Chapter 9
Pathways of Climate-Resilient Health Systems in Bangladesh

Muhammad Abdur Rahaman, Mohammad Mahbubur Rahman and Syed Hafizur Rahman

Abstract Climate change is a complex phenomenon that will have a range of both anticipated and unexpected direct and indirect effects. The IPCC Fifth Assessment Report (AR5) affirms that recent decades have seen warming air and ocean temperatures, changing rainfall patterns, variations in the frequency and intensity of several extreme events including droughts, floods and storms and rising sea levels. The changing climate will adversely affect the health of human populations. These include primary or direct effects (e.g. increased deaths due to extreme weather events like cyclones); secondary or indirect effects (e.g. increased health problems due to disease vectors, such as malaria-carrying mosquitos and contaminated food and water); and tertiary or long-term effects (e.g. distractions for health and social services). This chapter provides an introduction to the relationship between climate change and human health, using the country-specific example of Bangladesh. Bangladesh is a low-lying country in which extreme climatic events are a common phenomenon. With the objective of providing an overview of the likely health impacts caused by climate change, the chapter examines the relationship between three distinct climatic events – flooding, salinity intrusion and drought – in relation to human health. In Bangladesh, issues such as poor water quality, unhygienic environmental conditions and poor sanitation, exacerbate the impact of climate-sensitive diseases (diseases of which transmission is linked to climatic and weather conditions). This chapter provides a foundation for studying the relationship between the climatic characteristics of the study area, climate-sensitive diseases and other anthropogenic phenomena. It demonstrates the pathways of climate-resilient health systems in Bangladesh.

Keywords Climate change · Climate extremes · Climate-resilient Health system · Bangladesh

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9.1 Introduction

There is increasing global concern about the impacts of climate change on human health. Climate change related hazards, such as drought, flooding, waterlogging, tidal inundation, cyclones, storm surges, erratic rainfall and rising temperatures, are common events in Bangladesh. They have direct and indirect adverse impacts on water resources, agriculture, livelihoods, ecosystems and human health.

9.1.1 Climate Change in Bangladesh

Bangladesh is situated in the world's largest and most populous Ganges–Brahmaputra delta system (Hossain et al. 2010). The country is considered the most vulnerable to tropical cyclones, the third most vulnerable to sea level rise in terms of the number of people affected, and the sixth most vulnerable to floods in the world (Francis and Maguire 2016). Scientists have proved that the erratic nature of rainfall and temperature is gradually increasing in Bangladesh. Precipitation is becoming less predictable and the monsoon is now characterised by higher amounts of rainfall within shorter periods of time (Islam et al. 2014). Temperatures are becoming more extreme, with regional variations and an overall annual rise. Tropical cyclones are also expected to increase in intensity.

As a low-lying country, Bangladesh is highly vulnerable to these climatic changes and extremities. Climate and weather patterns and behaviour play a significant role in freshwater availability, agriculture, economic growth and performance, and livelihoods (NAPA 2009). The most damaging effects come from flooding, drought and heat stress (World Bank 2013). The adverse effects of these on agricultural productivity and availability of freshwater are already evident in many areas of Bangladesh. Crop productivity is much reduced by drought, and perennial trees and livestock are damaged and lost as a result of floods every year. Furthermore, the increase in cyclone activity, combined with sea-level rise (SLR), will increase the depth and risk of inundation from floods and storm surges and reduce the area of cultivable land (particularly in low-lying deltaic regions like Bangladesh) (World Bank 2013).

9.1.2 Climate Change and Health

The relationship between climate change and human health is multidimensional. The health and wellbeing of human populations are sensitive to shifts in weather patterns and other aspects of climate change (IPCC 2014). There are three basic pathways by which climate change affects health, which can be classified as primary or direct impacts, secondary or indirect impacts, and tertiary or long-term

implications respectively (see Butler 2014). Significant effects are those that affect people directly, such as heat stress and trauma from exposure to serious weather events (Butler/Harley 2010). Such effects are increasingly recognised and understood (Bowles et al. 2014). Secondary effects act less directly, through ecosystem change and other synergies, including shifts in the occurrence and predominance of diseases and vectors (Butler/Harley 2010). However, tertiary health effects, which are mediated through impacts on social, political, and economic systems, will likely have the greatest long-term impact on human health. This possibility remains relatively unexplored and scarcely recognised (Butler/Harley 2010).

The causal connections between climate change and human health are complex, as they are usually indirect, context-specific and dependent on specific climatic phenomena (Fig. 9.1). People's health depends on the ecosystem goods and services (such as availability of freshwater, food, wood, etc.) that are essential for sound human health and productivity (Corvalán et al. 2005). Notable direct human health impacts can occur if ecosystem services are no longer able to meet community needs. At the same time, changes in ecosystem services affect livelihoods, income and local migration and, at times, may even cause political conflict. The resulting impacts on economic and physical security, freedom, choice and social relations have wide-ranging effects on wellbeing and health, and the availability of ecosystem services (Fig. 9.1).

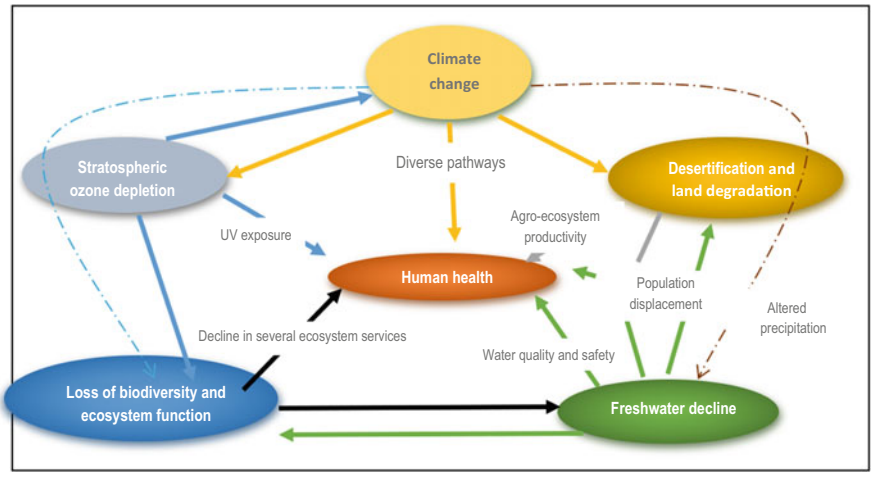

Fig. 9.1 Climate change threats to ecosystems and human health. *Source* Adapted from WHO (2016)

9.1.3 Context of Climate Change and Health in Bangladesh

In Bangladesh, climate change is having clear and significant mental and physiological impacts on human health (Rahman 2008; UNICEF 2011). The most direct effects of climate change on human health occur through extreme events. For example, in 2004, floods in Bangladesh caused 800 deaths and, in 2007, a significant cyclone (Sidr) affected more than 8.5 million people, causing more than 3,500 deaths (Shovo et al. 2013). Such extreme events result in both mental and physical health impacts. Slow onset climatic events also result in a multitude of health impacts. These are discussed in more detail throughout this chapter.

Climatic extremes such as heat stress also affect slum-dwellers. Over the last few decades, climate-induced migration of people has become inevitable in Bangladesh (Akter 2009). Many displaced people, having lost their land, home, and livelihoods to different climatic hazards, move to nearby small cities or distant larger cities like Dhaka to find a place to live and a livelihood, only to end up in a slum. Living conditions in these slums go from bad to worse with the rapid and uncontrolled increase of their populations (Saha 2012). Overall health and environmental conditions in urban slums are indigent, primarily due to overcrowding and lack of access to essential services, such as safe water and sanitation (Streatfield and Karar 2008). These poor conditions are exacerbated by climatic events such as frequent flooding and inundation, and waterlogging, which result in outbreaks of water-borne (diarrhoea, cholera, dysentery, jaundice, skin diseases) and vector-borne (dengue, malaria) diseases and other health problems (cold/cough, fever, pneumonia, pox, asthma, headaches) (Rashid et al. 2013).

