



CHAPTER 9
The Health Sector

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Climate change is likely to affect the basic determinants of health: clean air and water, disease vectors, and the availability of food.

Many major diseases are highly climate sensitive. A warmer and more variable climate increases air pollutants, which in turn lead to respiratory and airborne diseases. With likely impacts of climate change coming in the form of extreme events such as floods and cyclones, the transmission of diseases is also likely to proliferate. Climate change threatens to slow the considerable progress that has been made in combating climate-sensitive diseases.

In South Asia many of the leading causes of mortality, such as diarrheal diseases and respiratory infections, reflect the poverty that remains endemic to much of the region. For example, in areas with inadequate sanitation, diarrheal disease outbreaks are likely during times of flooding. With increased rainfall during the monsoon season, these outbreaks will become more frequent. In urban areas, an increase in air pollutants associated with rising ozone levels will exacerbate chronic illnesses such as cardiovascular disease and asthma. Climate change will likely affect both communicable and chronic causes of illness. The more prosperous parts

of the region are undergoing an epidemiologic transition, with the health burden shifting away from communicable diseases toward a higher incidence of chronic diseases.

The relationship between climate change and human illness is complex, little understood, and difficult to assess. Accordingly, chapter 9 provides a broad qualitative overview of its *likely* impacts. The risks to health stemming from climate change will occur through three channels: (i) the impacts that are directly related to weather or climate; (ii) the likely impacts that result from environmental changes that occur due to climate change; and (iii) the impacts that result from consequences of climate-induced economic dislocation, environmental decline, and conflict (WHO 2005). Each of these is explored in the South Asian context in greater detail.

Impacts Directly Related to Weather or Climate

Human health impacts directly related to weather or climate include changes in the frequency and intensity of temperature extremes and severe weather events. In South Asia, this includes heat waves, flooding, and increased intensity of tropical cyclones and storm surges.

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Heat Waves

As summer temperatures rise, heat waves are projected to become more common and of longer duration. This may cause an increase in heatstroke and in the incidence of cardiovascular, cerebrovascular, and respiratory diseases (Hales, Edwards, and Kovats 2003). In South Asia, heat waves are associated with high mortality rates in rural areas and, also, among the poor and outdoor laborers (Chaudhury, Gore, and Ray 2000). A large number of heat-wave-related deaths have been reported, mainly among vulnerable populations: the poor, the elderly, and laborers such as rickshaw pullers and agricultural workers (Lal 2003). A heat wave that took place in Andhra Pradesh, India, in 2003, with temperatures rising to over 48°C (118°F), caused more than 3,000 deaths (Government of Andhra Pradesh 2004).

Rising temperatures are also expected to exacerbate the existing urban heat island effect, thus increasing the vulnerability of some urban environments to heat-related mortality. The air temperature in cities can be up to 12°C warmer than that in surrounding suburban and rural areas due to absorption of heat by dark-paved surfaces and buildings; lack of vegetation and trees; heat emitted from buildings, vehicles, and air

conditioners; and reduced airflow around buildings (CEIDH 2001). With five of the world's megacities and many other urban areas situated in South Asia, rising city temperatures have the potential to impact the health of city dwellers, particularly of those residing in slums, who generally are more exposed to natural elements.

Flooding

Greater intensity of rainfall events in South Asia is projected to likely increase the frequency of floods (Cruz et al. 2007). These trends are already being seen. In 2007, floods resulting from monsoon rains killed more than 2,000 people and displaced more than 20 million people in Bangladesh, India, and Nepal. In the Himalayas, the frequency of glacier lake outburst floods rose during the second half of the 20th century⁶⁶ (WHO 2005).

