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Strengthening the base: preparing health research for climate change

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Strengthening the base: preparing health research for climate change

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Executive summary

As recognition of the reality of climate change grows, so too does the awareness of its current and potential impact on global health. There is irrefutable proof of climate change due to human activity, most notably caused by the release of greenhouse gases from fossil fuel use. The impact is expected to accelerate if immediate steps are not taken to mitigate greenhouse gas emissions. While this primary cause of climate change comes largely from high-income countries, as low- and middle-income countries grow they also will add to the problem. It is a global problem but it is clear that it will be the people of the developing world on whom climate change will exact the greatest toll – the same populations that already bear the heaviest burdens of infectious and chronic diseases. Millions are at risk of increasing health problems stemming from floods, drought, windstorms and the spread of disease enabled by warming temperatures. While there is need for a response to health threats caused by climate change for all the world's people, it is especially urgent for those in the developing world, especially for large populations in Asia and Africa.

The optimum strategy for the South is to strengthen current public health systems to ensure safe water and food supplies, sanitation and disaster preparedness while preventing an increase or emergence of disease. These steps will increase the resilience of these regions to deal with gradual and abrupt climate change events.

As low- and middle-income countries build resilience, they can also use basic and innovative strategies specific to their needs to draw on the impact assessments and strategies that have already been developed by richer nations. The recent increase in global concern about climate change has given rise to a willingness to address climate change collectively, using fiscal transfers, knowledge translation and collaboration. Knowledge translation of the complex science of climate change is primarily being done through governmental and intergovernmental organizations but civil society must also be engaged.

Research on climate change and health needs to be interdisciplinary; it also must be both empirical and applied. It needs to look at broad ecological, demographic and socioeconomic issues to assess both the impact and the opportunities for intervention. Climate change presents complex problems in multiple settings, sometimes under severe pressures. Existing ecological frameworks need to be evaluated and interventions developed that integrate climate change into existing public health models.

Research on ways to mitigate the effects of greenhouse gases from fossil fuel use is absolutely essential. These gases have been shown to be the primary cause of climate change. Mitigation would have a long-term impact on arresting further impacts. However, significant climate change already appears inevitable and research on adaptation to the changing climate is also critical. Research should progress concurrently in both areas; neither stream of research can replace the other. Mechanisms are being

put in place through intergovernmental efforts to accelerate research on mitigation strategies, an effort that is supported by increasing public and industry interest in cleaner energy production technologies. Alternate multidisciplinary funding streams for research and knowledge translation and dissemination need to be established for the human health needs for adaptation to climate change.

Funding for research on the health effects of climate change and adaptation mechanisms is significantly limited. There has been some concern that research on health effects of climate change may detract from the already limited research funds for other pressing needs. It is imperative to integrate climate change research into relevant areas of health and social sector research to ensure that progress made in these areas are not then offset by the effects of climate change. Research initiatives pertaining to food security, water and sanitation, vector-borne diseases, air quality, thermal stress and emergency preparedness must identify how they have adjusted for progressive climate change in a sustainable way.

The need for research and action is urgent. Climate change must become a priority in health research frameworks and it must be recognized by policy-makers from both health and non-health backgrounds. Public health systems must be strengthened, impact assessments must be completed and responses, including adaptation, should be health-advancing.

The concern regarding climate change research is consistent with the mission of the Global Forum for Health Research, which is to apply research to the health problems of the world's poor and most vulnerable. When the Global Forum endorsed the need to achieve the eight Millennium Development Goals (MDGs) in 2000, climate change was just beginning to be recognized and its widespread effects on health were largely unclear. Now that we know more, it would be irresponsible not to employ our efforts to sensitize key players and initiate research to combat this latest health threat that adds to and exacerbates existing ones. The concern with climate change will complement efforts to achieve the MDGs, not detract from them.

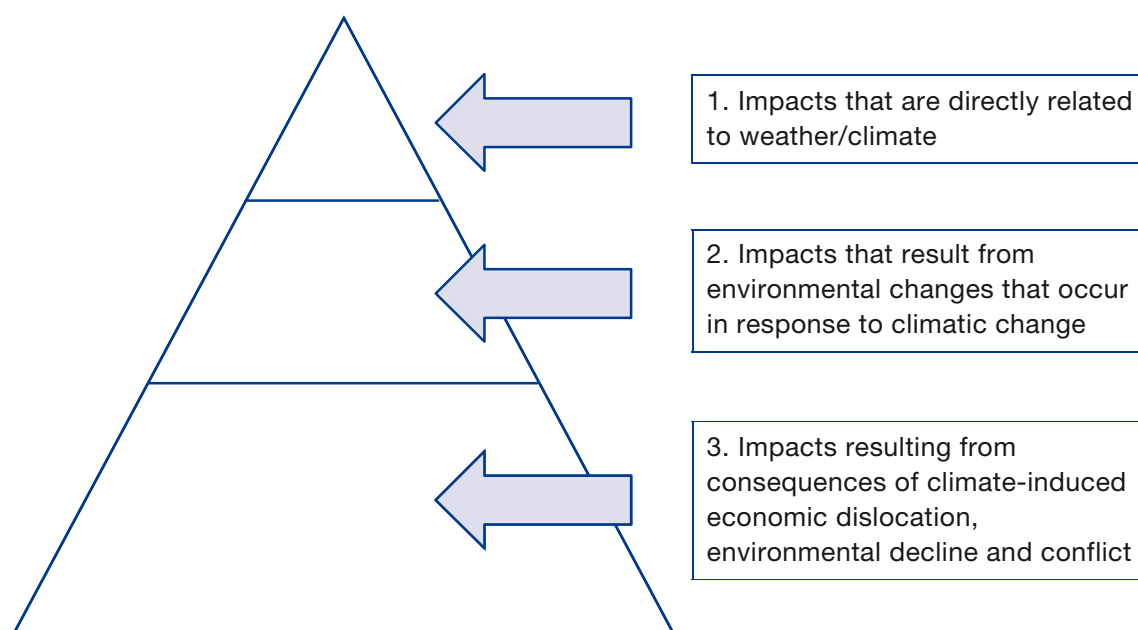
Framework

Research on climate change and health intersects and builds on other scientific and social areas concerned with the earth's changing environmental patterns. By identifying the role of health researchers within this arena, other researchers from non-health backgrounds may be encouraged to contribute from their respective fields and collaborate for a broader understanding and better solutions. Just as health research has progressed from description of disease, epidemiology and risk factors to more upstream determinants of health issues, climate change research in general and climate change/health research in particular will benefit from inclusion of researchers from diverse backgrounds and approaches.