But even within communities there are certain marginalised socioeconomic groups. For example, as a result of gender division, women are more vulnerable to climatic events than men. Other marginalised vulnerable groups include physically or mentally challenged persons, ethnic minorities (i.e., the tribal group of Chittagong hill tracts, Cox's Bazar and Mymensing) (CCC 2009b). Though some coping strategies for these vulnerable group have been discussed, concern for minorities was absent in Bangladesh's established plan for coping with climate change. Therefore, the state should prioritise different vulnerable social groups including women, youth and ethnic minority groups in planning coping mechanisms and adaptation strategies.

It should be noted at this stage that data on climate change and health in Bangladesh is limited. The Bangladesh Medical Research Council (BMRC), International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), and Essential National Health Research (ENHR) carry out biomedical and operational research in Bangladesh. ICDDR,B has recently started a specialised unit called the Center for Population, Urbanization and Climate Change (CPUCC), with an aim to conduct research on human health and climate change. Nevertheless, there remains a lack of access to sufficient data, quality and availability of studies in this field, which must be addressed. This chapter reviews some of the data that is available to provide an overview of climate change and health in Bangladesh.

The chapter will focus on some of the indirect physiological impacts of climate change on human health in Bangladesh. It will first examine the relationship between climate hazards and climate-sensitive health afflictions and then look at the response processes that communities in Bangladesh have adopted to combat climatic stressors on human health.

9.2 Climate Related Specific Health Impacts in Bangladesh

9.2.1 Climate-Sensitive Diseases and Infections

One of the most poignant challenges of climate change in Bangladesh is its impact on climate-sensitive diseases and illnesses. These include malaria, dengue, typhoid and cholera, alongside skin diseases and newly identified rodent-borne diseases. Flooding can lead to increased rates of typhoid and cholera, while drought increases the risk of malaria and skin disease. Incidences of malaria have increased dramatically over the last 30 years (Alam 2011) (see Fig. 9.2).

Malaria is a mosquito-borne infectious disease induced by parasitic protozoans of the genus *Plasmodium* (*vivax, malariae*, *oval*, *knowlesi*, and *falciparum*) and is transferred by female mosquito vectors of the *Anopheles* species (Cox 2010). The spread of the disease is impacted by climate determinants and the local potential to manage it (Caminade et al. 2014). The impact of temperature on malaria prevalence appears to be nonlinear and is vector-specific (Alonso et al. 2011). Enhanced variation in temperature, when it is close to the uppermost boundary for vectors and pathogens, leads to decreased transmission of the disease, while increasing variations of daily mean temperature near the minimum limit for vectors and pathogens, increases transmission (Paaijmans et al. 2010). The nonlinear response to temperature means that even moderate warming may drive substantial increases in malaria transmission, if conditions are suitable (Alonso et al. 2011; IPCC 2014).

The average annual incidence of malaria in Bangladesh doubled from the period 1981–1990 to the period 1991–2000. It increased by another 65 percent between 2001–2010 and is now a major public health problem, with 13.25 million people

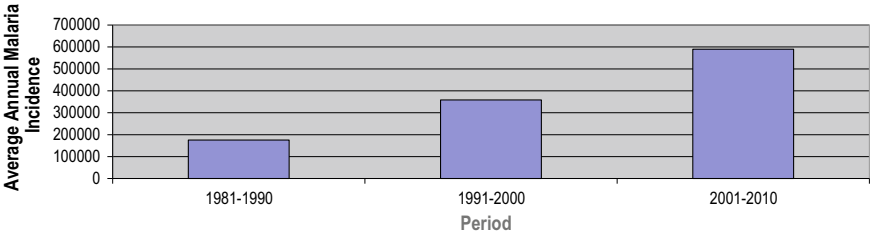

Fig. 9.2 Malaria trends in Bangladesh from 1981 to 2010. *Sources* DG-Health data (1997–2010)

across 13 districts in Bangladesh at risk of the disease (M0HFW 2015). Among these 13 districts, five districts (Rangamati, Khagrachari, Bandarban, Chittagong and Cox's Bazar) are at high risk, four districts (Mymensingh, Netrakona, Sherpur, and Kurigram) are at moderate risk and another four districts (Sylhet, Hobigonj, Sunamgonj, and Moulvibazar) are at low risk of malaria. The geophysical locations, climate, and other favourable conditions for the vector species transmission make these areas vulnerable (MoHFW 2015).

It is evident that variations in seasonal temperature and rainfall patterns significantly influence the mortality rate in Bangladesh. Each milimeter (mm) rise in average weekly precipitation up to 14 mm was associated with decreased mortality risks, while rainfall above 14 mm or below 3 mm was associated with increased mortality risk (Alam et al. 2012). Furthermore, the weekly mean temperature had the strongest relationship with weekly mortality rates. Below 23 °C, the relative mortality risk rose by 2.3 percent with each 1 °C reduction in temperature, and between 23 and 29.6 °C, the relative risk increased by 2.4 percent with a 1 °C decrease, particularly among females and adults (Alam et al. 2012).

There is evidence of an association between climatic patterns, such as the El Niño Southern Oscillation and the Indian Ocean Dipole, and dengue prevalence in Bangladesh (Banu et al. 2015). The connection between dengue occurrence and local climate variables such as temperature and precipitation are significant and apparent in the context of Bangladesh (Banu et al. 2015). Trends in dengue prevalence indicate peaks during the summer months. Similar trends are found in skin disease, while jaundice is common in flood prone areas due to the negative impact of flooding on safe water supplies.

The Nipah virus infection, a recently identified infectious disease that is sensitive to weather and climate variability, affects both animals and humans. Though the associations to climate change are indirect, the case of the Nipah virus is a clear indicator of the potential for increased infectious disease outbreaks as future climate change and human activities like large-scale deforestation modify animal habitats as well (Bennett and McMichael 2010). An outbreak of Nipah virus was reported in Bangladesh in 2013, with 24 cases and 21 deaths across 14 districts including Gaibandha, Natore, Rajshahi, Naogaon, Rajbari, Pabna, Jhenaidah, Mymensingh, Nilphamari, Chittagong, Kurigram, Kustia, Magura, and Manikganj. The infection spread to humans through date palm sap that had been contaminated through infected fruit bats (WHO 2013).

A causal connection between climate change and these diseases is difficult to verify, though climatic parameters such as temperature and precipitation are considered as key determinants of the distribution of many disease-carrying vectors (McMichael et. al. 1996). In addition, the conditions associated with the impacts of climate change on water supply, sanitation, and food production, generate favourable environments for the incidence and spread of such diseases. For example, a decline in the availability of clean water results in a greater risk of water-borne diseases.

In Bangladesh, the mortality impacts of water-borne diseases are likely to increase as climate change reduces the availability of safe drinking water (Reid and

Sims 2007). As climate change affects water quality, its impacts on clean water and sanitation facilities, along with poor hygiene, relate to various illnesses such as diarrhoea, cholera and dysentery (NIPORT 2015). For example, the occurrence of diarrhoea increased from 1995 to 2010. The highest incidences of diarrhoea in this period were seen in 1998, 2004, 2007 and 2010, which correspond to major flood years in Bangladesh (CCC 2009a; DG-Health 2010). It is important to note that the impacts of climate change on water resources vary depending on the climate-vulnerable area in Bangladesh. The effects of climate change on water resources in different climate-vulnerable areas of Bangladesh and their potential health impacts are outlined in Table 9.1.