Flooding has been associated with direct and induced health risks. Direct risks include death due to drowning and trauma from being hit by objects moving rapidly in the flood stream (Ahern et al. 2005). Often the greatest harm stems from induced impacts. Flooding creates an environment conducive to the transmission of disease. If floodwaters become contaminated with human or animal waste, the rate of fecal-oral disease transmission may increase, allowing diarrheal disease and other bacterial and viral illnesses to flourish. Fecal-oral transmission of diseases is of particular concern in regions where access to clean water and sanitation is limited. Increases in diarrheal disease, cholera, dysentery, and typhoid are of specific concern (Morgan et al. 2005). For example, flooding in West Bengal caused an outbreak of cholera-induced diarrhea that resulted in 276 deaths (Sur et al. 2000). Numerous studies have correlated previous floods in Bangladesh and India with outbreaks of diarrhea and respiratory

⁶⁶ Glacial Lake Outburst Flood Monitoring and Early Warning System, <http://www.rrcap.unep.org/issues/glof/> (accessed September 9, 2008).

infections (Siddique et al. 1991; Kunii et al. 2002; Biswas, Pal, and Mukhopadhyay 1999; Mondal, Biswas, and Manna 2001). Flooding can also contribute to increased vector- and rodent-borne diseases. Stagnant water provides breeding grounds for mosquitoes, potentially aiding the spread of malaria (Ahern et al. 2005). Other studies have correlated flooding in Bangladesh and India with outbreaks of rotavirus infections (Fun et al. 1991) and leptospirosis (Leptospirosis, India, 1999; Sehgal, Sugunan, and Vijayachari 2002; Karande et al. 2003; Karande et al. 2002).

Tropical Cyclones and Storm Surges

South Asia is particularly vulnerable to cyclones, which often have devastating health consequences. (See Box 9.1.) Of all deaths resulting from the world's 35 most deadly cyclones (from the years 1584 to 1991), India and Bangladesh accounted for 76 percent (Ali 1999). Two of the world's three deadliest cyclones occurred in Bangladesh, causing 300,000 deaths in the 1970 cyclone and 138,000 deaths in the 1991 cyclone (Keim 2006). Likely increases in sea-surface temperatures are expected to increase tropical cyclone intensity and the height of storm surges in the region (Ali 1999) (Box 9.1). Although the frequency of cyclones originating in the Bay of Bengal and the Arabian Sea has decreased, their intensity has increased since 1970, causing significant damage (Ali 1999; Lal 2001; Lal 2003) (see also chapter 6).

The main health risks associated with these phenomena are drowning and the spread of diseases. The majority of deaths occur at the impact phase of the cyclone due to drowning (Keim 2006). Chronic diseases are known to be exacerbated after cyclones, as cyclone-affected populations undergo intense physical and mental stress and have limited coping abilities (Hess, Malilay, and Parkinson 2008). Unfortunately, disruptions in critical health services are highly likely following a cyclone (Keim 2006), leaving those suffering from chronic illness without care for indefinite periods of time. As in the case of flooding, other public health effects of cyclones include disease and illness associated with the loss of clean water, hygiene, and sanitation, particularly in densely populated shelters; increased pest- and vector-borne diseases; toxic exposures; and loss of shelter and population displacement that increase vulnerability to disease (Keim 2006).

Impacts Resulting from Climate-induced Environmental Changes

Other human health impacts will stem from changes in the environment due to altered climatic conditions. In South Asia, environmental changes are likely to decrease agricultural productivity and alter ecosystems in ways that will lead to a reduction in the food supply and an increase in vulnerability to outbreaks of infectious diseases, both waterborne and vector borne. The prevalence of diseases associated with air

Box 9.1 Storm Surges

Storm surges are bodies of water that are pushed toward the shore by swirling winds around a storm. The surges combine with normal tides to create the storm tide, which can increase the mean water level to heights that can impact roads, homes, and other critical infrastructure.

Additional wind-driven waves can amplify the storm tide and cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides. Because much of the Southern Asian coastal zone lies less than three meters above mean sea level, the danger presented by storm tides is tremendous.

