.

Global warming is taking place due to release into the atmosphere of greenhouse gases caused by, among other things, the burning of fossil fuels.

Clark *et al.* date the second Copernican revolution to the meeting in 2001 when delegates from over 100 countries signed the Amsterdam Declaration which established the 'Earth-System Science Partnership'.[25] The logical outcome of this profound paradigm shift is an increasingly sophisticated appreciation of what Rockstrom *et al.* have called our 'planetary boundaries' which define the 'safe operating space for humanity'.[26] The significance of the Rockstrom article is that it managed to integrate, for the first time, the quantifications of these 'planetary boundaries' that had already been established by various mono-disciplines. These included some key markers, such as not exceeding 350 parts per million of CO_2 in the atmosphere; extracting 35 million tonnes of nitrogen from the atmosphere per year; an extinction rate of 10; global freshwater use of 4 000 km^3 per year, and a fixed percentage of global land cover converted to cropland.[26] Without the 'second Copernican revolution' a new science appropriate for a more sustainable world and the associated ethics would be unviable.

Global warming

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in 2007 confirmed the general trends of the previous assessment reports, namely that global temperatures are rising, and that these temperature increases are due to an increase in concentrations of greenhouse gases in the atmosphere caused by human activities.[17] The International Energy Agency forecasts that if policies remain unchanged, world energy demand is set to increase by 45% by 2030.[18] At the same time, since 1988 the IPCC has warned that nations need to stabilise their concentrations of CO_2 equivalent emissions, requiring significant reductions in the order of 60% or more by 2050. In the latest report the IPCC argues that dangerous climate change global emissions need to start declining by 2012 - 2013, and that by 2020 global cuts of 25 - 40% are needed. By 2050 cuts of at least 80% are necessary. The main human activities that have resulted in a 70% increase in greenhouse gas emissions since 1970 are the burning of fossil fuels, deforestation and agricultural production. The projections for the future suggest that even if we act now to build low-carbon

economies, temperatures will still rise by 2˚C. If we make moderate changes along the lines envisaged by the Kyoto Protocol, we could face runaway global warming with devastating consequences. Either way, it may be worth quoting a conservative source on the impact on the poor, namely Sir Nicholas Stern, who wrote in his report to the UK government:[27]

'All countries will be affected. The most vulnerable – the poorest countries and populations – will suffer earliest and most, even though they have contributed least to the causes of climate change.'

The latest IPCC report suggests that the African continent, which has contributed least to global warming, will be drastically affected by climate change. The main findings are that between 75 and 250 million people will suffer the consequences of increased water stress by 2020; by the same date productive outputs from rain-fed agriculture could drop by 50%, with obvious negative consequences for food security; by the end of the twentieth century sea level rise will have negatively affected most of the low-lying coastal cities around the coast of Africa; and by 2080 arid and semi-arid land areas will have increased by between 5% and 8%. There is little evidence that researchers and decision-makers in Africa have registered the full implications of the multiple impacts of global warming for the way in which development policies are designed in Africa.

Sustainability, inequality and the limits of ecological modernisation

After all is said and done, the challenge of sustainable development in the current global conjuncture is about eradicating poverty, and doing this in a way that rebuilds the ecosystems and natural resources on which we depend for our collective survival.

It has been argued elsewhere that poverty eradication through a more equitable distribution of the world's resources can only be achieved if ways are found to restructure the global economy.[28] To do this, we will need to consider ways of achieving what Gallopin has called 'non-material economic growth'.[29] Whereas economic growth is traditionally associated with an increase in the size of material stocks (buildings, infrastructures) and the per capita consumption of material goods, this can be changed by introducing indicators of progress (such as, for example, a Happiness Index) that values well-being over personal wealth accumulation including, for example, improvements in public health, restored natural environment, greater choice of cultural activities, less inequality and more personal security. Non-material growth is about improvements in well-being without a growth in material infrastructures and goods. Gallopin makes useful distinctions between *development* (improvements in well-being plus material economic growth), *maldevelopment* (material economic growth with no improvements in well-being), *underdevelopment* (no material economic growth and no improvements in well-being), and *sustainable development* (improvements in well-being plus non-material economic growth). The challenge for many developing countries may well be conventional development for now to create the material basis for a transition later on to sustainable development. Developed countries can make that transition now. Gallopin argues as follows: [29]

'In the very long term, there are two basic types of truly sustainable development situations: increasing quality of life with non-material growth (but no net material growth) and zero-growth economies (no economic growth at all). Sustainable development need not imply the cessation of economic growth: a zero-growth material economy with a positively growing non-material economy is the logical implication of sustainable development. While demographic growth and material economic growth must eventually stabilize, cultural, psychological, and spiritual growth is not constrained by physical limits.'

For many in the developed world, the sustainability crisis is synonymous with global warming. However, an exclusive focus on global warming runs the danger of reinforcing the notion that global warming is just a hitch along the path of progress that will be resolved by some kind of grand techno-fix (legitimised by a narrow conception of 'mitigation'). Global warming is, in reality, not just an unfortunate side-effect of the global industrial system, it is an intrinsic part of how this system is constituted, fuelled and financed. As argued by Sachs *et al.* in their influential paper published in the lead-up to the World Summit on Sustainable Development in Johannesburg in 2002, unless we are prepared to deal with the root causes in the way our economic system is configured, solutions to global warming and ecosystem breakdown will elude us.[30] This means recognising that the most powerful corporations in the world profit from value chains that contribute directly to the worst aspects of global warming: mass private transit, oil production, cement-based building construction, energy production and distribution, large-scale commercial agriculture and deforestation. Very few of the mainstream global reports blame the core structure of this capitalist economic system and the over-riding logic of capital accumulation for the mess we are in and the implications for billions of people who will suffer the consequences.

The 2008 - 2011 financial crisis might raise some awareness about the linkages, but it is too early to tell. It is time, however, for the world's corporate elites to account for the products they produce, and the impacts of the sources of raw materials and processes of transforming these materials into final products.

Conclusion

In light of the massive expansion of our scientific knowledge about our natural resources and ecosystems, it may be necessary in future to accept what the Brundtland Report rejected, namely that there are indeed 'absolute limits' that should not be breached. This would mean endorsing, for example, the IPCC recommendation that average CO_2 emissions per capita should be 2.2 tonnes rather than the current 4.5 tonnes; or the suggestion by the International Panel for Sustainable Resource Management that the average consumption of extracted materials should be 6 tonnes per capita rather than the current 8 tonnes. Furthermore, it is not just about the biophysical limits to *absorption* of the effects of human activities that matter, but also limits to the quantities of remaining strategic non-renewable resources (such as oil and metals) and limits to how far ecosystems such as fisheries, water cycles, soils and atmospheres can be exploited and modified.

References available at www.cmej.org.za

IN A NUTSHELL

- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- Our global community is faced with seven major challenges to sustainable development:
  - degradation of eco-systems that support human life
  - climate change
  - peak oil
  - inequality
  - urbanisation and informal settlements
  - food insecurity
  - material flows.
- All of these, and not just climate change, will have an impact on our health.
- A fundamental change in our understanding of development and the global economic system is required.

So what is so unsustainable about the global economy?

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economies, temperatures will still rise by 2˚C. If we make moderate changes along the lines envisaged by the Kyoto Protocol, we could face runaway global warming with devastating consequences. Either way, it may be worth quoting a conservative source on the impact on the poor, namely Sir Nicholas Stern, who wrote in his report to the UK government:[27]

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Sustainability, inequality and the limits of ecological modernisation

After all is said and done, the challenge of sustainable development in the current global conjuncture is about eradicating poverty, and doing this in a way that rebuilds the ecosystems and natural resources on which we depend for our collective survival.

It has been argued elsewhere that poverty eradication through a more equitable distribution of the world's resources can only be achieved if ways are found to restructure the global economy.[28] To do this, we will need to consider ways of achieving what Gallopin has called 'non-material economic growth'.[29] Whereas economic growth is traditionally associated with an increase in the size of material stocks (buildings, infrastructures) and the per capita consumption of material goods, this can be changed by introducing indicators of progress (such as, for example, a Happiness Index) that values well-being over personal wealth accumulation including, for example, improvements in public health, restored natural environment, greater choice of cultural activities, less inequality and more personal security. Non-material growth is about improvements in well-being without a growth in material infrastructures and goods. Gallopin makes useful distinctions between *development* (improvements in well-being plus material economic growth), *maldevelopment* (material economic growth with no improvements in well-being), *underdevelopment* (no material economic growth and no improvements in well-being), and *sustainable development* (improvements in well-being plus non-material economic growth). The challenge for many developing countries may well be conventional development for now to create the material basis for a transition later on to sustainable development. Developed countries can make that transition now. Gallopin argues as follows: [29]

'In the very long term, there are two basic types of truly sustainable development situations: increasing quality of life with non-material growth (but no net material growth) and zero-growth economies (no economic growth at all). Sustainable development need not imply the cessation of economic growth: a zero-growth material economy with a positively growing non-material economy is the logical implication of sustainable development. While demographic growth and material economic growth must eventually stabilize, cultural, psychological, and spiritual growth is not constrained by physical limits.'

For many in the developed world, the sustainability crisis is synonymous with global warming. However, an exclusive focus on global warming runs the danger of reinforcing the notion that global warming is just a hitch along the path of progress that will be resolved by some kind of grand techno-fix (legitimised by a narrow conception of 'mitigation'). Global warming is, in reality, not just an unfortunate side-effect of the global industrial system, it is an intrinsic part of how this system is constituted, fuelled and financed. As argued by Sachs *et al.* in their influential paper published in the lead-up to the World Summit on Sustainable Development in Johannesburg in 2002, unless we are prepared to deal with the root causes in the way our economic system is configured, solutions to global warming and ecosystem breakdown will elude us.[30] This means recognising that the most powerful corporations in the world profit from value chains that contribute directly to the worst aspects of global warming: mass private transit, oil production, cement-based building construction, energy production and distribution, large-scale commercial agriculture and deforestation. Very few of the mainstream global reports blame the core structure of this capitalist economic system and the over-riding logic of capital accumulation for the mess we are in and the implications for billions of people who will suffer the consequences.

