Climate change and public health:

the role of adaptive management[1]

Jeremy J. Hess, Julia Z. McDowell and George Luber

Public health adaptation to climate change

Climate change is expected to increase the burden of climate-sensitive diseases such as heat-related illness, vector-borne disease, diarrhoeal disease, injuries from extreme events and respiratory diseases. Clearly, these impacts cross cut the communicable/ non-communicable divide. Although the developing world is most at risk, industrialised countries are also ill prepared. Public health institutions at all operational scales will need to consciously modify their approaches to both science and practice in anticipation of climate change health impacts.

Some studies have outlined climate change as a public health concern, advancing the public health community's awareness. Others have explored climate change epidemiology and risk assessment by examining fundamental scientific questions and by providing epistemological insights. Still others have clarified methodologies and practical strategies for conducting vulnerability and impact assessments, assessed relevant environmental health frameworks and articulated guidelines for climate impact and adaptation assessments and advanced research agendas.

Despite this progress, there has been little discussion of how public health organisations should implement and manage the process of planned adaptation. Apart from significant work by Huang et al. (2011) there has been relatively little discussion of how to increase public health's adaptive capacity or how this process could increase public health's resilience. Besides resource availability, many other factors are important, including social and human capital, attention to institutional decision-making and information management, and processes for spreading risk. Also key is the promotion of social learning, which means building collective knowledge through social interactions and integrating learning into management. Literature from other sectors highlights the connection between high levels of adaptive capacity and resilience in socioeconomic systems, emphasising that such systems have the capacity to retain their essential structure and function after significant disruption, to reorganise and to learn.

Identifying public health impacts of climate change

The contention that innovative strategies will be required is based on a concern that climate change, which could jeopardise critical infrastructure and destabilise various systems that maintain public health, may represent a categorically distinct public health stressor. Thus, novel frameworks, strategies and tools are required to help manage systemic risk. Rather than affirming the conventional approach that adaptation will primarily entail programme expansion, the innovation perspective, recognising its limitations, highlights its limits, particularly the potential for systemic instability to undermine public health gains.

Investments without clear near-term payoffs are hard to sell. Even in settings with a well-developed infrastructure, climate change adaptation competes, often unsuccessfully, with other urgent public health concerns. Particularly in regions with less public health infrastructure, many believe that adaptation should be secondary to more immediate concerns such as basic public health services and essential medicines. Most public health institutions and health-care systems have chosen to rely on existing infrastructure and all-hazards preparedness rather than investing in innovations when increased risks have yet to materialise. And a management-oriented, systems-based, long-view approach to public health is logistically difficult to pursue because it requires secure long-term funding, interdisciplinary and intersectoral collaboration and integrated information management, which existing funding and administrative structures inadvertently discourage.

However, identifying areas where vulnerability is particularly high – threats that exhibit distinct climate sensitivity – can help clarify where efforts to increase adaptive capacity should be focused. Criteria for identifying these threats include:

- High population vulnerability to hydro-meteorological hazards (i.e., high levels of exposure and susceptibility and low adaptive capacity), such that increases in the frequency and severity of such hazards will significantly increase overall risk. One example is systems in which recurrent flooding, combined with other exposures that erode household coping capacity, undermines long-term adaptive capacity and increases cumulative risk.
- The potential for extreme events associated with climate change to present hazards outside the coping range of a given public health system. The probability of the European heat wave of 2003, for instance, was significantly increased by anthropogenic emissions and by imposed stresses outside public health systems' capacity to cope.
- The likelihood that increasingly severe and frequent hazards associated with climate change could undermine or compromise systems and infrastructure and have significant population health impacts. For example, more frequent heat waves increase reliance on mechanical air conditioning, increasing electricity demand and thus the probability of cascading grid failure.
- The likelihood that climate change will fundamentally alter basic ecosystem services important to public health. Abundant examples include ecosystem shifts driving increased bioaccumulation of toxins such as mercury and polychlorinated biphenyls and the potential for groundwater salinity as a result of saltwater intrusion from sea level rise.

