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Climate change and infectious disease risk management: a localised health security perspective

Andrew Collins*

Disaster and Development Centre (DDC), School of Applied Sciences,
Northumbria University, Ellison Building, Ellison Place, Newcastle, NE1 8ST,
UK.

*Corresponding author email: andrew.collins@northumbria.ac.uk

Abstract

Pathogenic risks in relation to climate change are not fully understood and to a large extent have to be regarded as unpredictable. It is therefore important to focus attention on human vulnerability and coping for which more certain influences on disease risk can be assessed. Despite commonplace environmental conditions for infectious diseases around the world, only some people are affected. This is because the larger proportions of disease risks are regularly a function of human socio-economic and consequent biological susceptibility to infection rather than significant changes in environmental hazards. As poverty and environmental degradation exacerbate disease risks for billions, poverty reduction is the core issue in mitigating climate related infectious disease risks, but human impoverishment and climate change can be complexly interrelated. Studies in Mozambique and Bangladesh are used here to examine key issues in the complex association between climate change and health. Some evidence suggests that individual and community based health risk reduction can build community resilience and health security and overall wellbeing in the face of epidemics in locations prone to the effects of climate change. Success in this respect would offset health impacts of changes in climate. However, the association between climate and health will continue to demand pro-poor precautionary risk reduction investments and proactive national and global governance contexts within which this can succeed.

Key words: Climate change, infectious disease, complexity, resilience, health security, pro-poor risk reduction

Introduction: current infectious disease assessments in contexts of climate change

There are many extreme predictions being made in relation to climate change but little clarity in specifying more precisely the ways in which human health will be compromised. If the International Panel on Climate Change (IPCC Fourth Assessment Report 2007) predictions are correct that there is likely to be a five degree increase in temperature by 2080 then change in health risks are certain. The report indicates that future climate change is expected to put close to 50 million people at risk of hunger by 2020. Coastal populations in Asia are flagged as also vulnerable to sea level rise, which is slightly higher than the global average. Projected sea level rise could flood millions of people living in the low lying areas of

South, Southeast and East Asia such as Vietnam, Bangladesh, India and China. Also, extreme weather patterns are already taking their toll on crop yields. The suggestion is clear that challenges in tackling global warming concerns is mounting pressures on developing countries that already have high infant and adult mortality rates, particularly from infectious diseases.

The World Health Report (2007, p.25) states that 'intensifying climatic conditions, together with a range of environmental, epidemiological and socioeconomic factors, are bringing about changes in the exposure of populations to infectious diseases', as illustrated by the example of Rift Valley fever. In this instance, above-normal rainfall associated with the occurrence of the warm phase of the El Niño Southern Oscillation phenomenon has been increasing the breeding sites of mosquitoes, with a consequent rise in the number of outbreaks of Rift Valley fever. Surprisingly, little more is mentioned of climate change in this year's report. However, the World Health Report of 2002 (p.72) addressed it in more detail stating that:

'Such a rise [in temperature between 1990 and 2100] would be faster than any rise encountered since the inception of agriculture around 10 000 years ago. Predictions for precipitation and wind speed are less consistent, but also suggest significant changes. Potential risks to human health from climate change would arise from increased exposures to thermal extremes (cardiovascular and respiratory mortality) and from increases in weather disasters (including deaths and injuries associated with floods). Other risks may arise because of the changing dynamics of disease vectors (such as malaria and dengue fever), the seasonality and incidence of various food-related and waterborne infections, the yields of agricultural crops, the range of plant and livestock pests and pathogens, the salination of coastal lands and freshwater supplies resulting from rising sea-levels, the climatically related production of photochemical air pollutants, spores and pollens, and the risk of conflict over depleted natural resources. These effects will undoubtedly have a greater impact on societies or individuals with scarce resources, where technologies are lacking, and where infrastructure and institutions (such as the health sector) are least able to adapt.' For this reason, a better understanding of the role of socioeconomic and technological factors in shaping and mitigating these impacts is essential. Because of this complexity, current estimates of the potential health impacts of climate change are based on models with considerable uncertainty.'

Based on this type of recent, though uncertain, prediction Table 1 summarises the expected climate changes and their likelihood as indicated by IPCC alongside an indication of health impacts that have been commonly suggested in recent years from multiple sources, particularly the media. The basis is largely through observation of existing associations between health and environmental events and those observed in the past. Whilst the IPCC judgement of future changing climates would appear to be more reliable than ever before, the actual health impacts are presented here as merely hypothesised. Insufficient proof that these impacts will occur in the future can be provided. This paper however progresses to provide an indication of the disaster and development contexts within which such impacts appear certain, uncertain or improbable in Mozambique and Bangladesh. Further the use of infectious disease risk management to control the impacts of climate change and of health security in offsetting are introduced.

