Commentary

Climate Change and Health

Strengthening the Evidence Base for Policy

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The work of the UN Intergovernmental Panel on Climate Change (IPCC) has contributed greatly to the advancement of knowledge about the causes and consequences of climate change.[1,2] It has been a key influence in forging a growing scientific consensus about the contribution of human activities in a range of sectors including power generation, transport, built environment and agriculture, and land use to the increasing concentrations of greenhouse gases in the atmosphere. The potential impacts of climate change on human health have been reviewed by the IPCC.[3] There are, however, many uncertainties about the range and magnitude of impacts of climate change on health. Increasing international multidisciplinary research efforts are required in three broad areas: to improve our understanding of the complex linkages between climate change and health; to clarify how societies worldwide can adapt to climate change in order to minimize the adverse impacts; and to understand the potential health effects of greenhouse gas–mitigation strategies.

Much of our understanding of climate–health relationships arises from the study of short-term associations of health outcomes with events such as heat waves, floods, and storms. Study of the effects of the El Niño phenomenon on health in different parts of the world shows how wide-ranging climatic fluctuations can affect a wide range of diseases including malaria, cholera, and dengue, as well as the number of people affected by disasters.[4,5] However, these short- and medium-term associations may not necessarily provide an accurate indication of the impact of climate change occurring over many decades because of the impact of adaptation strategies or modulating factors such as socioeconomic development. The Stern review[6] has documented the potential magnitude of the adverse effects of climate change on the world economy and made the case for urgent action to reduce greenhouse gas emissions. Unabated emissions are likely to affect health by increasing poverty as well as through a wide range of other mechanisms.

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There are a number of difficulties in attributing changes in the range and incidence of diseases to climate change, including the weakness and fragmentation of health information systems, particularly in low-income countries. There are relatively few sources of long-term data on health outcomes that could be potentially influenced by climate change to permit time–series analyses of data that has accrued over several decades. There are often many competing explanations of changes in the incidence and/or range of potentially climate-sensitive diseases. For example, there may be population movements caused by migration that increase exposure of non-immune populations to new diseases. Changes in disease patterns may also occur as a result of drug resistance, for example in the case of malaria, or breakdown in health systems and changes in nutritional status due to non–climate-related factors. There may also be interaction between climate change and other environmental changes. For example, deforestation may cause both local increases in temperature because the removal of tree cover and may contribute to climate change by reducing the capacity for absorption of CO_2 from the atmosphere. It may also lead to population movements and changes in the distribution of vector species leading, for example, to outbreaks of malaria in deforested areas. A study of deforestation in the Peruvian Amazon showed that the abundance of a mosquito vector for malaria transmission, *Anopheles darlingi*, was over 200-fold higher in deforested locations compared to more pristine rainforest sites, even taking into account human population density.[7]

Research on the potential health impacts of climate change also needs to take into account the effectiveness of adaptation strategies as societies and public health systems respond to the challenges posed by climate change. In addition, the success of initiatives to eliminate potentially climate-sensitive diseases such as malaria will also substantially influence the degree to which climate change affects human health.[8]

Studies of the potential impacts of climate change and the effectiveness of adaptation strategies need to take into account the likely difference in vulnerability of populations according to their location. There is a need to build international collaborations of researchers studying a range of populations including those in coastal and low-lying areas susceptible to coastal flood-

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ing and tropical cyclones. For example, a country such as Bangladesh is likely to experience increasing problems with inundation, with over 50% of the population being affected with an increase in temperature of 4°C.[9] Populations living on small islands may be particularly vulnerable to floods and storms and changes in a range of vectorborne (malaria, dengue) and other infectious diseases depending on location.[10] Those living in arid areas are likely to be susceptible to increasing desertification and increased frequency of drought. Populations in polar regions may experience changes in their diet as a result of alterations in animal migration or the distribution and access to traditional food sources. There may be longer transmission seasons at high latitudes for those diseases transmitted by ticks, such as tickborne encephalitis: In some populations there may be reductions in excess winter mortality as winter temperatures increase. Thus epidemiologic studies need to be tailored to address the most likely impacts on health in different regions.

Adaptation strategies need to be evaluated to determine their (cost) effectiveness. In the case of heatwaves, for example, heat early-warning systems have been set up in some cities to alert vulnerable groups, for example elderly people and their care-givers of impending heatwaves and to mobilize the community to ensure that appropriate advice and support are given.[11] Such systems need to be evaluated in a range of locations, including mega cities in low- and middle-income countries.

Linkages among malnutrition, climate change, and agricultural policy are a particularly important area for research. There is a growth in demand for meat and dairy products that contributes to climate change through, for example, the production of methane, but that also increases the challenge of feeding the growing world population because of the growing grain requirements for meat production.[12] In addition, inappropriate biofuel policies may exacerbate food shortages.

Assessment of the health impacts of biofuels should encompass the full lifecycle of fuel production in common with the health-impact assessment of other energy sources. For example, in Brazil, while air quality in urban centers has improved since ethanol has been used as an automotive fuel, the burning of sugar cane before manual harvesting causes geographically dispersed particulate air pollution in populations in the areas surrounding plantations.[13]

There are potentially major public health benefits from addressing the lack of access to clean and reliable energy and energy services for the 2.4 billion people, mainly in low-income countries, who depend on the combustion of traditional biomass for household energy use with resulting high levels of indoor air pollution.[14] Therefore, in addition to reducing greenhouse gas emissions, policies should be put in place to address lack of access to clean energy.

Greenhouse gas–mitigation policies in transport, built environment, and high-generation agricultural sectors can all have near-term benefits for health, as well as contributing to greenhouse gas mitigation.[15] Strengthening the evidence base for quantifying these co-benefits to health[16–18] in turn strengthens the case for implementing policies that can achieve near-term benefits for health and welfare, as well as long-term benefits resulting from climate change mitigation. Such policies could include the promotion of active transport, such as cycling, and walking in urban centers, which can reduce obesity and the health burden of inactivity while reducing greenhouse gas emissions. They also encompass the promotion of renewable energy technologies, which reduce air pollution while reducing greenhouse gas emissions, and the redesign of the built environment to facilitate a low-carbon lifestyle. Collaborative international multidisciplinary research to improve the understanding of the potential impacts of climate change on health, cost effectiveness of adaptation strategies, and policies to improve health in the near term while reducing greenhouse gas emissions, should be given higher priority by research funding organizations. Such research has the potential to contribute greatly both to the achievement of improved public health and environmental sustainability.

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