Source: Federal Emergency Management Agency (FEMA): Hurricane Hazards: Storm Surge. (http://www.fema.gov/hazard/hurricane/hu_surge.shtm)

pollutants and aeroallergens is also predicted to increase with changes in the hydrologic cycle and increases in ambient temperature.

The burden of climate-related disease is greatest for the poorest populations. For example, per capita mortality rates from vector-borne diseases are 300 times higher in developing nations than in developed countries. This is due, in part, to the fact that vector-borne diseases are more common in warmer regions, but it also reflects poverty-related vulnerability. Individuals without adequate food, shelter, or health services are obviously more vulnerable to climate-related health risks.

Waterborne Diseases

Waterborne diseases, including cholera and diarrheal diseases, such as giardiasis, salmonellosis, and cryptosporidiosis, are common and frequent. The frequency of such incidents is likely to increase in South Asia as an effect of an increase in temperature (Hales, Edwards, and Kovats 2003). Diarrheal disease is already a major cause of morbidity and mortality in South Asia, particularly among children. It is estimated that 25 percent of childhood deaths are due to diarrhea (Zaidi, Awasthi, and de Silva 2004). Diarrheal diseases are largely attributable to drinking unsafe water and lack of basic sanitation (Ezzati et al. 2004). Reductions in the availability of freshwater are therefore likely to increase the incidence of such diseases. Water shortages are

already a reality due to rapid urbanization and industrialization, population growth, and inefficient use of available water (Cruz et al. 2007). The shortage of freshwater is likely to be aggravated by climate change. As previously discussed, flooding is also associated with increased incidence of diarrheal disease, particularly in regions where access to clean water and sanitation is limited: as floodwaters become contaminated with feces, fecal-oral disease transmission routes increase the incidence of diarrheal disease.

Evidence is emerging to show that cholera outbreaks are likely to increase in some areas.

Phytoplankton blooms, which are supported by warmer sea-surface temperatures, provide an excellent habitat for the survival and spread of infectious bacterial diseases such as cholera (Pascual, Bouma, and Dobson 2002). Evidence also shows that El Niño plays an important role in the interannual variability of endemic cholera (Pascual, Bouma, and Dobson 2002), and annual weather patterns also influence these patterns (Box 9.2). In Bangladesh there are two peaks of cholera cases, one in the spring and a larger peak following the monsoon season. The onset of these epidemics is correlated with dry weather and warm water temperatures (Lipp, Huq, and Colwell 2002).

Vector-borne Diseases

Several tropical vector-borne diseases are highly sensitive to climate. Not only does

Box 9.2 Cholera and El Niño

A study by Rodo et al. (2002) determined a relationship between stronger El Niño events and cholera prevalence in Bangladesh over a 70-year period. The study used statistical methods to verify periods of historical cholera data dating back to 1893, enabling an examination of the effect of nonstationary interannual variability possibly associated with climate change.

Since the 1980s there has been a marked intensification of the El Niño southern oscillation (ENSO), beyond that expected from the known shift in the Pacific Basin temperature regime that began in the mid-1970s. The authors found the association of cholera incidence with ENSO in the earlier part of the study period (1893–1940) to be weak, while later in the period (1980–2001) a strong correlation emerged between intensified ENSO events and the incidence of cholera.

Source: Rodo et al. 2002



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temperature and precipitation influence pathogen development within vectors, but vectors themselves are also subject to climactic variability.⁶⁷ Given the complexity of the interactions, the relationship between climate change and human illness caused by vector-borne pathogens is difficult to assess. However, studies suggest that climatic variability and extreme weather events, likely to occur in South Asia, may increase the occurrence of outbreaks and the spread of vector-borne diseases in some areas. Climate variability that induces changes in human

behavior can also alter the patterns of vector-borne diseases. For example, changes in population density, water storage, irrigation practices, land use, construction techniques, and the use of air conditioners can all vary the way in which vectors and humans interact (Gage et al. 2008). Box 9.3 uses the example of migratory birds to illustrate the complex relationships that can exist between climate, species population dynamics, and disease vectors.

