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Health Vulnerability and Adaptation Assessmen of Climate Change Impact in Bangladesh

Final Report

2023

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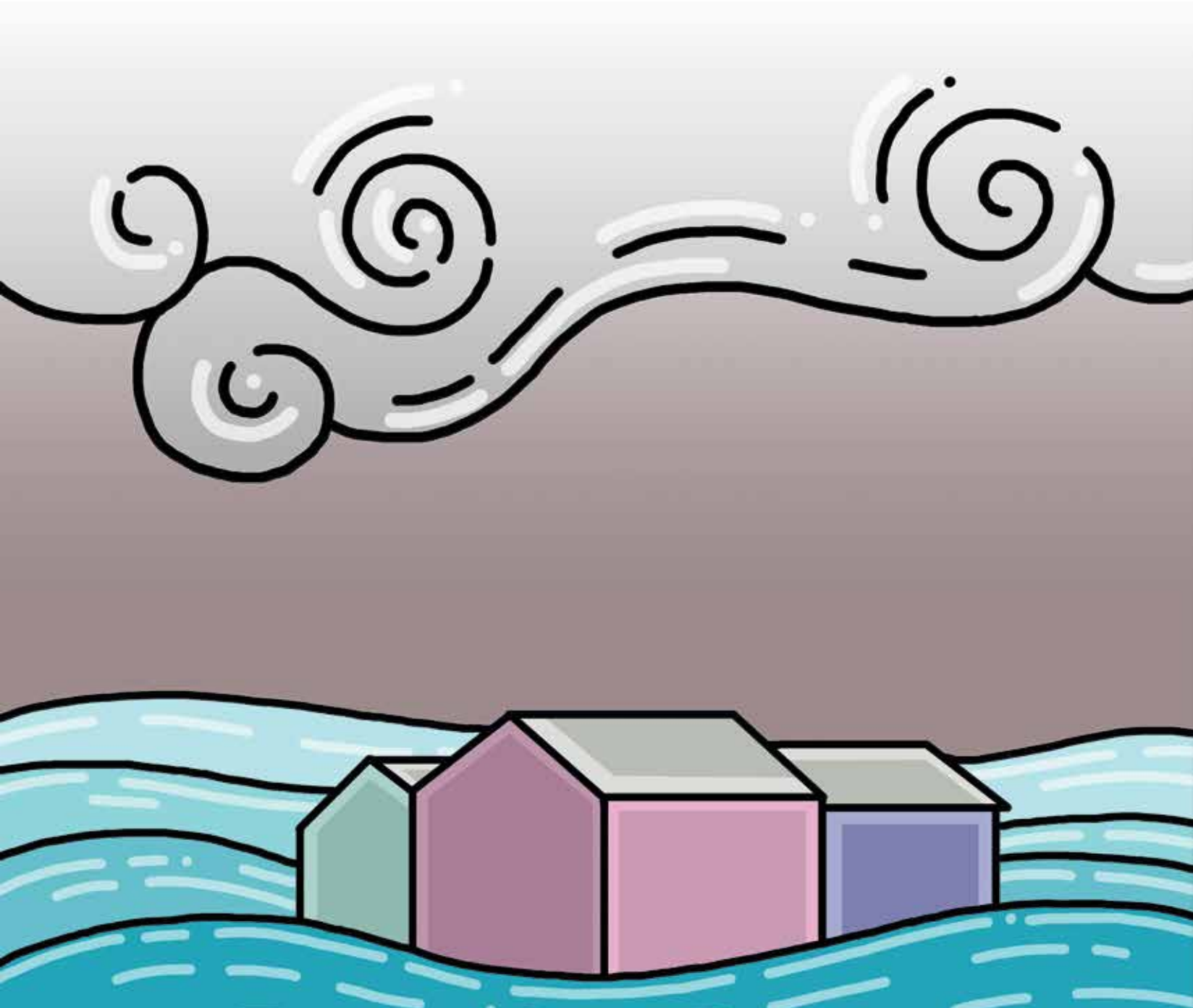

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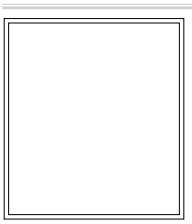

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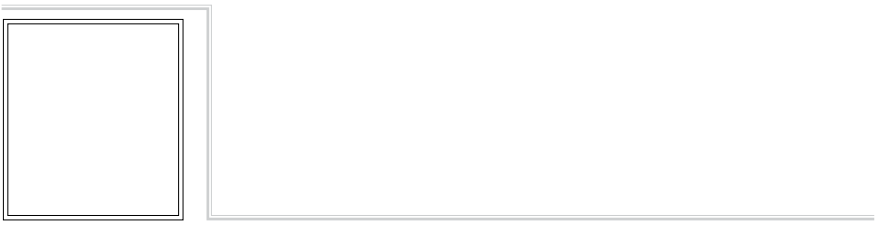