Categorization of health impacts

Figure 1 postulates the three broad categories of health impacts to result from changing climatic conditions (as given in Ebi¹, from McMichael 2001 IPCC Health²):

Figure 1: Three broad categories of health impacts



¹ Ebi KL, Kovats RS, Menne B. An approach for assessing human health vulnerability and public health interventions to adapt to climate change. *Environ Health Perspect.* 2006 Dec: 114(12):1930-4

² McMichael A, Githeko A, Akhtar R, Carcavallo R, Gubler F, Haines A, et al. 2001. Human health. In: *Climate Change 2001. Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* (McCarthy JJ, Canziani OF, Leary NA, Dokken DJ, White KS, eds). Cambridge, UK: Cambridge University Press, 451-485

While significant advances have been made in understanding trends and impacts of direct health effects of climate change in the developed regions of the world, not all of those can be directly translated to the developing world. Investment in capacity to measure, analyze and integrate climatic data would aid understanding of the situation in poorer countries.

Modeling to estimate more downstream, longer-term impacts of climate change would focus on the effects on changing ecology, biodiversity and species loss and variation in rain, freshwater and other environmental parameters. Robust data and analysis over time from a variety of sectors is needed for the modeling of these impacts. In addition, enhancement of interdisciplinary, transnational and regional research capacity is required.

To determine the impact of climatic and environmental changes on societies now and in the future, researchers are able to construct dynamic research models, which can be validated and scaled so that users from various disciplines can develop tools for estimating and communicating impacts and plans for their remediation. This type of complex predictive modeling can be accomplished through access to the Internet and computational resources; researchers, planners and civil society can all use the same tools but different interfaces.

New climate models enable a much higher level of spatial resolution than the older continental scale models and can generate information over tighter time periods. Thus, national planners may be able to use near-term local climate scenarios to focus on regional impact and vulnerability assessments.

National-level assessments for impact of climate change on health

Enhanced research capacity at local, regional and national levels is needed to provide support for country-level assessments being developed with assistance from the World Health Organization. Standardized templates for national-level assessments would aid comparison and make possible collaboration for intervention and evaluation. These include:³

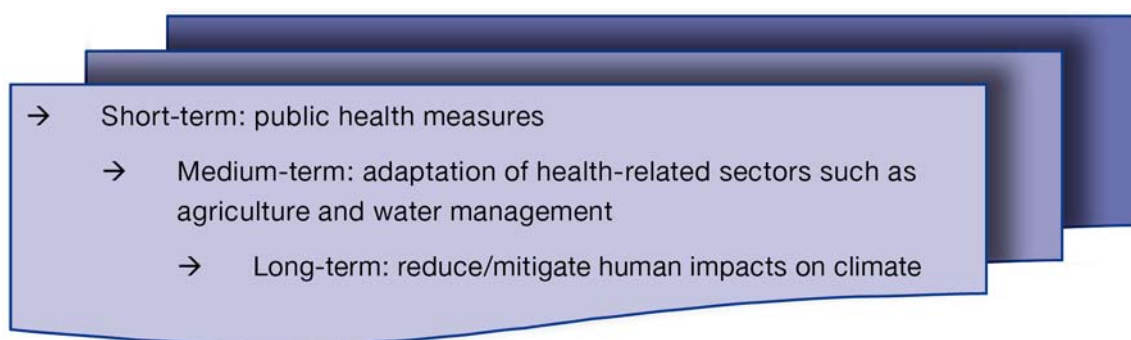
- scope of the assessment;
- distribution and burden of climate-sensitive health determinants and outcomes;
- identification and description of current strategies, policies and measures to reduce the burden of climate-sensitive health determinants and outcomes;
- health implications of impacts of climate variability and change to other sectors;
- estimation of potential health impacts using scenarios of future changes in climate, socioeconomic factors, etc.;
- synthesis of the results;
- identification of additional adaptation policies and measures to reduce potential negative health impacts.

³ Ebi KL, Kovats RS, Menne B. An approach for assessing human health vulnerability and public health interventions to adapt to climate change. *Environ Health Perspect.* 2006 Dec;114(12):1930-4

Short-, medium- and long-term responses

Emphasis on proven public health measures, implemented immediately, is a first significant step to address some current climate change impacts and help prepare for the future. Research needs to focus concurrently on medium-term issues such as drought resistant crops and more efficient water use for agriculture, industry and sanitation; over the longer term, the benefits to health from successful mitigation strategies, such as improved air quality, need to be evaluated and ranked as outcomes. A simultaneous application of short-, medium- and long-term responses is needed to address, mitigate and prepare for the impact of climate change on health (Figure 2).⁴

Figure 2: Responses to prepare for the impact of climate change on health



Furthermore, action on factors that impact on health as well as determinants of health is required (Figure 3).

Figure 3: Factors that impact on health as well as determinants of health

Health risk	>	Primary prevention: mitigation	>	Secondary prevention: minor adaptation until mitigation effective	>	Tertiary prevention: major adaptation assuming no effective mitigation takes place
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Geographical scope of research

National-level assessments of climate change have been carried out around the world, from the United States and China, the world's two greatest producers of greenhouse gases, to the small countries most vulnerable to the consequences of global warming, the 51 small island developing states scattered throughout the world's oceans. Not

⁴ Adapted from Cambell-Lendrum D, Corvalan C, Neira M. Global climate change: implications for international public health policy. Bull World Health Organ, Mar. 2007, vol.85, no.3, p.235-237

surprisingly, high-income countries have done far more impact assessment than low- and middle-income countries. There is a need for regional impact and vulnerability assessments of common threats that affect many countries. The effects of large-scale displacement of populations or of declining water supplies and quality of water concern many countries and require a coordinated regional research response.

Environmental impact assessments

Most country-level environmental impact assessments have been done in OECD countries or have been global surveys calling attention to areas especially vulnerable to climate extremes. Key findings are described, but adaptation recommendations have not been uniformly made in these assessments.

Ecological consequences

There are several frameworks to approach ecological integrity; the more specific ones for climate change take a broad “determinants of health” approach. Research in the development and application of an integrated ecological approach is necessary for climate change and the linked issues of ecological sustainability.⁵ A variety of broad approaches and frameworks need to be applied in order to understand the impact of not just climate change but also other broad ecological and population pressures.⁶

Humans and animals are especially vulnerable to diseases that increase with temperature and humidity, two characteristics of global warming. This may increase the dual threats of vector-borne diseases and emerging (or re-emerging diseases) that will tax current health-care systems and bring new challenges to entire populations, but especially the young, the old and those already ill. On a larger scale, these health issues may also contribute to the emigration of “environmental refugees.”

⁵ Burkhardt HA. Full Spectrum Integrity Index of nations. In Soskole C, ed Sustaining life on Earth. 2008. Lexington Books.