Table 9.1 Typology of climate-vulnerable areas and potential health impacts in Bangladesh

Climate-vulnerable areas	Locations	Potential impacts of climate change	Risk intensity	Diseases and health impacts
Drought-prone areas	Northern and northwestern districts of Bangladesh	Depletion of groundwater level and quality, water scarcity, dehydration and heat stress, etc	Moderate, severe to very severe risk	Respiratory diseases (asthma), cardiovascular diseases (heart attack, heart failure, heart disease), heat stroke, diarrhoea, malaria, dengue, skin diseases, malnutrition and infectious diseases (kala-azar, Nipah virus)
Flood-prone areas	Ganges, Brahmaputra, and Meghna floodplain areas of Bangladesh	Drowning and inundation, water logging, lack of safe water, poor sanitation and hygiene, etc	Severe, very severe, and high-risk	Water-borne diseases (diarrhoea, cholera, dysentery, typhoid, jaundice, skin diseases), vector-borne diseases (dengue, malaria, filaria), fever and mental disorders

(continued)

Table 9.1 (continued)

Climate-vulnerable areas	Locations	Potential impacts of climate change	Risk intensity	Diseases and health impacts
Salinity-prone areas	Southern and southwestern coastal zone of Bangladesh	Scarcity of freshwater, high salinity in both surface and groundwater sources, etc	Very severe to high-risk	Diarrhoea, skin diseases, malnutrition, pneumonia, jaundice, diabetes, hypertension and reproductive health diseases

Source The authors

Climatic impacts on water resources vary in different locations. In drought-prone areas, groundwater quality depletes and water scarcity increases. Flood-prone areas become submerged during torrential rains and overflowing rivers. Flood water contaminates tube-wells, which means that they cannot supply drinking water at these times. Those living in flood-prone areas thus suffer from different climate-sensitive illnesses related to drinking water scarcity (quality and quantity). In coastal regions, salt water intrusion resulting from SLR affects groundwater and surface water, causing health burdens for coastal populations.

9.2.2 Climate Change and Malnutrition

Fish and livestock are the principal sources of protein and nutrition for both rural and urban people in Bangladesh. Without them, people suffer from malnutrition and poor health. However, in Bangladesh, agricultural, forestry and fishery systems are increasingly being affected by fluctuating SLR, cyclones, flooding and drought. During the 1998 floods, 69 percent of Aus rice production, 82 percent of deepwater Aman and 91 percent of transplanted Aman were lost, leaving the whole country food insecure (Dewan 2015). Each year, drought in Bangladesh affects approximately 2.32 million hectares of cropland during the *Kharif* (summer monsoon) and 1.2 million hectares of such land during the *Rabi* (winter) seasons (Sugden et al. 2014). Frequent cyclonic events, inland and coastal flooding, low water flow, droughts, salinity intrusion and changes in morphological processes, threaten existing aquatic ecosystems, fisheries, and livestock, thereby impacting fish and livestock production. Climate change and its impacts can result in the outbreak of new diseases and pests that will further affect these subsectors (IPCC 2014). Figure 9.3 illustrates the pathways through which malnutrition or undernourishment develop in the human body.

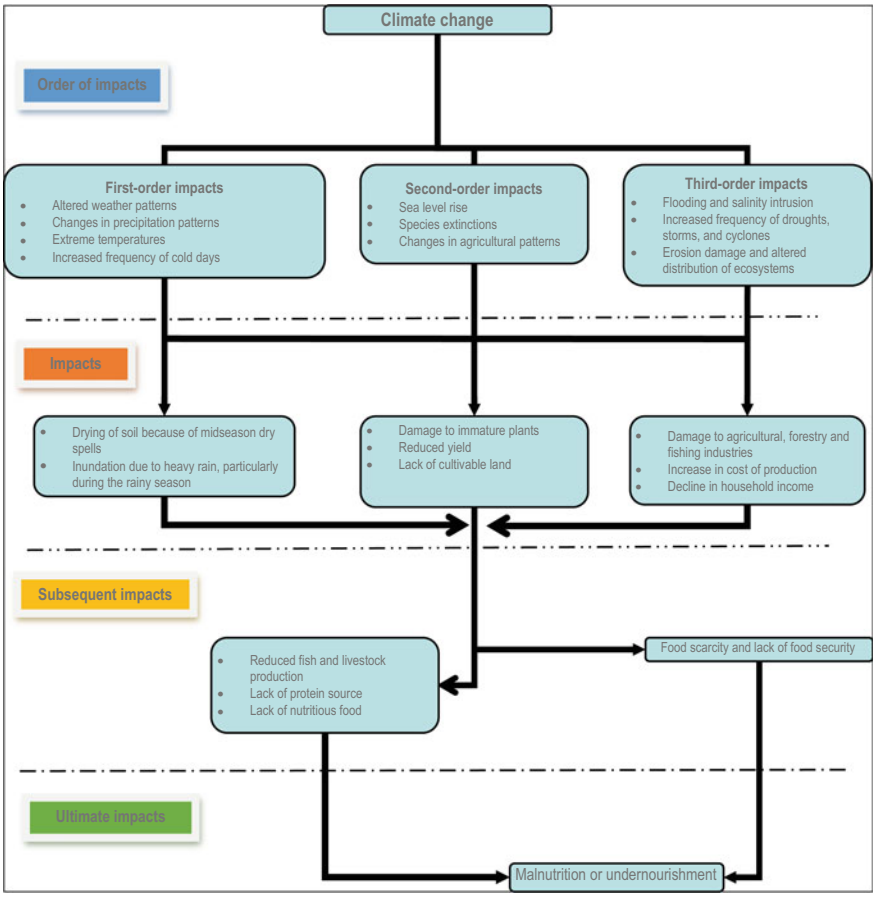

Fig. 9.3 Climate change impacts on agricultural systems in Bangladesh and pathways to malnutrition. *Source* The authors

Processing, distribution, acquisition, preparation and consumption activities are equally important for food security and are also impacted by changes in climate. For example, increased frequency and intensity of severe weather increase damage to transport and distribution infrastructure, with consequent disruption to food supply chains (FAO 2008). Ultimately these climatic impacts are reducing people's access to food and the specified range of nutrients, thereby affecting malnutrition levels in Bangladesh.

9.3 Health Trends in Three Climatic Zones

Outbreaks of dangerous, water-borne, vector-borne and other types of disease, are most prevalent in climate sensitive areas, including drought-prone, flood-prone and saline-prone areas (Fig. 9.4). The disease trends in three locations (Rajshahi, Sirajganj and Patuakhali) are discussed in this section.

9.3.1 Health Trends in Drought-Prone Areas

In drought-prone areas, health ailments such as diarrhoea, skin disease, malnutrition, and asthma are increasing (Dey et al. 2012). Figure 9.5 points to such increases during the period 2004–2010. This trend is particularly significant for skin disease, rates of which increased nearly four-fold between 2009 and 2010.

9.3.2 Health Trends in Flood-Prone Areas

The occurrence of diseases such as diarrhoea, cholera, skin disease, malnutrition, asthma, cold/cough and fever appear to correlate with events like flooding and water logging (Rahaman 2013). Skin disease and malnutrition trends are gradually increasing in flood-prone areas, mainly because of a shortage of safe drinking water, proper hygiene, and sanitation facilities, especially during the monsoon season. As Fig. 9.6 shows, when looking at disease prevalence between 2001 and 2010, diarrhoea and skin disease incidence was highest in 2007, which was a significant flood year in Bangladesh. Figure 9.6 further highlights the trends of some these health issues in the flood-prone area of Sirajganj during the period 2001–2010.

9.3.3 Health Trends in Salinity-Prone Areas

Diarrhoea, skin disease and malnutrition rates are increasing in the saline-prone areas of Bangladesh. This is because of the frequency of various natural disasters, including cyclones, storm surges, coastal flooding, sea level rise and salinity intrusion, which increases the burden of water-borne and vector-borne diseases. By looking at trends from 2001 to 2010, Figs. 9.8, 9.9 and 9.10 show that the prevalence of diarrhoea, malnutrition and skin disease is rising in Patuakhali, a saline prone coastal district of Bangladesh.