Table 1 Projections for extreme weather events for which there is an observed late 20th century trend and accompanying suggested impact on health

Climate phenomenon and direction of trend	Likelihood of future climate trend based on projections for 21st century	Suggested health impacts
Warmer and fewer cold days and nights over most land areas	<i>Virtually certain</i>	Increase in infectious disease incidence through spread and persistence of disease vectors and pathogens in areas where the cold previously prevented them.
Warmer and more frequent hot days and nights over most land areas	<i>Virtually certain</i>	Increase in infectious disease incidence through spread and persistence of warm climate pathogens and vectors.
Warm spells / heat waves. Frequency increases over most land areas	<i>Very likely</i>	Increase in heat stroke in temperate climates. Increase in infectious disease risks from hot climate disease vectors and pathogens.
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	<i>Very likely</i>	Increase in flash flooding and related break down in infrastructure, increasing health hazards, injuries, vulnerability and displacement.
Area affected by droughts increases	<i>Likely</i>	Increase in food and nutrition insecurity. Climate related forced migration increases susceptibility and exposure to health hazards. Loss of livelihood assets increases socio-economic vulnerability to ill-health.
Intense tropical cyclone activity increases	<i>Likely</i>	Increase in rapid onset break down in infrastructure causes injuries and health hazards, vulnerability and displacement. Loss of livelihood assets increases socio-economic vulnerability to ill-health.
Increased incidence of extreme high sea level (excludes tsunamis)	<i>Likely</i>	Widespread flooding increases health hazards, vulnerability and displacement. Loss of productive land through flooding and salinisation increases food insecurity. Loss of livelihood assets increases socio-economic vulnerability to ill-health.

Source: First two columns are taken from IPCC (2007 p.7) Climate Change 2007: The Physical Science Basis, Summary for Policymakers, Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva: WMO and UNEP.

Integrated infectious disease risk assessment

Human health and its relationship to the environment is a complex field and therefore precisely what might happen with predicted climate change is uncertain. This is particularly the case with major infectious diseases, which account for the greater

part of health burdens in economically poorer parts of the world, reduction of which forms a core aspect of the Millennium Development Goals (MDG) due to be achieved by 2015. Whilst all of the MDG ultimately relate indirectly to improvements in health and serve to emphasise that health and poverty are closely linked, goal four to reduce child mortality and goal six to combat HIV/AIDS, malaria and other diseases directly target infectious diseases. But the precise linkages between poverty and infectious disease are also a function of a variety of environmental, social and economic influences. These tend to vary across space and through time and for individual pathogen types. However, ongoing evaluation of disease risks using an interdisciplinary assessment can provide guidance as where, when and with whom different types of risks are more predominant (Collins 1998, Collins et al. 2006). Based on this perspective, analysis of climate change and infectious disease presents an extension to an existing challenge to find ways of assessing multivariate health risks. Identifying what change might be expected for each health influence need not be an entirely speculative exercise. An enormous quantity of research output on infectious disease causality has been perpetually produced for the last 150 years that provides us guidance. When broken down into constituent parts we can extrapolate evidence of changes in local health risks with seasons, landscapes, economies, health or development policies, or ideas about health. A rich background of public health, epidemiological, microbiological, ecological, social, economic and behavioural work, and associated analysis frameworks, can contribute in the assessment of health disaster risk in the context of climate change.

For the case of health disasters one of the more obvious is to conceptualise disease threats as hazards, and the risk of an epidemic outcome a function of these in conjunction with human vulnerability. Hazard, vulnerability and capacity to mitigate disaster are a mainstay of disaster reduction more widely. (Blaikie et al. 1994, Wisner et al. 2004), and clearly so in the case of infectious disease mitigation (Collins 1994, 1996, and successively).

Beyond environmental threats, such as the earthquake, volcano, hurricane, flood, drought, and so forth, the same underlying rationale applies to threats of economic collapse, social decay or bio-terrorism. For studies of infectious disease disasters, development, risk and uncertainty an emphasis can variously be put on pathogenic hazards, disease transmission, or people's susceptibility to being infected. Ultimately each component is present, but here we consider which of these alters detrimentally in relation to climate change?

Using a vulnerability approach, theoretically, no infectious disease can be considered natural and no loss of life inevitable. We would consider epidemics (and for that matter most other disasters) as a function of being in the wrong place at the wrong time with inadequate forms of protection. Moreover, infectious disease hazards (here considered to be the pathogen itself), are organic and evolve over time spontaneously or in relation to changing environments, and variously get excluded from disaster risk monitoring. They present an ongoing, rapidly or slowly emergent hazard. Uncertainty prevails in that, to date, the world's microbiologists are unable to determine precisely the origin, spontaneity (i.e. random mutation) or more predictable evolutionary influences for some of the greatest of contemporary infectious disease threats. However, laudable progress has been made in identifying where the transfer of genetic material gives rise to new strains.

Studies on climate change impacts on infectious diseases have tended to focus on impacts on pathogens and their habitats (i.e. Patz and Olson, 2006). However, the mechanisms of a health impact may be through change in risks originating from multiple social, ecological and economic influences on infectious diseases and our ability to intervene in these changes early enough. Climate change can impact on the pathogens (the organism causing infection), the path through which it is transmitted (diseases vectors, environmental reservoirs and flows), directly on people making them more susceptible (i.e. through nutritional weakening), on the places upon which people's health depends, on the policy context of health (i.e. affecting prioritisation of investments), and on the way health and health risks are understood (perception). Such a health ecology approach is represented in Table 2. This lists the 'six p's', recognising aspects of disease ecology, epidemiology, political ecology, sociology, medicine, and the environment, but essentially here with indication of the climate change link to each of these.

