

# YOU'VE GOT TO BE CAREFUL IF YOU DON'T KNOW WHERE YOU'RE GOING BECAUSE YOU MIGHT NOT GET THERE (YOGI BERRA)

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## **Abstract**

The future is uncertain, not just in terms of the magnitude and pattern of climate change but also how socio-economic development will unfold and what that pathway could mean for the vulnerability and resilience of future populations to the health risks of climate change. Scenarios are standard tools for exploring how these health risks might change under different development assumptions (and how climate change could itself affect development), including the timing and effectiveness of adaptation and mitigation policies. Scenarios typically include qualitative and quantitative descriptions of atmospheric composition, climate change and associated physical impacts, and socio-economic development pathways. Although existing scenarios contain factors relevant for exploring health risks in a changing climate, additional variables are needed to project social, economic, demographic and ecological dynamics likely to affect future health burdens, as well as to describe how governance and institutions might change to increase resilience to current and future health risks. New scenarios are needed to explore health-related questions about the future. Professor McMichael's extensive publications on global environmental change focus on questions of how climate change could affect the future sustainability of life on Earth, including how history can illuminate factors determining population health vulnerability.

## Introduction

Climate change will continue to alter weather patterns over coming decades, including more frequent and intense extreme weather and climate events; increases in the average and local variability of temperature, precipitation and other weather variables; and rises in sea level (e.g. IPCC, 2007, 2012). Projections of the magnitude and pattern of these changes offer an opportunity for public health (and other sectors) to modify current policies and measures proactively and develop new means to manage known and anticipated risks effectively and efficiently.

While projections of how the climate could change are necessary, they are insufficient to project health impacts and manage risk. Climate is one of many drivers of climate-sensitive health outcomes. Other drivers also will change over coming decades, including increases in population (albeit not uniformly around the world), the social determinants of health will change from global to local scales, new technologies will be identified and the policy environment for adaptation and mitigation will evolve at the international and national level. Understanding how these other drivers might change will be important for understanding the magnitude and extent of possible impacts. This information is critical for effective risk management, including identifying opportunities for modifying current and planned policies and measures to increase resilience over future decades.

Scenarios are standard tools to understand the magnitude and extent of changes in climate and associated risks, the degree to which mitigation and adaptation policies can reduce risks, the interactions among and trade-offs between climate change impacts, and adaptation and mitigation policies, and the relationship between climate change and development. Scenarios typically include qualitative and quantitative descriptions of socio-economic development pathways, atmospheric composition, and climate change and associated physical impacts.

One focus of Professor McMichael's extensive publications is on questions of how global environmental change could affect the future sustainability of life on Earth, including insights into thinking about development pathways (c.f. McMichael, 2001, 2008, 2012; McMichael and Lindgren, 2011).

## Approaches to and History of Scenario Development

There are two basic approaches for developing scenarios (Ebi and Gamble, 2005). One is to envision a particular future at a particular date and then work backwards to determine the policies, measures and technology developments that are needed to achieve that future. This was the approach used for the Millennium Development Goals (MDGs) (UN Millennium Project, 2005). Specific activities (e.g. national programmes, funding) were recommended to achieve each goal, with the activities updated regularly based on monitoring and evaluation of the efforts to achieve national targets. For example, one goal is to reduce by two-thirds, between 1990 and 2015, the under-five mortality rate. In 2010, it was reported that the number of children in developing countries who died before they reached the age of 5 dropped, between 1990 and 2008, from 100 to 72 deaths per 1000 live births ([www.un.org/millenniumgoals/pdf/MDG\\_FS\\_4\\_EN.pdf](http://www.un.org/millenniumgoals/pdf/MDG_FS_4_EN.pdf)). However, of the 67 countries defined as having high child mortality rates, only 10 are currently on track to meet the MDG target. Activities were proposed or initiated to accelerate the reduction in child mortality to reach the goal in a timely manner.

Another approach, commonly used in the global change research community, is to describe internally consistent pathways from the near to the far future that can be used to explore the possible impacts of climate change under different development pathways, including the possible costs, benefits and harms of adaptation and mitigation policies. Over the past decade, projections of climate change and scenario-based analyses of impacts, adaptation and mitigation have been based primarily on the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES) (Nakicenovic et al., 2000), developed to represent the range of driving forces and emissions in the scenario literature, including reflecting current understanding about underlying uncertainties. The SRES scenarios were developed by first creating internally consistent storylines of possible future worlds (Nakicenovic et al., 2000).