⁶ Ladd B, Soskolne C. A toolkit for ecoepidemiological enquiry under global ecological change. In Soskole C, ed Sustaining life on Earth. 2008. Lexington Books

Chronology of the climate change agenda

Table 1: Chronology of the climate change agenda

Theme	Timeline
1. Climate change identified as a scientific reality	1890's to early 1990's ⁷
2. Science of climate change endorsed by policy-makers, governments and intergovernmental panels	1990's to present
3. Steps to mitigate climate change described	1960's to present
4. Country-level assessments on climate change, mitigation and adaptation	1990's to present
5. Call for action to mitigate irreversible global climate change.	2000 to present
6. Concerns about abrupt climate change	2000 to present

Table 2: Chronology of research on the health effects of climate change

Theme	Timeline
1. Health effects of climate change postulated	1950's to present
2. Future health effects modeled given different scenarios of mitigation, population growth and other factors	1980's to present
3. Early health effects of climate change observed	1990's to present
4. Some climate change seen as inevitable irrespective of degree of success of mitigation measures. Adaptation introduced as a key strategy to reduce the health impacts of climate change	1990's to present

Estimated magnitude of direct health effects

There are several estimates of the direct and indirect effects of climate change. While the direct effects have been estimated with some confidence, the indirect effects are less evident. Most estimates come from research in high-income countries and have to be extrapolated to poorer regions and countries with varying climates, demography and economic conditions. There are areas of knowledge that are more transferable than others, such as physiological responses to heat. Other information is strongly dependent on the setting and will require local research, for example, the “dose” of heat received by city dwellers, which is highly behaviour-dependent.

While mortality is quoted most reliably, morbidity and impacts on quality of life and social cohesion are harder to quantify. Research is essential to identify some of the emerging health and societal effects and to develop indicators that reflect their relationships. As the climate continues to change, so must our knowledge and preparations change. Research in low- and middle-income countries must be updated

⁷ Climate change overview. Environment Canada. Accessed Dec 2007. <http://www.ec.gc.ca/climate/timeline-e.html>

just as research in richer countries is. When the 2008 UK report on health effects of climate change includes plans for containing malaria in the UK and forecasts increased skin cancer caused by exposure to sun, it is clear that contingencies in poorer countries should also be adjusted.

Direct effects are better understood through observation and modeling while indirect effects are dependant on other key variables. For example, if water and sanitation improve, deaths due to diarrhoea will decrease. If water and sanitation levels stay the same or worsen, deaths due to diarrhoea will increase significantly. Similarly, global food production capacity currently appears to be maintainable over the medium term – 50 to 80 years. However, there will be marked regional variations in food production with poorer, more densely populated regions facing significant shortages as droughts and floods affect crops. Global flow of food through open trade and aid may be able to address this regional imbalance. Business as usual or diversion of agricultural land to non-food production uses will significantly increase global malnutrition, especially in the poorest and most vulnerable populations.

Increased recognition and understanding of climate change in the past 20 years has resulted in better appreciation of its effects on health, especially the direct effects. High-income countries will face a much lower burden of direct health effects, for example, from vector-borne diseases and thermal heat stress. Compared with low- and middle-income countries, they are relatively well prepared to adapt to the health effects even if mitigation is unsuccessful or delayed. Lower income countries however face significant health challenges from vector-borne diseases, weather extremes and thermal stress. Numerous initiatives, including the Millennium Development Goals,⁸ have thus far been only partially successful in meeting health challenges. When climate change results in increased morbidity and mortality, the extent of the impact will depend not primarily on climate specific adaptation strategies, but on the underlying capacity of regions to meet the basic public health needs of their populations.

⁸ UN Millennium Development Goals. <http://www.un.org/millenniumgoals/>

Research areas and approaches

Table 3: A conceptual map of research areas and domains

Health impacts of climate change	>	Research	>	Evidence	>	Policy	>	Action
Adaptation to climate change								
Impact of mitigation on health								
		↑		↑		↑		↑
		What works		Can it be applied to other settings: - Translation - Generalization - Cost		What incentives exist for reducing the impact on health		Who will put in place these measures? May not always be the health or public sector

Research approaches, broadly defined

Impact: Ascertaining the impact of climate change for direct, indirect and possible health effects. Among these, direct health effects have been the best described in the literature. However, there is an increasing interest in estimating indirect and possible health impacts.

Adaptation: Research on measures for adaptation to climate change has become an increasing focus, especially in Europe or other areas where there is good information on impacts already and where resources exist for both the adaptive measures and their evaluation.

Mitigation: Researching strategies for mitigating climate change include studies from the energy resource perspective as well as the industry and consumer perspective.

Published literature has been weighted towards high-income countries; there is increasing realization of gaps in knowledge in all three areas in low- and middle-income countries.⁹

⁹ Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds. Cambridge University Press, Cambridge, UK, 391-431

Climate change impacts on health

Direct effects

Heat waves and continued thermal stress

Recent decades have seen some of the highest temperatures on record, especially in temperate areas such as Western Europe. Nearly 35 000 deaths were recorded in the European heat wave of 2003. The United Nations has warned of an increase in frequency and duration of heat waves in Asia and Latin America that will increase mortality and morbidity. It also has predicted that heat waves will hinder ability to achieve the Millennium Development Goal of reducing child mortality. Heat waves have become accepted as an important direct cause of increased mortality.^{10,11,12} Additionally, there are suggestions that increased exposure to sun in some populations may lead to higher incidence of skin cancer.

Global populations, and especially populations in low-income countries, are rapidly urbanising. Urban environments will amplify the climatic thermal stresses of global warming.¹³ Poorly planned urban environments will also contribute to indirect health effects including water pollution, introduction and amplification of urban adapted vector-borne diseases such as dengue and health effects of air pollution and ground-level ozone. Based on current planning assumptions, while cities in richer regions may be able to address some or all of these issues, it appears unlikely that cities in poorer regions of the world will.¹⁴

Extreme weather events

Major storms and floods have occurred during the past two decades that have put an increasing number of people at risk. In 2004, floods in Bangladesh displaced 20 million people and hundreds of millions of dollars of crops were lost. In China, floods affected 130 million people in 2003, in Venezuela 30 000 died from floods and landslides in 1999. In the United States, Hurricane Katrina claimed 1836 lives in 2005 and became the costliest natural disaster in its history and the sixth strongest Atlantic hurricane ever recorded.

Accelerated melting of the polar ice will contribute to sea level rise, putting at risk people in areas that had never experienced flooding before. Densely populated mega deltas in Asia and Africa and islands will be especially vulnerable.

