Chapter 12
Climate Change and Health Impacts in Bangladesh

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Abstract There is increasing evidence that global climate change will have adverse effects on human health, mainly among the poorest population of the developing countries. Bangladesh may experience some of the more severe impacts because of its characteristic climatic and geographical conditions, coupled with high population density and poor health infrastructure. Many of the climatic events would make the climate change-induced health impacts worse as a result of newer environmental threats, such as changes in microclimate, erratic climatic behavior, and salinity intrusion in soil and water. This paper identifies some of the possible direct and indirect impacts of climate change on health condition of Bangladesh. In identifying such impacts, secondary sources of information have been widely reviewed. It has been seen that even though climate change-induced health impacts have been gaining importance in Bangladesh, there is still a lack of research and capacity in this field and its ever-increasing level of vulnerability of the people. Linkage between climate change and the increased incidences of disease, rate of mortality, and availability of safe water has not yet received the proper focus it requires.

Keywords Climate change • Contamination • Drought • Food security • Heat stress • Salinity intrusion

12.1 Introduction

Today, the world is already experiencing various impacts of climate change. These are reflected through melting glaciers on high hills and subarctic areas to perch lands, floods, and cyclone disasters. The changing climates are changing all forms of lives in many countries – and perhaps forever. Therefore, climate change

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is considered as the single most important challenge of this century. This is more so for countries like Bangladesh, Sri Lanka, India, Maldives, Solomon Island, Vanuatu, and other small low-lying island states and coastal communities around the world. Bangladesh will be severely affected by inundation of land and resultant displacement of population.

The scenario for Bangladesh is very scary to say the least. It is the most densely populated deltaic country in the world with low-lying coastal zone, which has been repeatedly devastated by tropical cyclone. For Bangladeshis – who are habitually geared for tragedy – the experiences of 2007 floods, followed by devastating cyclone, *Sidr*, are still very vivid in their memories. Historically, Bangladesh used to endure a big flood every 10 years or so. Now, such devastating floods and cyclones are likely to be regular event every year due to global warming and changes in the climatic pattern. With these, a range of health-related problems is bound to follow as a set pattern for this country (Zaman et al. n.d.).

About 23 % of the country's area is critically vulnerable due to sea-level rise and will be permanently flooded, according to many experts, by 2050 displacing an estimated 25 million people. At the same time, the northwestern region will be subject to scarcity of water leading to drought and changing in hydrological regime creating untold misery, including affecting food security and agricultural production. Bangladeshi scientists estimate that approximately 40 % of crop yield will be reduced by 2050 due to climate change or variability. Both fishery and forestry will likewise be immensely affected. Climate change is also likely to have wide-ranging adverse impacts on human health and well-being. Decreased availability of potable water due to raising salinity will be responsible for increased illness and death, while many infectious diseases, including malaria and dengue, could rise due to climate change. In sum, these cumulative factors, associated with weak infrastructure, poor governance, and lack of resources, will lead to greater risks in the future, to say the least. A recent World Bank study (cited by Islam 2008) revealed that about 4 % of the GDP is being eroded by environmental degradation in Bangladesh annually.

12.2 Climate Change, Sea-Level Rise, and Bangladesh

One of the reasons for defining disasters in Bangladesh in terms of health issues is that Bangladesh has emerged as one of the world's predicted hot spots for potential tropical diseases due to climate change. Bangladesh is particularly vulnerable to sea-level rise because of the compounding effects of global warming and land subsidence due to removal of groundwater and the weight of accumulation of huge quantities of river sediments in the Ganges-Brahmaputra-Meghna (GBM) river system, estimated at between 0.5 and 2 billion metric tonnes per year (Ahmed 2006). The most recent projections by the Intergovernmental Panel on Climate Change (IPCC) estimate global sea-level rises within the range of 0.18 to 0.59 m (IPCC 2007). These estimates are considerably lower than that of the first IPCC

assessment in 1990 (70 cm by 2100) but are more consistent with recent findings by Church and White (2006) and Church et al. (2004, 2006a, b). Much more catastrophic projections (exceeding a rise of 1 m by the end of 2100) by a group of non-IPCC scientists are based on computer simulations of accelerations of glacier melting (Munro 2006; Hansen 2007). Even with a conservative estimate of 70 cm of sea-level rise (the maximum projection of the first IPCC assessment), Bangladesh is likely to experience a sea-level rise of up to 1.9 m by 2100, largely because of the remaining contribution by land subsidence (Houghton 2004).

