

Health and climate change: a roadmap for applied research

Climate change is one of the defining challenges of the century, and increasingly recognised as a public health priority.¹ Research in this field is increasing, but is comparatively undeveloped in view of the complexity of the issue, and the potential magnitude and range of health consequences. For example, the average annual number of articles published in PubMed-indexed journals that referred to “health” and either “climate change” or “global warming” more than doubled between the early 1990s and the middle of the current decade. Over the same period, however, more than eight times as many articles referred to “health” and “air pollution”, and over 40 times more referred to “health” and “smoking”.

To promote health protection from climate change, national governments requested WHO to undertake research under a series of defined headings.¹ In the second half of 2008, WHO convened a global consultation of over 70 public health researchers, practitioners, representatives of the UN and other agencies, and donors to identify immediate research needs. Their insights and recommendations are summarised around six key themes in a new report.²

The first is that research on the health effects of climate change must be placed more firmly within the overall context of improving global health, and health equity, rather than being considered to stand alone. Such research should more closely link the immediate imperative (reduction of the burden of climate-sensitive health outcomes) to the long-term aim of increasing resilience to climate change. This effort should include making use of the substantial existing research capacity in fields such as infectious disease control and air pollution.

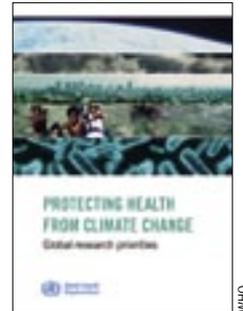
The second is the need for improved policy-relevant risk assessment, building a stronger bridge between evaluation of the existing health risks from short-term to medium-term climate variability and the effects of gradual climate change, in the context of other drivers such as socioeconomic development and urbanisation. This risk assessment should pay greater attention to previously neglected mechanisms, such as the diverse effects of population displacement or the degradation of water supplies. Assessments should further focus on particularly vulnerable population groups, especially those exposed to multiple environmental hazards.

Third, a comprehensive evaluation of the effectiveness, and cost-effectiveness, of protective measures is needed. Proven interventions exist against most climate-sensitive risks, and expanding their coverage would reduce current and future health burdens. But there are gaps in baseline cost-effectiveness information, and limitations in our understanding of how these interventions might be compromised by changing environmental conditions. Another need is the development of analytical methods that take into account the uncertainty, long time frames, and equity considerations that characterise decisions related to climate change.

Fourth, applied research can help maximise the health benefits of decisions taken beyond the health sector. This interdisciplinary research needs to include assessment of the diversity of potential health effects of mitigation actions, from macro level policies such as carbon pricing, to decisions in key sectors, such as household energy, power generation, transport, and agriculture. The health implications of adaption policies, such as increasing use of wastewater, also need to be evaluated. These sectoral studies can be complemented by settings-based approaches that provide a more holistic assessment of the effect of, for example, urban development plans.

Fifth, improved research on surveillance and other decision-support tools is necessary to enhance operational effectiveness. Although existing disease surveillance systems already provide some coverage for most climate-sensitive diseases, there are gaps. The potential for using environmental information to enhance early warning, avoid health risks, and lower costs remains largely unproven. Additional research is needed to improve understanding of the kinds of information, dissemination methods, and participatory approaches that are most effective in engaging decision makers, including the general population.

Sixth, economic assessments of the costs and benefits of mitigation and adaption decisions are crucially important. The limited available research suggests unmitigated climate change will substantially increase financial costs to health services, and that health co-benefits could be larger than the costs of many mitigation policies. More studies, over a wider range of health-impact pathways, are needed.



See [Editorial](#) page 1659

See [Perspectives](#) 1669

See [The Lancet Commissions](#) page 1693

Identifying urgent and immediate research needs for evidence-based action is just the first step in reducing the health risks of climate change. Filling these research gaps requires a sustained process to mobilise resources and update objectives as needs change.³ Crucially important is the need to build interdisciplinary research capacity, with a focus on the low-income countries that are most vulnerable to the health effects of climate change and have the weakest research base. Meeting this challenge will require additional human and financial resources. However, the necessary investment will be very small compared with current investment in climate research, marginal compared with the economic implications of adaptation and mitigation decisions, and trivial compared with the potential health consequences of unmanaged climate change or poorly designed climate policies.