The 2008 - 2011 financial crisis might raise some awareness about the linkages, but it is too early to tell. It is time, however, for the world's corporate elites to account for the products they produce, and the impacts of the sources of raw materials and processes of transforming these materials into final products.

Conclusion

In light of the massive expansion of our scientific knowledge about our natural resources and ecosystems, it may be necessary in future to accept what the Brundtland Report rejected, namely that there are indeed 'absolute limits' that should not be breached. This would mean endorsing, for example, the IPCC recommendation that average CO_2 emissions per capita should be 2.2 tonnes rather than the current 4.5 tonnes; or the suggestion by the International Panel for Sustainable Resource Management that the average consumption of extracted materials should be 6 tonnes per capita rather than the current 8 tonnes. Furthermore, it is not just about the biophysical limits to *absorption* of the effects of human activities that matter, but also limits to the quantities of remaining strategic non-renewable resources (such as oil and metals) and limits to how far ecosystems such as fisheries, water cycles, soils and atmospheres can be exploited and modified.

References available at www.cmej.org.za

IN A NUTSHELL

- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- Our global community is faced with seven major challenges to sustainable development:
  - degradation of eco-systems that support human life
  - climate change
  - peak oil
  - inequality
  - urbanisation and informal settlements
  - food insecurity
  - material flows.
- All of these, and not just climate change, will have an impact on our health.
- A fundamental change in our understanding of development and the global economic system is required.

The South African burden of disease and climate change

'…it is unlikely that there will be any/many entirely new adverse health outcomes, but rather a worsening of existing health problems, through a change in patterns.'

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Background, burden of disease and the hierarchy of health determinants

Professor Tony McMichael, one of the pioneers of research and policy relating to the human health effects of anthropogenic climate change (CC) has provides the following 3 seminal statements:

'…it is unlikely that there will be any/many entirely new adverse health outcomes, but rather a worsening of existing health problems, through a change in patterns.'[1]

'There is need for good, critical, thinking and research within each particular population setting, as to what are likely to be the "early and most reasonably attributable health impacts of climate change."'[2]

'…human health can – indeed should – be viewed as the real "bottom line" of climate change consequences.'[1]

Given that the main CC effects of interest to us are health impacts it is useful to consider the burden of disease (BoD), or the pattern of current health and disease with which we are familiar, as a template for thinking about and anticipating the earliest effects, with a view to prevention, cure and care.[3]

The BoD approach allows us to combine premature mortality with morbidity estimates for different diseases into a single indicator, and has been used to estimate the contribution of CC to global health.[4] It may also be used in conjunction with a hierarchy of determinants of that burden (see Fig. 1) to understand and think about the existing pattern of disease with which we are now faced and how this might change in the future as a consequence of developing CC.

If we use the breakdown of the Western Cape BoD as an example, the following priority disease contributors to the burden are shown in Table 1.[5]

Table 1. Burden of disease components in decreasing order of contribution to premature mortality as years of life lost (YLL)

Outcome (disease group)	%YLL
Major infectious diseases	22.0
Injury	19.8
Mental disorders	-
Cardiovascular disease	10.5
Childhood diseases	>6.0

Consideration of the priority components contributing to the BoD allows us to orient our clinical or public health practice in ways that promote more effective and efficient outcomes, and allow some rational basis for prioritising problems and expenditure

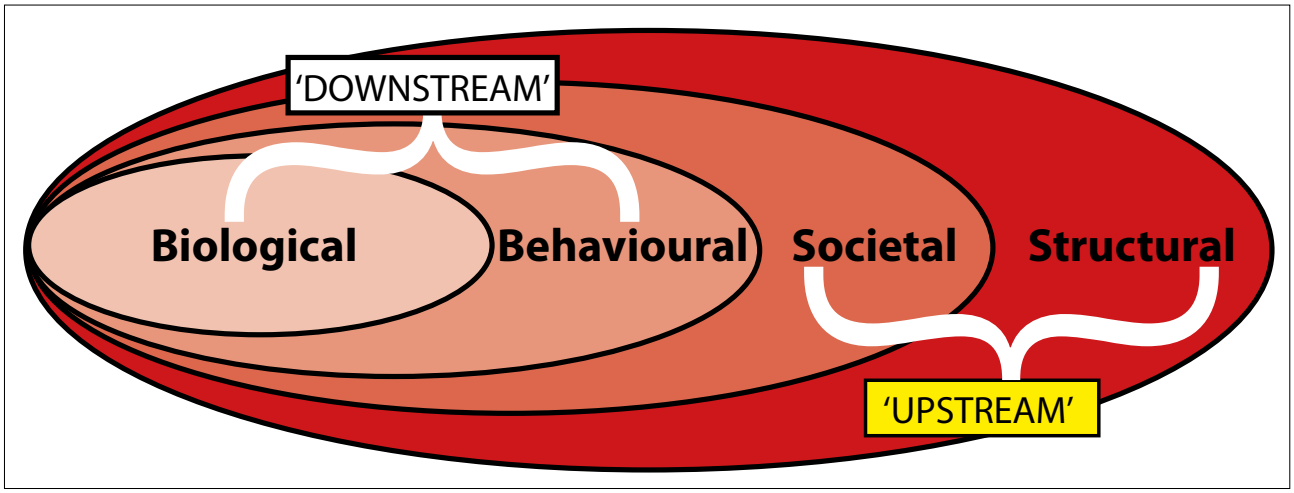

Fig. 1. Conceptual model of risk factors for disease.

of human and material resources according to the potential modifiability of health outcomes and their determinants.

The hierarchy of determinants can be represented by the 'layers of the onion' diagram in Fig.1.[5] Climate change determinants fall within the extreme upstream or outer layer of Fig. 1.

How do we understand anthropogenic climate change?

This article accepts as scientific fact that anthropogenic climate change results from economic activities that emit greenhouse gases (GHG) like carbon dioxide (CO_2) and methane, which accumulate and increase the heat-trapping capacity of the lower atmosphere, resulting in global warming, with surface temperatures and the annual number of dry days and hot nights increasing over time. The Intergovernmental Panel on Climate Change (IPCC) (http://www.ipcc.ch/), a scientific intergovernmental body established in 1988 and tasked with evaluating the risks of anthropogenic climate change, predicts increased frequency and intensity of extreme events (extreme heat, severe storms, droughts and floods).[6] The global average sea level rose by 1.8±0.5 mm per year between 1961 and 1990 and 3.1±0.7 mm per year from 1993 to 2003 due to thermal expansion of ocean water and melting land-based glaciers and ice-sheets.

What are the principal climate change-related determinants of health?

Fig. 2 shows how CC determinants may impact on health.[3] Apart from direct effects like increased temperature, changes in precipitation, extremes of climate and sea level rise, the fundamental requirements for health – safe drinking water, clean air, sufficient food, secure shelter, and control of vectors and infectious organisms, may be severely impacted. There are additionally many other CC-linked determinants which act and interact with other determinants at various levels to directly and indirectly impact health in a complex web of causation.

What are the climate-related adverse health outcomes?

Direct effects

There is an increased risk of death, injury and population displacement as a result of extreme climate events such as fires, droughts, hurricanes and floods. Anxiety, post-traumatic stress disorder, depression and other mental health conditions follow trauma, loss of loved ones and property and displacement.

The BoD approach allows us to combine premature mortality with morbidity estimates for different diseases into a single indicator, and has been used to estimate the contribution of CC to global health.

Prolonged exposure to high temperatures can cause heat-related illnesses such as heat cramps, heat syncope, heat exhaustion, heat stroke and death. More frequent and intense heat waves are associated with an increased morbidity and mortality. The elderly and people with pre-existing medical conditions (e.g. cardiovascular disease, psychiatric conditions) and those on medication which affects salt and water balance are

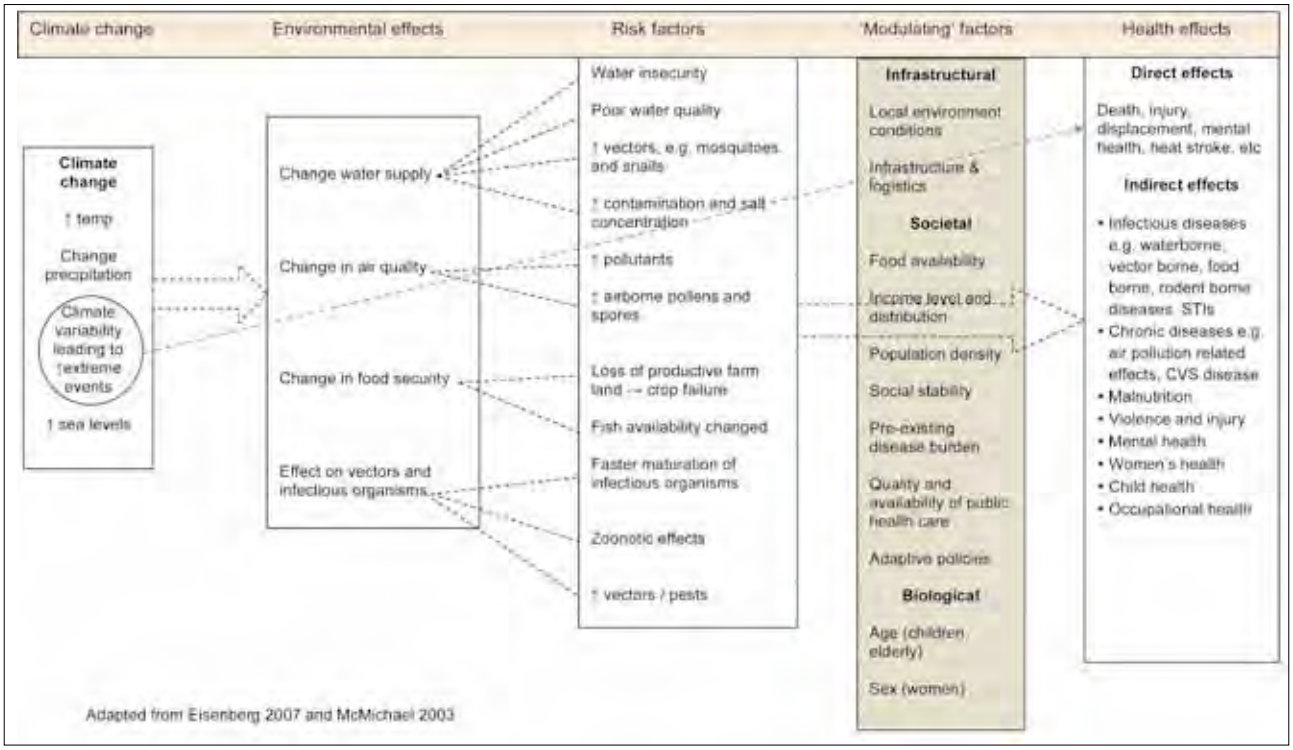

Fig. 2. Impact of climate change on health.

at great risk for heat-related illness and death. Drinking alcoholic beverages, ingesting narcotics and participating in strenuous outdoor activities, such as manual labour in hot weather, which is a feature of much work in the developing world during summer, are also associated with heat-related illnesses.