Since the 2007 IPCC assessment projects about 10 % lower sea levels than in its first assessment, thus prorated, Bangladesh is still expected to experience a sea-level rise of about 1.7 m by the end of this century. This amounts to a rate of 1.7 cm or 0.66 in. of rise per year.

Expressed in this manner, this may not sound alarming, but in a low-lying coastal environment with extremely gentle slopes, about one-fifth of the land area of Bangladesh is at risk of inundation (Houghton 2004). Estimates of the number of people that would be displaced by inundation of one-fifth of Bangladesh range from 15 million to as high as 25–35 million (Nicholls and Mimura 1998; Rabbani et al. 2010). Notwithstanding such divergence in estimates, large-scale population displacement and associated socioeconomic and health problems due to sea-level rise is a disaster-in-waiting for Bangladesh as it is the most anticipated impact of climate change in this low-lying country. However, the health issues as an inevitable consequence of the climate change and sea-level rise has not so far been addressed to in-depth in the existing literature. The National Adaptation Program of Action (NAPA) of the Government of Bangladesh does not shed much light on this particular problem either (MoEF 2010).

12.3 Climate Change, Sea-Level Rise, and Health Issues

There is increasing evidence that global climate change will have adverse effects on human health, mainly among the poorest population of the developing countries. Bangladesh may experience some of the more severe impacts because of its characteristic climatic and geographical conditions, coupled with high population density and poor health infrastructure. Many of the climatic events would make the climate change-induced health impacts worse. For example, in 2004, about 50 % of the total land mass of the country was inundated for nearly 2 months, while in 1998, flood affected approximately 30 million people in 52 out of 64 districts of the country. At the same time, a large number of people are annually affected by coastal cyclones leading them to lead economic deprivation affecting their nutritional level and general health. Thus, such high degrees of "vulnerability" to the impacts of climate change make the population particularly susceptible to adverse health impacts and threaten development achievements (Khan et al. 2011a, b).

Such vulnerability conditions are directly linked with some human health problems as a result of newer environmental threats, such as changes in microclimate,

erratic climatic behavior, and salinity intrusion in soil and water. This paper identifies some of the possible direct and indirect impacts of climate change on health condition of Bangladesh. In identifying such impacts, secondary sources of information have largely been reviewed.

12.3.1 Climate Change and Health: Some Generalizations

As indicated above, climate change affects human health both directly and indirectly as people get exposed to some of the key weather elements (temperature, precipitation, air mass, etc.) directly and indirectly through changes in the quality of water, soil, given ecosystems, agriculture, industry, human settlements, and nature of health infrastructure. Such exposures in varying degrees can cause disability and sufferings – even death. Further, health problems can increase vulnerability and reduce the capacity of individuals and/or groups to adapt to climate change. At present the impacts of climate change are rather subtle to observe, but the IPCC has projected a progression in health hazards for all regions of the world. The IPCC (2007 quoted by Rahman 2008) has observed some emerging evidence of climate change affecting human health as:

- Altered the distribution of some infectious disease vectors
- Altered seasonal distribution of some allergic pollen species
- Increased heat wave-related deaths

Systematic reviews of empirical studies provide the best evidence for the relationship between health and weather or climate factors, but such formal reviews are rare. The evidence published so far indicates that:

- Climate change is affecting the seasonality of some allergic species as well as the seasonal activity and distribution of some disease vectors.
- Climate plays an important role in the seasonal pattern or temporal distribution of malaria, dengue, tick-borne diseases, cholera, and other diarrhea diseases.
- Heat waves and flooding can have severe and long-lasting effects.