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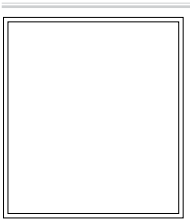

Acknowledgement

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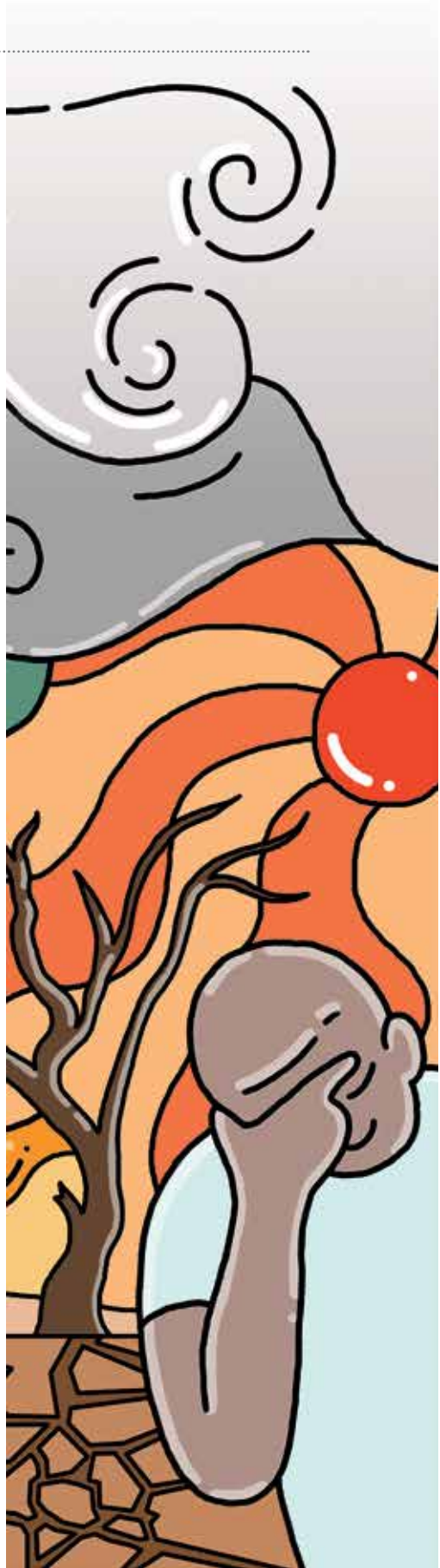

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Acronyms and Abbreviation

BMD	Bangladesh Meteorological Department
BBS	Bangladesh Bureau of Statistics
CC	Climate Change
CCHPU	Climate Change and Health Promotion Unit
CSD	Climate Sensitive Disease
DGHS	Directorate General of Health Services
DGFP	Directorate General of Family Planning
FGD	Focus Group Discussion
FFWC	Flood Forecasting and Warning Centre
GED	General Economics Division
GoB	Government of Bangladesh
GBM	Ganges Brahmaputra Meghna
GEF	Global Environmental Facility
H-NAP	Health National Adaptation Plan
HPSNSP	Health Nutrition and Population Sector Program
icddr,b	International Centre for Diarrheal disease Research, Bangladesh
IPCC	Intergovernmental Panel on Climate Change
IUCN	The International Union for Conservation of Nature
LGIs	Local Government Institutes
MS	Microsoft
MSW	Multi Stakeholder Workshop
MOEF	Ministry of Environment and Forest
MoHFW	Ministry of Health and Family Welfare
NAP	National Adaptation Plan
NAPA	National Adaptation Plan for Action
NDC	Nationally Determined Contribution
NGOs	Non-governmental organizations
PRA	Participatory Rural Appraisal
PIP	Project Implementation Plan
PHE	Public Health and Environment
SDG	Sustainable Development Goal
SLR	Sea Level Rise
SIP	Strategic Implementation Plan
SWL	Specific Warming Level
SWAp	Sector-Wide Approach
UNISDR	United Nations International Strategy for Disaster Reduction
UNDP	United Nations Development Programme
V&A	Vulnerability and Adaptation
VAA	Vulnerability and Adaptation Assessment
WASH	Water, sanitation and hygiene
WHO	World Health Organization

Executive Summary

Recent statistics illustrates that climate change and extreme weather events in Bangladesh are imposing threats to the health of population and its health system. Therefore, a regular update is required to address the vulnerabilities and improve the adaptation capacity of the health system in the country. This study assessed health vulnerability, caused by impacts of climate change and extreme weather events, in five distinct geographical areas of the country.

