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CLIMATE CHANGE AND HUMAN HEALTH: EXAMINING THE NEXUS

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Abstract

Climate change is the biggest global health threat of the 21st century. The epidemiological outcome of climate change on disease patterns worldwide will be profound, especially in developing countries, where existing vulnerabilities to poor health remain.Global climate change would affect human health via pathways of varying complexity, scale and directness and with different timing. Similarly, impacts would vary geographically as a function both of environment and topography and of the vulnerability of the local population.

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Introduction

In early 2007, the Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report, in which it noted that over the past 150 years, global average surface temperature has increased by 0.76º C, and that most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (human) greenhouse gas concentrations.1 It is generally believed that this global warming has caused changes in precipitation patterns, increased the frequency and/or intensity of extreme weather events, and has caused a rise in mean global sea levels.With projected increases in temperature, changes in rainfall patterns, and increase in the frequency and/or intensity of tropical cyclones and storms, climate change is expected to impact almost every sector of human and economic activity, every region of the world, and every community, including the public health community.

In May 2009, Costello et al. (2009) called climate change “the biggest global health threat of the 21st century.” It further noted that the “epidemiological outcome of climate change on disease patterns worldwide will be profound, especially in developing countries, where existing vulnerabilities to poor health remain.” It is projected that several negative health impacts will be exacerbated as a result of climate change in Asia and the Pacific. While the nature of the relationship remains uncertain, climate change is likely to affect health through a number of different pathways. A first, and perhaps most immediate, pathway through which climate change may affect health is water. Adequate and clean water resources are vulnerable to climate change stress, and the lack of these heightens the risk of diarrhea and cholera in rural and urban areas. Greater rainfall, combined with warmer temperatures, is likely to make provision of clean water and adequate sanitation more complex and costly, and expand the vectors for waterborne communicable diseases, including malaria and dengue fever. For example, by 2080, approximately 6 billion people may be at risk of contracting dengue fever as a consequence of climate change, 2.5 billion more than if climate were to remain unchanged (Hales et al. 2002). In Indonesia and the Philippines, there is a clear correlation between the incidence of dengue fever and La Niña’s years (Indonesia) and rainfall (the Philippines). Recent data from Kathmandu, Nepal also show the number of typhoid cases at their highest annual levels, with peaks in maximum and minimum temperatures, as well as in rainfall. A second pathway, independent of water-related issues, is temperature increases. The urban population in developing countries is rapidly increasing, and is often combined with poor housing and living conditions. These conditions increase the risk of heat strokes due to the heat island effect.A third pathway is agriculture, as the agricultural productivity of existing crops is expected to be challenged significantly. Agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops, while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. Although there will be gains in some crops in some regions of the world, the overall impacts of climate change on agriculture are expected to be negative. In turn, this may have adverse impacts on nutrition and food security. Climate change is expected to boost the number of malnourished children by 2050. More specifically, in East Asia, instead of 2.3 million malnourished children in 2050—which is projected in the case of no change in the climate—this number is projected to reach between 4.9 million to 5.3 million with climate change. In South Asia, instead of 52.3 million malnourished children in 2050 under prevailing climate conditions, predictions indicate that between 57.2 million and 58.2 million will be malnourished due to climate change (ADB 2009a). In a recent report, it was estimate that calorie availability in 2050 may not only be lower than in the no-climate-change scenario, but that it may actually decline relative to 2000 levels throughout the developing world (IFPRI 2009). Finally, a fourth pathway is extreme weather events and heat waves (e.g., droughts, storms, rainfalls), which are expected to become more severe and/or more frequent. Over the period 1960–2007, the number of people around the world affected by droughts, floods, storms, and extreme temperatures has increased approximately tenfold.