Temperature extremes affect physiological functioning, mood, behaviour (injuries or aggression) and workplace productivity, especially in outdoor workers (e.g. subsistence farming) and those working in poorly ventilated, hot conditions. An association with increased civil and military violence has been documented.

Chemical and biological effects of air pollutants and allergens may also increase mortality from asthma and chronic lung disease.

Indirect effects

These are systematically considered in the light of the major contributors to the South African national and provincial burden of disease.[7]

Infectious diseases

Waterborne enteric diseases are affected by changes in rainfall patterns, which affect river flows, flooding, sanitary conditions and the spread of diarrhoeal diseases, including cholera, as well as other enteric diseases caused by enteroviruses, and hepatitis A and E. Heavy runoff after severe rainfall can contaminate recreational waters and increase the risk of human illness through higher bacterial counts. This association is strongest at beaches closest to rivers. Ear, nose, and throat, skin, respiratory and gastrointestinal illnesses are commonly associated with recreational swimming in fresh and oceanic waters. Other diseases include hepatitis, giardiasis and cryptosporidiosis.

This article accepts as scientific fact that anthropogenic climate change results from economic activities that emit greenhouse gases (GHG) like carbon dioxide (CO_2) and methane, which accumulate and increase the heat-trapping capacity of the lower atmosphere, resulting in global warming, with surface temperatures and the annual number of dry days and hot nights increasing over time.

Vector-borne disease distribution can be adversely affected through faster reproduction of vectors and pathogens.[8] For southern Africa, however, the net climate change impact on malaria has been estimated to be neutral, while Dengue fever, tick-borne encephalitides and plague are predicted to increase.

Salmonella has been found in the UK, Australia and Canada to be associated with short-term (e.g. weekly) high temperatures and increase the risk of food-borne infections. This effect could be aggravated in less-developed settings.

Sexually transmitted infections, specifically HIV in southern Africa, are associated with population displacement, poverty and dislocated communities, gender violence, transactional sex, commercial sex work, increased partner numbers and increased risk-taking behaviours, all of which may be aggravated by climate change.

Violence and injury

As a consequence of worsening climate and environmental conditions, there will be increased immigration and refugee pressures on the environment and on neighbouring countries. The demographic disruption and associated social tension will be associated with adverse health effects, which include increased interpersonal violence and crime. In addition, damaged transport infrastructure and poor weather conditions or increased temperature may increase the incidence and severity of motor vehicle-related crashes. There is evidence that higher temperatures are associated with greater civil and military violence.

Mental health

Anxiety, depression, post-traumatic stress disorder and suicide may result from displacement, loss of family members, disabling injuries, lost livelihood (e.g. long-term drying in rural regions) and impoverishment as indirect consequences of climate change. Substance (especially alcohol) misuse and abuse are also more prevalent among displaced populations and populations subject to extreme environmental or climatic stressors.

Non-communicable chronic diseases

There is an increased risk of respiratory illnesses from the higher ground-level ozone and other air pollutants. Increases in airborne pollens and spores can exacerbate asthma, chronic obstructive pulmonary disease (COPD) and other respiratory allergic conditions. Cardiovascular system disease (e.g. cardiac failure, stroke) worsen as a result of air pollution, and renal disease is associated with heat waves (for example,

kidney stone disease associated with dehydration and increased hospitalisation for acute renal failure, or renal damage due to chronic dehydration).

Malnutrition

Increased risk of malnutrition results from impaired agriculture or loss of rural livelihoods. The WHO's estimate of disease burdens already attributable to climate change in the year 2000 identified malnutrition as the pre-eminent component of health loss. Most of that estimated loss (via premature deaths, stunting and disabling infection) was in young children in developing countries.

Women's and child health

Women and children are more vulnerable to effects of heat, water insecurity, extreme events, malnutrition, and infectious diseases. Women's lower social standing within communities results in a greater economic stress and resultant direct and indirect health impact from climate changes.

Occupational health

Physical hazards due to temperature extremes can cause heat illness and loss of productivity since most subsistence agriculture takes place in hot parts of the globe and factory conditions with no air conditioning are also common. Chemical hazards from the effect of wild fires in dry and hot conditions, or smog in cold weather with temperature inversions, can have serious cardiorespiratory effects. Emergency and health personnel are particularly at risk from stressful social and environmental conditions and infection hazards.

What is the path to prevention of the climate change-related burden of disease?

Because this article is primarily about the public health or population approach, considerations of prevention must begin at a societal level with policy needs. We must continue to implement preventive interventions that are ordinarily required to reduce the disease burden from all the contributors to the BoD, and which will still be required indefinitely with or without CC, while considering how to respond to the extra demands placed by CC, and providing climate-related curative services and care wherever possible, as outlined elsewhere in this special CC and health issue of *CME*.

In the broadest sense of the word, what is required is for us as health practitioners to become more political ...

When it comes specifically to climate change-related prevention we need to think systematically through ways in which we can promote optimal mitigation and adaptation at all possible layers of the onion of determinants (see Fig. 1). Mitigation means striving to reduce GHG at source (e.g. promoting solar and wind energy production instead of 'fracking' for carbon-intensive shale gas), while adaptation focuses on interventions that will reduce the impact of CC determinants of health (e.g. early detection of cholera and upgrading of emergency medical responses).

This is always the point at which many health professional are lost, as the gap between the doctor-patient relationship level of intervention and action at the more distal levels of the onion is difficult to bridge mentally and programmatically from the vantage point of a medical practitioner.

In the broadest sense of the word, what is required is for us as health practitioners to become more political (oriented to policy formulation and implementation). Looking at our policies, whether at national, provincial or local government levels, it is clear that the newly emerging globally relevant slogan of 'health in all policies' is thinly practised in South Africa. We need only to look at the national environmental policy (the white paper) on climate change, or the very recently released National Development Plan, or our energy policy to see this. There is nevertheless vigorous debate around all of these policies, and we individual health professionals, as well as our health organisations, need to join these debates providing essential facts about health determinants and their likely impacts about which most policies are typically silent. In 2011 when the COP17 meeting took place in Durban the cliché that 'politics begins at home' was particularly relevant. We should infuse all of our organisations and practice with CC and health awareness.

All this may appear to be a little vague for many medical practitioners. More concretely, we need to move from climate-friendly policies to the implementation of mitigatory and adaptive interventions wherever possible. We need to understand what the greatest threats to health are from different levels of CC determinants, and to give priority to and promote those interventions that aim at reversing their adverse health effects. Looking at each layer of the onion we should be asking what interventions we can support either personally or collectively through our organisations.

Think proactively. Think preventively. Use the hierarchy to help you think systematically about these issues. Prepare yourself professionally for changing patterns of disease – anticipate and be ready!

References available at www.cmej.org.za

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- The health impacts of climate change in South Africa have received little attention.
- Climate change will not give rise to new diseases but will change the pattern of disease, exacerbating many conditions while benefitting others.
- Direct effects are heat waves, floods, storms, droughts, injury, displacement and infectious disease.
- Indirect effects apply across the burden of disease.
- Understanding the current and projected burden of disease is important for surveillance of likely climate change health effects.
- Preventing adverse effects includes mitigation (reducing greenhouse gases) and adaptation (being prepared for anticipated health effects).
- Emergency and long-term preparedness of society is key to prevention.
- Health professionals can take preventive action individually and through their organisations to make a difference.

Health lifestyle interventions and climate change

How can we change our lifestyle to help mitigate climate change?

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The recent high-level meeting of the general assembly of the United Nations noted with concern the 'increasing challenges posed by climate change and the loss of biodiversity, and their effect on the control and prevention of non-communicable diseases.'[1] This article explores what lifestyle interventions should be promoted in order to mitigate climate change and in particular explores those that also contribute towards preventing and controlling non-communicable chronic diseases.

Health professionals are in a unique position to offer education and counselling on healthy lifestyle as they come into frequent contact with their patients and are viewed as reliable sources of information.[2] As climate change is now one of the major public health challenges of the 21st century we anticipate that health professionals will incorporate appropriate lifestyle education and counselling into their interactions with patients.

Health professionals are in a unique position to offer education and counselling on health lifestyle as they come into frequent contact with their patients and are viewed as reliable sources of information.

It is estimated that if all the population achieved a middle-class lifestyle at current levels of consumption we would require an average of 5 planets to provide the resources required. Lifestyle change could reduce this to an average of 2 planets, but to bring this down to 1 planet more fundamental societal and structural changes would be required for sustainable development.[3] This article addresses the lifestyle changes that can contribute to this goal at a personal level.