This study was conducted under the WHO and MoHFW project titled “Building resilience of health and health system from the impact of climate change” with financial assistance from GEF. The project sought to achieve the outcome of updating H-NAP through effectively revising and integrating health risks from climate variability and adaptation options. While previous assessments in 2011 and 2015 provided opportunities to understand and evaluate climate change impact on disease pattern and associated vulnerabilities, an updated vulnerability and adaptation (V&A) assessment as well as analysis and quantification of current health impact of climate variability and change was required.

The overall objective of this study was to identify the gender-disaggregated population vulnerable to climate variability and change, by verifying identified climate sensitive diseases (CSD) and other health risk factors in climate vulnerable regions for a better planning of health programs for improvement of health resilience. The five climate-vulnerable regions are represented in the study by: (i) Dinajpur (Birampur Upazila) as drought prone area; (ii) Sirajganj (Ullapara Upazila) as flood prone area; (iii) Patuakhali (Patuakhali Sadar Upazila) as coastal cyclone and storm surge prone area; (iv) Rangamati (Rangamati Sadar Upazila) as hilly, land slide prone area; and (v) Dhaka city as a case of urban vulnerability.

The approach and methodology of the study included: (i) inception phase with inception meeting and selection of study area; (ii) literature review of relevant documents; (iii) qualitative and quantitative data collection through workshops, FGDs, community meetings, structured questionnaire for household survey, and secondary data collection from various sources; (iv) understanding future impact of climate change on health; (v) current adaptation policy and strategy; and (vi) finally assigning weights and scores to the vulnerabilities and adaptations. The V&A assessment or VAA followed the step-by-step guideline by Crane-Doesh (2008) where the questionnaires were developed considering the current vulnerability of health and health system. In total, 830 household questionnaire surveys were conducted with 166 in each of five climate vulnerable areas.

The results show that the communities in all study areas have a good perception of overall climate variability and extreme weather events that lead to diseases or health problems. In all areas, largest number of households opined that flood is the main reason among all extreme weather events that is responsible for diseases or health problems. Findings (from FGD, workshops, community meetings) reveal that respondent noticed increase of temperature in summer with prolonged dry period, temperature is dropping drastically for short period in winter, and massive change in rainfall pattern with increase of lightning and thunder strikes in recent days in all areas. Similar results were found from the analysis from the meteorological data of Bangladesh Meteorological Department during the period from 2001 – 2010 to 2011 – 2020 such as temperature increased by 0.2 to 0.4 in summer in the study areas, and rainfall decreased in all study areas except for Rangamati. Moreover, 69% to 74% of annual rainfall occurs during 4 months of monsoon (June – September) while the remaining 8 months is getting drier, which has also been observed to becoming more common during 2011 – 2020 than 2001 – 2010.

As per household survey, the overall impact of climate change on health is large in all areas while severe impact was observed to be highest in Patuakhali (20%). According to the household survey, the top five affected sectors due to climate change are agriculture, food security, livelihood, social unrest, and health and health system, although the order varied among the five areas. The impact of these sectors on male and female is also inconsistent as agriculture and livelihood loss were ranked higher by males than females, whereas health, food security and social unrest sectors were ranked mostly by females as top affected sectors due to climate change. Apart from that, the respondents highlighted that the water sources are getting affected, both in terms of quality and quantity, due to the extreme weather events and climate change. From the household survey, a large percentage of respondents complained about increase of various diseases due to impact of climate change, e.g., diarrhea, dysentery, fever, cold, skin diseases, hypertension (Birampur, Patuakhali, Dhaka), kidney diseases (Birampur, Patuakhali, Dhaka), typhoid (Ullapara, Birampur, Dhaka) and stomachache (Ullapara, Birampur, Dhaka). Consequently, the health care expenditure of the respondents was reported to have increased largely in all areas of the study.

According to household survey, half the respondents (n=82 respondents) think floods is the main reason among all the extreme weather events that is responsible for diseases or health problems, according to household survey **in Ullapara**. Respondents think that impact of flood on food availability causes malnutrition problem during and post flood situation **in Sirajganj**. Diarrhea, dysentery, fever, and skin diseases were the common diseases identified by the respondents. 119 respondents (70%) mentioned that their yearly health care expenditure is increasing due to climate change. **In Birampur,** among the respondents of household survey, half (50%) of the respondents (83 participants) mentioned that drought is the main reason among all the extreme weather events that is responsible for diseases or health problems in their area. More than 12% respondents think that diarrhea, dysentery, fever, cold and skin diseases are the common diseases caused by the impact of changing climate.