Potential health impacts of climate change

Global climate change would affect human health via pathways of varying complexity, scale and directness and with different timing. Similarly, impacts would vary geographically as a function both of environment and topography and of the vulnerability of the local population. Impacts would be both positive and negative (although expert scientific reviews anticipate predominantly negative). This is no surprise since climatic change would disrupt or otherwise alter a large range of natural ecological and physical systems that are an integral part of Earth's life support system. Via climate change humans are contributing to a change in the conditions of life on Earth.The more direct impacts on health include those due to changes in exposure to weather extremes (heat waves, winter cold); increases in other extreme weather events (floods, cyclones, storm-surges, droughts); and increased production of certain air pollutants and aeroallergens (spores and molds). Decreases in winter mortality due to milder winters may compensate for increases in summer mortality due to the increased frequency of heat waves. In countries with a high level of excess winter mortality, such as the United Kingdom, the beneficial impact may outweigh the detrimental. The extent of change in the frequency, intensity and location of extreme weather events due to climate change remains uncertain. Climate change, acting via less direct mechanisms, would affect the transmission of many infectious diseases (especially water, food and vector-borne diseases) and regional food productivity (especially cereal grains). In the longer term and with considerable variation between populations as a function of geography and vulnerability, these indirect impacts are likely to have greater magnitude than the more direct. For vector-borne infections, the distribution and abundance of vector organisms and intermediate hosts are affected by various physical (temperature, precipitation, humidity, surface water and wind) and biotic factors (vegetation, host species, predators, competitors, parasites and human interventions). Various integrated modeling studies have forecast that an increase in ambient temperature would cause worldwide, net increases in the geographical distribution of particular vector organisms (e.g. malarial mosquitoes) although some localized decreases also might occur. Further, temperature related changes in the life-cycle dynamics of both the vector species and the pathogenic organisms (flukes, protozoa, bacteria and viruses) would increase the potential transmission of many vector-borne diseases such as malaria (mosquito), dengue fever (mosquito) and leishmaniasis (sand-fly)—although schistosomiasis (water-snail) may undergo a net decrease in response to climate change. Recently, there has been considerable effort in developing mathematical models for making such projections. The models in current use have well recognized limitations—but have provided an important start. For example, from computer multiple modeling studies it seems likely that malaria will significantly extend its geographical range of potential transmission and its seasonality during the twenty-first century as average temperatures rise.

Health Costs of Climate Change

Estimating the future costs of the health impacts of climate change is a daunting task, fraught with uncertainty and incomplete information. This task is made even more difficult when analyzing specific subsets of defined populations, such as those living in poverty.Using the Policy Analysis for the Greenhouse Effect Integrated Assessment Model, Stern (2006) estimates the total cost of a business-as-usual climate change scenario over a period of 200 years. This cost includes the “market impacts” of climate change (impacts on goods and services for which market prices can be used to monetize the impacts into costs), as well as the “non-market impacts” of climate change, which in the Stern Review include impacts on environment and human health.

While the Stern Review includes “non-market” impacts, the report notes these are difficult to monetize and that the results from this monetization process are problematic in terms of concept, ethical framework, and practicalities. Perhaps more importantly for the purpose of this paper, it is to be noted that the Stern Review systematically refers to the “environment and human health” impacts of climate change, and not solely to the impacts on human health. As pointed out by Confalonieri et al. (2007), studies focusing on the welfare costs of climate change impacts (such as the Stern Review) rarely include health outcomes explicitly, and if they do, the studies are generally limited to assessing the costs of extreme heat- and cold-related mortality and malaria. A limited number of studies have strictly focused their effort on estimating the health costs of climate change. The UNFCCC report estimated the global adaptation costs for the health sector to be in the range of $4 billion–$12 billion per year in 2030 (UNFCCC 2007). The adaptation costs are for preventing the additional climate change–induced cases of solely diarrheal disease, malnutrition, and malaria in 2030. Note that malnutrition accounts for a very small proportion of the estimated total costs, whilemalaria and diarrheal diseases contribute to approximately the same proportion to this total cost (though for the high-cost scenario, diarrheal diseases account for a slightly higher share). As noted by Ebi (2008), a key assumption behind these estimates is that the number of annual cases of diarrheal diseases, malaria, and malnutrition, as well as the cost of treatment, remain constant over the period of analysis. Given the projected increase in population, this implies that the rates of incidence of each of these health outcomes decrease over time in line with the rate of population growth.

In a recent World Bank study (2010) such attribution was explicitly modeled insofar as income is concerned. The study used WHO econometric models using panel data on income and health to project cause-specific deaths and disability-adjusted life-year rates by demographic group through 2030 (WHO 2004). Accounting solely for this attribution (as income increases, the rate of incidence falls), the average global costs of adaptation in the health sector for the prevention and treatment of diarrhea and malaria alone (not including malnutrition) over the period 2010–2050 was estimated to reach $1.3 billion (in the dry weather scenario) to $1.6 billion per year (in the wet weather scenario), in 2005 dollars. East Asia, the Pacific, and South Asia account for half of this estimated cost of adaptation. As a result of the different modeling approaches, these estimates (World Bank 2010) are significantly lower than those reported by Ebi (2008). One concludes that (i) there remains large uncertainty as to the adaptation costs for climate change–related health outcomes, and (ii) the analyses have so far captured a limited number of climate change–related health outcomes. For example, neither Ebi (2008) nor theWorld Bank (2010) studies include cost estimates for other infectious diseases that are known to be climate sensitive (such as dengue), heat and cold stresses, population displacement, and increased air pollution.