The threat from malaria is likely to be the greatest concern. Malaria is already one of the most important vector-borne diseases in Bangladesh, India, and Sri Lanka. Changes in temperature and precipitation patterns have the potential to expand the geographic range of malaria into temperate and arid parts of South Asia (Hales, Edwards, and Kovats 2003). For example, in India the malaria distribution may expand to higher latitudes and altitudes. Again, the relationship between climate and disease distribution is complex: in some areas increasing temperatures may restrict malaria transmission, but the extent is not known (Gage et al. 2008).

Other diseases of concern are mosquito-borne dengue and chikungunya fever;

Box 9.3 Climate Change, Migratory Birds, and Infectious Diseases

Several species of wild birds can act as biological or mechanical carriers of human pathogens and vectors of infectious agents. Many of these birds are migratory species that seasonally fly long distances through different continents. Climate variability has been implicated in changes in the migratory patterns, reproductive penology, abundance, and population dynamics of several bird species and a northward expansion of their geographic range in Europe. Two possible consequences of these changes for the dispersion of pathogens and their vectors are the following:

- ◆ Shifts in the geographic distribution of the vectors and pathogens due to altered distributions or changed migratory patterns of bird populations.
- ◆ Changes in the life cycles of bird-associated pathogens due to mistiming between bird breeding and the breeding of vectors, such as mosquitoes.

Source: Confalonieri et al. 2007

⁶⁷ For example, arthropod vectors are exothermic. Thus, fluctuating temperatures impact their development and reproduction. The distribution and abundance of zoonotic hosts to pathogens is also affected by climate.



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parasitic diseases such as leishmaniasis, lymphatic filariasis, and onchocerciasis; and tick-borne diseases. These have the potential to shift geographic ranges and the timing of peak abundance. Human plague, a vector-borne disease carried by fleas, has had devastating effects in South Asia historically, but it may also be heavily influenced by climatic factors. Rainfall and temperature are likely to influence the frequency of plague in the future by affecting the spread of rodents, which carry fleas. Murine typhus—an arthropod-borne infectious disease caused by *Rickettsia typhi* bacteria—is also transmitted by fleas; its survival and development is also heavily influenced by temperature and humidity (Gage et al. 2008).

Diseases Associated with Air Pollutants and Aeroallergens

Air quality is significantly affected by weather conditions, including amounts of ground-level ozone, fine particulate matter, smoke, and aeroallergens. In urban areas, warmer temperatures may result in the production of more ground-level ozone through conversion of carbon dioxide emissions. Ozone is known to have negative

respiratory effects, particularly affecting individuals with asthma. Being home to five of the world's megacities, South Asia will continue to be affected considerably by urban air pollution. Rising carbon dioxide levels and warmer temperatures have the potential to increase the amount of aeroallergens, such as pollen or spores, in the air. These airborne substances are characterized by their ability to cause an allergic response in humans (Githeko and Woodward 2003), which can in turn lead to an increase in the incidence of respiratory allergies.

Possible Impacts Resulting from the Consequences of Climate-induced Economic Dislocation

As climate change is likely to alter the environment, a growing concern will be the health consequences of social and economic dislocation. Specifically, the greatest health impacts associated with environmental decline in South Asia are likely to be population dislocation and displacement.

Population displacement is certain to occur, thus creating “climate refugees.” South Asia's population is large and growing rapidly, and almost any perturbations to the environment may be cause for dislocation. Displacement may be the result of extreme weather events, such as the monsoon floods that displaced more than 20 million people in Bangladesh, India, and Nepal in the summer of 2007, or of sea-level rise. Since many cities are situated along the coasts, the coastal impacts of climate variability could result in mass displacement of urban populations.