97 respondents (58%) mentioned that their yearly health care expenditure is increasing due to climate change. **In Patuakhali Sadar,** among the respondents of household survey, 36% (59) of the respondents mentioned health and health system as an affected sector due to climate change. 74% of the respondents (123 participants) in Patuakhali think that flood and 51 respondents (31%) think tidal wave are the main reasons among all the extreme weather events that is responsible for diseases or health problems, according to household survey. Among the diseases, diarrhea, dysentery, fever and cold are the common diseases caused by the changing climate. 157 respondents (94%) mentioned that their yearly health care expenditure is increasing due to climate change. **In Rangamati**, 18% of the respondents (30 participants) think waterlogging (caused due to heavy rainfall) and 14% of respondents (23) think cyclone and storm surge are the main reasons among all extreme events that caused diseases or health problems. Among various diseases, diarrhea, fever, cold and skin diseases are the common diseases caused by the changing climate in this area. 91 respondents (55%) mentioned that their yearly health care expenditure is increasing due to climate change. Previously, malaria was seen in pre and post monsoon period but now malaria patient is seen round the year, according to the information collected during FGD and community meeting. I**n Dhaka,** 35 respondents (21%) mentioned health and health system as the affected sector due to climate change. 142 respondents (86%) in Dhaka city think that waterlogging is the main reason among all the extreme weather events that is responsible for diseases or health problems. Among the diseases, most of the respondents mentioned about diarrhea, dysentery, fever, cold, skin diseases and typhoid as the common diseases caused by the impact of climate change. 108 respondents (65%) mentioned that their yearly health care expenditure is increasing due to climate change.

From analysis of qualitative data, major climate sensitive diseases identified can be summarized as water- borne (cholera, diarrhea, dysentery, and skin diseases) and vector-borne (malaria, dengue, chikungunya) diseases in the study areas. Moreover, respondents reported about the changing disease pattern in all study areas, e.g., increasing frequency of respiratory, kidney, non-communicable, heart and mental diseases. Participants in **Ullapara** opined that impact of flood on food availability causes malnutrition problem during and post flood situation in Sirajganj. Diarrhea, dysentery, fever, and skin diseases were the common diseases identified by them. **In Birampur** (drought prone area), respiratory and skin diseases were reported to be common among all age groups. Elderly people and farmers who work in the field, suffer by heat stroke. **In Patuakhali,** in summer monsoon, diarrhea and dysentery are increasing along with hepatitis and typhoid. Non-communicable, kidney and skin diseases are also increasing. Heat stroke is common among elderly people and farmers. Dust allergy is also increasing over the years, especially during the dry period. Few cases of dengue were found in 2019 and 2020 in Patuakhali. I**n Rangamati,** scarcity of safe drinking and lack of health care facility in remote hilly areas are responsible for increasing diarrhea, pneumonia, hepatitis, typhoid and kidney disease, while malaria cases are decreasing here due to various government initiatives. **In Dhaka,** respondents experienced that acute

hepatitis, skin diseases, malignancy, gastroenteritis, respiratory diseases, and heart disease are increasing in last 10 years although mosquito borne diseases (dengue, chikungunya) have seen the largest increase. Diarrheal diseases outbreak including cholera are common in densely populated slum areas. Other water borne diseases like hepatitis and typhoid fever are also increasing. Elderly and low-income people are affected by heat stroke. Dust allergy and other respiratory problems have been increasing among all age groups in the recent years.

Four years data (2017 – 2020) of diarrheal cases of Ullapara, Birampur, Patuakhali and Rangamati were collected from DGHS and have been analyzed. Most diarrhea cases have been found in June in Ullapara while in Birampur and Dhaka, people suffer in diarrhea mostly in April; in Patuakhali in May due to low rainfall and high temperature and in Rangamati mostly in December due to low rainfall. However, statistical analyses showed variability of lags of 0 – 2 months of low rainfall, high/low temperature and low humidity may cause peak diarrhea at various study areas. In Rangamati, malaria cases (collected from DGHS for the period of 2015 to 2020) have been found in peak during June – August due to high rainfall, humidity, and temperature. However, limited disease data availability limits the statistical analyses that impeded establishing relationship with climatic variables. In Dhaka, 15 years (2006 – 2020) data of diarrheal, cholera and shigella cases have been collected from icddr,b. A statistical analysis shows a strong statistically significant correlation between maximum monthly temperature and diarrhea (also cholera and shigella) for the period from 2006-2020 in Dhaka. Among vector-borne diseases, malaria and dengue were analyzed. Several Dengue outbreaks in last 20 years have been observed, while the largest in 2019 peaked from July to October. The statistical analysis shows that a strong and statistically significant relationship was found between climatic variables (rainfall and relative humidity) and dengue in Dhaka.