The four main storylines (labelled A1, A2, B1 and B2) describe the relationships between the driving forces of greenhouse gases and sulphur emissions, and their evolution, with each storyline representing different demographic, social, economic, technological and environmental development pathways. The axes of the scenarios are worlds with a more global versus a more regional focus, and worlds with a more economic versus a more social/environmental focus (see Table 33.1). For each storyline, several scenarios were developed using different models to examine the range of possible outcomes associated with similar assumptions about driving forces. Forty scenarios were quantified for

the SRES report, six of which were selected as illustrative scenarios (one for each of the storylines, plus additional high and low emissions variants of the A1 storyline). By design, the SRES scenarios assumed no specifically targeted climate mitigation and adaptation policies and measures.

**Table 33.1 The Intergovernmental Panel on Climate Change emission scenarios from the special report on emission scenarios.**

Driving forces	Economics	Environmentalism
Globalisation	A1 (market forces; economic and technological convergence)	B1 (sustainable development; economic and technological convergence)
Regionalisation	A2 (market forces; slower economic growth)	B2 (sustainable development; slower economic growth)

Source: Nakicenovic et al., 2000.

Quantification of the storylines resulted in estimated emissions of greenhouse gases and sulphur that were used as input to climate models for projecting how patterns of weather variables, such as temperature and precipitation, could vary with climate change. These projections have been used to estimate possible impacts associated with each scenario (IPCC, 2007).

The Millennium Ecosystem Assessment (MEA) was a large assessment of the current status, present trends and longer-term challenges to the world's ecosystems, including climate change and other sources of stress (MEA, 2005). The MEA sought to assess changes in ecosystems in terms of the services they provided to people. It also examined the effects of ecosystem change on human well-being and identified and assessed methods to mitigate and respond to ecosystem change. Scenarios to 2050, with more limited projections to 2100, were developed in an iterative process, including consultations with potential scenario users and experts (Carpenter et al., 2005).

Two basic dimensions of uncertainty in long-term ecosystem stresses were identified: globalisation (continuation and acceleration of present global integration trends) versus reversal of these trends (increasing separation and isolation of nations and regions); and whether responses to increasing ecosystem stresses were predominantly reactive (waiting until evidence of deterioration and loss of services were clear) or predominantly proactive (taking protective measures in advance of their clear need). The extreme values of each of these dimensions yielded four scenarios (see Table 33.2).

**Table 33.2 The Millennium Ecosystem Assessment scenarios.**

Ecosystem management	World development	
	Global	Regional
Reactive	Global orchestration	Order from strength
Proactive	Techno-garden	Adapting mosaic

Source: Carpenter et al., 2005.

One chapter in the MEA described the implications for human well-being of the four scenarios based on qualitative analysis of the storylines, quantitative model results and an assessment of the assumptions underpinning the scenarios (Butler et al., 2005). The extensive work on describing the components of human well-being (basic material needs for a good life; health; good social relations; security; and freedom of choice and action) will be helpful in underpinning the development of new scenarios for use by the health sector to explore the possible impacts of and adaptation and mitigation response options to manage the risks of global environmental change.

The Global Environmental Outlook 4 (GEO-4) conceptual framework is based on the drivers–pressures–state–impacts–responses framework that reflects the key components of the complex chain of cause and effect relationships that characterise the interactions between society and environment at all spatial scales (Agard et al., 2007). Environmental changes are induced by drivers and caused by pressures, which also affect each other. Responses include measures by society for mitigating and adapting to environmental changes.

Through the GEO-4 scenario exercise, stakeholders explored the interplay between environmental issues in atmosphere, land, water and biodiversity. The scenarios were based on assumptions related to institutional and socio-political effectiveness, demographics, economic demand, trade and markets, scientific and technological innovation, value systems, and social and individual choices, and highlighted areas of uncertainty in the coming decades. The main scenarios are:

- **Markets first:** the private sector, with active government support, pursues maximum economic growth as the best path to improve the environment and human well-being.
- **Policy first:** the government sector, with active private- and civic-sector support, implements strong policies intended to improve the environment and human well-being, while still emphasising economic development.
- **Security first:** the government sector and the private sector vie for control in efforts to improve, or at least maintain, human well-being for mainly the rich and powerful in society.