Most importantly, waterborne diseases will pose a major public health concern in the country with changes in climate factors in terms of yearly maxima and minima as observed by a study conducted by Bangladesh Center for Advanced Studies (BCAS) and National Institute of Preventive and Social Medicine (NIPSOM) with support from Climate Change Cell of the Environment Directorate of the Government of Bangladesh. The study was conducted in three climatic zones, i.e., drought prone (Rajshahi), flood prone (Manikganj), and coastal zone (Satkhira) (Climate Change Cell 2009). According to the study, climatic factors are associated with malnutrition problems. Incidence of diarrhea was found to have positively correlated with annual rainfall in Rajshahi and Satkhira districts. Total monsoon rain was also found to have positively correlated with incidence of rainfall. In contrast, dry season rainfall was found to have positive correlation with Manikganj area. Skin diseases and

malnutrition were also found to be positively correlated with temperature differentials in both Rajshahi and Satkhira and negatively correlated in Manikganj area. The study also shows that the climatic factors of Satkhira are sensitive to diarrhea, skin diseases, and malnutrition as they are positively correlated with at least one of the climatic variables. Rainfall variations came next as the main cause of such diseases and are followed by natural hazards and other disorders (UNB 2009). However, these findings should be viewed with caution as simple statistical correlation does not imply any causal relationship between variables under consideration as there are other elements that could have interventions, including access to health infrastructure, with human health and diseases in a given area.

12.4 Climate Change and Diseases Scenario

In the early 1990s, there was little awareness of health risks posed by global climate change. Broadly a change in health conditions can have three kinds of health impacts:

- Impacts on human health directly by weather extreme (death, injury by flood, storm)
- Indirect impacts through changes in the range of disease vector-borne and waterborne pathogens
- The health consequences of various processes of environmental and ecological disruption that occur in response to climate change

Over the years it has been suggested that changes in the incidences of diseases and other health problems related to climate and environmental changes have occurred. Vector-borne and waterborne diseases have been on the rise along with the increased shortage of freshwater supply and sanitation. Even though it has been recognized that climate change affects the health sector as much as the other sectors, climate change-related health problems have been virtually ignored. Research in this area has been very limited, and there has been no study to find out the extent of impact climate change has had on health-related issues (IIED and BCAS 2008).

According to the World Bank (2000 quoted by Rahman 2008), Bangladesh is vulnerable to outbreaks of infectious, waterborne, and other types of diseases. Available information shows that the incidence of malaria has increased from 1,556 cases in 1991 to 15,375 in 1981 and from 30,282 cases in 1991 to 42,012 in 2004 (Elahi and Sultana 2010). Other diseases, such as dengue, diarrhea, dysentery, and other gastroenteric diseases, are also on the rise especially during summer months when humidity is high and monsoon rains break in (MoEF 2005) (Table 12.1). Other high-temperature and rainfall-related diseases on the increase are dehydration, malnutrition, and heat-related morbidity mainly among children and aged population groups. These diseases are also linked to some environmental conditions, like water supply, sanitation, and seasonal food habits.

Table 12.1 Incidence of some climate-induced diseases in Bangladesh

Diseases	Period	Total cases	Average annual cases
Diarrhea	1988–2005	48,302,636	2,842,273
Skin diseases	1988–1996	23,697,833	2,623,092
Malaria	1974–2004	1,018,671	33,956
Mental disorder	1988–1996	201,881	22,431
Dengue	1999–2005	19,830	3,305

Source: WHO (2006), Director-General, Health, GoB (1996, 1997), MoEF (2005) (After Rahman(2008))

Streatfield (2012) followed the framework for Climate Change-Health Research of the WHO projects' impacts of climate change that indicated increase of global temperature (relative to preindustrial) ranging from 0 to 5 °C and identified five major areas, i.e., food, water, ecosystems, extreme weather events, and risk of abrupt and major irreversible changes. Consequently, with above 3 °C changes in temperature, each of the above areas will lead to falling crop yield particularly in developing regions and also falling yields in many developed regions, and many major cities will be threatened by sea-level rise, extinction of increasing number of species, rising intensity of climatic events, and increasing and abrupt risks of large-scale shifts in the climate system, respectively (Streatfield 2012). Most of these will directly impact on human health conditions in Bangladesh. Such a situation is now already emerging in Bangladesh in terms of increased incidence of infectious diseases which may be termed as the *direct impacts* of climate change. These are briefly discussed below:

Malaria About 15 million people are now at risk of malaria attack, and according to the Ministry of Health and Family Welfare (GoB 2011), 37 deaths were reported, but the "actual cases may be 5,000 to 10,000" (Streatfield 2012). The most affected areas are in the northeastern and southeastern parts of Bangladesh (Elahi and Sultana 2010). Many parasites prefer 24–26 ° C and mosquitoes (*Plasmodium falciparum*) like similar range (above 20 °C). A study was conducted in Rangamati, Sylhet, and Faridpur districts over the period 1972–2002 to observe the impacts of climate change on public health especially on malaria. The climate-related variables included were temperature, rainfall, and relative humidity. It was observed that with the rise of yearly average maximum temperature, yearly total rainfall, and yearly average humidity, malaria prevalence in Rangamati has increased, and with the rise of yearly average maximum and minimum temperature in Sylhet and Faridpur, malaria prevalence was also increased. Yearly average minimum temperature in Rangamati, yearly total rainfall in Sylhet and Faridpur, and yearly average humidity in Faridpur were found to be negatively correlated with malaria prevalence (Amin et al. 2011).

Dengue The rise in average temperature and increased instances of waterlogging due to floods has increased the population of mosquitoes in some tropical countries. The Bangladesh National Adaptation Program of Action (NAPA) noted the increas-

ing trend and variation of dengue outbreaks are consistent with the corresponding trend and variation of temperature, which indicates that the anticipated future warming in Bangladesh might enhance the dengue occurrence (MoEF 2005). Dengue is a viral febrile illness that is also transmitted by mosquito vectors (*Aedes aegypti*). Outbreaks of dengue have become frequent in recent years for a number of reasons. Almost all ages and both sexes are susceptible to dengue. Dengue transmission occurs during the rainy season of the year. Since July 2000 there had been four outbreaks of dengue in the Dhaka City, and cases had also been reported from other big cities of different parts of the country (Dhaka, Chittagong, Khulna, Rajshahi) (IIED and BCAS 2008). Dengue fever is showing a fluctuating trend – 6,000 cases with 58 deaths in 2002 and 500 cases with 0 deaths in 2007. But there was a trend of dengue outbreaks in every 2 years. An increase of 3° to 4 ° C of temperature may double the reproduction of *Aedes aegypti* mosquito – the carrier of dengue – and there is no vaccine yet to treat this disease.

Kala-azar In Bangladesh kala-azar had almost disappeared in the late 1970. But it reappeared sporadically and an increase of kala-azar cases reported during 1982–1988. During the last few years, cases have been increasing but the reasons for this are not clear. The disease pattern is extremely localized with most cases reported from rural areas, a familial and contiguous household clustering pattern among the lower socioeconomic groups (IIED and BCAS 2008). There was an incidence of kala-azar in only 8 upazilas (out of 509) in 1981–1985, it increased to 105 in 2011, and a total of nearly 9,000 cases were detected causing 15–30 deaths per year. As the surveillance is weak, the estimated cases will be about 45,000 (Streatfield 2012). Female sand flies (*Phlebotomus argentipes*) carry the parasitic protozoa (*Leishmania donovani*) whose favorite habitats are river embankments and crevices in mud houses and in weeds/vegetation around houses. The prevalence of kala-azar is expected to rise with temperature as well as erratic rainfall due to global warming affecting this part of the world.

Diarrhea and Cholera Diarrhea, the most common disease in Bangladesh, accounts for about 16 % of total morbidity. The transmission of disease is associated with poor hygiene and inadequate access to water and sanitation and a warmer and humid environment. In the summer months, the incidences increase. Diarrhea and cholera epidemics are often reported in Bangladesh, and especially the children are affected by excessive heat, floods, waterlogging, lack of safe drinking water, etc. The proportional morbidity rate due to diarrhea disease has decreased in Bangladesh ranges from 17.5 % (1992) to 14.2 % (1996). The most vulnerable groups to diarrhea which ranged are children under five. Of them, infants had relatively high proportional morbidity due to diarrhea (IIED and BCAS 2008). A warmer water body is favorable to the growth of cholera pathogen in blue-green algae and copepods which explains the endemic nature of the disease in the Ganges floodplain in Bangladesh. A Bangladesh study found that abundance of *V. cholera 01* increases with copepods which feed on phytoplankton in coastal waters (Colwell 1996;

Pascual et al. and Rodo et al. *Science*, 2000 as quoted by Streatfield 2012). No wonder cholera is quite endemic along a wide belt of coastal Bangladesh.