¹⁰ Meehl, GA et al., Heat Waves in the 21st Century More Intense, More Frequent, and Longer Lasting. *Science* 305, 994 (2004)

¹¹ Hajat S, Armstrong BG, Gouveia N, Wilkinson P, Mortality displacement of heat-related deaths: a comparison of Delhi, São Paulo, and London. *Epidemiology*. 2005 Sep;16 (5):613-20

¹² Kosatsky T, The 2003 European Heat Waves. *Eurosurveillance*. Vol 10, Issue 7- 9 July 2005

¹³ Wilby RL, Perry GLW, Climate change, biodiversity and the urban environment: a critical review based on London, UK, *Progress in Physical Geography* 30 (1): 73-98 FEB 2006

¹⁴ Dawson R, Re-engineering cities: a framework for adaptation to global change *Philosophical transactions. Mathematical, physical, and engineering sciences* [1364-503X] yr:2007 vol:365 iss:1861 pg:3085-3098

Air pollution, aeroallergens

Climate change is expected to aggravate health effects of air pollution due to particulates, chemical smog and ground-level ozone. Changing plant ecology could increase allergies.^{15,16} As mitigation measures are successful, some of these negative impacts may halt or reverse. Reversals are currently already happening in richer regions of the world but in poorer regions, significant technology transfer would be required before that could happen.

Research is needed to determine whether the heightened concentrations of ground-level ozone in urban areas may increase the frequency of cardiovascular and other diseases.

Indirect effects

Food/water supplies

While global food supply would likely be maintained, significant regional imbalances are expected to occur. High-income countries are expected to increase cereal yields, but not all of it may be used for food. Low- and middle-income countries will face wider regional variations and reductions in food crops.¹⁷ This is expected to exacerbate malnutrition in the poorest regions of the world.

Droughts affect people directly, both by shortages of drinking water and indirectly through crop failures. Food and water shortages become components of security concerns when they lead to conflict. Food and water contamination, due to unusually warm and/or wet weather, can lead to disease, such as cholera and diarrhoea, which tend to take the greatest toll on vulnerable populations.

Vector-borne and water-borne infectious disease

The geographic range of certain diseases will expand, bringing diseases like malaria, dengue fever and West Nile virus to areas that were once too cool for mosquitoes. Water-borne diseases such as cholera are life-threatening and spread quickly.

Postulated

There are many potential problems connected with the uncertainties of climate change. Most are poorly quantified or difficult to predict:

- social, environmental and economic disruption
- conflict due to resource shortages, especially water
- population migrations due to agricultural failures, floods.

¹⁵ Beggs PJ (2004) Impacts of climate change on aeroallergens: past and future. *Clinical & Experimental Allergy* 34 (10), 1507–1513

¹⁶ Bell M et al. Climate change, ambient ozone, and health in 50 US cities. *Climatic change* 2007 vol:82 iss:1-2 pg:61-76

¹⁷ Parry, M. L., Rosenzweig, C., Iglesias, A., Livermore, M. & Fischer, G. Effects of climate change on global food production under SRES emissions and socioeconomic scenarios. *Glob. Environ. Change* 14, 53--67 (2004)

Research already done on climate change/health

Empirical/observational research

Most of the published literature in this category focuses on past and present trends on climatic conditions (e.g. mean seasonal temperatures) as well as direct and indirect health effects (mortality from heat stroke, frequency of hurricanes and flooding, etc.). There is a research need to standardize the indicators used and make the reporting comprehensive and comparable at the global level. Trends need to be shown by countries as well as by geographically and climatically contiguous regions.

Country-level assessments

Sixteen national health impact assessments of climate change are summarized in the 4th Intergovernmental Panel on Climate Change (IPCC) report in 2007.¹⁸ Eleven were from industrial countries and five from low- and middle-income countries, emblematic of the disparity in capacity and incentives for such assessments. Key findings from the countries, however, were similar: an increase in heat-related deaths, vector-borne diseases, loss of life and disease caused by floods and other natural disasters. An opportunity exists to support a regional approach for country-level assessments to make it easier for low- and middle-income countries to take action on these findings. Intergovernmental organizations such as the World Health Organization and regional universities can play a synergistic role with national governments in developing common templates for conducting such assessments, refining the methodology, research on evidence of impacts; tools for translating evidence into actionable policies; creating capacity to take action and evaluation of interventions for replication.

A regional approach on impact, policy and adaptation may also foster collaboration for stewardship of dwindling resources.

Forecasting of health and other impacts given different mitigation scenarios

This is a complex area and relies on data inputs from a variety of sectors including industry, energy, agriculture, etc. Because the inputs and impacts are multisectoral and transnational a legislative and regulatory framework needs to be established to aid data sharing in a timely and transparent manner.

¹⁸ Pp 395, Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds. Cambridge University Press, Cambridge, UK, 391-431

Adaptation as a key strategy to address climate change

The precautionary principle of public health states that any negative effects on health should be avoided even when the full evidence is not available. It is clear that the adverse health effects of the early stages of gradual climate change are already being felt and adaptation to an unknown degree of climate change is necessary. The 2007 UN Framework Convention on Climate Change has highlighted the urgency of adaptation for low- and middle-income countries. However, the issue of more dangerous climatic events should not be forgotten. Most estimates of the impact of climate change on health have been conservative and have probably underestimated the direct and indirect effects.

Adaptation measures vary according to a variety of factors, including estimates of impact, capacity and resources to adapt. Research is required to develop iterative models to make it easier for planners to determine the priorities in a given context and the comparable cost-effectiveness of interventions. Since climate change impact and adaptation will occur within the context of existing public health pressures, climate change adaptation indicators need to be integrated into the current lexicon of health and environmental indicators and not exist in isolation. Interaction models that show synergies in both impact as well as response need to be developed to aid evaluation and planning.

Funding climate change research

1. Due to the multisectoral nature of climate change research, funding has come mostly from national research granting organizations.¹⁹
2. The focus of research has been the environmental health units of public health departments of universities, with increasing linkages to other faculties within the universities (such as geography, natural resources, agriculture), as well as collaboration with intergovernmental organizations such as the World Health Organization (WHO), the United Nations Framework Convention on Climate Change (UNFCCC), IPCC, the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP).
3. Nongovernmental organizations (NGOs) have an increasing role in translating research to policy.^{20,21,22}
4. Most of the policy-level discussions propose mitigation strategies combined with carbon and emission taxes on producers of greenhouse gases.²³ It is not clear how fiscal transfers would occur, of what magnitude they would be or what preconditions might be set. It must also be determined whether they would assist the health and other adaptations of the most vulnerable populations or go into a general fiscal pool to benefit those most affected by climate change.
5. WHO is piloting interventions with UNDP and the Global Environmental Facility (GEF) as an example of actionable interventions with the potential of replication in other regions.²⁴
6. Many donor agencies are investing in collaborative efforts for mitigation, which is crucial to reduce the impact of climate change in the medium- to long-term period. Significantly less emphasis is being placed on adaptation measures on the donor agencies' agendas, an area where the agricultural sector is getting some attention but health is poorly represented.^{25,26} Much less information is currently available about the costs and effectiveness of adaptation than about mitigation.