In the case of diarrhoea, the incidence rate was found to be higher during the monsoon and pre-monsoon periods, whereas it was comparatively lower during the

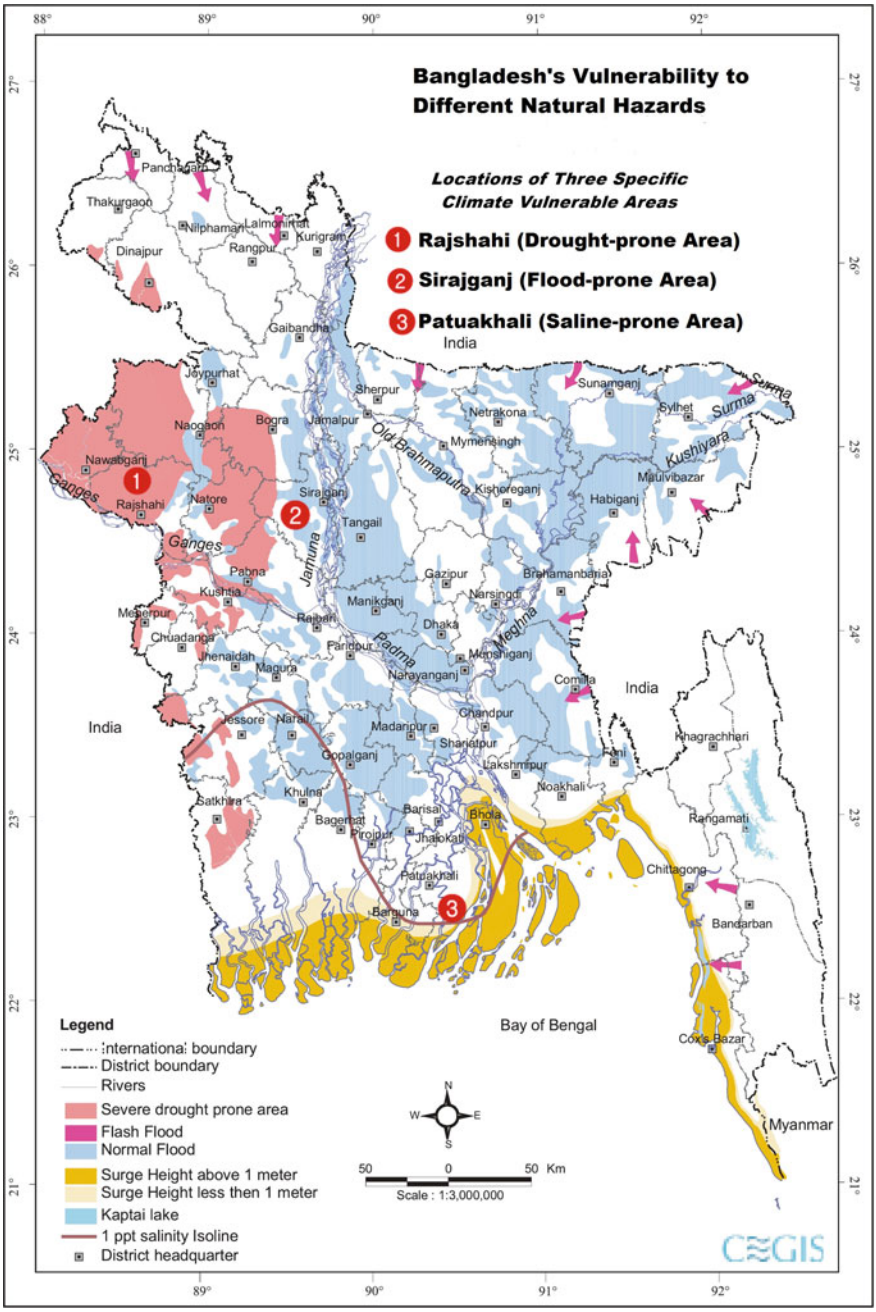

Fig. 9.4 Locations of three distinct climate-vulnerable areas: *Source* Authors OWN using data From CEGIS, Dhaka

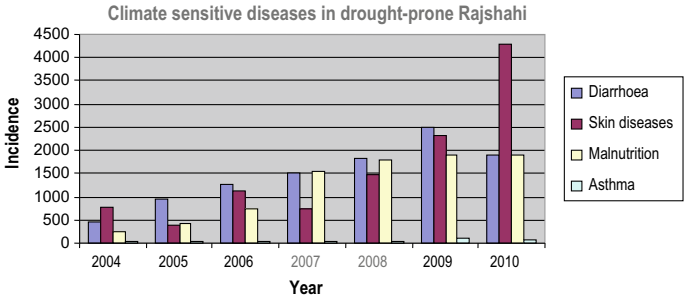

Fig. 9.5 Health trends in the drought-prone Rajshahi district from 2004 to 2010. *Source* Rahaman (2013)

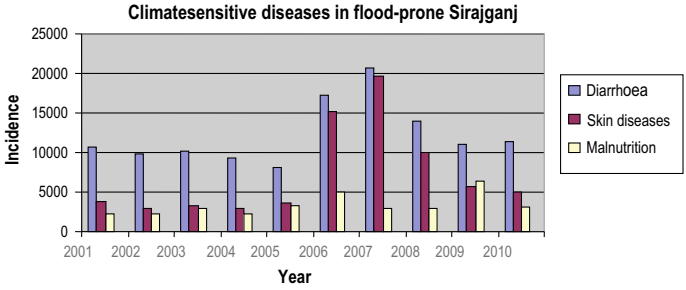

Fig. 9.6 Health trends in the flood-prone Sirajganj district from 2001 to 2010. *Source* Rahaman (2013)

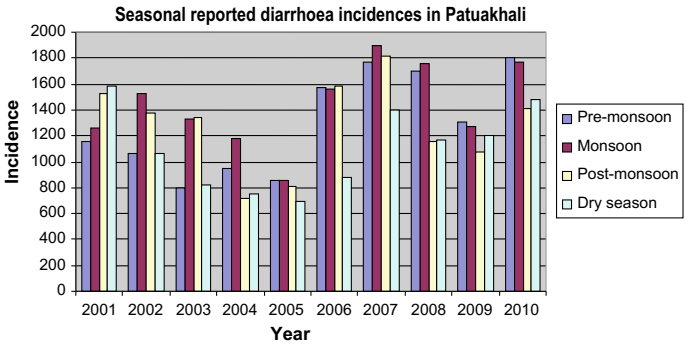

Fig. 9.7 Seasonal occurrence of diarrhoea in saline-prone Patuakhali district from 2001 to 2010. *Source* Rahaman (2013)

post-monsoon and dry seasons (Fig. 9.7). The overall disease occurrence rate increased at a significant rate (Fig. 9.7). Malnutrition rates were higher, especially during the monsoon (2004, 2007, 2008, 2009 and 2010) and post-monsoon (2001, 2002, 2004 and 2008) seasons (Fig. 9.8). As a result of flooding during this period,

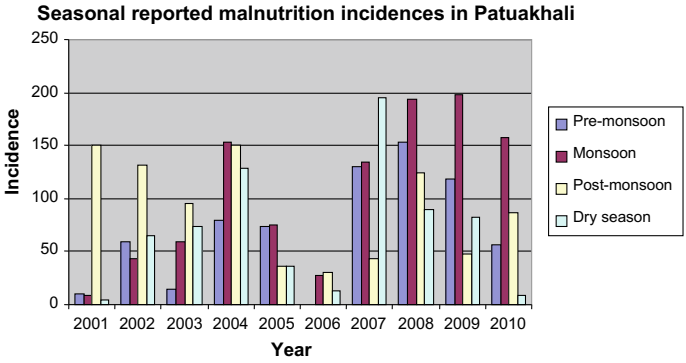

Fig. 9.8 Seasonal occurrence of malnutrition in saline-prone Patuakhali district from 2001 to 2010. *Source* Rahaman (2013)

agricultural activities were hampered and caused unemployment that resulted in food shortages and, consequently, increases in malnutrition. Natural hazards also damaged crops and livestock and increased unemployment rates in the affected area, causing undernourishment in the same period (Fig. 9.8). Skin diseases were highest during the monsoon and post-monsoon seasons, particularly due to the frequency of flooding and waterlogging in the same period (Fig. 9.9).