Sustainability first: the civic, government and private sectors work collaboratively to improve the environment and human well-being for all, with a strong emphasis on equity.

## Limitations of Current Scenarios

As the brief summaries of different scenarios indicate, some drivers of global change included in these scenarios are highly relevant to future health burdens, as well as to the effectiveness of future public health and health-care organisations and institutions whose mission is to manage adverse health outcomes. Drivers include population growth, general socio-economic development and the relative emphasis on developing new technologies and investing in research. Factors such as the extent to which countries collaborate suggest regional and international priorities for addressing adverse health outcomes in countries, particularly low-income countries, requiring external funding to manage risks.

Although important for developing narratives on how public health and health care might evolve over the coming decades, additional variables are needed to project social, economic, demographic and ecological dynamics that could affect future health burdens, as well as to describe how governance and institutions might change to increase resilience to current and future health risks (Ebi and Gamble, 2005). For example, the effectiveness of vector control programmes, drug and pesticide resistance, land-use change, travel and a range of other variables not captured by the SRES and other scenarios will affect possible alterations in the geographic range of malaria due to climate change.

Projections and descriptions are needed, from the local to the global scale, to provide decision makers with policy-relevant insights into how the future might unfold. Health researchers and practitioners have been slow to provide input on the variables needed, resulting in scenarios without the richness needed to inform policy- and decision makers on the health risks of global change and the options for managing those risks effectively, including estimates of the health co-benefits and co-harms of mitigation and adaptation policies.

Scenarios also could be enriched with descriptions of the possible impacts of climate change on the frequency, duration, spatial extent and timing of extreme weather and climate events. The IPCC *Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (IPCC, 2012) concluded that recent projections suggested the frequencies of heatwaves and of heavy precipitation are likely to increase in the 21st century over many regions.

There is evidence that droughts will intensify over the coming century in southern Europe and the Mediterranean region, central Europe, central North America, Central America and Mexico, north-east Brazil and southern Africa, but confidence is limited because of issues regarding how to classify and measure a drought, the lack of observational data and the inability of models to include all the factors that influence droughts (IPCC, 2012). In addition, it is very likely that average sea level rise will contribute to upward trends in extreme coastal high-water levels. Further, the projected precipitation and temperature changes imply changes in floods, although, overall, there is low confidence at the global scale regarding climate-driven changes in the magnitude or frequency of river-related flooding, due to limited evidence and because the causes of regional changes are complex.

The effectiveness of particular policies and measures depend on local circumstances, including geography, development pathways, social and cultural contexts, financial and human resources and other factors. Developing scenarios to illustrate the possible risks of extreme weather and climate events would be helpful to ensure that disaster risk management and adaptation activities take into consideration how factors determining risk could evolve over time.

## Health Transitions

One approach to thinking about future public health and health-care pathways is from the perspective of past health transitions (Ebi, 2008). Over the past century, the populations in higher-income countries experienced socio-economic, demographic and epidemiologic transitions from high to low fertility and mortality rates, as well as from high infectious to high chronic disease morbidity and mortality (Omran, 1998; Martens, 2002). Incorporating health transitions into scenarios could provide more nuanced descriptions of possible future population health. Typically, three stages are used to describe these health transitions: the age of famine and infectious diseases, the age of receding pandemics and the age of chronic diseases (Omran, 1998).

- The age of famine is characterised by high fertility and low life expectancy, with infectious diseases the primary causes of death, inadequate food and safe water supplies, limited access to health care and education, insufficient social and economic capital and slow technology development. Many of the least-developed countries are in this stage.
- The age of receding pandemics is characterised by somewhat lower mortality rates and increased life expectancy, primarily from increased access to safe water and adequate nutrition, leading to a reduction in the prevalence of infectious diseases (Omran, 1998). Higher-income countries entered this stage

in the middle of the 19th century. Countries with economies in transition and some low-income countries are in this stage.