¹⁹ Identifying National Research Priorities for the Environmental Influences on Health. Canadian Institutes for Health Research <http://www.cihr-irsc.gc.ca/e/1155.html>

²⁰ Pew Center on Global Climate Change <http://www.pewclimate.org>

²¹ Tyndall Centre for Climate Change research UK www.tyndall.ac.uk

²² Combating Climate Change Theme. Leadership in Environment and Development. <http://www.lead.org/page/48>

²³ Bodansky D, International Climate Efforts Beyond 2012: A Survey of Approaches. Pew Center on Global Climate Change November 2004

²⁴ WHO Climate Change and Health Programme Activities. <http://www.who.int/globalchange/climate/activities/en/index.html> Accessed 9 Jan 2007

²⁵ Adapting to Climate Variability and Change. USAID. http://www.usaid.gov/our_work/environment/climate/policies_prog/vulnerability_overview.html. Accessed 6 Jan 2008

²⁶ UNFCCC Adaptation. <http://unfccc.int/adaptation/items/2973.php>. Accessed 6 Jan 2008

Challenges in researching climate change and health

Key gaps in research

1. National assessment of the potential impact of climate variability and change are missing from many low-income countries.
2. Most assessments have ignored indirect effects and concentrated on only five direct health effects of climate change:
 - heat waves and continued thermal stress
 - extreme weather events (e.g. storms, floods)
 - air pollution
 - food and water supplies
 - vector-and water-borne diseases.
3. Although the impact of direct health effects will be greater in warmer latitudes, little research on the needs for planning, designing, delivering and evaluating interventions and adaptation measures in low-income settings has been done.
4. Study is needed of interactions between the direct and indirect effects of climate change; these are complex and multilevel and require interdisciplinary and transdisciplinary research.
5. Social, political, economic and security issues related to climate change are vitally important but not well understood. The United Nations Security Council has voiced concern with the impact of climate change including the health and social effects of displacement of environmental refugees:
 - “Flooding, disease and famine and from that, migration on an unprecedented scale.
 - Drought and crop-failure and from that intensified competition for food, water and energy.
 - Economic disruption on the scale predicted in the Stern Report and not seen since the end of World War II”.²⁷

This assessment calls for research in areas of regional governance and cooperation to ensure that acute emerging stresses can be predicted and managed.

6. The capacity for adaptation for low-income countries needs to be clarified.
 - Adaptation for low-income countries can only occur on the foundations of a strong, effective and sustainable public health system.
 - The gains made in public health infrastructure by middle-income countries need to be sustained and the coverage made more equitable.

²⁷ UN Security Council debate on energy, climate and security. Speech by UK Foreign Secretary Margaret Beckett. New York 17 April 2007
<http://www.fco.gov.uk/servlet/Front?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1007029391629&a=KArticle&aid=1176454354972>

- Middle-income countries need to pool research and knowledge translation resources with high-income countries to minimize the health impacts of climate change.
 - A broad, sustained effort to strengthen public health infrastructure in low-income countries must be the main focus, otherwise efforts directed against postulated climate change impacts will certainly fail. Low-income countries are low greenhouse gas producers and will have a minor role to play in mitigation beyond environmental preservation. They are also the most poorly equipped to adapt to climate change and will see the earliest and most severe effects of it.
7. Effective programs must address current environmental and climatic risks. The areas of the world that will be impacted most significantly by climate change, and appear to be least able to adapt to it, are areas that are already facing severe and deteriorating environmental conditions and demographic pressures. For most of these issues technical solutions such as those implemented in middle-income countries are not applicable to a significant proportion of the population in low-income countries. The reasons for this may be macro- or microeconomic, organizational, related to cultural acceptability or local adaptability.

Key issues for low-income regions

1. “High levels of vulnerability and low adaptive capacity in the developing world have been linked to factors such as a high reliance on natural resources, limited ability to adapt financially and institutionally, low per capita gross domestic (GDP) product and high poverty and a lack of safety nets. The challenges for development are considerable, not least because the impacts are complex and highly uncertain.”²⁸
2. There is a need to conceptualize vulnerability not just as a determinant for poor outcomes but also as a starting point for determining and enhancing adaptive capacity at the household and societal level.²⁹
3. Research on how to translate technical knowledge into interventions in resource poor settings.

²⁸ Thornton PK, Jones PG, Owiyo T, Kruska RL, Herrero M, Kristjanson P, Notenbaert A, Bekele N and Omolo A, with contributions from Orindi V, Otiende B, Ochieng A, Bhadwal S, Anantram K, Nair S, Kumar V and Kulkar U (2006). Mapping climate vulnerability and poverty in Africa. Report to the Department for International Development, ILRI, PO Box 30709, Nairobi 00100, Kenya. <http://www.dfid.gov.uk/research/mapping-climate.pdf>

²⁹ Füssel, H-M. Vulnerability: A generally applicable conceptual framework for climate change research (2007) *Global Environmental Change*, 17 (2), pp. 155-167

Table 4: Example of a framework for North-South and South-South consultations on research, knowledge translation and capacity

Issue	Do technical solutions exist?	Are technical solutions successfully implemented in low-income countries?	Barriers to implementation	Opportunities for research, knowledge translation, implementation and evaluation
Vector-borne diseases	Yes	Somewhat	Climate, geography, economy, governance.	Solutions need to be appropriate, acceptable and sustainable.
Disasters: hurricanes, cyclones	Limited	Limited	Vulnerable populations.	Increase state and community capacity and resiliency to predict and respond to natural disasters.
Water stress	Limited	Limited	Loss of local control over water resources. Powerful competing interests for decreasing fresh water supplies.	Resource-poor communities have traditionally conserved water; local knowledge and empowerment has to be linked to new technologies for water conservation.
Safe water supply	Yes	Not uniformly	Macroeconomic limitations; lack of local training and infrastructure.	National fiscal transfers to public health; investment in infrastructure and point of use capacity.
Changing agricultural yield	Historically strong capacity to increase agricultural yields.	Significant experience in translating research into improved agricultural yields.	Some areas may have peaked in their capacity to sustain increasing yields.	Understanding fundamental changes that may be required in crop types.
Poverty and inequity	Limited	Significant successes related to micro credit, literacy and empowerment.	Continuing unmet needs in female literacy and gender equity.	Demonstrating how addressing poverty and inequity can increase community capacity and social capital.
Conflict	Limited	Non-conflict based dispute resolution as advocated by intergovernmental organizations and local and global civil societies.	Perceived national self-interest. Historical rivalries.	Demonstration of non-conflict based solutions as ultimately more sustainable.