- The likelihood that climate change will result in abrupt ecosystem shifts favouring the introduction or re-emergence of diseases for which effective surveillance and management practices are not yet in place. An example of this is the 2004 outbreak of Vibrio parahaemolyticus associated with Alaskan oysters harvested during an unusually warm period, which abruptly shifted the northernmost range of the endemic area for this disease by 1,000 km.

Focusing on distinctly climate-sensitive threats

Other sectors have identified a need for focused innovative adaptation efforts, and health is likely to be similar. Indeed, public health has previously identified challenges in need of focused innovation, such as the articulation of the Grand Challenges in Global Health[2] and corresponding funding of innovative strategies to address these challenges. A focused approach could minimise friction between the climate–health community and other areas of public health. Although this friction has not proven a significant impediment to date, there are several instances – such as the contentious debate around climate change and malaria (Chaves and Koenraadt, 2010; Reiter, 2001) – in which the emphasis on climate change has been seen as an inappropriate distraction from established, evidence-based efforts at disease prevention and control.

Such a focus may also be strategic from a policy perspective, because it allows climate–health advocates to highlight the need for general investment in public health infrastructure, particularly in resource-poor settings where 'adaptation to climate change is essentially a matter of basic public health protection' (Campbell-Lendrum et al., 2007), as well as specific climate–health programming for issues of greatest concern. This may prove attractive to policy makers who craft health adaptation portfolios in the developing world, where a strong case can be made for general investment in public health to reduce climate-related and other risks.

Management challenges for distinctly climate-sensitive public health concerns

Developing effective adaptations to distinctly climate-sensitive health threats presents a host of management challenges, including uncertainty in climate projections and future socioeconomic conditions, financial challenges, limits in technology, institutional constraints on collaboration and evidence gathering, limits on social capital at the community level and uninformed or inaccurate perceptions of individual risk (Huang et al., 2011).

Two other issues – scale and complexity – are also significant. The scale issues that complicate adaptation are both temporal and spatial. Temporal concerns include the need to focus on short-term planning for discrete events, such as a severe heat wave, and longer-term needs for strategies to reduce hazardous exposures and increase resilience. Spatial concerns arise from mismatches between hazard distributions, political and administrative boundaries and resource availability. The issue of spatial scale and climate has been explored more thoroughly in the ecological, agricultural and modelling literature than in public health, although examinations of heat hazards at various scales (Harlan et al., 2006; Stone et al., 2010) and synchrony of cholera outbreaks (Constantin de Magny et al., 2007) suggest how this research may unfold.

Complexity is perhaps the most pervasive concern, extending to a host of systems concerns related to managed socio-ecosystems, from cities to fisheries, whose complex dynamics, including delays, positive and negative feedbacks, stock-and-flow relationships and thresholds, complicate management. Climate change has introduced additional uncertainty into these dynamics.

Adaptive management and its potential

These management challenges highlight the need for strategies that embrace uncertainty and emphasise learning. Adaptive management was developed as an iterative method for managing natural resource systems where linear approaches had failed as a result of the systems-wide range of responses to management choices, the managers' difficulty understanding the systems' dynamics, and the dynamic interplay between managers, stakeholders, interventions and system responses. To manage these systems, ecosystem managers needed an iterative process that acknowledged complexity and uncertainty, emphasised ongoing learning and allowed for continuous stakeholder input. Adaptive management was created in response to these needs.

The National Research Council's (2004) guide to adaptive management emphasises six primary elements:

- management objectives that are regularly revisited and revised
- a model of the system(s) being managed
- a range of management choices
- monitoring and evaluation of outcomes
- mechanisms for incorporating learning into future decisions
- a collaborative structure for stakeholder participation and learning.

The process allows for an approach tailored to the unique specifics of each system and situation and integrates management and learning instead of consigning them to different domains. Adaptive management has yet to secure a significant place in the public health toolbox, although several agencies have used it to engage a wide range of environmental health concerns, sometimes coupled with structured decision analysis processes. Adaptive management is most appropriate in circumstances in which modelling and decision-making scales are matched and external factors are considered, there is explicit consideration of uncertainties, stakeholders agree on metrics of cost and risk and stakeholders are sufficiently engaged and provide adequate institutional support.