Non-communicable chronic diseases

Hypertension, diabetes, cardiovascular disease, asthma, chronic obstructive pulmonary disease and some cancers all make a significant contribution to the burden of disease in South Africa.[4] A recent national summit on non-communicable chronic diseases in South Africa noted that: 'In Africa non-communicable diseases are anticipated to overtake mortality from communicable, maternal, perinatal and nutritional diseases by 2030. In South Africa in 2000 non-communicable diseases were responsible for around 40% of all deaths (excluding injury) and around 35% of the burden of disease.'[5]

Four lifestyle-related risk factors contribute to the growing impact of these diseases: tobacco smoking, physical inactivity, unhealthy eating and alcohol use.[6] Physical inactivity and unhealthy eating together contribute to levels of overweight and obesity. Fig. 1 shows very high rates of physical inactivity across all age groups in South Africa, with women more inactive than men.[7]

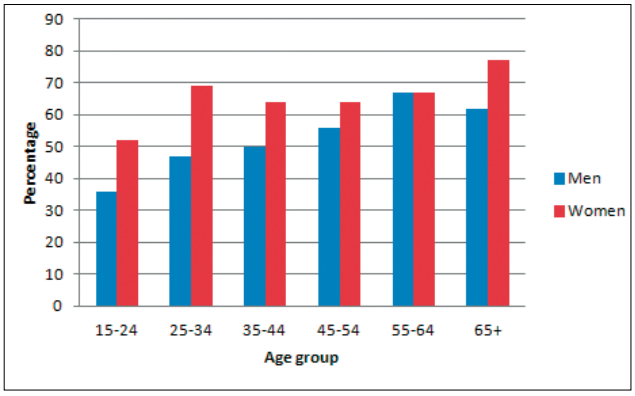

Fig. 1. Levels of physical inactivity by age group.

Fig. 2 shows an increasing consumption of fat in the South African diet over the last 20 years.[7] Unhealthy diets have been characterised as high in 'saturated fat, particularly of animal origin, and an imbalance between the different polyunsaturated fatty acids. This diet is also very high in salt, cholesterol, alcohol, sugar and energy intake, and very low in fibre, vitamin and trace element intake.'[8] Daily red meat consumption in South Africa has been estimated at 126 g per person per day on average,[9] compared with a global average of 101 g, the average in developing countries being 47 g and in developed countries 224 g.[10]

Not surprisingly this has been mirrored by increasing levels of overweight and obesity in both men and women. Rates in women however far exceed those in men, as shown in Fig. 3.[7]

Unhealthy diet

The agricultural sector is an overlooked contributor to greenhouse gas emissions and yet accounts for 15 - 20% of global greenhouse

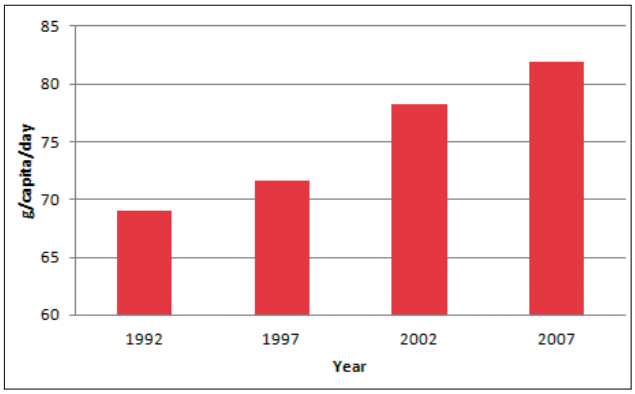

Fig. 2. Supply of fat in the South African diet.

gases – as much as the transport industry.[10,11] Agricultural greenhouse gases, however, are predominantly from nitrous oxide (46%) and methane (45%) rather than carbon dioxide (9%).[11] Methane and nitrous oxide are more potent greenhouse gases than carbon dioxide. Nitrous oxide is released from the use of synthetic fertilisers, while methane derives from ruminant livestock and manure. Livestock production, however, also contributes indirectly through deforestation for grazing land and soy-feed production.[10] Worldwide, the trend is for an increase in meat production, particularly in low- and middle-income countries, from 229 million tonnes in 2000 to 465 million tonnes in 2050.[10] The associated increased consumption of livestock products in transitional countries such as South Africa is reflected in the increased fat content of the diet.[10] Livestock production is

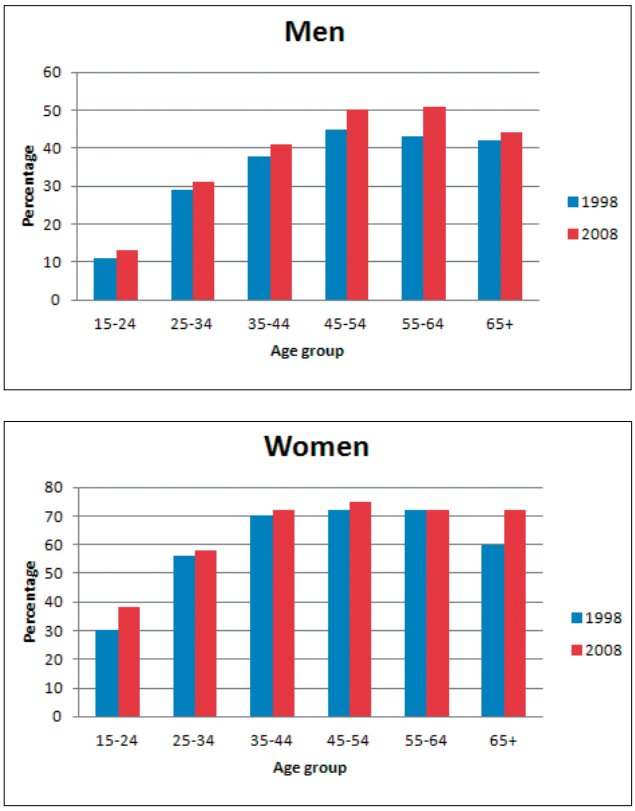

Fig. 3. Rates of overweight and obesity in South Africa.

increasing in South Africa and we are now importing soy feed to support the growing industry.[10]

The carbon footprint of the agricultural sector is compounded by the food industry and consumer choices. Food and beverage manufacturers add greenhouse gas emissions through processing, packaging and transporting food over long distances. Food retailers add additional greenhouse gas emissions through distribution and storage. Consumers add greenhouse gas emissions depending on how they travel to shop, and how they dispose of waste and packaging. Every food product we buy therefore has a carbon footprint. A diet that is low in fruit, vegetables and plant protein, but high in animal protein and fat, is not only unhealthy, but has a much higher carbon footprint. The impact of a diet that requires high amounts of animal protein is illustrated by the following observations:[11]

- The use of fossil fuels is 11 times higher to produce 1 kg of animal v. plant protein.
- It takes 6 kg of plant protein to make 1 kg of animal protein.
- Currently, 50% of the world's grain goes to feed livestock and not people.
- Livestock occupy 30% of the Earth's land surface.
- 70% of deforested land goes to grazing.

To put these figures into more a dramatic form:

- 'If everyone in the UK stopped eating meat on one day a week, this would equate to taking 5 million cars off the road.'[12]
- 'A kilogram of steak could be responsible for as many greenhouse gases as driving a car for three hours while leaving all the lights on at home.'[13]

In other words, recommendations for a diet that prevents overweight and obesity and which also mitigates climate change are the same. A low-calorie diet that is designed to assist with weight loss should ideally consist of:[14]

- 50 - 55% carbohydrates, particularly vegetables, fruit, wholegrains and beans
- 15 - 25% lean protein
- 30% fat, particularly unsaturated fats.

When making food choices from a climate change perspective the following principles also apply: [11]

- Eat more plant protein and vegetarian food.
- Buy more unprocessed and unfrozen food.
- Buy foods with minimal packaging.
- Eat more organic food.
- Make use of locally produced and seasonal products.
- Grow your own food.

Physical inactivity

A sedentary, urban lifestyle characterised by reduced physical activity, is also based on substituting fossil fuel energy for our own physical activity.[15] We aspire to car ownership, and passenger cars per 1 000 of the population have increased by 25% between 1996 and 2006.[15] In 2005, South Africa consumed 328 litres of diesel

and petrol per person compared with a global average of 283 litres, 12 litres in Ethiopia and 2 135 litres in the USA.[15,16] The increased use of motorised transport is also associated with other health consequences, such as high rates of road traffic accidents (the fourth highest contributor to the burden of disease in South Africa[1]) and significant amounts of air pollution.[15] We use cars to travel even the shortest distance, when walking or cycling would allow us to meet targets for physical activity. In South African cities, collective public transport is underdeveloped and poses serious safety considerations.

It is estimated that if all the population achieved a middle-class lifestyle at current levels of consumption we would require an average of 5 planets to provide the resources required.

A reduced emphasis on physical activity at school and a lack of access to suitable sport facilities may also be an important factor. Physical inactivity may also be compounded by fears of safety and a lack of access to green spaces.

Nevertheless, an exercise prescription may be an important part of preventing and controlling non-communicable chronic disease and mitigating climate change. The key principles of an exercise prescription are:[14]

- 150 minutes of moderate-to-vigorous physical activity per week for everyone. This is activity that raises one's heart rate or produces a sweat. Activity should ideally be every day of the week and at least 10 minutes at a time.
- 150 - 250 minutes of moderate-to-vigorous physical activity per week to prevent the typical weight gain seen during adulthood in our society.
- 225 - 420 minutes of moderate-to-vigorous physical activity per week (30 - 60 minutes per day, 7 days per week) to lose weight if already overweight or obese.

It should be noted that physical activity does not necessarily imply organised sport or attendance at a gym. Activity can be incorporated into one's daily life through greater use of public transport (bus, train or taxi), brisk walking or even cycling.