- The age of chronic diseases is characterised by improvements in health care and the social determinants of health (Martens, 2002). Chronic diseases are the dominant causes of death, with continued improvements in social circumstances and economic growth, further increases in life expectancy and low fertility rates. High- and middle-income countries are in this stage.

Although many developed countries passed through these phases sequentially, health transitions in developing countries are more complex because recent and current socio-economic and political conditions differ from those prevailing when high-income countries were developing (Ebi, 2008). Many currently developing countries are simultaneously in an age of receding pandemics and an age of chronic disease, with high burdens of infectious and chronic diseases (Martens, 2002). Public health and health care are struggling to cope with this double burden, trying to reduce disease epidemics while also trying to reduce the health consequences of lifestyle choices, high levels of environmental exposures and other factors contributing to chronic disease burdens.

Possibilities for the next stages in the health transition include an age of emerging infectious diseases, an age of medical technology and/or an age of sustained health and an age of reduced life expectancy (Olshansky and Ault, 1986; Olshansky et al., 1998; Martens, 2002).

- An age of emerging infectious diseases could result from the re-emergence of currently controlled infectious diseases and the simultaneous emergence of new infectious diseases. This transition would be characterised by increasing infectious disease rates in high- and low-income countries, with falling life expectancies and economic productivity. Factors facilitating this transition would include travel and trade, microbiological resistance, human behaviour, breakdowns in health systems and increased pressure on the environment (Barrett et al., 1998). A number of worldwide events and trends suggest this transition is possible.
- Increased economic growth, investments in social and medical services and improvements in technology could lead to an age of medical technology and/or sustained health, with associated reductions in lifestyle-related diseases and the elimination of most infectious diseases (Martens, 2002). Life expectancy would increase, with implications not only for medical care and other services but also for sectors from water to energy consumption.
- Another possible pathway for future population health is a decrease in life expectancy and economic productivity owing to an increased burden of lifestyle-related diseases in high- and low-income countries. Trends supporting this health transition include projections for the burden of

obesity and other lifestyle-related diseases in most countries (Mokdad et al., 1999, 2001).

Global issues not considered in many of these pathways could affect health transitions in complex and non-linear ways (Ebi, 2008). Population health and economic growth are affected increasingly by conditions that transcend national borders and political jurisdictions, such as macroeconomic policies associated with international financial institutions, global trade agreements, water shortage and pollution that crosses borders (Labonte and Spiegel, 2003). Further, climate change could affect a transition through potentially devastating impacts on ecosystems, agricultural productivity and water availability (Butler and Harley, 2010). More work is needed to consider how these and other trends could influence socio-economic development, to further our understanding of the range of possible futures in which global change will be operating.

## Discussion

Scenarios are valuable tools for exploring the range of possible interactions between human and natural systems and climate and other global environmental changes. However, developing scenarios is complex because of the multiple and interacting drivers of climate-sensitive health outcomes, with interactions among the drivers.

Ebi and Gamble (2005) recommended that scenario building should first determine why the scenario was being built, such as risk management, to inform policy or for communication purposes. The purpose will influence the baseline variables to be included, the geographic and temporal scale of the scenario and the focus on vulnerability versus impact. The purpose also will determine the kind of scenario needed to achieve the aim, and the appropriate methods and tools for generating the scenario.

Scenarios developed to date have not focused sufficiently on health issues. Modifications of scenarios are needed that specifically identify and address health-related questions about the future. Considerations in health scenario development include:

- Identifying key determinants of population health and how they may evolve into the future. This includes consideration of how to incorporate development pathways.
- Incorporating adaptation, mitigation and adaptive capacity.
- Incorporating thresholds and non-linear events, such as extreme weather and climate events.

- Identifying events or processes that could change projected trends, leading to alternative futures.
- Identifying and characterising critical uncertainties.
- Involving stakeholders in scenario development.

## Conclusion

While the future is inherently uncertain, scenarios are important tools for providing insights into how the future could unfold and what those changes might mean for avoiding, preparing for, responding to and recovering from climate change impacts. Such insights are critical for informing strategies, policies and measures to increase population health resilience now and in the future.