People displaced internally or across borders are vulnerable to disease (St. Louis, Campbell-Lendrum, and Hess 2008). Displaced populations often end up living in refugee camps or urban slums; these are environments in which health suffers dramatically, as they are characterized by close quarters, poor sanitation, and insufficient food supply or livelihood opportunities. Mental health

impacts of extreme climate events and disasters present another public health challenge. The most common consequences of severe weather events, such as floods and cyclones, include anxiety, depression, and posttraumatic stress disorder (Ahern et al. 2005; Keim 2006). Although the mental health impacts of disasters are not well studied, an assessment in Bangladesh did show increased behavioral problems among children following flooding (Durkin et al. 1993). These behavioral health effects may be the least apparent, but they are among the most long-term and debilitating public health impacts of natural disasters (Ursano, Fullerton, and McCaughey 1994; WHO 1992).

Health Sector Priorities to Address Climate Change

Priorities

Because climate change is global in its impact, regional collaboration is necessary. In an

economically integrated world, infectious diseases can spread rapidly, far beyond their origins. The past decade saw the reemergence and regional spread of many climate-sensitive diseases such as cholera, Rift Valley fever in Africa, and dengue in South Asia and Latin America. These outbreaks can cause major economic loss. Consequently, rapid disease-control responses and surveillance systems capable of detecting and tracking disease activity in a timely fashion will be essential. These will need to go beyond attention to infectious diseases and include monitoring of aspects of acute population migration, nutrition, mental health, air quality, and stress-related chronic disease. These surveillance and disease-control systems need agility and flexibility to respond quickly to the health effects of heat waves, flooding, and severe storms. They also need to be sensitive enough that they can detect changes in nutritional status linked to agricultural output declines and population migration.

Approaches to minimizing the likely health-related burden of climate change in South



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Asia need to focus on improving responses to ongoing issues that, in the future, will likely occur with greater frequency, intensity, and geographic range. A major component of a country's climate-change approach will be the prioritization of actions (see following section). The urgency of the problem, the country's current public health capacity, technology, and other limiting circumstances will all need consideration. Notwithstanding some successes, most of the countries in the region are now struggling with developing quality surveillance systems and provision of health services. Many issues, including higher-level ones such as migration, have challenged or slowed the development of the health sector. Prioritizing climate-change activities will need to consider this context as well as ongoing developments in other nonhealth sectors. Increases in the incidence of infectious diseases require health surveillance, preventive measures, and treatment efforts that are effective and have the capacity to deal with increased workloads expected in the health and related sectors.

Due to differences in vulnerabilities to climate-change health effects, country-specific strategies will be essential. However,

all strategies will need to include health and environmental surveillance, building new systems or enhancing systems that are currently in place. It will be necessary to assess these needs and retool public and curative health-care services so they provide effective responses.

Role of the World Bank

The Bank can play a role in assisting countries as they tackle likely health impacts of climate variability. The following could be priorities for the Bank:

- ◆ Playing a convening role to highlight the health dimension of the climate-change issue in the region.
- ◆ Facilitating regional- and country-level efforts aimed at developing strategies and policy dialogues.
- ◆ Providing technical assistance and knowledge products to improve health policy development.

Table 9.1 presents an action matrix for a health sector response to climate change in South Asia.

Table 9.1 Action Matrix for Climate Change in South Asia

Activity	Purpose
Awareness of the health implications of climate change	To improve policy and decision makers' understanding of the implications of climate change and the need for strategic planning
Disease surveillance	To improve government's ability to detect and monitor injuries, environmental exposures, infectious diseases, and chronic diseases that are sensitive to climate change
Response capacity	To improve the population-base public health awareness, interventions and health system capacity for climate-change-sensitive issues and diseases
Assess current and future impact of climate change	To assess current health burden due to climate change and to project it into the future in order to inform policy directions
Engage in a Country and regional approach	To develop a plan with short-, medium-, and long-term country strategies and to integrate with regional strategies