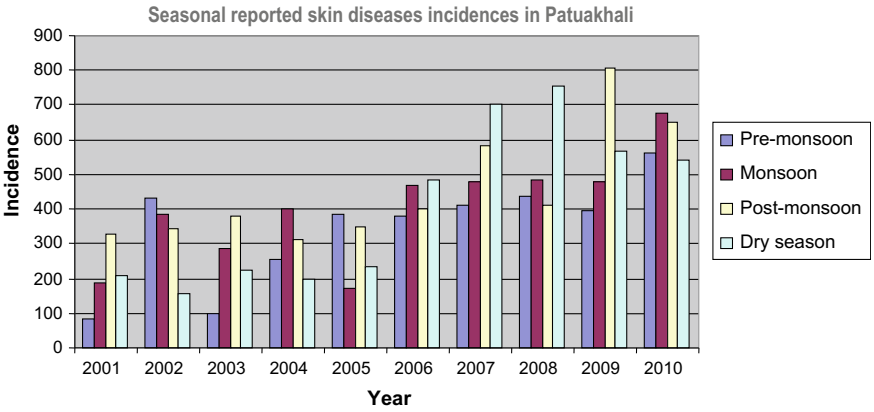

Fig. 9.9 Seasonal occurrence of skin diseases in saline-prone Patuakhali district from 2001 to 2010. *Source* Rahaman (2013)

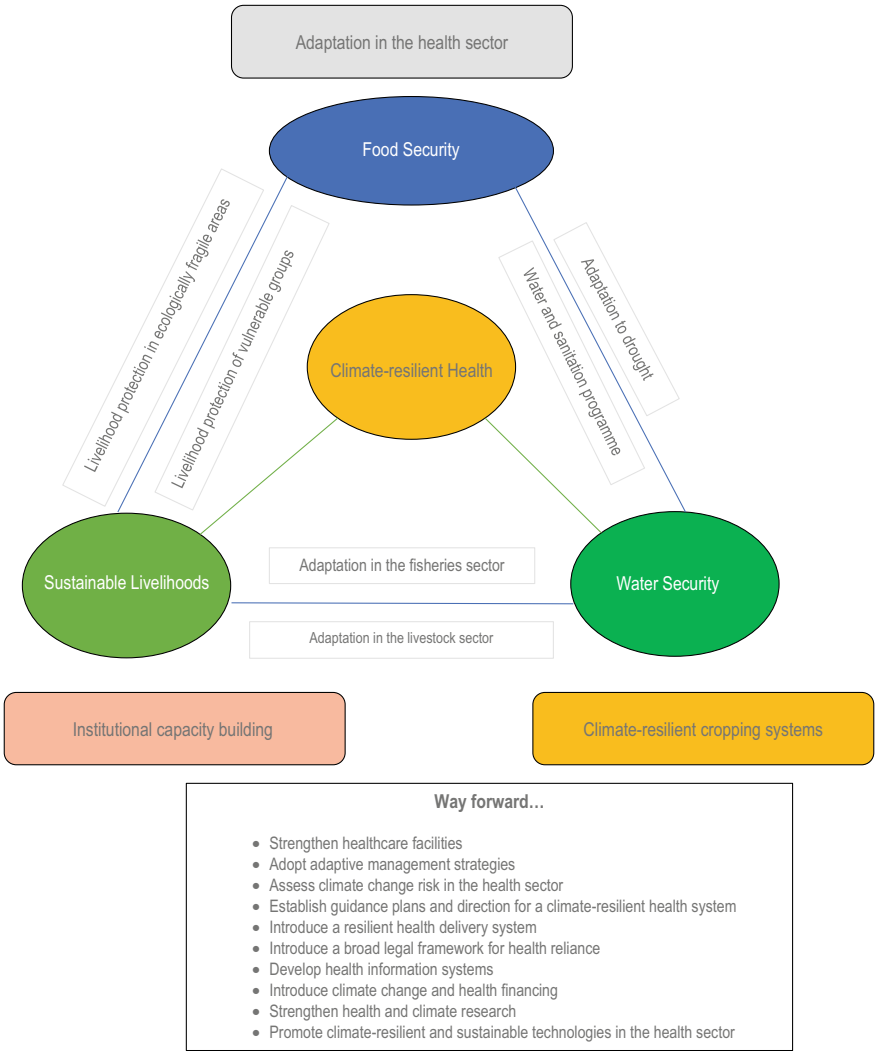

Fig. 9.10 Pathways to climate-resilient health. *Source* The authors based on BCCSAP (2009)

9.3.4 Health Trends in Heat and Cold Waves

Bangladesh also experiences health-related problems as a result of climatic hazards such as heat waves and cold waves each year. Heat waves occur in Bangladesh during the summer, when the maximum temperature goes above 36 °C. Sometimes the minimum temperature goes below 10 °C and a severe cold wave occurs over the western and northern parts of the country (Khatun et al. 2016). Researchers found that these heat and cold waves affected infants and the elderly (aged 60 years and

older) the most (Lindeboom et al. 2012). Urban areas were seen to be facing an increased summer mortality peak, particularly regarding cardiovascular mortality (Burkart et al. 2011). A significant increase in deaths in rural Bangladesh was observed due to cardiovascular, respiratory and perinatal causes during periods of low temperature (Hashizume et al. 2009).

9.4 Pathways of a Climate-Resilient Health System

It is necessary to take steps and action to increase health resilience within a changing climate. The steps and actions taken will vary depending on the climate-vulnerable community and location. Several activities are currently in place to support a comprehensive climate-resilient health system in Bangladesh and are being undertaken by different actors, including governmental and non-governmental actors, development partners, private sector representatives and local communities. These actors are working to address different health-related issues and to build health system resilience to climate change by strengthening the health-related infrastructure in Bangladesh.

This section will first explore Bangladesh's institutional health system and its responsibilities. It will then look at the existing healthcare system and explore projects to improve wellbeing in terms of livelihoods, and food and water security, which are central to the support of climate-resilient health pathways.

9.4.1 Institutional Responses to Health Resilience

A strong institutional response is recognised as a vital determinant for building resilience capability in developing countries like Bangladesh. Though a significant attempt has been undertaken to promote resilience of the country's health system, there is still room for improvement at the institutional and administrative levels that could further secure the process (WHO 2015). However, there remains a lack of service centres and educational programmes in medical centres and medical colleges on climate-sensitive diseases. Such centres and programmes are vital to ensuring climate-resilient health delivery systems. From this perspective, a strengthened institutional response is needed to build climate-resilient health systems for Bangladesh. As a result, governmental, non-governmental, inter-governmental and development partner institutions should pay more attention to what is needed for the country's health system to become climate-resilient.

Adaptive management strategies could be an essential adaptation practice for promoting resilient public health systems in Bangladesh. Adaptive management is a management model possessing unique and indispensable components that can enhance the effectiveness of facility restoration in response to management choices and for its dynamic interplay between managers, stakeholders, interventions and

policy responses (Whicker et al. 2008; Hess et al. 2012). There are three specific tools for facilitating adaptive management processes: assessment tools, modelling tools and decision support tools. Assessment tools identify and locate hazards and vulnerable populations; modelling tools project or assess appropriate climate-induced health warnings using scenarios; and decision support tools evaluate adaptation options (Hess et al. 2012). Hence, the adaptive management framework is likely to be a helpful strategy for building resilience through strengthening learning at all levels and rebuilding management plans to distinctly climate-sensitive health risk.