Priorities for research and intervention in climate change and health

Key points

1. Research should be linked to knowledge translation and sustainable intervention.
2. Research on cost effective, equitable and sustainable interventions must take priority over research on surveillance, estimation and modeling of health effects and impacts, all of which should continue.
3. There is need to develop scaleable models (for estimating and modeling health effects and impacts) that are accessible for use by resource-poor communities, regions and states.
4. Interventions specifically for climate change will fail in the absence of a robust and credible public health system that encompasses disease prevention, provision of water supplies and sanitation, health education and promotion, early diagnosis and treatment.
5. If a cost-effective, efficient and sustainable public health system is in place to treat the current burden of disease, it may also efficiently address, with appropriate modifications and adjustments, disease attributable to climate change.

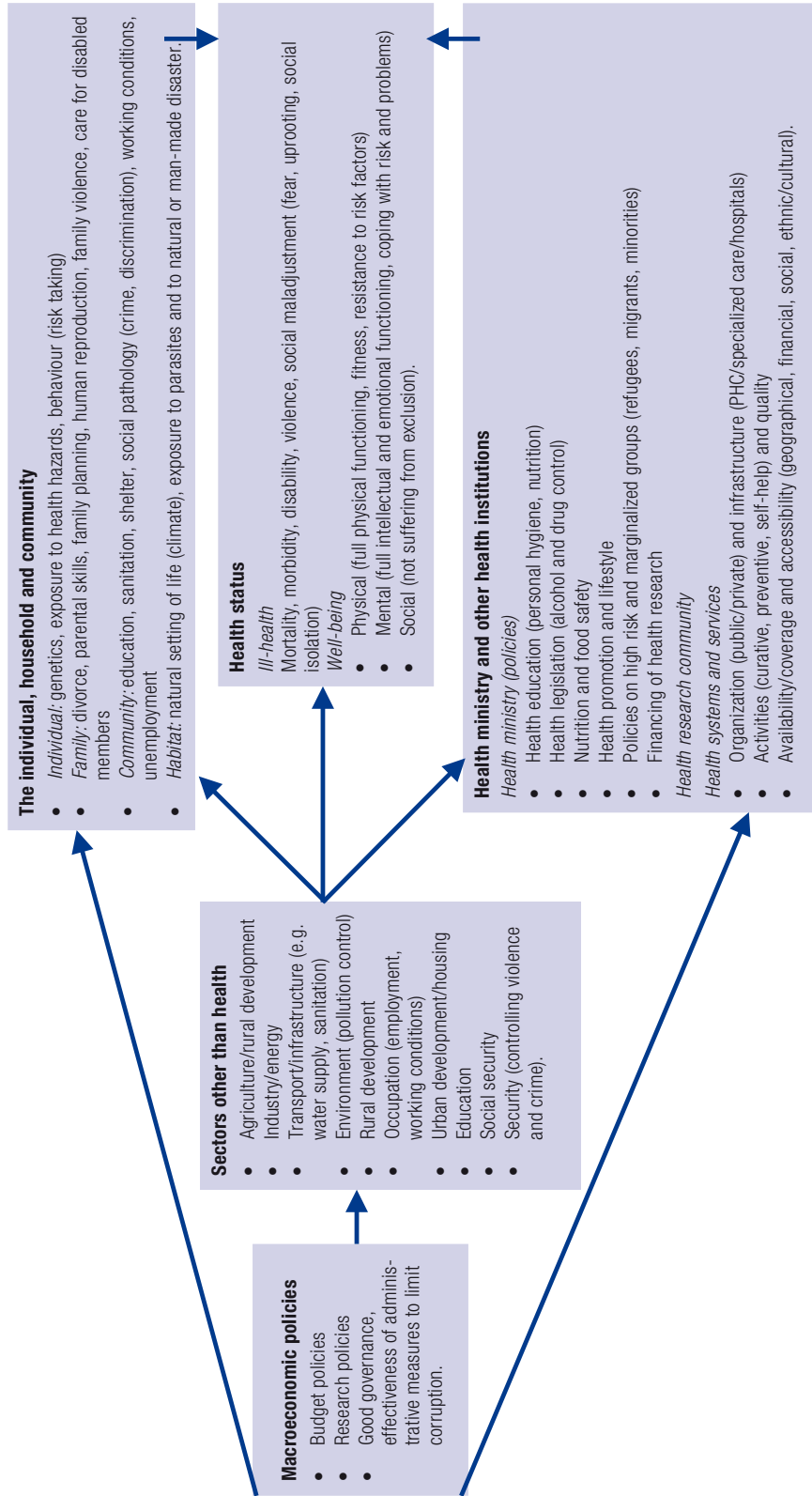
Approaches to priority setting

1. Require a broad-based, intersectoral approach that addresses root causes and determinants of health. A good example of sectors that should be involved in climate change research and intervention is listed in the “Combined Approach Matrix” (Figure 4).³⁰
2. Distinguish between areas in which new research is needed and those for which effective interventions exist but need to be deployed in a more cost-effective way (Figure 5).³¹
3. Ensure carbon tax resource flows address mitigation and adaptation on an equitable basis. While most green house gas emissions are produced by high- and, increasingly by middle-income countries, the most significant health impacts will be felt by countries that produce low amounts of greenhouse gases and are ill-equipped to adapt to climate change. The striking exception is China, a low- and middle-income country of 1.3 billion people *and* the world’s biggest emitter of greenhouse gases.

³⁰ Abdul Ghaffar, Andres de Francisco and Stephen Matlin. The Combined Approach Matrix: A priority-setting tool for health research. Insert 1, pp 14, Global Forum for Health Research, 2004 http://www.globalforumhealth.org/Site/002__What%20we%20do/005__Publications/003__Combined%20approach%20matrix.php

³¹ Abdul Ghaffar, Andres de Francisco and Stephen Matlin. The Combined Approach Matrix: A priority-setting tool for health research. Insert 1, pp 14, Insert 2, Global Forum for Health Research, 2004 http://www.globalforumhealth.org/Site/002__What%20we%20do/005__Publications/003__Combined%20approach%20matrix.php