Table 2 Climate related risks to health based on integrated health security approach

Health risk category	Process of change in health risk and resilience in relation to climate
Pathogens	Temperature and biogeochemical sensitivity.
Pathways	Distribution and viability of transmission routes of pathogens including via vectors (mosquitoes, flies, fleas, rats, snails, aquatic organisms etc) and environmental reservoirs (water, soil, phytoplankton, and living spaces). Hospitals (MRSA). Food.
People	Temperature and water. Nutrition security. Psychosocial wellbeing. Displacement. Exposure and susceptibility to infection, including through drought and flood. Socio-economic status and livelihood security.
Perceptions	Education. Fear. Experience. Conscience. Coping with uncertainty. Media representations.
Politics	Prioritisation of resources. Politics of humanitarian aid, trade and environmental issues including changing roles of international regimes, and conflict over natural resources.
Places	Environmental quality through drought and flood related changes to water, land, air, vegetation. Hazard modification in natural (i.e. land and water stability) and built environments (i.e. building, energy and water infrastructures).

Application of integrated assessment for Infectious Disease Risk Management (IDRM) in the context of climate

Integrated health risk assessment may assist as an entry point in considering the complex realm of infectious disease risk management with climate change. The purpose here is to contribute to an analytical framework suitable for isolating strands

of causality for different diseases and contexts. This is to facilitate assessment of the extent to which prevention and control in the context of climate change might better address the hazards, vulnerability, or capability aspects of this confluence. The options supported by this framework would include;

- i) an assault on the pathogen (i.e. pathogen risks such as bacteria, viruses, protozoa, parasites)
- ii) interruption of transmission (i.e. pathway risks such as vectors and pathogenic reservoirs in the environment)
- iii) strengthening social, economic and physical aspects of environment and infrastructure (i.e. place risks including physical environmental quality, culture and local economies)
- iv) reducing susceptibility to infection (i.e. risks relating to people's basic and extended needs including nutritional status, access to appropriate health care and livelihoods)
- v) enhancing awareness and behaviour (i.e. perceptions based on knowledge and attitudes learnt through experience and through formal or informal education, personality changes and sense of community based action)
- vi) investing in policies that prioritise preventative health actions, including for an improved political economy of health, advocacy and lobbying, and the knowledge environment.

Identifying the contexts whereby different aspects of health ecology are prone to change through climate is key to deciding how much climate change may be tolerable or acceptable, what type of adaptation is necessary, who, how, when and where the costs might be borne, and the extent to which improved health security offsets climate impacts on health and wellbeing.

An IDRM study in Mozambique and Bangladesh and subsequent health security programme has found that community based strategies can integrate risk assessment and risk management of some of the above at the local level. There is also evidence that improved health security in this respect might offset some of the climate impacts on infectious disease risk. The presentation provided for this UK – Asia Scientists and Practitioners Seminar provides much of the lessons learnt from these programmes concerning people centred research approaches, capacity building and development of disease and health risk monitoring and analysis systems. Further information is available from the set of slides provided with these proceedings and is being published elsewhere.

Conclusion: Addressing climate change and infectious disease

Integrated infectious disease risk assessment provides theoretical development that can strengthen an informed debate about the circumstances within which climate change may impact on health and those where it may not. As an essentially applied analysis, it suggests that varied interventions and adaptations are required. These are shown to need to vary from place to place and over time in relation to the nature of the risks identified. As pathogenic and environmental hazards would appear to be likely to be undergoing change, and also be in the ascendancy during these times of

climate change, a precautionary approach is needed, including investments that lead to blocking transmission cycles of pathogens and their vectors. Where vulnerability factors are more clearly the main risk in the climate – health nexus, disaster reduction and development work in effect becomes a process of making people more resilient, and extending resilience to aspirations of wellbeing. Investing in sustainable development and vulnerability reduction are part of this agenda and, if addressing combined influences on health adequately, may offset the impact of climate change.

Reducing emissions that contribute to climate change is crucial whether or not proven impacts on health can be quantified at this point, as advocated by a precautionary approach. Climate related pollutants are in any event bad for health even before they may contribute to ill-health through climate change. Structural changes for better governance of development can bring about change internationally and locally within what we currently refer to as a health security approach (WHO 2007). Poverty reduction will however have a bigger positive impact on health than climate change modifications. It is not sufficient to await improvements in global or national level governance for sustainable development to be achieved. To this end community based programmes (human agency driven) must also be activated in the interests of addressing health security, for which infectious disease risk reduction constitutes a large part. What may start with the desire of the individual to achieve better health security in respect of local infectious disease risks, can progress to communities and beyond. One way in which this is evidenced is through the community based organisation, such as risk committees. Examples of this approach to assessment, management and governance of health risks have been experimented with through the programmes in Mozambique and Bangladesh that support this short overview.

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