Though several institutions are empowered with regulating the behaviour of health service providers and standardising services, regulatory control is highly incorporated within the health ministry. The stewardship role of the public sector has been constrained by a weak legal framework and the institutional inadequacies of administrative functionaries (WHO 2015). Articles 15 and 18 of the Constitution specify the State's duty to provide the basic needs of life (including medical care), raise nutrition levels and improve public health. Along with this broad legal framework, the government has developed several policies and programmes under the *Ministry of Health and Family Welfare* (MoHFW). Table 9.2 summarises Bangladesh's institutional and stakeholder roles for securing a climate-resilient health delivery system.

Table 9.2 Main Contributions of different interested parties and institutions for promoting climate-resilient health systems

Stakeholders	Key Role
National government (Ministries of Environment & Forests and Health & Family Welfare)	• Guides all climate change associated policy issues and represents the country's climate-sensitive health situation at international negotiations under the UNFCCC • Ministries guide Bangladesh's preparation and response to climate-resilient health in the national parliament • Leads the *Local Consultative Group* (LCG) on Climate Change and Health, which plays the highest coordination role among the government and development partners on climate change and health agendas • Active in raising and mobilising funds and introducing mechanisms for dealing with climate change and health
Local government (e.g., Union Parishads)	• Acts as the primary medium of interaction for most of the issues affecting the community people and their livelihoods • Local Government Standing Committees (all committees formed by the UPs for accomplishing its functions efficiently)

(continued)

Table 9.2 (continued)

Stakeholders	Key Role
	perform climate change relevant activities, e.g. disaster management, health, education, agriculture, etc • LGIs partner with NGOs and donors to implement climate-resilient health initiatives at the local level
Individuals, communities and households	• Make the strategies implemented by other stakeholders effective. They are the primary audience, users, and a workforce of health services and health security-related activities • Principal actors in strategising, establishing and developing healthcare systems and other health support activities to ensure their effectiveness, relevance, and sustainability
Academic/research institutes (ICDDR,B; James P Grant School of Public Health)	• Shape the global discussion on equity issues and intergenerational aspects of climate change and health • Research outputs can inform the evaluation of what is already working, what needs to be improved and the potential options for such improvements • Small scale research on health impacts due to climate change can contribute to decision making in the health sector, which is being carried out by different research institutes
Media (Radio; Television; Newspaper)	• Promotes awareness through news coverage, use of readers' forums and seminars • Helps raise national debate on climate-resilient health and financing by bringing the issues to the attention of political leaders, including parliamentarians and development partners • Covers international negotiations and other major events, e.g. Conference of the Parties to the UNFCCC • Issues success and failure stories of climate change projects
Private sector	• Ensures more financial support and collaborate with government, NGOs and health institutes to promote health facilities for climate-vulnerable communities
Development partners and international financial institutions	• Small-scale financing to acquire the knowledge base on climate modification • Financial support to NGOs to integrate climate-resilient health in development plans • Technical and fiscal backing for the government to develop climate-resilient health plans

(continued)

Table 9.2 (continued)

Stakeholders	Key Role
Non-governmental organisations and civil society organisations	• A central link between development partners, government, and communities and, therefore, a vehicle through which activities and strategies can be communicated and implemented • Raising awareness on elementary concepts of climate change and health, causes, risks and potential means of addressing these issues • Advocacy, campaigning, and participatory research on responses to climate-resilient health

Source Adapted from Asia foundation (2012) that granted permission

9.4.2 Climate-Resilient Health Policy

Securing climate-resilient health in Bangladesh is a key focus of the government's vision for responding to climate change. The *Bangladesh Health Policy* (BHP) (2011) aims to establish surveillance for adverse health effects of climate change and create ways to prevent climate change associated health disasters and diseases. It also ensures availability of emergency relief including essential health services, medicines, and other goods to ensure health security for the victims of climatic and natural hazards (BHP 2011). The government recognises health as a priority issue in the *Bangladesh Climate Change Strategy and Action Plan* (BCCSAP), which, drafted in 2008 and updated in 2009 (BCCSAP 2009), was a substantial expansion of the Bangladesh National Adaptation Program of Action (NAPA) (NAPA 2009). The government established the *Climate Change Trust Fund (*CCTF) under the Bangladesh Climate Change Trust (BCCT) in 2010 to provide financial support to projects under the BCCSAP (2009). The government recognises health as a priority issue in the BCCSAP, which highlights six pillars needed to ensure that the poorest and most vulnerable in society are protected from climate change (BCCSAP 2009). The first pillar relates to Food Security, Social Protection, and Health. Under this pillar, the *Government of Bangladesh* (GoB) has developed nine strategic programmes to ensure climate-resilient food security, social protection, and health in Bangladesh. These are:

(a) Institutional capacity for research towards climate-resilient cultivars and their dissemination
(b) Development of climate-resilient cropping systems
(c) Adaptation to drought
(d) Adaptation in the fisheries sector
(e) Adaptation in the livestock sector
(f) Adaptation in the health sector

(g) Water and sanitation programme in climate-vulnerable areas
(h) Livelihood protection in ecologically fragile areas, and
(i) Livelihood protection of vulnerable socio-economic groups (including women)

Though resilience to the adverse impacts of climate change in the health sector has been somewhat acknowledged in both Bangladesh's health policy and the BCCSAP, implementation and monitoring of strategies at the local level is limited. Furthermore, practical knowledge and resources are insufficient to ensure sustainability of the programmes mentioned above.

9.4.3 Health Delivery System and Healthcare Facilities in Bangladesh

The government, private sector, NGOs and donor agencies work together to provide a health system in Bangladesh. The government and the private sector are the primary authorities responsible for rendering health services to people. A comprehensive network and integration of various health facilities extend from the community level to the national level. This network includes primary healthcare centres, community clinics, community health workers, medical colleges, hospitals, maternal and child welfare centres, doctors and nurses, and forms the backbone of Bangladesh's health system. Community clinics provide the bulk of communities' primary healthcare services including maternal and child healthcare, reproductive health and family planning services, immunisations, nutrition education, health education and counselling and first aid, and refer patients to higher-level health centres when necessary. Telemedicine services, introduced by the government in 2011, provide people in rural areas with remote medical advice via real-time video conferencing. ICDDR,B, one of the world's leading global health research institutes, contributes to understanding and resolving severe public health challenges confronting Bangladesh.

Despite these achievements, Bangladesh's health system faces challenges. Health service providers often lack the capacity required to ensure comprehensive healthcare settings and services, such as a lack of funding and members of staff. Moreover, there are no specialist services or units to offer health assistance to the climate-vulnerable populations. The increasing frequency of extreme climatic events, such as floods, cyclones and storm surges, affects the health infrastructure, including hospitals, clinics, diagnostic centres and healthcare facilities, which are used for diagnosing, treating and preventing diseases and illnesses. To overcome these challenges and promote resilience in the overall health system, existing programmes should be strengthened and improved. Access to healthcare facilities must be equal, regardless of geographic location, race, ethnicity, age, gender, social class, culture or ability to pay for the services. Coordination between all parties involved in the health system, including the government, private sector, NGOs and donor agencies is also essential.