In the study areas, a significant percentage of the community people go to public hospital followed by private hospital for their health need. Registered doctor's chamber and pharmacy are still playing a big role for providing the immediate health care in the community. Rural people from rural areas prefer government hospital compared to city dwellers. Most of the participants are satisfied with current outdoor and indoor hospital services. While the health professionals said that the health systems are prepared for extreme weather events such as floods or cyclones, the respondents of household survey opined that there are still some limitations such as lack of water supply, insufficient number of doctors in the hospitals. It is evident from the household survey findings that the health system's response to extreme weather at the local level is yet to reach at effective level.

The vulnerability and adaptation assessment (VAA) scores in all five areas are lower than 2 (on a scale range from 1-3 where 1 is highly vulnerable, 2 is moderately vulnerable, and 3 is less vulnerable. Out of five locations, Ullapara (flood-prone area) is the most vulnerable with the lowest VAA score of 1.31. The other four locations show relatively lower vulnerability than Ullapara, 1.44 in

drought-prone area (Birampur), 1.49 in coastal area (Patuakhali), 1.49 in hilly area (Rangamati), and 1.83 in Dhaka city. From the VAA scoring, it is found that Dhaka city shows lower vulnerability than the rural areas, which is mainly because of the improved condition of health structure, sanitation system and food availability. Therefore, the rural areas more attention in different sectors (e.g., sanitation system, food availability, health system, etc.) to cope with the effects of future climate change.

From the policy review, the study found that there are several strategies or policies addressing health systems adaptability on climate change. The completion of ongoing programs should strengthen the health system of the country to better prepare for the impact of climate change. However, some of the major public health indicators are still not improving as per the target. Advocacy and training of health managers, community awareness and surveillance activities considering climate change adaptation also need significant strengthening. There is no dedicated single strategic action plan for coordinating and supervision (from the perspective of climate change) of all these activities. Therefore, it is recommended to have a strong, financially sustainable dedicated program with dedicated manpower under the health sector to coordinate all these activities in relation to the effect of climate change on health. Conducting more operational and epidemiological research works to provide specific data needed for developing specific planning would also play a vital role. Another area for improvement is the coordination between various programs and communication among central and field level health professional.

Chapter 1

Introduction

Background

The vulnerability and adaptation capacity of any region varies with its diversified geographical/ecological settings. Bangladesh has distinct geographical/ecological areas namely flood, coastal, drought and hilly that pose varied degrees of risk. The change of climatic variables and frequency of extreme weather events is different in the different geographical areas in terms of magnitude and nature. The overall circumstances of the impact of climate change and extreme weather events showed that the people in this country are gradually becoming more vulnerable, especially on the health aspects. Recent statistics illustrated that the climate change and the extreme weather events are imposing threat to the health and health system with variable degree in different geographical areas of Bangladesh in recent decades. For example, a study in 2018 predicted that climate changes after 2014 may have caused some ecological imbalances in the environment that leads to increased occurrence of dengue cases in the pre- and post- monsoon seasons as well as an explosion of chikungunya for the first time in 2017 in Bangladesh, which is highest for the past 18 years. As for diarrhea, the proportion of diarrheal death and other water-borne diseases attributable to climate change is projected to increase up to 13% of total cases by 2050 (from 8% in 2008).

WHO Bangladesh is providing technical support to build resilience to the health and health system in Bangladesh. It is also building capacity of the health professionals to address the impact of the climate change in the country. In this regard, WHO prepared a Health National Adaptation Plan (H-NAP) for the country's health sector professionals and relevant stakeholders. Currently, WHO and Climate Change and Health Promotion Unit (CCHPU) under the Ministry of Health and Family Welfare (MoHFW) have been implementing a project namely "building resilience of health and health system from the impact of climate change" with the financial assistance of the GEF. The project seeks to achieve an important outcome namely updating the H-NAP through effectively updating and integrating health risks from climate variability and change, and adaptation options. This warrants to update vulnerability and adaptation (V&A) assessment to reflect current evidence and specificity in climate risks and adaptation priority to feed into the H-NAP. It needs to be noted that the H-NAP will be the part of the National Adaptation Plan (NAP) which is under preparation.

Since the H-NAP largely builds upon the findings on the current vulnerability and adaptation practices in the country's health system, an update of the vulnerabilities and adaptation capacity of the health and health system in the country is required. In the past, WHO conducted two V&A assessments in 2011 and 2015. While the previous V&A assessments provided opportunities for an

understanding of and evaluating the climate change impact on disease patterns and their associated vulnerabilities, the study was impeded by limited data availability. Therefore, the sector professionals opine that a comprehensive V&A assessment as well as an updated analysis and quantification of the health impact of climate variability and change is needed in different geographical areas of the country. Hence, PHE unit of WHO Bangladesh aimed to conduct the V&A assessment in five climatic vulnerable geographical area of Bangladesh (coastal, flood prone, drought prone, hilly, and urban area) for integrating updated health, climate and other data into a comprehensive and quantitative assessment while taking into account the different climatic and regional contexts of the country.