## References

- Agard, J., Alcamo, J., Ash, N., Arthurton, R., Barker, S., Barr, J., et al. 2007. *Global Environment Outlook: Environment for Development (GEO-4)*. United Nations Environment Programme (UNEP), Nairobi, Kenya.
- Barrett, R., Kuzawaa, C., McDade, T. & Armelagos, G. 1998. Emerging and re-emerging infectious diseases: the third epidemiologic transition. *Annual Review of Anthropology* 27, 247–71.
- Butler, C.D. & Harley, D. 2010. Primary, secondary and tertiary effects of the ecoclimate crisis: the medical response. *Postgraduate Medical Journal* 86, 230–4.
- Butler, C.D., Oluoch-Kosura, W., Corvalán, C., Fobil, J., Koren, H., Pingali, P., et al. 2005. Human well-being across the scenarios. In: Carpenter, S.R., Pingali, P.L., Bennett, E.M. & Zurek, M.B. (eds) *Ecosystems and Human Well-Being: Scenarios Vol 2*. Island Press, Washington, DC, USA, 409–29.
- Carpenter, S.R., Pingali, P.L., Bennett, E.M. & Zurek, M.B. (eds) 2005. *Ecosystems and Human Well-Being: Scenarios Vol 2*. Island Press, Washington, DC, USA.
- Ebi, K.L. 2008. Healthy people 2100: modeling population health impacts of climate change. *Climatic Change* 88, 5–19.
- Ebi, K.L. & Gamble, J.L. 2005. Summary of a workshop on health scenarios development: strategies for the future. *Environmental Health Perspectives* 113, 335–8.

- Intergovernmental Panel on Climate Change (IPCC) 2007. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R.K. & Reisinger, A. (eds)]. IPCC, Geneva, Switzerland.
- IPCC (ed.) 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the IPCC* [Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. & Midgley, P.M. (eds)]. Cambridge University Press, Cambridge, UK.
- Labonte, R. & Spiegel, J. 2003. Setting global health research priorities. *BMJ* 326, 722–3.
- McMichael, A.J. 2001. *Human Frontiers, Environments and Disease: Past Patterns, Uncertain Futures*. Cambridge University Press, Cambridge, UK.
- McMichael, A.J. 2008. Public health, the environment and the 21st century: a wider field of vision (Editorial). *European Journal of Public Health* 18, 101.
- McMichael, A.J. 2012. Insights from past millennia into climatic impacts on human health and survival. *Proceedings of the National Academy of Sciences (USA)* 109, 4730–7.
- McMichael, A.J. & Lindgren, E. 2011. Climate change: present and future risks to health, and necessary responses. *Journal of Internal Medicine* 270, 401–13.
- Martens, P. 2002. Health transitions in a globalizing world: towards more disease or sustained health? *Futures* 34, 635–48.
- Millennium Ecosystem Assessment (MEA) 2005. *Ecosystems and Human Well-being. Synthesis*. Island Press, Washington, DC, USA.
- Mokdad, A.H., Serdula, M.K., Dietz, W.H., Bowman, B.A., Marks, J.S. & Koplan, J.P. 1999. The spread of the obesity epidemic in the United States, 1991–1998. *Journal of the American Medical Association* 282, 1519–22.
- Mokdad, A.H., Bowman, B.A., Ford, E.S., Vinicor, F., Marks, J.S. & Koplan, J.P. 2001. The continuing epidemics of obesity and diabetes in the United States. *Journal of the American Medical Association* 286, 1195–200.
- Nakicenovic, N., Alcamo, J., Davis, G., de Vries, B., Fenhann, J., Gaffin, S., et al. 2000. *IPCC Special Report on Emissions Scenarios (SRES)*. Cambridge University Press, Cambridge, UK.

- Olshansky, S.J. & Ault, A.B. 1986. The fourth stage of the epidemiologic transition: the age of delayed degenerative diseases. *Milbank Quarterly* 64, 355–91.
- Olshansky, S.J., Carnes, B.A., Rogers, R.G. & Smith, L. 1998. Emerging infectious diseases: the fifth stage of the epidemiologic transition? *World Health Statistics Quarterly* 51, 207–17.
- Omran, A.-R. 1998. The epidemiological transition theory revisited thirty years later. *World Health Statistics Quarterly* 51, 99–119.
- UN Millennium Project 2005. *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals*. Earthscan London, UK.

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