9.4.4 Sustainable Livelihoods, Food and Water Security

Sustainable livelihoods, food security, and a clean water supply all lie at the heart of human health. In Bangladesh, adaptation strategies reflect comprehensive responses to climate change to ensure sustainability of these three crucial survival elements through livelihood diversification, crop, fishery and livestock adaptation activities and technological pathways to secure a clean water supply and improved sanitation facilities. The BCCSAP addresses extensive planning and investment to protect the health and livelihoods of poor farmers, with a particular priority on the health and nutrition of women and children, which will ultimately help to ensure food security and combat malnutrition. When combined, these elements can provide climate-resilient health benefits to communities in Bangladesh. Recognising the interrelation between these elements is important. For example, in the context of climate change, sustaining food security will often require diversification of livelihood activities. Many livelihoods in rural Bangladesh are directly linked to natural resources and therefore need a reliable water supply.

The pathways to climate-resilient health in Bangladesh are illustrated in the following diagram:

Livelihoods are one of the social determinants of health. Climate change affects natural resources in Bangladesh, which restricts a secure supply of clean water, food, fodder, shelter, medicine, clothing and the capacity to acquire the above necessities. Most of the population of Bangladesh is fully dependent on nature for their water, food, fodder, medicine, shelter and clothing. Therefore, a shortage of natural resources exerts pressure on the health of climate-vulnerable people (people living in areas vulnerable to adverse climatic hazards including floods, drought, salinity intrusion, etc.), as it results in a lack of balanced and nutritious diet. Livelihood diversification, for example moving from a farming (e.g. crops, livestock and fisheries) to a non-farming (e.g. day labour, small businesses and services) occupation, is a means of livelihood adaptation. Such activities to ensure livelihood security, therefore, are essential to ensuring climate-resilient health.

Agricultural adaptation strategies are among the most prioritised actions in Bangladesh. Their success has significant positive implications for the health of Bangladesh's population, including direct benefits for reducing rates of malnutrition (Yu et al. 2010). Different actors including development partners, government ministries, international NGOs, and local community-based organisations have facilitated the implementation of a wide range of agricultural adaptation measures. These draw from both local knowledge and modern technology, being adapted as appropriate to the geographic location and socioeconomic conditions of their site of application (Yu et al. 2010).

In addition to these agricultural adaptation strategies, productive fisheries and livestock systems are essential for ensuring climate-resilient health and reducing malnutrition rates in Bangladesh. Salt-tolerant fish species need to be identified for aquaculture in water-logged areas and ponds. Furthermore, technological advancement of traditional fishing boats to include weather warning systems could be a useful adaptation choice for fishers so that they can take shelter before a storm or cyclone evolves. Other possible coping options include protection against development of pond aquaculture, provision of alternative livelihoods for vulnerable fishermen, and the introduction of climate-resilient fodder crops and climate-resilient poultry (i.e., semi-scavengers or slatted housing patterns for poultry) and livestock breeds. In different climate change scenarios, Bangladesh has introduced several climate-resilient interventions for the fisheries and livestock sectors specifically designed to have health outcomes (see Yu et al. 2010). It can be noted that all successful agricultural adaptation activities are likely to have health benefits, even if they do not explicitly target that outcome.

The water and sanitation sector is another crucial area for ensuring climate-resilient health. Consequently, numerous technological pathways are employed in Bangladesh to ensure health by securing safe drinking water. In cities, people mostly get access to water through pipelines and deep tubewells. Rural communities use deep tubewells, shallow tubewells, dug wells, *rainwater harvesting systems* (RWHSs), pond sand filters (PSFs), rivers and canals to access water for drinking, agriculture and other domestic needs. The freshwater sources in the coastal areas – groundwater and surface water reservoirs – are severely affected by salinity intrusion. As a result, people get drinking water from interventions such as PSFs, RWHSs and dupe tubewells. However, the supply of safe water remains inadequate and there is a need to identify a response to these water supply challenges in Bangladesh to ensure climate-resilient health.

Several technologies are already being used in communities in Bangladesh to address these challenges. Yu et al (2010) provide some examples of water technology that have been employed in Bangladesh. Though Bangladesh has introduced a secure water supply scheme, the unavailability of freshwater aquifers at appropriate depths limits its benefits. Better health can be supported through the scaling-up of locally appropriate technologies to ensure sufficient freshwater for drinking and domestic purposes. These adaptive techniques are essential for human wellbeing in climate-vulnerable areas in Bangladesh. They fill the supply gap in areas where the existing water supply scheme is inadequate to match the requirements (Islam et al. 2013). By enabling access to safe drinking water, they provide a pathway to climate-resilient health (Table 9.3).

Table 9.3 Technologies for water resilience in Bangladesh

Technology	Application	Cost-effectiveness and social acceptance
Rain water harvesting systems (RWHSs)	RWHSs in small earthen pots or reservoir tanks provide safe water for drinking and other household activities in drought-prone, flood-prone and saline-prone areas at both the household and community levels	Rainwater harvesting tanks in Bangladesh vary in capacity from 500 litres to 3200 litres, costing from 40 to 110 USD *Acceptance*: Rate of acceptance is the best
Pond sand filters (PSFs)	PSFs enable clean water to be collected from a water source through filtration of the water to remove debris and germs, especially in saline-prone coastal Bangladesh	Installation cost is within the range of 420 to 1600 USD with a capacity to supply water from 4000 to 10,000 litre/day *Acceptance*: Rate of acceptance is good
Desalination panels	This technology can be used to remove salinity and germs from the available water in coastal areas to ensure safe drinking water and overcome health burdens of climate-vulnerable coastal people	Very efficient technology but requires huge installation cost on an average 30,000 to 40,000 USD with a capacity of 10–15,000 litres/day *Acceptance*: Rate of acceptance is moderate due to high installation and maintenance cost

Source The authors

9.5 Conclusions

Climate change is increasing the frequency and magnitude of extreme weather events and creating risks that impact health and healthcare facilities in Bangladesh. People living in flood-prone, drought-prone, and saline-prone areas are the most vulnerable to climate-induced health impacts in Bangladesh (CCC 2009b). The frequency of numerous natural hazards and seasonal disasters is perceived to be the primary cause of prolonged outbreaks of various climate-sensitive diseases, including water-borne and vector-borne diseases, respiratory and cardiovascular disease in Bangladesh. Furthermore, the overall vulnerability of marginal people (including the poor, physically/mentally challenged, ethnic minorities, etc.) to any abovementioned hazardous events is high. In addition, within the marginal populations, the susceptibility of women, children and the elderly are of the utmost in order. Vulnerable poor people are suffering the most from climate-sensitive diseases and insufficient healthcare facilities in the absence of a climate-resilient health system. Healthcare facilities need to assess climate change risks and adopt adaptive management strategies to be resilient. Response activities are increasing, but the guidance, plans and direction for climate-resilient health remain limited. Actors involved in health delivery sectors must take immediate and increased action to work towards a climate-resilient health delivery system. For example,

climate-sensitive health policies and plans need to be developed, implemented and coordinated by the MoHFW. This could include setting up service centres and educational curriculums in medical centres and medical colleges to tackle climate-sensitive diseases and ensure a climate-resilient health delivery system.

References

Akter T (2009) *Migration and living conditions in urban slums: implications for food security*. Unnayan Onneshan, Dhaka.

Alam A B M M (2011) Climate change and infectious diseases: global & Bangladesh perspective. *J of Shaheed Suhrawardy Med College* 3(1):1–2.

Alam N, Lindeboom W, Begum D and Streatfield P K (2012) The association of weather and mortality in Bangladesh from 1983–2009. *Glob Health Action* 5:53–60.

Alonso D, Bouma M J and Pascual M (2011) Epidemic malaria and warmer temperatures in recent decades in an East African highland. Proceedings of the Royal Society of London *B: Biological Sciences*, 278(1712):1661–1669.

Asia Foundation (2012) A Situation Analysis of Climate Change Adaptation Initiatives in Bangladesh. Asia Foundation, Dhaka.

Banu S, Guo Y, Hu W, Dale P, Mackenzie J S, Mengersen K and Tong S (2015) Impacts of el niño southern oscillation and indian ocean dipole on dengue incidence in Bangladesh. *Sci Rep* 5:16105.