Objectives

The overall objective of the assignment was to identify population vulnerability (with gender disaggregated data, where available) to climate variability and change by verifying identified climate sensitive diseases (CSD) and other health risk factors in climate vulnerable regions for a better plan of health programmes for improvement of health resilience. The specific objectives were to:

a) Assess population vulnerability to climate risks and climate sensitive diseases, and to identify vulnerable regions and populations.

b) Gather data on perceptions that communities have on past, current, and future impacts of climate risks.

c) Assess trends and patterns of specified climate sensitive diseases (CSD).

d) Assess health system vulnerability and level of preparedness to manage CSD.

e) Describe and assess effectiveness of policies and programmes.

f) Evaluate existing health sector programmes & plans and recommend priority programs for enhanced health adaptation and resilience to climate change in health and relevant sectors.

Focus Areas

1. Different climate sensitive water and food borne diseases (e.g., cholera, diarrhea, typhoid, hepatitis etc.), vector borne diseases (e.g., malaria, dengue, kala azar), and malnutrition, heat stroke, hypertension and respiratory diseases, mental health and any other specific health outcomes in the selected areas were given special consideration.
2. The study looks at the facilities and capacity of the Upazila health complex and health facilities in Dhaka city, considering different issues including medical staff, access to health care facilities (HCF), medical supplies, etc.
3. The assessment focuses on understanding how well the policies and programs are protecting individuals and communities against climate related hazards.

Organization of the Report

This study report consists of eight chapters. The **Chapter 1** describes the background, objectives, and focus areas for this study. The approach and methodology, from the inception phase to final report writing have been described in **Chapter 2.** This is followed by **Chapter 3** which presents the major climate disasters, change and variability on climate risks, and the communities' perception on climate risks with gender disaggregated analyses. **Chapter 4** describes the qualitative and quantitate analysis on major climate sensitive diseases. **Chapter 5** describes the health system vulnerability and level of preparedness to manage climate sensitive diseases. **Chapter 6** describes the findings of Vulnerability and Adaptation Assessment of the study areas. **Chapter 7** addresses the different policies, plans, and programmes on health sector. **Chapter 8** offers conclusions and recommendations of this study.

Chapter 2

Approach/ Methodology and Activities

Approach and Methodology

In general, the approach and methodology for the study was developed with an aim to accomplish the six specific objectives of the study. The course of the study was divided into different phases with different milestones set to make sure that the linkages between the activities could be monitored well. The approach and methodology for the different phases is presented in Figure 2.1 and discussed in this chapter.