Drought-Related Ailments There has been an increasing trend of erratic climatic behavior in Bangladesh reflected through shifts in seasonal pattern in terms of change in rainfall regime and localized drought condition. The effects of drought on health include malnutrition, various infectious diseases, and respiratory diseases (Menne and Bertillini 2000). Because of the loss of productivity of land and loss of crops due to drought, it will reduce dietary diversity and negatively affect overall food intake and may therefore lead to malnutrition and/or nutrition-related diseases. A study by Aziz et al. (1990) in Bangladesh has found that drought and lack of food were related with an increased risk of mortality from diarrhea illness.

Heat Stress Globally cities are experiencing "urban heat island effect" with higher temperature than the surrounding areas. Most major cities of Bangladesh are also experiencing the same effect. Again, some parts of northwestern (i.e., Rajshahi, Naogaon) and southwestern (Kushtia, Satkhira) Bangladesh experience extremely high summer temperature – often reaching a maximum of around 38° to 42 °C. The heat index analysis from 1961 to 2010 portrays significant amount of change in both temperature and relative humidity in the past 20 years. Table 12.2 summarizes observed change in temperature over Bangladesh. Both the temperature and humidity are showing increasing trends in almost all parts of Bangladesh except that the SWR is showing decrease of humidity. It is decreasing up to 0.16 %. In the NWR, the increase of maximum temperature in recent years is quite considerable. On the other hand, comparatively small increase of temperature is observed in the very region in case of mean temperature. The changes of mean maximum temperature in SWR (+0.650 °C), mean temperature in ER (+0.550 °C), and humidity in NWR and CR (+4.3 % and +4.2 %, respectively) between the period range of 1961–1990 and 1991–2010 are very significant (Rajib et al. 2011).

It is believed that the global warming is responsible for the remarkable increase of maximum and mean temperature during summer in Bangladesh (and the adjoining areas in West Bengal in India). The mean heat index value ranges from 42° to 59 °C in different parts of the country. Besides adverse climatic condition, environmental pollution and the erratic pattern of rainfall result in noticeably rising trend of humidity in northwest, central, and eastern parts of the country. Consequently, both heat and humidity levels play significant role to physical discomfort and diseases for many people (Rajib et al. 2011). But most observable health ailments are reflected through dehydration, heat stroke/exhaustion, and aggravation of cardiovascular diseases in elderly people and reduced work capacity and productivity.

Water and Food Contamination With the change in the pattern of temperature and precipitation with climate change, the waterborne and food-borne diseases will increase. In general, increased temperature results in higher pathogen replication, persistence, survival, and transmission for bacterial pathogens and has mixed effects on viral pathogens but often reduces the overall transmission rate (MoEF n.d.).

Table 12.2 Observed change in temperature and humidity by region in Bangladesh

Years	NWR	SWR	CR	ER
Mean maximum temperature				
1961–1990	32.970C	32.80C	31.760C	31.330C
1991–2010	33.470C	33.450C	32.280C	31.730C
Change	**+0.50 °C**	**+0.650 °C**	**+0.520 °C**	**+0.40 °C**
Mean temperature				
1961–1990	28.370C	28.80C	27.90C	27.320C
1991–2010	28.520C	29.210C	28.240C	27.870C
Change	**+0.150 °C**	**+0.410 °C**	**+0.340 °C**	**+0.550 °C**
Humidity (%)				
1961–1990	81.50	85.78	80.40	84.97
1991–2010	85.00	85.64	83.80	85.10
Change	**+4.3 %**	**−0.16 %**	**+4.2 %**	**+0.15 %**

Source: Rajib et al. (2011)
NWR northwestern region, *SWR* southwestern region, *CR* central region, *ER* eastern region

Higher temperature produces a greater number of waterborne and food-borne parasitic infections, and overall increased rainfall is associated with increased burdens of disease for bacteria, viruses, and parasites though the causes of these increases differ by pathogen and ecological setting. On the other hand, changes in rainfall patterns are likely to compromise the supply of safe water, thus increasing the risk of waterborne diseases. They are also associated with floods and waterlogging that increase the incidence of diarrhea, cholera, skin, and eye diseases (Rahman 2008).