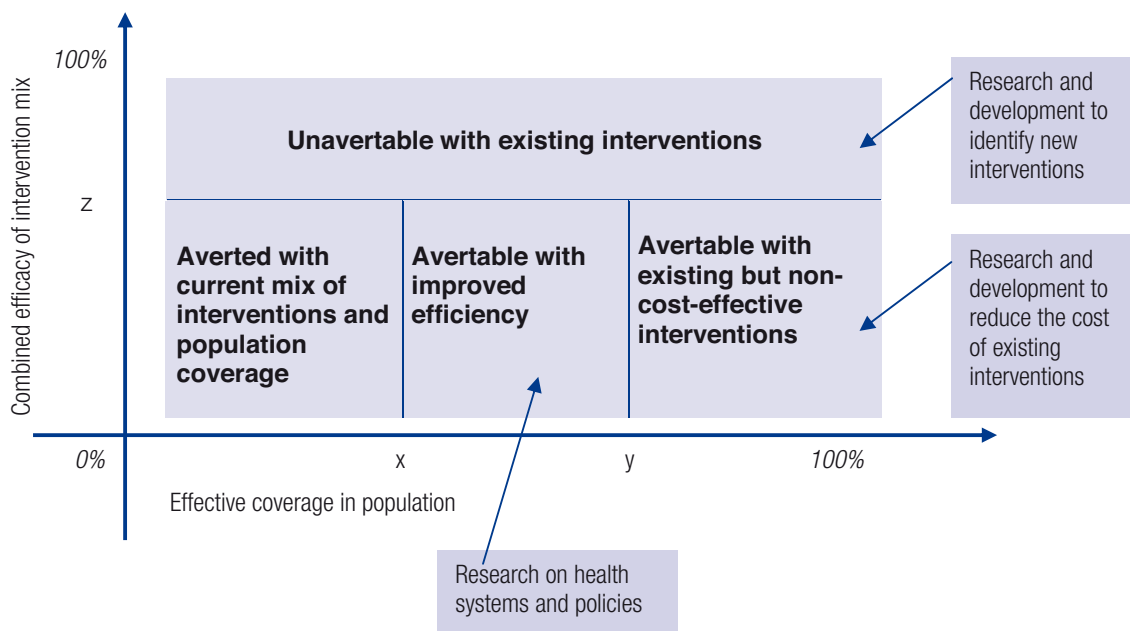
Figure 4: Main actors and factors determining the health status of a population



Source: Global Forum for Health Research

4. Establish priorities for research and cost-effective intervention.
5. Ensure involvement of civil society in global research priority setting.³²
6. Research needs to reflect the global distribution of health burdens.
7. Global and regional clearinghouses should provide an online directory of current research as well as toolkits for knowledge translation and application.
8. Emphasize the development, piloting, evaluation and replication of sustainable interventions.
9. Ensure that adaptation to climate change strengthens basic public health systems in low-income countries and that public health planning ensures adaptation. Climate change awareness needs to be explicitly integrated into public health, as it has been into economic, energy, agriculture, water and development issues.^{33,34}

Figure 5: Analysing the burden of a health problem to identify research needs



x — population coverage with current mix of interventions
 y — maximum achievable coverage with a mix of available cost-effective interventions
 z — combined efficacy of a mix of all available interventions

Source: Adapted from Ad Hoc Committee on Health Research, *Investing in health research and development* (WHO, 1996)

³² Labonte R, Spiegel J. Setting global health research priorities. *BMJ*. 2003 Apr 5;326(7392):722-3

³³ UNDP. 2004. *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies, and Measures*. New York: Cambridge University Press

³⁴ The World Bank, Global Environmental Facility. 2006. *Managing Climate Risk: Integrating Adaptation into World Bank Group Operations*

Immediate steps that should be taken

1. Research on ways to strengthen the public health system that also address climate change threats:
 - protection and assurance of water supplies and sanitation;
 - control for vector-borne diseases;
 - health education and promotion, especially related to thermal stress;
 - intersectoral approaches for improving environment, food security and alleviating poverty.
2. Research should also focus on ways to estimate and replicate long-term health benefits from climate change mitigation:³⁵ Over years and decades, the anticipated benefits of successful climate change mitigation have the potential to be significant globally. These include:
 - improvement of air quality, especially reduction in indoor and outdoor air pollution due to particulates and ground-level ozone, by conversion to cleaner, non fossil-based energy generation;
 - promotion of safer public transport systems;
 - encouragement of walking and cycling in communities to reduce chronic diseases and reduce air pollution that is exacerbated by climate change.

The approach to adaptation in low-income countries must be different from that in richer countries. The worse outcome of doing no planning for adaptation in resource-poor settings would be an emergency diversion of already limited funds to urgent public health programmes that are unsustainable and locally inappropriate, modeled after the approach being taken by resource-rich countries.

Advocacy approaches for climate change and health

Public health needs to advocate strongly for the “best case scenario” of successful mitigation with minimal impact of climate change on human health, simultaneously preparing for the “worst case scenario” of minimal mitigation and significant impact on health. Investments made and actions taken under the “worst case scenario” will not be wasted in any case. They will still address existing health burdens that are:

- preventable, by application of cost-effective interventions;
- affecting large populations, especially in low-income countries due to poor environmental conditions and weak public health infrastructure;
- inequitable, affecting low-income countries and the poorest in middle-income countries, but with limited current impact in high-income countries.

Knowledge translation of the complex science of climate change is being done primarily through governmental and intergovernmental organizations. However, it

³⁵ Cambell-Lendrum D, Corvalan C, Neira M. Global climate change: implications for international public health policy. Bull World Health Organ, Mar. 2007, vol.85, no.3, p.235-237

is important that civil society globally is engaged to enhance the social capital of all communities. Resilient and informed communities will have a synergistic effect on state public health measures in both adapting to gradual climate change as well as being able to withstand extreme weather events.

It is not instructive to consider simply a country's level of wealth; it is already clear that wealth can be correlated with the causes of climate change as well as having the ability to cope with it. How a nation's wealth is allocated is just as important as the average level of wealth. The heat waves in Paris or the floods in New Orleans demonstrate that even wealthy countries can be vulnerable. While it may be generally accepted that the level for countries that will be unable to adapt to climate change will be those with less than US\$ 6000 per capita GDP, it is misleading to believe there is nothing they can do to prepare for it.

Two basic questions of responsibility

Considering the inequity of the burden of health impacts and the inability of low-income countries to respond to the threats to health from climate change, many questions arise, but there are two that are most frequently asked:

- Do current producers of greenhouse gases and heavy consumers bear greater responsibility than those who contribute little to global warming?
- Does promoting adaptation accept climate change as an irreversible event and detract from the urgent need to take definitive steps to mitigate climate change?

Climate change and health in resource-poor settings

Table 5 shows what a semi-arid region in South Asia experiences over a 30-year period.

Table 5: Experiences in South Asia

Climate change effect	Health impact	Locally appropriate, sustainable adaptation measure
Increase in mean temperature	Heat stress	Public education; urban and building design
Earlier and longer summer	Higher incidence of bacterial water-borne diseases	Improve access to safe drinking water and improved sanitation throughout the year
Increase in local rainfall	Increase in rain-fed agriculture output	Adapt local agriculture, crop selection and diets
Increase in extreme weather events, including high winds and heavy precipitation, over a short period of time	Land erosion; damage to crops and buildings; flash flooding with loss of human life and livestock	Micro and macro flood planning and disaster preparedness; sustainable land use with empowerment of local communal governance systems
Increasing urbanization, from 50% to 70% of the population	Higher urban temperatures and heat island effect; increase in dengue fever in urban areas	Urban design; co-locating housing and work areas as much as feasible; enhancing efficient and cleaner public transit systems
Population increase	Pressures on housing, utilities	Address unmet need for contraception; enhance female literacy; address gender inequity

Glossary

(From IPCC unless otherwise specified)³⁶

Adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- Anticipatory adaptation – Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
- Autonomous adaptation – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.
- Planned adaptation – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain or achieve a desired state.