Electricity use

At the heart of greenhouse gas emissions and climate change is the issue of energy use and consumption. In South Africa the majority of our energy is derived from burning fossil fuels, particularly coal.[17] The health sector is often a major energy user and in South Africa the private sector is likely to have a carbon footprint on a par with high-income countries.[18] At home and work there are a variety of relatively easy ways in which one can reduce energy use, save money and mitigate against climate change:[11]

- Use compact fluorescent lamps (CFL) or light-emitting diodes (LED) for lighting and switch off lights when not in use.
- Buy energy-efficient appliances and switch off appliances when not needed.
- Reduce the geyser temperature and install a geyser blanket.
- Invest in solar water heating.
- Take short showers instead of baths.
- Wash clothes in cold water and use a clothes line, not a tumble drier.
- Install insulation in the ceiling.
- Audit your energy use.
- Offset your electricity use by planting trees.

Travel

Travel is another major source of greenhouse gases, and health professionals often travel large distances for conferences and meetings. Referral of patients to distant hospitals also contributes to travel-related emissions from health care. At home and work there are a number of personal lifestyle changes that can be promoted:[11]

- Avoid flying whenever possible.
- Avoid driving on your own when you can join a car pool.
- Drive more slowly and maintain your car as this improves fuel consumption.
- Buy a more fuel-efficient car.
- Offset your travel emissions by planting trees.

The agricultural sector is an overlooked contributor to greenhouse gas emissions and yet accounts for 15 - 20% of global greenhouse gases – as much as the transport industry.

Waste

Landfill and the treatment of waste water are major producers of methane, which is a powerful greenhouse gas, and burning waste in many areas also contributes to additional greenhouse gases. The mantra of waste management is reduce-reuse-recycle:[11]

- Reduce consumption and choose products with fewer hazards when thrown away or less embodied energy in production.
- Reuse items when possible rather than discarding them.
- Recycle items such as paper, cardboard, glass and plastics. Also consider worm farms and other means of rapidly breaking down organic waste into compost.

Family planning

One additional driver of increasing consumption and greenhouse gases is likely to be global population growth, although it should be noted that many of the countries with the highest levels of emissions also have the lowest population growth.[19] Family planning therefore can make a contribution towards limiting unsustainable population growth, and as South Africa has a huge number of children in need (particularly orphans), fostering, adoption and support of these children is a priority.[11]

Being the change

The therapeutic relationship between health professionals and patients is central to health care. To be therapeutic the relationship relies on an experience of genuine concern and interest, acceptance of the patient's views, sensitivity, empathy and support.[20] When promoting wellness and lifestyle change there is also a need for congruency between one's own striving for wellness as a health professional and the behaviour change that you are promoting for your patient. Resonant leadership, mindfulness, self-care and reflection have been identified as critical components of this. In other words, who the doctor is as a person and not just their technical skills or knowledge has an important influence on the therapeutic relationship.[21]

With this in mind it follows that health professionals should strive to manifest the same healthy behaviours that they expect of their patients. It is not about perfection, but about struggling with the same issues and hopefully being a role model for health and wellness. In the realm of climate change therefore health professionals should also strive for more sustainable lifestyles. At a basic level this may involve:[11]

- Learning more about climate change and one's own carbon footprint.
- Reflecting on one's own values and priorities.
- Reducing one's own consumption.
- Encouraging action on climate change through professional organisations, colleagues, friends and family.

Conclusion

Climate change is a major challenge to public health in the 21st century, and health professionals should include messages about healthy lifestyle and the mitigation of climate change in their interactions with patients. Many of the lifestyle changes, such as increased physical activity and reduced consumption of meat, are also beneficial in the prevention and control of non-communicable chronic diseases. In addition to these changes, other key areas for change are use of electricity, travel, waste disposal and family planning. Health professionals should be congruent in the way that they strive for wellness in their own lives and promote healthy lifestyles to their patients.

References available atwww.cmej.org.za

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- Health professionals should include messages about healthy lifestyle and the mitigation of climate change in their interactions with patients.
- Many of the lifestyle changes, such as increased physical activity and reduced consumption of meat, are also beneficial in the prevention and control of non-communicable chronic diseases.
- Other key areas for change are use of electricity, travel, waste and family planning.
- Health professionals should be congruent in the way that they strive for wellness in their own lives and promote healthy lifestyles to their patients.

SINGLE SUTURE

Wine results faked?

If you thought that all the news reports that wine was good for your health were too good to be true, you could be right. Some of the research was faked, says the University of Connecticut.

A 3-year investigation by the university concluded that Dipak Das, head of its cardiovascular research centre, 'is guilty of 145 counts of fabrication and falsification of data'.

An anonymous tip of possible fraud in 2008 triggered the investigation. The resulting report came to 600 000 pages, drawn from examining more than 100 papers. The university has notified 11 journals in which Das published suspect papers and has begun dismissal procedures.

Much of Das's work centred on the health benefits of resveratrol, a compound found in red wine. Other labs have also reported similar benefits of the compound.

New Scientist, 21 January 2012.

Communities, climate change and the district health system

Climate change is inevitable – how can we adapt to these changes?

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Bart Willems qualified at Stellenbosch University in 2005. He did his internship and community service in East London. Always interested in ways to prevent disease and disaster, he has since started specialising in public health. He is a nature lover and hopes to become involved in the interface between humans and the environment and the effects it has on the health and healthy living of individuals and communities.

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Neil Cameron is a public health physician with a keen interest in infectious diseases and sustainable development. Key work experiences have been at Madwaleni Hospital in Transkei, in the Department of Health in communicable disease control and, more recently, encouraging under- and post-graduate students to develop a community health perspective.

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Climate change is increasingly recognised as affecting the planet we live on, fundamentally changing weather patterns, with an accompanying increase in 'natural' disasters such as tropical storms, floods, wild fires and droughts. Climate change will threaten water and food supplies, disrupt physical infrastructure and increase mortality.[1] The prediction is that in the next four decades southern Africa will become warmer, especially over the inland plateau, and drier, especially over the western half.[2] It is important to realise that the way we live, and the places where our towns, cities, farms, dams and other infrastructure are, were all created around the more or less stable climate that has prevailed in the last century or two. It is not possible to uproot all of this to move to places where the climate might be similar in the near future. Even so, large-scale migration and conflict have also been predicted because of diminishing natural resources, and displacement because of environmental degradation.[3,4] Events in the Horn of Africa (Somalia and Ethiopia) are a case in point. For most communities in South Africa, however, adaptation to a changing climate will be required.

Concern about the cost of energy and climate change has led to the National Climate Change Response Green Paper that emphasises the need to decrease carbon footprints and improve efforts to increase resilience at a personal and health system level[5] (also see articles by Reynolds and Mash in this issue).[6,7]

The prediction is that in the next four decades southern Africa will become warmer, especially over the inland plateau, and drier, especially over the western half.

The questions to be answered in this article are: What can we do now in districts or neighbourhoods to decrease the impact of these changes and to better adapt to them? Is it possible that the changes we need to make in the way we live and work can help us to cope with other fundamental global crises?

Ways to minimise the effect of disasters

The effect of any disaster depends on the nature of the hazard and the vulnerability of the population. Mitigation of climate change focuses on reducing the hazard – in this case the increase of ambient temperature and the effects it will have on our lives through the changes it will bring to our climate. The UN Intergovernmental Panel on Climate Change concluded that most of the observed increase in global average temperature since the 1950s is very probably due to the observed increase in anthropogenic greenhouse gas concentrations.[8] Some sceptics still believe that it is unclear whether human behaviour is the cause of increased surface temperature. The ambient temperature is rising and we will have to adapt to the change whether we are the cause of it, or not.

Adaptation focuses on reducing the vulnerability of the population by decreasing susceptibility and increasing resilience or ability to cope with change. The vulnerability of a population could depend on the following: population density,

level of economic development, food availability, income level and distribution, quality and availability of public health care, education, local environmental conditions and the pre-existing health status of the population.[9] Socio-economic systems moderate or amplify the impact of climate change and have a marked effect on the ability of communities to adapt.

The ambient temperature is rising and we will have to adapt to the change whether we are the cause of it, or not.

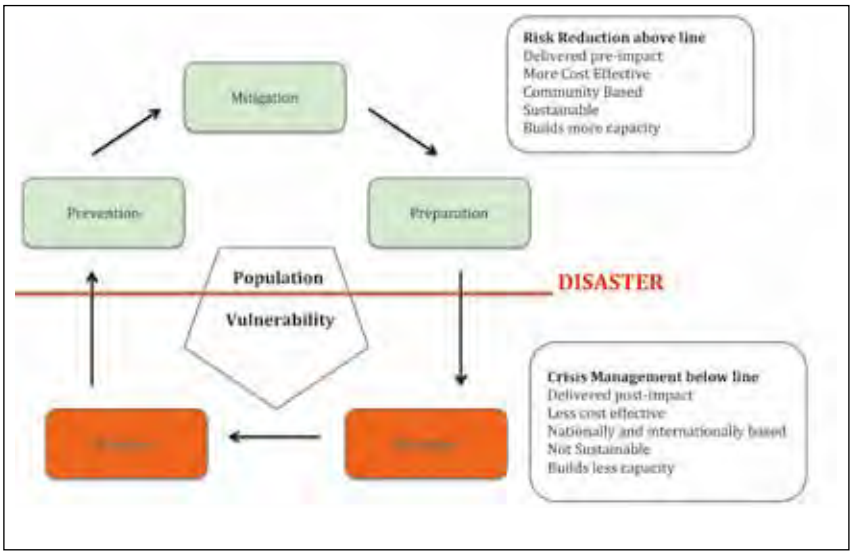

Fig. 1. A disaster risk management cycle.

The approach to disasters in general, such as earthquakes or flooding, has shifted to a more systematic and comprehensive risk management process involving prevention, mitigation and preparation (Fig. 1). Risk reduction measures are delivered pre-impact, tend to be community based, less expensive and more sustainable. On the other hand, crisis management responses tend to be expensive, depend on outside intervention and therefore are often extremely limited.[10] The success of post-disaster actions is also to a large extent determined by pre-disaster planning, awareness and readiness within local government and civil society organisations. In this way, community action and partnerships with local government are central, not just to minimising risk, but also to responding to impact and shaping recovery in ways that can strengthen local livelihoods and quality of life.[6] In line with the primary healthcare approach, risk management and adaption that reduce the impact of climate change should be integrated into development policy and practice with full participation of communities, businesses and local government and so help build resilience of communities and families.[7]

In Fig.1 risk reduction measures are contrasted with crisis management.[10] Ideally we want to function in the area above the horizontal disaster line. In this case the disaster line might represent extreme weather events on a background of changing climate patterns.