In regard to climate change, as Ebi (2011) has noted, adaptive management closely parallels frameworks for general climate change adaptation and public health adaptation. It has been used to explore issues related to ecosystem management, watersheds, emissions trading and air quality monitoring. In its 'active' form, which facilitates analysis of multiple decision possibilities, adaptive management appears to have significant potential for public health adaptation efforts. Many of the essentials of adaptive management – modelling complex, dynamic problems, interacting with a wide range of stakeholders and taking an evidence-based, iterative approach to decision-making – are familiar to public health. The process is perhaps most akin to evidence-based medicine and its cousin, evidence-based public health. As with these approaches, embracing the entire paradigm confers several advantages over a disjointed approach.

Adaptation requires a new level of cross-sectoral planning, and other sectors are increasingly acknowledging the need to incorporate health and vice versa. Implementation should also be approached via more interdisciplinary, trans-sectoral efforts, as it will require integration of several dynamic information streams tracking exposures, population response to early warnings and assets available for response. Monitoring provides data fundamental to learning in adaptive management and should be planned early in the process.

Implement

Evaluation in adaptive management is explicitly focused both on the efficacy of the intervention (management objectives) and on increasing understanding of the system being managed (learning objectives). Adjustment is crucial to adaptive management. The adjustment phase is when future decisions regarding management and research are made, linking to the next cycle. Reviews of adaptive management efforts have shown that inattention to key social learning elements – particularly rapid knowledge acquisition, effective information management and explicit attention to creating shared understandings among diverse stakeholders – are key culprits (McLain and Lee, 1996). This is a concern in any discipline, but public health, with its emphasis on the social determinants of health and integration within community-based organisations, has a set of tools for facilitating such processes (Baker et al., 2005; Rowitz, 2004).

Because of constantly shifting baseline conditions, it is difficult to generate baseline estimates of disease burden. However, comparing one extreme event with another can give some indication of efficacy, as with the 2003 and 2006 heat waves in Europe, where the later one resulted in far lower mortality after significant prevention measures were taken. Of the various hazards associated with climate change, extreme heat events (EHEs) are the best studied and among the most urgent. In this example, the urban environment is a particularly relevant system. Cities have high concentrations of people vulnerable to heat-related injury, urban environments amplify heat exposure at several levels and EHE response plans are typically administered at the metropolitan level.

Conclusion

To date much of the climate–health literature has focused on establishing and projecting climate change health impacts. This work has shown that certain distinctly climate-sensitive health threats are very likely to pose challenges outside public health's coping range. The question of how to increase public health capacity has received less attention. Our findings suggest that management of these threats is likely to require innovative strategies acknowledging that the systems protecting public health have limited resources and are dynamic, incompletely understood and subject to multiple stakeholders. Institutional learning at multiple levels is key to increasing adaptive capacity, and adaptive management is a potentially useful framework. Its components are familiar, but the coordinated process and the use of modelling in iterative decision-making are relatively new. Several helpful tools are available[3] but must be revised for new contexts, and significant gaps remain. Developing a centralised tool repository should be a high priority and, along with increased focus on learning, modelling and adaptive management, will help increase the resilience of local public health systems.

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Endnotes

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[2] See www.grandchallenges.org/Pages/Default.aspx

[3] See the original article, referenced at endnote 1.

Dr Jeremy Hess, MD, MPH is a board-certified emergency medicine physician also trained in global environmental health. He is on the faculty of the Emory University Dept. of Emergency Medicine and has a joint appointment in the Dept. of Environmental Health in the Emory Rollins School of Public Health. In addition, he serves as a Senior Medical Advisor with the Climate and Health Program in the Division of Environmental Hazards and Health Effects at the CDC's National Center for Environmental Health. **Julia McDowell** also works in the Dept. of Emergency Medicine and at Emory Rollins School of Public Health. **Dr George Luber** is an epidemiologist and the Associate Director for Global Climate Change for the National Center for Environmental Health at the Centers for Disease Control and Prevention. His research interests include the epidemiology of harmful algal blooms and the health effects of climate change.