**Diarmid Campbell-Lendrum, Roberto Bertolini,*

Maria Neira, Kristie Ebi, Anthony McMichael

Public Health and Environment Department, WHO, Geneva 1277, Switzerland (DC-L, RB, MN); Intergovernmental Panel on Climate Change Technical Support Unit, Carnegie Institution, Stanford, CA, USA (KE); and National Centre for Epidemiology and Population Health, Australian National University, Canberra, ACT, Australia (AM)

campbellendrumd@who.int

DC-L, RB, and MN coordinated the global consultation exercise; AM chaired the consultation meeting; and KE acted as rapporteur for the meeting, and participated in writing background reports. The consultation process was organised by WHO's Public Health and Environment Department, with financial and logistical support from the UN Foundation, the US National Institute of Environmental Health Sciences, and the Ministry of Health of Spain. We thank the participants in the research consultation: Maarten van Aalst (Red Cross/Red Crescent Climate Centre, Netherlands), Josep M Antó (Center for Research in Environmental Epidemiology, Spain), Hamed Bakir (WHO Eastern Mediterranean Regional Office Centre for Environmental Health Activities, Jordan), John M Balbus (Environmental Defense Fund, USA), Cristovam Barcellos (Oswaldo Cruz Foundation, Brazil), Aderrez Bouchama (King Faisal Specialist Hospital & Research Centre, Saudi Arabia), Colin Butler (Australian National University, Australia),

Daniel Carucci (UN Foundation, USA), Dominique Charron (International Development Research Centre, Canada), Luis A Cifuentes (Catholic University of Chile, Chile), Ulisses Confalonieri (Oswaldo Cruz Foundation, Brazil), Christine M Coussens (Institute of Medicine, USA), Valerie Detemmerman (World Meteorological Organization, Switzerland), Alhassane Adama Diallo (African Center of Meteorological Applications for Development, Niger), Ferrán Ballester Díez (Valencia School of Health Studies, Spain), Carlos Dora (WHO, Switzerland), Paul R Epstein (Harvard Medical School, USA), Howard Frumkin (US Centers for Disease Control and Prevention, USA), Kathryn Gallagher (US Environmental Protection Agency, USA), Christopher Portier (National Institute of Environmental Health Sciences, USA), Kee-Tai Goh (Ministry of Health, Singapore), Debarati Guha-Sapir (Catholic University of Louvain, Belgium), Alexander von Hildebrand (WHO South East Asia Regional Office, India), Yasushi Honda (University of Tsukuba, Japan), Yun Chul Hong (Seoul National University College of Medicine, Republic of Korea), Guy Hutton (World Bank), R Sari Kovats (London School of Hygiene and Tropical Medicine, UK), Wilfried Kreisel (formerly of WHO, Switzerland), Jostacio Lapitan, (WHO Kobe Centre, Japan), Rocio Licht (UN Framework Convention on Climate Change Secretariat, Germany), Elisabet Lindgren (Karolinska Institute, Sweden), David Lynn (Wellcome Trust, UK), Anil Markandya (University of Bath, UK), Glenn McGregor (University of Auckland, New Zealand), Bettina Menne (WHO European Regional Office Centre for Environment and Health, Italy), Paola Michelozzi (Roma-E Local Health Authority, Italy), Zac Morse (Fiji School of Medicine, Fiji), Jo Nurse (Department of Health, UK), Buruhani Nyenzi (World Meteorological Organization, Switzerland), Sylvie Olifson (Global Forum for Health Research, Switzerland), Kiran Dev Pandey (World Bank, USA), Mathilde Pascal (National Institute of Health Surveillance, France), Michel Pletschette (European Commission Directorate General for Health and Consumers, Belgium), Katherine Pond (University of Surrey, UK), Annette Richardson (New York, USA), Annie Roberts (WHO, Switzerland), Elisabeth Robert-Gnansia, (Agency for Health and Safety, France), Ian Roberts (London School of Hygiene & Tropical Medicine, UK), David Rogers (Health and Climate Foundation, Switzerland), David J Rogers (Oxford University, UK), Giovanni Rum (Group of Earth Observation, Switzerland), Carmen Perez Samaniego (German Agency for Technical Assistance, Germany), Fernando Simón Soria (Carlos III Health Institute, Spain), Kirk Smith (University of California, Berkeley, USA), Johannes Sommerfeld (TDR, Switzerland), David Stone (Health and Environment Alliance, UK), Hiwot Teka (Climate and Health Working Group, Ethiopia), Madeleine Thomson (International Research Institute for Climate and Society, USA), Tomas Turecki (European Commission-DG Research, Belgium), Paul Wilkinson (London School of Hygiene and Tropical Medicine, UK), Tanja Wolf (WHO European Regional Office Centre for Environment and Health, Italy), Alistair Woodward, (University of Auckland, New Zealand), Jin Yinlong (China Centers for Disease Control, China). Our views do not necessarily reflect the position of WHO. We declare that we have no conflicts of interest.

- 1 WHO. Climate change and health: Resolution of the 61st World Health Assembly. 2008. http://apps.who.int/gb/ebwha/pdf_files/A61/A61_R19-en.pdf (accessed May 4, 2009).
- 2 WHO. Protecting health from climate change: global research priorities. Geneva: World Health Organization, 2009.
- 3 The Lancet. The Bamako call to action: research for health. *Lancet* 2008; **372**: 1855.