BCCSAP (2009) Bangladesh climate change strategy and action plan. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka.

Bennett C M and McMichael A J (2010) Non-heat related impacts of climate change on working populations. *Glob Health Act* 3:62.

BHP (2011) *Bangladesh Health Policy.* Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh, Dhaka.

Burkart K, Khan M H, Krämer A, Breitner S, Schneider A and Endlicher W R (2011) Seasonal variations of all-cause and cause-specific mortality by age, gender, and socioeconomic condition in urban and rural areas of Bangladesh. *Int J Equity Health* 10(1):1.

Butler C D (Ed) (2014) *Climate change and global health*. CABI, Wallingford.

Butler C D and Harley D (2010) Primary, secondary and tertiary effects of eco-climatic change: the medical response. *Postgrad Med J* 86(1014):230–234.

Caminade C, Kovats S, Rocklov J, Tompkins A M, Morse A P, Colón-González F J, Stenlund H, Martens P and Lloyd S J (2014) Impact of climate change on global malaria distribution. *Proceedings of the National Academy of Sciences*, 111(9):3286–3291.

CCC (2009a) *Climate change and health impacts in Bangladesh. Climate Change Cell (CCC)*, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka.

CCC (2009b) *Climate change, gender and vulnerable groups in Bangladesh. Climate Change Cell (CCC)*, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka.

Corvalán C, Hales S and Anthony M (2005) *Ecosystems and human well-being: health synthesis*. World Health Organization, Geneva.

Cox F E G 2010 History of the discovery of the malaria parasites and their vectors. *Parasites & Vectors* 3:5.

Dewan T H (2015) Societal impacts and vulnerability to floods in Bangladesh and Nepal. *Weather and Climate Extremes* 7:36–42.

Dey N C, Alam M S, Sajjan A K, Bhuiyan M A, Ghose L, Ibaraki Y and Karim F (2012) Assessing environmental and health impact of drought in the northwest Bangladesh. *Journal of Environmental Science and Natural Resources* 4(2):89–97.

DG-Health (1997) *Bangladesh health bulletin*. Director General of Health Services, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh, Dhaka.

DG-Health (2010) *Bangladesh health bulletin*. Director General of Health Services, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh, Dhaka.

FAO (2008) *Climate Change and food security: a framework document*. Food and Agriculture Organization of the United Nations, Rome.

FAO, IFAD and WFP (2015) *The state of food insecurity in the world 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress*. Food and Agriculture Organization of the United Nations, Rome.

Francis A and Maguire R (eds) (2016) *Protection of refugees and displaced persons in the Asia pacific region*. Routledge, New York.

Hashizume M, Wagatsuma Y, Hayashi T, Saha S K, Streatfield K and Yunus M (2009) The effect of temperature on mortality in rural Bangladesh—a population-based time-series study. *Int J Epidemiol* 38(6):1689–1697.

Hasib E and Chathoth P (2016) Health Impact of Climate Change in Bangladesh: A Summary. *Current Urban Studies* 4(01):1.

Hess J J, McDowell J Z and Luber G (2012) Integrating climate change adaptation into public health practice: using adaptive management to increase adaptive capacity and build resilience. *Environ. Health Perspect* 120(2):171.

Hossain M, Kathuria R and Islam I (Eds) (2010) *South Asian economic development*. Routledge, New York.

IPCC (2014) Climate Change 2014: *Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge.

Islam A K M S, Murshed S B, Khan M S A and Hasan M A (2014) *Impact of climate change on rainfall intensity in Bangladesh*. Institute of Water and Flood Management (IWFM). Bangladesh University of Engineering and Technology (BUET).

Islam M A, Sakakibara H, Karim M R and Sekine M (2013) Potable water scarcity: options and issues in the coastal areas of Bangladesh. *J Water Health* 11(3):532–542.

Khatun M A, Rashid M B and Hygen H O (2016) *Climate of Bangladesh*. (Rep. No. 08/2016), Bangladesh Meteorological Department and Norwegian Meteorological Institute, Dhaka.

Lindeboom W, Alam N, Begum D and Streatfield K (2012) The association of meteorological factors and mortality in rural Bangladesh, 1983–2009. *Glob Health Action* 5:61–73.

McMichael A J, Haines A, Slooff R and Kovats S R (eds) (1996) *Climate change and human health: an assessment by a task group on behalf of the World Health Organization*. The World Meteorological Organization and the United Nations Environment Programme, WHO, Geneva.

MoHFW (2015) *Malaria national strategic plan 2015–2020*. National Malaria Control Programme (NMCP), Communicable Disease Control Division, Directorate General of Health Services, Government of the People's Republic of Bangladesh, Dhaka.

NAPA (2009) *National adaptation programme of action*. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka.

NIPORT (2015) *Bangladesh Demographic and Health Survey 2014*. National Institute of Population Research and Training, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh, Dhaka.

Paaijmans K P, Blanford S, Bell A S, Blanford J I, Read A F and Thomas M B (2010) Influence of climate on malaria transmission depends on daily temperature variation. *Proceedings of the National Academy of Sciences*, 107(34):15135–15139.

Rahaman M A (2013) *Impact of climate change on health in Bangladesh*, Balaka Prakashani, Dhaka.

Rahman A (2008) *Climate change and its impact on health in Bangladesh*. Regional Health Forum 12(1):16–26.

Rashid S F, Gani S and Sarker M (2013) Urban poverty, climate change and health risks for slum dwellers in Bangladesh. In: Shaw R (ed) *Climate Change Adaptation Actions in Bangladesh*, Springer Japan, pp 51–70.

Reid H and Sims A (2007) *Up in Smoke? Asia and the Pacific*. IIED, London.

Saha S (2012) Security implications of climate refugees in urban slums: A case study from Dhaka, Bangladesh. In Scheffran J et al. (ed) *Climate change, human security and violent conflict: challenges for societal stability*, Springer, Heidelberg Berlin, pp 595–611.

Save the Children (2015) *Malnutrition in Bangladesh: Harnessing social protection for the most vulnerable*. Save the Children, UK.

Shovo T E A, Howlader M H and Kumar T (2013) Risk and vulnerability of climate change on coastal people: a study form socio-economic and environmental perspective. *Bangladesh Res Pub J* 8(3):195–202.

Streatfield P K and Karar Z A (2008) Population challenges for Bangladesh in the coming decades. *J Health Popul Nutr* 26:261–272.

Sugden F, de Silva S, Clement F, Maskey-Amatya N, Ramesh V, Philip A and Bharati L (2014) *A framework to understand gender and structural vulnerability to climate change in the Ganges River Basin: lessons from Bangladesh, India and Nepal*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 50p. (IWMI Working Paper 159).

UNICEF (2011) *Children's vulnerability to climate change and disaster impacts in East Asia and the Pacific*. UNICEF, Bangkok.

Whicker J J, Janecky D R and Doerr T B (2008) Adaptive management: a paradigm for remediation of public facilities following a terrorist attack. *Risk Anal* 28(5):1445–1456.

WHO (2013) Nipah Virus outbreak in Bangladesh; at: http://www.searo.who.int/entity/emerging_diseases/links/nipah_virus/en/ (7 Aug 2016).

WHO (2015) *Bangladesh Health System Review*. World Health Organization, Geneva.

WHO (2016) Climate change and human health: Ecosystem goods and services for health; at: http://www.who.int/globalchange/ecosystems/en/ (19 July 2016).

World Bank (2013) *Turn down the heat: climate extremes, regional impacts, and the case for resilience*. A report for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics, World Bank Washington DC.

Yu W, Alam M, Hassan A, Khan A S, Ruane A C, Rosenzweig C, Major D C and Thurlow J (2010) *Climate change risks and food security in Bangladesh*. Earthscan, London.