Mitigation: An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

SRES: The storylines and associated population, GDP and emissions scenarios associated with the Special Report on Emissions Scenarios (SRES) (Naki enovi et al., 2000), and the resulting climate change and sea-level rise scenarios. Four families of socio-economic scenario (A1, A2, B1 and B2) represent different world futures in two distinct dimensions: a focus on economic versus environmental concerns and global versus regional development patterns.

Stakeholder: A person or an organization that has a legitimate interest in a project or entity, or would be affected by a particular action or policy.

Sustainable development: Development that meets the cultural, social, political and economic needs of the present generation without compromising the ability of future generations to meet their own needs.

Uncertainty: An expression of the degree to which a value (e.g., the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts). See also confidence and likelihood.

³⁶ Appendix I: Glossary. IPCC 2007 <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-app.pdf>

United Nations Framework Convention on Climate Change (UNFCCC): The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the ‘stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’. It contains commitments for all Parties. Under the Convention, Parties included in Annex I aim to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The Convention entered in force in March 1994.

Urbanization: The conversion of land from a natural state or managed natural state (such as agriculture) to cities; a process driven by net rural-to-urban migration through which an increasing percentage of the population in any nation or region come to live in settlements that are defined as ‘urban centres’.

Water stress: A country is water-stressed if the available freshwater supply relative to water withdrawals acts as an important constraint on development. Withdrawals exceeding 20% of renewable water supply have been used as an indicator of water stress. A crop is water-stressed if soil-available water, and thus actual evapotranspiration, is less than potential evapotranspiration demands.

Vulnerability: Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity.

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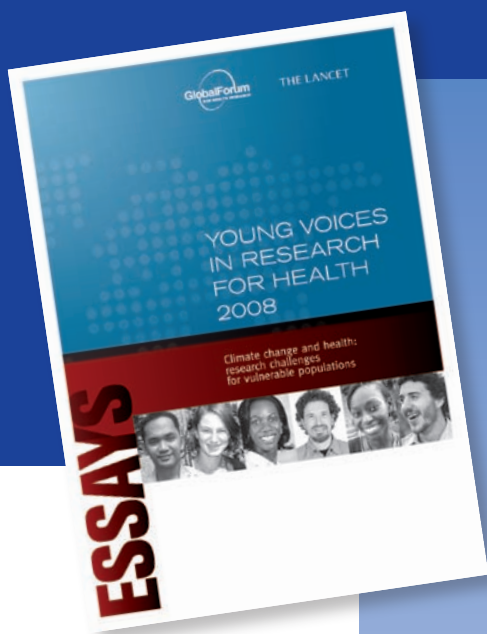
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Red Cross/Red Crescent disaster guide. http://www.proventionconsortium.org/themes/default/pdfs/RCRC_climateguide.pdf	Disaster preparedness, low-income countries
Reid, Hannah and Saleemul Huq. 2007. "International and National Mechanisms and Politics of Adaptation: An Agenda for Reform." IISD publications on adaptation to climate change, developing countries. http://www.iisd.ca/publications_resources/human_devt.htm	Adaptation, low-income countries
Roberts I. The economics of tackling climate change. BMJ. 2008 Jan 26; 336 (7637):165-6.	Health impacts, health economics
Schipper L, Pelling M. Disaster risk, climate change and international development: scope for, and challenges to, integration. Disasters, Volume 30, Issue 1, Page 19-38, Mar 2006.	Economics, disasters, policy
Stern Review on the economics of climate change. HM Treasury http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm	Economics, policy
Tanser F, Sharp B Global climate change and malaria. The Lancet Infectious Diseases, Volume 5, Issue 5, Pages 256-258	Health impact, vector-borne diseases, malaria
Tanser FC. Potential effect of climate change on malaria transmission in Africa. Lancet - 29-NOV-2003; 362(9398): 1792-8	Health impact, vector-borne diseases, malaria
Thornton PK, Jones PG, Owiyo T, Kruska RL, Herrero M, Kristjanson P, Notenbaert A, Bekele N and Omolo A, with contributions from Orindi V, Otiende B, Ochieng A, Bhadwal S, Anantram K, Nair S, Kumar V and Kulkar U (2006). Mapping climate vulnerability and poverty in Africa. Report to the Department for International Development, ILRI, PO Box 30709, Nairobi 00100, Kenya. http://www.dfid.gov.uk/research/mapping-climate.pdf	Adaptation, low-income countries
Tyndall Centre for Climate Change research UK www.tyndall.ac.uk	Research, knowledge transfer and engagement
UN Chronicle Issue 2, 2007 http://www.un.org/Pubs/chronicle/2007/issue2/0207cont.htm	Policy briefs
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UNFCCC 2007. Climate change: Impacts, vulnerability and adaptation in developing countries. http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/txt/pub_07_impacts.pdf	Adaptation, low income countries
UNFCCC. 2005. United Nations Framework Convention on Climate Change Home Page. Available: http://www.unfccc.int	Climate change impacts, policy

Reference	Main theme
UNFCCC. Capacity-building. http://unfccc.int/cooperation_and_support/capacity_building/items/1033.php Accessed 6 Jan 2008	Capacity building, collaboration, technology transfer
Van der Sluijs. Integrated Assessment. Responding to global environmental change, Vol 4, Pp 250-253. In Munn, T. Encyclopedia of Global Environmental Change. John Wiley and Sons. 2002	Environmental climate change
WHO Climate Change and Health Accessed 28 December 2007 http://www.who.int/globalchange/climate/en/index.html	Health
WHO Climate Change and Health Program Activities. http://www.who.int/globalchange/climate/activities/en/index.html Accessed 9 Jan 2007.	Adaptation, low-income countries
Wilby RL, Perry GLW, Climate change, biodiversity and the urban environment: a critical review based on London, UK, Progress in Physical Geography 30 (1): 73-98 FEB 2006	Health impact, heat stress, urbanization
Yasmin von Schirnding, Health in Sustainable Development Planning: The role of indicators. Chapter 7 - Framework for Linkages Between Health, Environment, and Development. WHO Accessed 28 Dec 2007 http://www.who.int/wssd/resources/indicators/en/	Health impact

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The next steps will be to establish the research agenda on ways to counter climate change threats to the health of the world's poorest populations. As funding for research on the health effects of climate change and adaptation mechanisms is significantly limited, then the resources to implement priorities on the agenda must be quickly found and the results used to focus policies and action.

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