The health system is in the middle of it all

This article outlines what doctors and other health professionals can do within a district health system in South Africa to facilitate community mitigation and adaption to climate change. Our district health service is based on the primary healthcare approach, which promotes ongoing improvement in the health of the population served, encourages partnership between communities and the service providers in the area, and monitors trends in the burden of disease.[7]

To do this, the district health team needs to engage people from health and other sectors, private and public, as well as formal and informal community structures, to discuss and respond to key issues that affect the health of all people in the district, with a special focus on vulnerable groups who will be most affected. Health professionals have a key role in raising awareness of the scientific evidence linking climate change to human activities and encouraging others, both in the private and public sector, to strengthen mitigation and adaption efforts and at the same time to improve health and health equity at district level.[11]

Communities that are involved realise the problem, take responsibility and become part of the solution.

These are complex issues, so the process should start with a dialogue of interested parties, even though most communities may not see climate change as a priority. Much of the call for lifestyle changes to mitigate the impact of climate change is directed at people from higher socio-

economic groups – and correctly so – as they not only have more ability to adapt their behaviour, but also contribute far more to greenhouse gas emissions. Attention to adaptation and resilience of communities should, however, focus more on lower socio-economic groups that are more vulnerable. Involving appropriate representatives of such communities in the design, implementation and monitoring of interventions should aim to improve overall family and household resilience to cope with change. Improving resilience of communities can harness community commitment to more directly felt needs and priorities such as food security, water supply, and social support, all of which will also improve adaptation to climate change. In the longer term such interaction should also build support for development that is more sustainable and that follows a low carbon emission pathway.

A participatory approach that involves both critical reflection and planning leads to a greater understanding of the issues and more appropriate local action.[12] This can be envisaged as a participatory action research (PAR) project (whether it is done as a project or actually written up as research) and should ensure community participation. This also allows the researcher or project manager and the rest of the team a better sense of the situation and possibilities in the community. It is a generic approach that could be used to tackle a range of problems faced by a community (Fig. 2).[12,13]

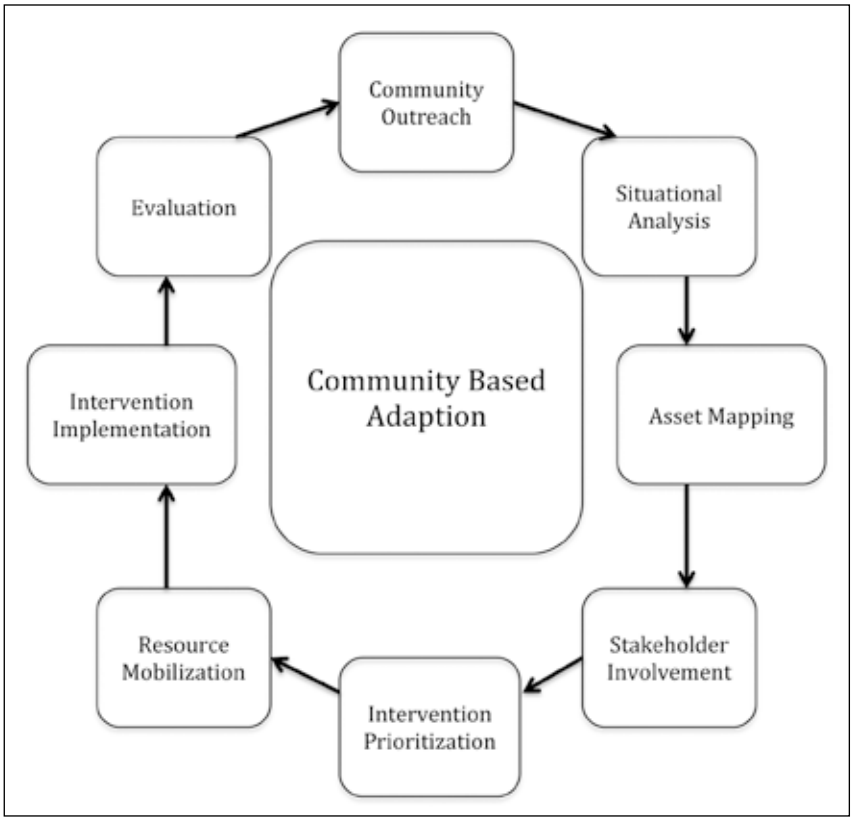

Fig. 2. The eight steps of a participatory action research cycle (adapted from Ebi and Semenza, 2008[13]).

The eight steps of a participatory action research cycle are as follows:

1. **Community outreach.** Initiate a discussion and raise awareness about the problem in a community forum. Identify community boundaries, participants or participatory organisations and set up a team to take the process forward.
2. **Situational analysis.** Describe the community needs, constraints, challenges and obstacles that decrease adaptability and identify possible future problems and risks. A situational analysis should also assess factors that could influence vulnerability. These will include, e.g. demographics, education, land use, and water supply. Producing a participatory community risk assessment may be a good first to raise awareness and mobilise resources. Storylines are a way of sketching different scenarios and endings to improve community engagement on shorter- and longer-term risks and interventions.
3. **Asset mapping.** This will include natural resources, social capital within the general community as well as local opinion and community leaders. Social capital is a term used to describe the potential within the relationships of a community to solve problems together. Structural social capital is contained within networks between individuals and organisations in a community, while cognitive social capital develops as a result of common ideas, beliefs and attitudes. Social capital can be increased by synergistically linking quite different individuals and institutions and different levels of the societal hierarchy together to achieve a common goal.[14] Because of the complexity and wide impact of climate

change, mitigation and adaptation solutions will be most effective in a community with full utilisation of their capacity and social capital. Assets would include organisations such as faith-based organisations, colleges, governmental agencies, local agencies and non-government organisations (NGOs).

4. **Stakeholder involvement.** This combines social capital from different sectors, allowing a broader exploration of options and more comprehensive solutions. An important outcome would be to facilitate social networks and personal connections between individuals and organisations within the neighbourhood.
5. **Intervention prioritisation.** All stakeholders should be involved in transparently prioritising interventions and developing an explicit intervention plan.
6. **Resource mobilisation.** After the highest priority interventions have been identified a detailed intervention plan should be created and widely published. Resources –human, organisational and financial – will have to be mobilised in preparation plan implementation.
7. **Intervention implementation.** Utilising all the stakeholder and social capital identified and empowered in the planning process to work together in implementing the plans.
8. **Evaluation, reflection, revision.** Monitor and evaluate the outcomes and impact and continuously give feedback to everyone involved. It is then important to continue with this cyclical process of action and reflection to move forward.[13]

How do we create an environment that helps people to make healthy lifestyle choices?

The Community Orientated Primary Care (COPC) approach, which aims at strengthening capacity to deal with other important health issues within a community, is a long-term PAR process.[15]

Starting with a problem of common concern, such as food security, a group of families affected and the primary healthcare team could be part of a task group. COPC aims to improve links and relationships between community members and the formal health service, and provide an opportunity for dialogue, action and review. Capacity and confidence are built in a community and ultimately positive health outcomes are achieved. It is likely that climate change *per se* will not be a priority for most vulnerable communities; however, much of what needs to be done to improve the health of families and communities, such as vegetable gardens and local markets, crèches, cycle tracks, safer parks, more opportunities for physical exercise, better public transport, improved sanitation, taps and toilets inside homes, hot water from solar panels, recycling, ensuring immunisation coverage, oral rehydration, early recognition of health problems and support to complete treatment, will also build resilience to cope better with climate change. The process can help a significant proportion of people living in the area to see themselves as part of a wider community with links to a primary healthcare team and local government.

The Health Promoting Schools (HPS) approach is a creative way to work with a school and the wider school community and is a particularly pertinent strategy for enhancing health, resilience and future sustainable development.[16]

The generic processes described above will enable communities to prepare for climate change and other health issues. These issues are often inter-related, and 'thinking about climate change' needs to be part of all these discussions even if the focus is elsewhere, e.g. on non-communicable diseases or food security. In the same way that 'health in all policies' is promoted we should also consider climate change and sustainability in all policies. This means including climate matters in health policy.

Conclusion

The challenge of responding adequately to climate change at community level is daunting. It does seem that significant and uncomfortable change is inevitable. However, some consideration of the literature shows that there are ways to decrease the size of the impact by seriously rethinking our energy use, especially in affluent communities, and by helping to build resilience, especially in more vulnerable communities. The impending disaster could either be ignored and wreak havoc when it happens, or we could take preventive and preparatory action now to reduce future impact. It is also clear that working together with all sections of society synergistically is essential. In some ways it is encouraging that quite a few of the actions that need to happen to improve the health of communities, families and individuals are also needed to decrease the causes and effects of greenhouse gases. We need to take up the challenge. While we continue to treat people who are ill and injured with care and competence, we should also shift the focus of healthcare from curative services to include community-orientated prevention and building resilience. There is an opportunity to use this common crisis of climate change to work towards the partnerships needed – not just to deal with challenges of climate change, but to be able to live and work in a fairer and more interdependent manner.

References available at www.cmej.org.za

IN A NUTSHELL

- Climate change is a complex problem that will have a broad range of effects on communities.
- A focus on risk reduction and preparation in anticipation of future disasters is more helpful than acute crisis management.
- Poorer communities are more vulnerable to the effects of climate change and should focus on improving resilience and strategies for adaptation.
- The district health system can contribute through community-orientated primary care to improving the resilience of communities.
- Primary healthcare is supportive of a population-based, preventive, participatory approach that engages healthcare providers and community members in action and reflection.