Apart from the above diseases, other conditions having bearing on human health are related to displacement of population due to various climatic disasters associated with global warming and sea-level change triggering off, what may be called, "climate refugees." Such a situation would cause social disruption and conflicts, unemployment, and economic uncertainty leading to anxiety syndrome and mental instability (Khan 2010). Thus, there will be a number of *indirect impacts* or slow onset of a number of health conditions due to climate change. Some of these are:

Physical Injury and Chronic Stress Extreme climate events and inevitable impacts of climate change, in the form of flood, torrential rain, cyclone, and tropical storms – often with salinity intrusion into coastal and its inland fringe areas – are likely to cause physical injury to loss of lives. Very recently, the super cyclone – *Sidr* – killed thousands of people and made millions homeless rendering them to experience physical stress and mental agony. Acute and chronic disorders, like post-traumatic stress disorders (PTSD), may occur in which a person experiences emotional numbness or withdrawal syndromes, flash back of traumatic events, extreme form of anxiety, chronic depression, etc. Such conditions have been observed in the cyclone-affected areas and in areas prone to riverbank erosion. A report by the Climate Change Cell of Department of Environment, GoB, indicates that the annual rate of mental disorder was 22,431 in Bangladesh (quoted by Khan 2010).

Domestic Violence Any environmental disaster is likely to cause frustration and anger due to loss of economic and social status. The climate change-induced disaster, like flood, drought, and cyclone, causes food scarcity, hunger, and malnutrition and leads to PTSD mostly among household heads, women, and female-headed members due to mental agony and depression as a result of financial hardship. These are manifested through domestic violence, family breakups, and often suicide.

Health Hazards due to Groundwater Depletion The risks of human health in countries of climate change exposure are multifarious. Importantly, drainage congestion and standing water will increase the likelihood of potential outbreaks of cholera and other waterborne and diarrhea diseases in the floodplain areas of Bangladesh. The pressure on the availability and access to safe water, in particular during the dry season or in draught condition, and the increasing dependence on groundwater are an additional threat.

The Global Agriculture Information Network claims that increasing HYV rice (Boro) is causing Bangladesh's water table to drop by 4–5 ft annually. Climate change is likely to bring more extreme events, possibly including a failure of the monsoon in South Asia, while IFPRI simulates an extended drought beginning in 2030 and continuing through 2035. Such a situation will hamper food production in the face of increasing population, demand for more food, and accelerating food price (Rahman 2012). The inevitable result of this situation will be a widespread malnutrition among the middle- and low-income groups of population in the country resulting increased morbidity situation. Further, the pressure irrigation for agricultural production will lead to water crises particularly in the drought-prone areas in northwestern Bangladesh. Such a situation may very well negatively impact upon food security.

Impact on Air Quality Climate change can contribute to some air quality problems. Respiratory disorders may be exacerbated by frequency of smog (ground-level ozone) events and particulate air pollution particularly in dry seasons (IPCC 2007). This can damage lung tissue and is especially harmful for those with asthma and other chronic lung diseases (MoEF n.d.)

Health Hazards Due to Salinity Intrusion Sources of safe water supply in coastal Bangladesh have been contaminated by varying degrees of salinity intrusion from rising sea levels, cyclone, storm surges, and transgression of tidal water through river inlets and upstream withdrawal of freshwater. On the other hand, in southern and coastal Bangladesh, a widespread intrusion of salinity into water and soil has already affected crop production and cropping practices to a great extent. The situation has further been aggravated with the increasing withdrawal of groundwater further inland. It is thought that this salinity intrusion problem will aggravate health condition related to hypertension and pre-eclampsia in pregnancy (Streatfield 2012).