Population vulnerability and adaptive responses

Human populations, as with individuals, vary in their vulnerability to certainhealth outcomes. A population's vulnerability is a joint function of, first, theextent to which a particular health outcome is sensitive to climate change and,second, the population's capacity to adapt to new climatic conditions. The vulnerabilityof a population depends on factors such as population density, level ofeconomic development, food availability, income level and distribution, localenvironmental conditions, pre-existing health status and the quality and availabilityof public health care.Adaptation refers to actions taken to lessen the impact of (anticipated) climatechange. There is a hierarchy of control strategies that can help to protect populationhealth. These strategies are categorised as: administrative or legislative,engineering, personal-behavioural. Legislative or regulatory action can be takenby government, requiring compliance by all or designated classes of persons.Alternatively, adaptive action may be encouraged on a voluntary basis, via advocacy,education or economic incentives. The former type of action would normallybe taken at a supranational, national or community level; the latter wouldrange from supranational to individual levels. Adaptation strategies will be eitherreactive, in response to climate impacts, or anticipatory, in order to reduce vulnerability. Adaptation can be undertaken at the international/national, communityand individual level—that is, at macro, meso and micro-levels.The reduction of socioeconomic vulnerability remains a priority. The poor (andespecially the very young and old) are likely to be at greatest health risk becauseof their lack of access to material and information resources. Long-term reductionin health inequalities will require income redistribution, full employment,better housing and improved public health infrastructure. There must beimprovement in services with a direct impact on health such as primary care,disease control, sanitation and disaster preparedness and relief. The vulnerabilityof the poor may jeopardize the well-being of more advantaged members ofthe same population. Examples of spillover effects include spread of infectiousdiseases from primary foci in poor populations and the opportunity cost of publicservices committed to dealing with problems related to disadvantage.Improved environmental management of health-supporting ecosystems (e.g.freshwater resources, agricultural areas) would reduce the adverse healthimpacts of climate change. A good example is the control of water-borneinfections. In many areas increased density of rainfall is likely to lead to morefrequent occurrence of significant human infections such as giardiasis andcryptosporidiosis. Traditional public health interventions that focus entirely onpersonal hygiene and food safety have limited effectiveness. A broader approachwould consider the interactions between climate, vegetation, agricultural practicesand human activity—and would result in recommendations for the type,time and place of “upstream” public health interventions such as changes inmanagement of water catchment areas. The maintenance of national public health infrastructure is a crucial element indetermining levels of vulnerability and adaptive capacity. The 1990s witnessed theresurgence of several major diseases once thought to have been controlled such astuberculosis, diphtheria and sexually-transmitted diseases. The major causes weredeteriorating public health infrastructure (especially the vaccination programme)as well as socioeconomic instability and population movement. Elementaryadaptation to climate change can be facilitated by improved monitoring and surveillancesystems. Basic indices of population health status (e.g. life expectancy)are available for most countries. However, disease (morbidity) surveillance varieswidely depending on locality and the specific disease. To monitor disease incidence/prevalence—which may often provide a sensitive index of impact—low costdata from primary care facilities could be collected in sentinel populations.

Conclusion

Climate change is expected to modify and often to magnify the current burden of diseases in the world. With projected increases in temperature and changes in rainfall patterns (generally yielding drier climate in dry seasons and wetter climate in wet seasons), and an increase in the frequency and/or intensity of tropical cyclones and storms, climate change will significantly challenge the public health community at the global, national, and local levels. While all populations are vulnerable to climate-induced health risks, the most vulnerable remain those in low-income groups with little adaptive capacity, among which the elderly, children, and women are most vulnerable. Reducing vulnerabilities and increasing resilience to help people cope with health effects of climate change will increasingly become a priority for the affected nations, while new innovative approaches should be explored to protect these populations.Rapid globalization has brought new, large-scale influences to bear on patterns of human health. Various global-scale changes — economic, social, demographic, and environmental (particularly climatic) — are linked, for example, to the increased prevalence of obesity, changes in regional food yields, the emergence of infectious diseases, and the persistence of health disparities. Undertaking primary prevention at the source to reduce health risks resulting from these global influences is a formidable challenge. It requires conceptual insights beyond the conventional understanding of causation and prevention, as well as political will, trust, and resources. The complexities of policies to mitigate human-induced climate change are clear. Meanwhile, additional resources and strategies will be needed to reduce the health risks related to global change that have already arisen or are now unavoidable. For populations to live sustainably and with good long-term health, the health sector must work with other sectors in reshaping how human societies plan, build, move, produce, consume, share, and generate energy.

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