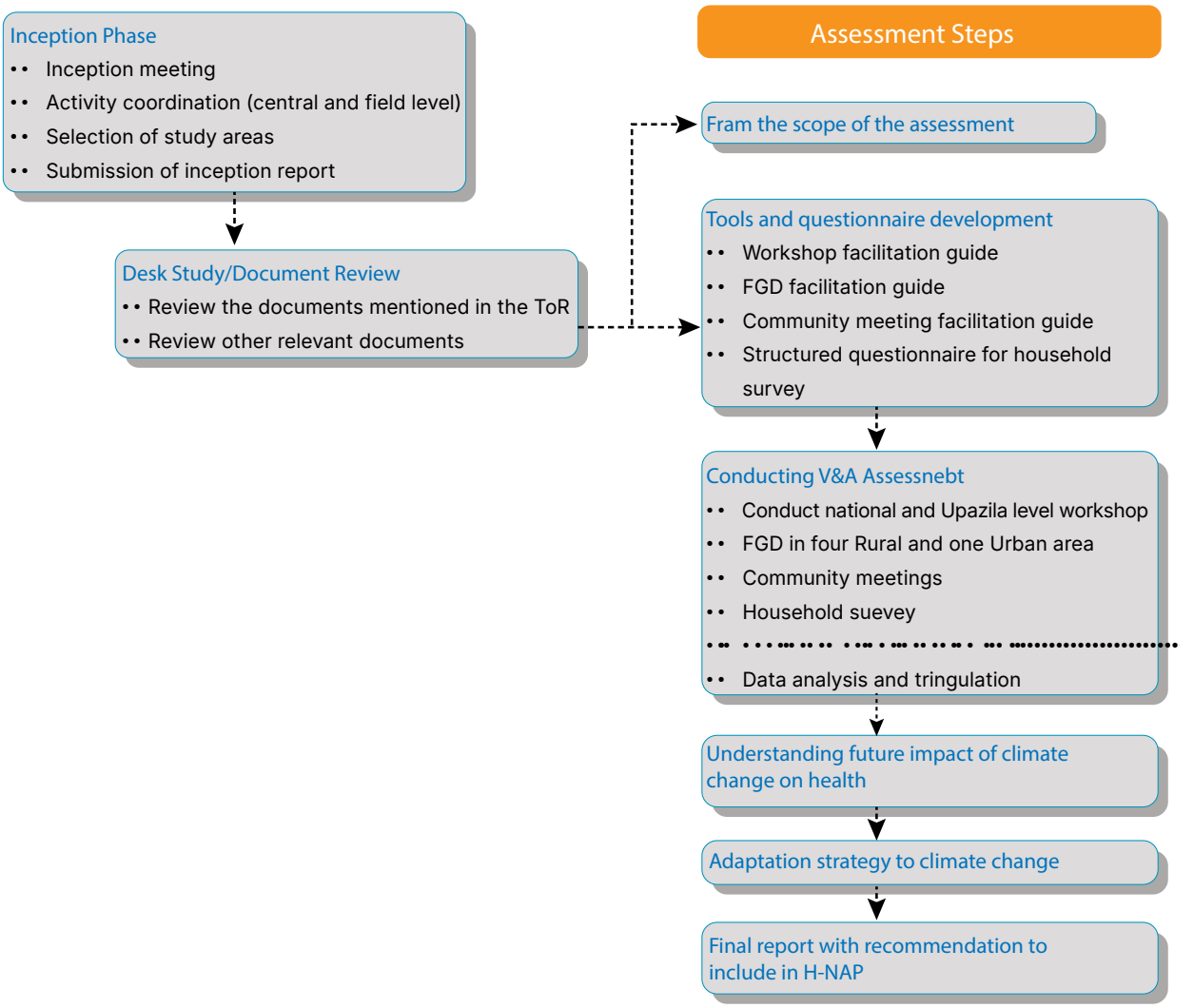


Figure 2. 1 Proposed approach for the V&A assessment

Inception Phase

Inception meeting

An inception meeting with National Professional Officer-WSH of WHO and other stakeholders (invited by WHO) was arranged at the beginning of the study. In the meeting, the work plan, required modification in approach/methodology/ activity, and scope of coordination among the stakeholders were discussed along with other project related issues as needed.

Activity coordination

Coordination among the WHO officials, field level stakeholders and informants, and members of the consultant team were pivotal for successful execution of the project. Therefore, coordination both at central and field levels were ensured through regular communication. During the inception meeting, the actions required to ensure effective coordination were discussed such as progress sharing, meetings, etc.

A. Central Coordination

During the project, the project Team Leader was reporting to National Professional Officer-WSH in all regards (program and financial). The consultant team maintained a close working condition with WHO-PHE, Programme Manager, DGHS, and relevant national agencies throughout the project.

B. Field Coordination

The consultant team worked closely with the health officials in the study areas and the community people. After selection of study areas (Upazila/Union), the consultant team started communication with the health officials and stakeholders in the selected areas.

Criteria for selection of study areas

The study areas were divided into two groups: urban and rural. As urban area, Dhaka city corporation was chosen. For selection of rural areas, the geographic coverage of the study for primary data collection was four climate vulnerable hot spot Unions of four Upazilas under four districts. The four districts were selected from four different areas having different climatic conditions such as:

- Flood-prone area,
- Coastal area,
- Drought-prone area, and
- Hilly area.

Dhaka city corporation was proposed in the inception meeting as the urban area for the study. For selection of the rural areas for the V&A assessment study, a desk-based study was carried out to identify the vulnerable areas. Based on review of historical records of major disasters and climatic effects, the four climate vulnerable areas were selected for the study (Table 2.1). The locations of the study areas are shown in Figure 2.2.

Table 2.1: Summary of the potential study sites considering climatic factors

District	Upazila	Climate Vulnerability (Major)	Year of Major Events
Sirajganj	Ullapara	Flood	1949, 1956, 1961, 1962, 1966, 1968, 1974, 1979, 1987, 1988, 1996, 1998 and 2007
Dinajpur	Birampur	Drought	Moderate- 1992, 1996, 1997, 1998, 2001, 2006, 2009, 2010 Severe- 1992, 1995
Rangamati (Hilly Areas)	Rangamati Sadar	Drought, Flash Flood, Landslides, Cyclones	Drought- 1972, 1982, 1992 and 1994Land-slides-193 events Cyclones- 1991, 2007
Patuakhali (Coastal Area)	Patuakhai Sadar	Cyclone, Flood, Salinity, Coastal Flooding (due to sea level rise)	Cyclone- 1584, 1822, 1876, 1948, 1958, 1960, 1961, 1963, 1965, 1966, 1970, 1977, 1983, 1985, 1986, 1991, 1997, 1998, 2007, and 2009 Flood-1988, 1998, 2007