More about...Climate change and health

The health profession and climate change: Advocacy needed

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Advocacy is defined as support or argument for a cause or a policy. The lead article in this journal certainly suggests major changes in lifestyle, which will not be palatable to all in the health profession. Do we need to be advocates for the policy of auditing and curtailing our use of energy? One thing is certain – as a result of overpopulation and a massive reliance on fossil fuels for energy we are releasing far more carbon dioxide into the atmosphere than ever before. Together with other greenhouse gases this will result in global warming and major changes in climate.

The World Medical Association and World Health Organization have been strong advocates for policy changes related to our carbon emissions.[1,2] The World Medical Association has pledged to fully involve physicians and national medical associations in the development of policies to prevent or reduce the health impact of climate-related emissions, in particular those initiatives which will also improve the general health of the population.[1] The following priority interventions are summarised from the World Health Organization's regional committee for Africa in 2011:[2]

- Undertake baseline risk and capacity assessments.
- Build capacity based on the needs and gaps identified in the above assessment.
- Implement integrated environment and health surveillance to support timely and evidence-based decisions.
- Undertake awareness raising and social mobilisation.
- Promote public health-orientated environmental management.
- Scale up existing public health interventions.
- Strengthen and operationalise the health components of disaster reduction plans.
- Promote research on climate change impacts and adaptation.
- Strengthen partnerships and intersectoral collaboration.

The South African government and the Department of Health have individually published their responses to the problem.[3,4] However, we need a united front to deal with these problems. We have to include not only the health department, but all departments involved in the environment, such as energy, agriculture, mining and water affairs. The government must realise that the time for only speaking the right words is far behind us and action is needed. Africa will bear the major burden of the negative impacts of global warming, and most countries on the African continent are ill-prepared for this event. As one of the most privileged countries in Africa we need to take a leading role. The Government White Paper on Climate Change published in October 2011 states:[3]

'Amongst a range of environmental constraints that are of necessity playing an increasing role in social development planning, climate change represents the most urgent and far-reaching challenge of our time. While every country will have to develop its own adaptive responses to the effects of climate change, mitigating climate change to ensure the disruption caused to human and natural systems is within manageable parameters, can only arise out of a global response. Furthermore, responding to climate change is a cross-generational challenge. The effects of action or inaction will not be felt immediately, but will have significant consequences for future generations.

'It is within this context, and informed by an appropriate sense of urgency, that the South African government has developed this National Climate Response Policy. The current plan represents the first iteration of South Africa's ongoing efforts to adapt to climate change and contribute to the global mitigation effort. In terms of our contribution to the global mitigation effort, the decision to institute sectoral desired emission reduction outcomes and carbon budgets is momentous – it represents a concrete and practical commitment by South Africa.

'Realising this commitment will require sustained effort and cooperation from all spheres of government, the private sector and civil society formations, and ultimately will depend on decisions by individual citizens to embrace climate-friendly lifestyles and habits. Everyone is a stakeholder in this plan, and the level of engagement from the public in the process of drafting the national Climate Change Response suggests that there is no shortage of the requisite will to make the far-reaching changes that are required.'

In December 2011 the South African government hosted the 17th Conference of the Parties and alongside this Dr Motsoaledi, our national Minister of Health, gave the keynote address at a summit on health and climate change (http://www.climateandhealthcare.org). The summit was attended by many professional groups in South Africa, including the South African Medical Association (SAMA). Dr Fazel Randera spoke about SAMA's current response and explained that a 5-member task team has been set up to look at the issue and that a draft policy had been created. He also mentioned a campaign to sensitise members and interact with key stakeholders as well as an awareness poster. SAMA endorsed the final Durban Declaration from the summit which is summarised in Panel 1.[5]

We hope that health professionals will support these statements through practical action in their own lives, communities and practices and through membership of these professional bodies advocate for the necessary action by government and international bodies.

Panel 1. Durban Declaration from the Global Climate and Health Summit[5]

Having gathered at the first Global Climate and Health Summit in Durban on 4 December 2011, we – as health professionals, public health advocates, and healthcare policy makers from more than 30 countries – hereby call on national delegations to the UNFCCC's 17th Conference of the Parties to:

- Recognise the health benefits of climate mitigation and take bold and substantive action to reduce global greenhouse gas emissions in order to protect and promote public health.
- Ensure greater health sector representation on national delegations as well as within key mechanisms of the UNFCCC, recognising the role of the World Health Organization as the voice for public health within the UN system.
- Actively include the participation and empowerment of youth, women and indigenous peoples in the climate change processes.
- Adopt a strong second commitment period of the Kyoto Protocol which currently includes emission reduction targets for the time until 2012, to protect and continue the only binding climate law the world has.
- By 2015, negotiate a fair, ambitious and binding agreement that, consistent with the Prescription for a Healthy Planet, endorsed by more than 130 health organisations in Copenhagen in 2009:
  - Places the protection of human health as a primary objective of any agreement.
  - Establishes an ambitious fair shares framework to reduce global emissions (based on the principles of equity and common but differentiated responsibilities and respective capabilities) in order to avoid a global public health disaster.
  - Fosters both energy efficiency and clean, renewable energy that protects public health by reducing both local and global pollution.
  - Provides the immediate necessary resources to operationalise the Green Fund, and in the longer term, appropriate mitigation and adaptation funding required to address the health impacts of climate change, assuring all countries' rights to sustainable development and their ability to pursue a low carbon development pathway.

The matter is urgent. The health of the world's population is at risk. The time for action is now.

References available at www.cmej.org.za

The carbon cycle

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Understanding the global carbon cycle is the key to understanding climate change. The carbon cycle makes it clear that, if we want our grandchildren and their children to live decent lives, we have to achieve a world free of fossil fuels – a post-carbon civilisation – within a few years.

Carbon is essential to life. All living organisms are constructed out of carbon-containing organic molecules. These are made possible by the carbon cycle: the exchange of carbon between the earth's carbon reservoirs, as shown in Fig. 1.

The diagram shows how an enormous carbon cycle moves carbon between these reservoirs in a number of sub-cycles. It shows carbon reservoirs (in gigatons), and the flux between them (in gigatons per year).

The sub-cycles can be grouped into *biological cycles* (i.e. between the atmosphere and the land, ocean surface and vegetation) and *geological cycles* (exchanges with the deep ocean, sediments and rocks, including the formation – but not the combustion – of 'fossil fuels').

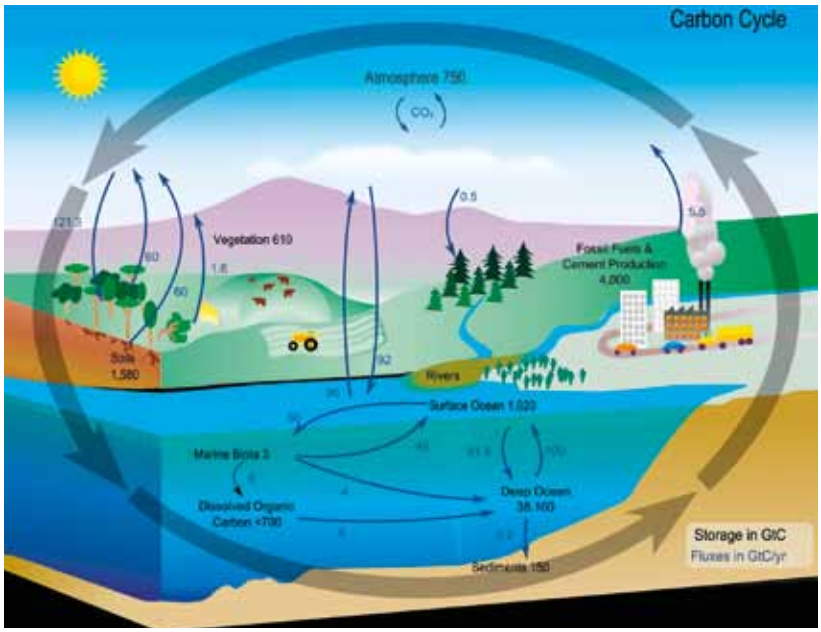

Fig. 1. The carbon cycle. (The diagram is a file from the Wikimedia Commons. Commons is a freely licensed media file repository. The copyright owner has given permission for it to be used freely for any purpose and without any conditions. See: http://en.wikipedia.org/wiki/Carbon_cycle.)

More about...

Geological cycles run at geological time-scales of millions of years. This means that for practical purposes, no new fossil fuels are being produced. Fossil fuel burning is not a feature of the natural biological cycle. The geological cycle has no meaningful relationship with climate change.

Natural biological carbon cycles, on the other hand, run at seasonal or annual time scales – we can see them happening in our daily lives: photosynthesis in green leaves, respiration, veldfires and combustion of wood, rotting plants, and so on.

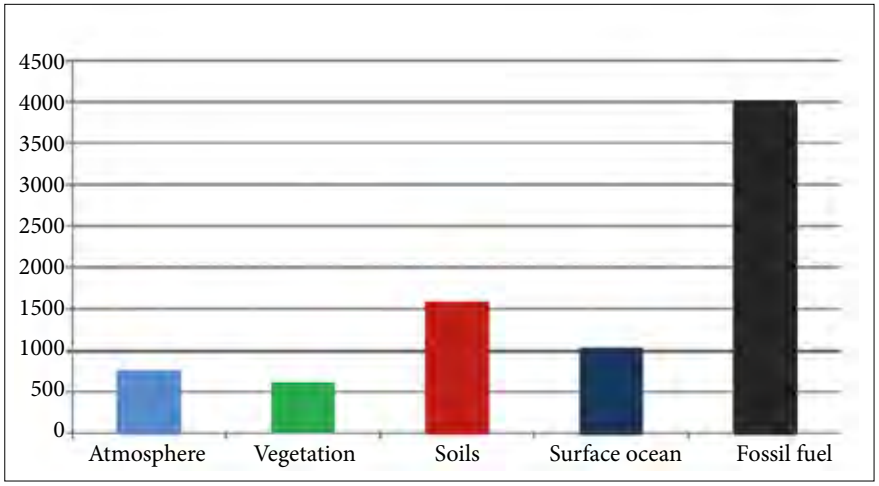

Fig. 2. Amount of carbon in the world's reservoirs (gigatons carbon).