Water salinity data for Dacope, a rural area in coastal Bangladesh, were collected by the Environment and Geographic Information System (EGIS) during 1998–2000, and information on drinking water sources from 343 pregnant women through 24-h

surveillance of urine samples, blood pressure monitoring during dry season (2009–2010), and hospital-based prevalence of hypertension in pregnancy for 969 women (2008–2010). The average estimated sodium intakes from drinking water ranged from 5 to 16 g/day in dry season compared with 0.6 to 1.2 g/day in rainy season. Average daily sodium excretion in urine was 3.4 g/day (range, 0.4 to 7.7 g/day) (Khan et al. 2011a, b). It may be mentioned that as per WHO and FAO, the current dietary intake of sodium is 2 g/day (<85 mmol/day) (Nishida et al. 2004), but in coastal Bangladesh, the mean sodium intake in pregnant women is well above this level.

The annual hospital prevalence of hypertension in pregnancy was higher in the dry season (odd ratio, 12.2 %) that in the rainy season (odd ratio, 5.1 %) with high confidence level. Evidently these health-related conditions are likely to be exacerbated by climate change-induced sea-level rise. Hypertension in pregnancy is associated with increased rates of adverse maternal and fetal outcomes, both acute and long term, including impaired liver function, low platelet count, intrauterine growth retardation, preterm birth, and maternal and perinatal deaths (Sibai 2002), The adverse outcomes are substantially increased in women who develop pre-eclampsia (see above). At the same time, with the increased density and distribution of salinity, cholera germs are getting favorable habitat and spreading in the coastal area (MoEF n.d.).

Food Security and Health In Bangladesh, food security is increasingly being adversely affected by extreme climatic events. Such a situation develops with the fall of income and rise in expenditure, loss of assets and often land through repeated disasters (mainly flood, coastal inundation, and bank erosion), and burden of loan repayments at household level. As such most low-income households fall into a process of pauperization as they reduce regular consumption of food, and the eroded livelihoods expose people to increased health risks. While the impoverishment is exposing the poor more to the adverse impact of climate change, this also bars people from prioritizing their health needs (Alamgir et al. 2011). On the other hand, some of the major riverbeds experience excessive sedimentation. This further aggravates the impact of sea-level rise upstream and increases the risk of local flooding and increased salinity moving further inland upstream resulting in restricted drinking water supply and crop failure in many areas. Such conditions lower the nutritional status as well as various health problems among the affected population.

12.5 Concluding Remarks

Bangladesh is already vulnerable to vector-borne and waterborne diseases, and over the years, their prevalence has shown an upward trend. Thus, diseases like malaria, diarrhea, and cholera are also on the increase especially during the summer and monsoon/rainy months. Climate change is also bringing about additional stresses like dehydration, malnutrition, and heat-related morbidity especially among children and elderly populations. These problems are thought to be closely interlinked

with water supply and sanitation issues as well. Climate change has already been linked to salinity intrusion from coastal areas to inland and subsequently leading to land degradation, groundwater contamination, and biodiversity loss and ecosystem damage. Changes in the above factors have direct impact on human health as well. Development of a nation is highly dependent on the health of the people. Bangladesh already carries the burden of high population and is characterized by natural disasters, diminishing and limiting natural resources, and the further burden of increased health problems will push back its development achievements.

Even though climate change-induced health impacts have been gaining importance in Bangladesh, there is still a lack of research and capacity in this field and its ever-increasing level of vulnerability of the people. Linkage between climate change and the increased incidences of disease, rate of mortality, and availability of safe water has not yet received the proper focus it requires. On the whole climate change is expected to present increased risks to human health in Bangladesh, especially in the light of the country's overall socioeconomic infrastructure and development (World Bank 2012). With the increased health risks, the expenditure on public health infrastructure will have to be enhanced by the government from now on.

In view of the above, the impacts of climate change on health would most likely depend upon the success to adapt to various aspects of climate change. And in particular, they would depend upon improved health infrastructure including health care and delivery systems, supply of safe drinking water, and improved sanitation that has to be included within the national climate change adaptation policy in a substantial way right now.

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