Banner at the COP-17 Conference on the UN Framework Convention on Climate Change.

Using the fluxes in the diagram, we can construct a natural carbon balance where positive and negative contributions refer respectively to removing carbon from, or releasing it into, the atmosphere. Table 1 demonstrates this in gigatons of carbon per year.

This means that the planet, in its natural, pre-industrial state, is a *carbon sink*, capable of removing 2.2 gigatons of carbon from the atmosphere each year, mainly through photosynthesis. It is this natural solar-powered ability to sequester carbon that made life on earth what it is today by reducing the atmospheric CO_2 concentration down to 0.04%, and safely storing the sequestered carbon, with all the solar energy that went into its photosynthesis, as what we now call fossil fuels.

The industrial revolution brought an end to this. Ever since we discovered that there are enormous amounts of stored fossil fuel energy, we have been doing our best to reverse the process. To the negative side of our carbon balance we now have to add 5.5 gigatons of carbon from fossil fuel burning per year. This brings the overall balance to minus 3.3 gigatons of carbon, accumulating in the atmosphere as CO_2, and leading to climate change and global warming through its greenhouse effect.

Fig. 2 shows the current carbon reservoirs that are part of this rapid carbon cycle. Fossil fuels are included because, since the industrial revolution, they have become part of the rapid biological cycle. However, unlike the exchange of carbon among the other reservoirs, fossil fuel combustion is a one-way process. It is not a true cycle. Effectively, it means moving carbon from the tall black fossil fuel bar on the chart and piling it onto the shorter blue atmosphere

Table 1. Positive and negative contributions to the biological carbon sub-cycle

Sub-cycle	Positive	Gt C	Negative	Gt C
Land and vegetation	Mainly photosynthesis	121.8	Respiration	60
			Decay	60
			Burning biomass	1.6
Surface ocean	Mainly photosynthesis	92	Respiration, decay	90
Total		213.8		211.6

bar – the greenhouse gas-containing bar, responsible for climate change.

The result is, effectively, reversal of the process that supports life as we know it – planetary suicide. The planet cannot recycle all that carbon, and if we don't reverse it, will become uninhabitable by humans.

The only lasting solution: Keep fossil fuels in the earth, where nature has put them

Ecuador has large oil reserves in one of the most biodiverse regions of the world. Some years ago social movements and civil society organisations who wanted to protect the biodiversity and indigenous lifestyles began a campaign for a world emancipated from the need to burn fossil fuels – a post-oil civilisation. The campaign is supported by the Ecuadorian government, and by campaigning groups in a growing number of countries. Germany has pledged financial support. The campaign slogan is: *Keep the oil in the soil, keep the coal in the hole, and keep tar sand in the land.*

Although it originated in Ecuador around local issues, the campaign has worldwide implications. If we look at the carbon cycle and its implications, it is clear that its simple, yet radical, slogan points to the only effective and lasting way to combat global climate change.

How well are we teaching health science students about climate change and health?

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Climate change and the issues of sustainable development are a new component of the health sciences curriculum. While the topic is now included in basic education the relevance to healthcare providers, health systems and the healthcare industry needs to be incorporated within higher education institutions.

Health sciences faculties are themselves part of the problem. For example, the Faculty of Health Sciences at Stellenbosch University used 16.4 million kWh in 2010, making it a

Fig. 1. Students and author paint a mural on climate change.

Table 1. Consensus on the medical school curriculum for climate change

Learning objectives

We propose nine learning objectives, of which four are core objectives to be used by all educators, regardless of the teaching format. Learning objectives are based on the WHO Health and Climate Change module.

Core objectives (with optional sub-topics)

1. Climate change as an environmental hazard: explain how climate change impacts on health inequalities and the wider determinants of health

a) Outline the effects of climate change on health:
- Mechanisms by which climate change affects the wider determinants of health
- Disease processes affected by climate change
- Examples of health effects that have already been observed
- Examples of projected health effects

b) Describe the impact of climate change on health inequalities:
- The exacerbation of inequalities through the impact of climate change
- The role of inequalities in causing climate change
- The theory of contraction and convergence

c) Discuss ethical issues over distributive justice in carbon reduction

2. Define the relationship between adaptation and mitigation and the health co-benefits of each

a) Define mitigation and adaptation

b) Give an example of an adaptation measure which runs counter to mitigation strategies

c) Give an example where adaptation and mitigation strategies are synergistic

d) Health co-benefits relating to policies on:
- Redistribution of resources (e.g. carbon allowances)
- Transport, food production, energy generation, home energy efficiency
- Population control

More about...

Table 1. Consensus on the medical school curriculum for climate change (Continued)

3. Demonstrate clinical, leadership and management skills for low carbon healthcare

a) Describe how sustainable lifestyle interventions (e.g. promoting active travel, dietary change, home energy efficiency, sustainable occupations) can be used to prevent common diseases.
b) Describe ways in which patients may be supported to care for themselves (e.g. through patient information & training, provision of direct access to health data, supporting uptake of home therapies, use of shared decision-making techniques, development of patient-centred care plans, provision for flexible/patient-initiated access to care)
c) Demonstrate effective conduct of a telephone consultation with a patient
d) Understand the principles and methods of service improvement with respect to sustainability, efficiency and patient experience. Describe how to obtain feedback from staff and patients, analyse processes, identify improvements and plan how these could be implemented and evaluated
e) Demonstrate awareness of the role of doctors as managers, including seeking ways to continually improve the environmental impact of care, and the use and prioritisation of resources

4. Demonstrate advocacy skills for action on climate change and the determinants of health

a) Demonstrate understanding of the wider implications of the duty of a doctor to 'protect and promote the health of patients and the public': give three ways in which doctors may influence the determinants of health for their patients
b) Explain how behaviour change models apply to promoting healthy, sustainable lifestyles
c) Informal advocacy: discuss with colleagues whether or why individuals in the health system should act on climate change, e.g.:
   - Importance of a healthy global and local environment to the health of patients
   - The potential benefits of sustainable care to patient experience
   - Health economics: increased productivity with fixed resources
   - Compliance with carbon reduction legislation and targets
   - Leadership in local communities
d) Formal advocacy: give a 15-minute presentation or write a letter to senior colleagues on what the health system can do to mitigate against climate change, covering, e.g.
   - Carbon reduction strategy
   - Trust level involvement: monitoring, reporting and reviewing carbon
   - Clinician engagement (prevention, self-care, lean pathways, low carbon treatment choices)
   - Partnerships with local councils and community organisations
   - Advocacy and awareness raising
e) Describe strategies for creating a support network to increase the effectiveness of professional actions
f) Discuss the potential conflicts of interest presented by a transition to sustainable healthcare (e.g. challenge to dominance of bio-medical models in healthcare, patient expectations, commercial interests)

Additional (optional) objectives

5. Explain the basic scientific evidence base for global warming and climate change. Make reference to systems theory and importance of feedback loops (normative and amplificatory) in auto-regulation of climate and global biological systems
6. Critically appraise scientific evidence linking climate change and health
7. Access information sources on climate change, health and mitigation measures and use the information in relation to patient care, health promotion, giving advice and information to patients and research and education
8. Explain the concept of 'carbon footprint' of individuals, organisations, products and clinical pathways, various methods of foot printing and the advantages and disadvantages of each
9. Discuss psychological aspects of environmental behaviour change (why and how people change or don't change)

Source: East of England Teaching Public Health Network (www.eetphn.org), The Campaign for Greener Health Care (www.greenerhealthcare.org), NHS Sustainable Development Unit (http://sustainablehealthcare.org.uk)

'very large power user' according to Eskom. This is the equivalent of 16.8 million kg of carbon dioxide and would require planting 45 073 trees to offset the greenhouse gas emissions. As with all large organisations, faculties need to consider their behaviour in relation to energy use, water use, travel, food consumption, waste and re-cycling, and use of land.

At the Faculty of Health Sciences at Stellenbosch University 'greening up the campus' has been a focus area for the last 2 years. Students, academics and support staff have worked together to create a more sustainable organisation. Current initiatives include retro-fitting the buildings to be more energy efficient, introducing a comprehensive waste and re-cycling plan, establishing a worm farm to handle the organic waste from the student cafeteria, planting trees to offset research air travel, and researching patterns of staff and student travel as well as the sustainability of the student cafeteria. Faculty media and communication channels have been used to regularly promote more sustainable activities. Students have also introduced an

'Earth Week' festival to draw attention to green issues.

Apart from striving for congruence with more sustainable and healthy living on campus the issues have also been introduced into the undergraduate curricula. A network of medical schools in the UK has reached consensus on the core curriculum as shown in Table 1. The elements of this curriculum can be integrated as a 'golden thread' into the existing modules and teaching activities.[1]

Reference available at www.cmej.org.za

SINGLE SUTURE

Immune system may help to trigger the menopause

The immune system may play a role in stopping a woman's biological clock.

John Perry at the University of Oxford and colleagues looked at 43 genomic studies of the menopause, covering more than 50 000 women. By comparing the age that menopause began, Perry's team identified 13 regions with possible links to menopause timing. Three of the regions were housed within genes associated with the immune system. Other regions occurred within genes that control gene repair, regulate hormones and trigger inflammation.

It's not yet clear whether the immune system is the main driver of the menopause or merely a backseat player to biological forces such as hormonal fluctuations. 'This will become clearer when we have identified more of the genetic basis of menopause onset,' says Perry. However, a genetic test to predict when menopause will begin is still a distant prospect.

The link between ovulation and the immune system isn't unexpected; some women with primary ovarian insufficiency, who undergo an unusually early menopause, have an autoimmune disease of the ovaries.

New Scientist, 28 January 2012.