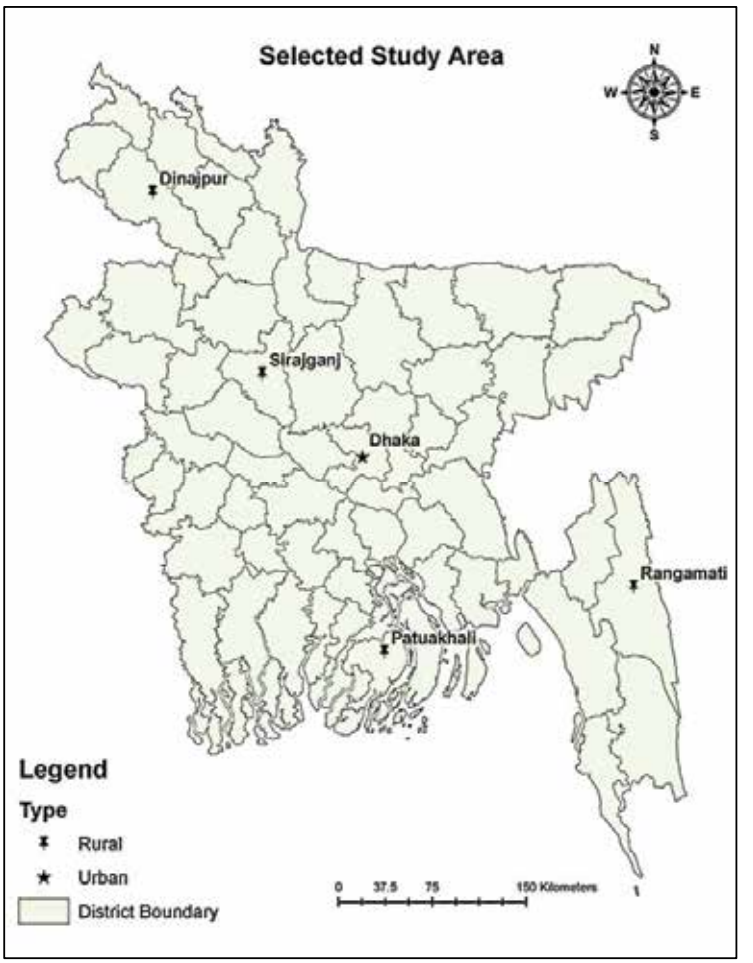


Figure 2. 2: Locations of the selected study areas

Desk Study/Document Review

During the desktop study, following documents were reviewed by the study team to understand the background of the study and current status of health system at both policy and field level in Bangladesh:

- Vulnerability and Adaptation Assessment Report (2011, 2015) of WHO and UNDP
- Health National Adaptation Plan, Bangladesh
- Bangladesh Climate Change Strategy and Action Plan
- National Adaptation Plan for Action (NAPA)
- 1st National Communication on Climate Change
- 2nd National Communication on Climate Change
- National Health Policy
- National Environment Policy
- Annual Health Report of Bangladesh
- Climate and Health Country Profile – 2015, Bangladesh

In addition, different databases for diseases and meteorology were studied. The consultant team reviewed other sectorial and international reports (e.g., V&A study conducted by UNDP in other countries, etc.) to gain further understanding on updating of the vulnerability and adaptation assessment.

Development of Questionnaire/Tools

Apart from collection of secondary data and information for carrying out analysis to fulfill the objectives of the study, primary data was collected through five workshops, five Focus Group Discussions (FGD), five community meetings and household sample surveys, conducted in the selected areas. Questionnaire and tools for these participatory rural appraisal (PRA) processes were prepared corresponding to the objectives of the study. The focus of the tools was to guide the PRA process to collect data/information on climate change and its impact on population, health system, climate sensitive disease, etc. The tools were prepared in a way that facilitated collection of all required data/information from stakeholders as well as communities to achieve the objectives of the study.

The PRA tools that were developed to facilitate the data/information collection for the **Vulnerability and Adaptation (V&A) Assessment** of WHO (2013) include the following:

- Workshop facilitation checklist
- FGD facilitation checklist
- Community meeting facilitation checklist
- Structured questionnaire for information collection from households in the selected Upazilas

Steps of Vulnerability and Adaptation (V&A) Assessment

Vulnerability Reduction Assessment (VRA) is a formation of Participatory Impact Assessment (PIA) which focus on "health decision-makers" perceptions of health vulnerability and adaptive capacity to climate change. In this report, Vulnerability and Adaptation (V&A) Assessment or VAA is designed based on the VRA concept outlined in the guideline of Crane Doesh, A. (2008). Based on the guideline, a questionnaire was developed considering a few indicators that include assessing vulnerability of health and health

system. These questions were placed in the H-form to collect a numerical score of their opinion from the communities on health vulnerability in the five selected study areas (Figure 2.3) against each question.

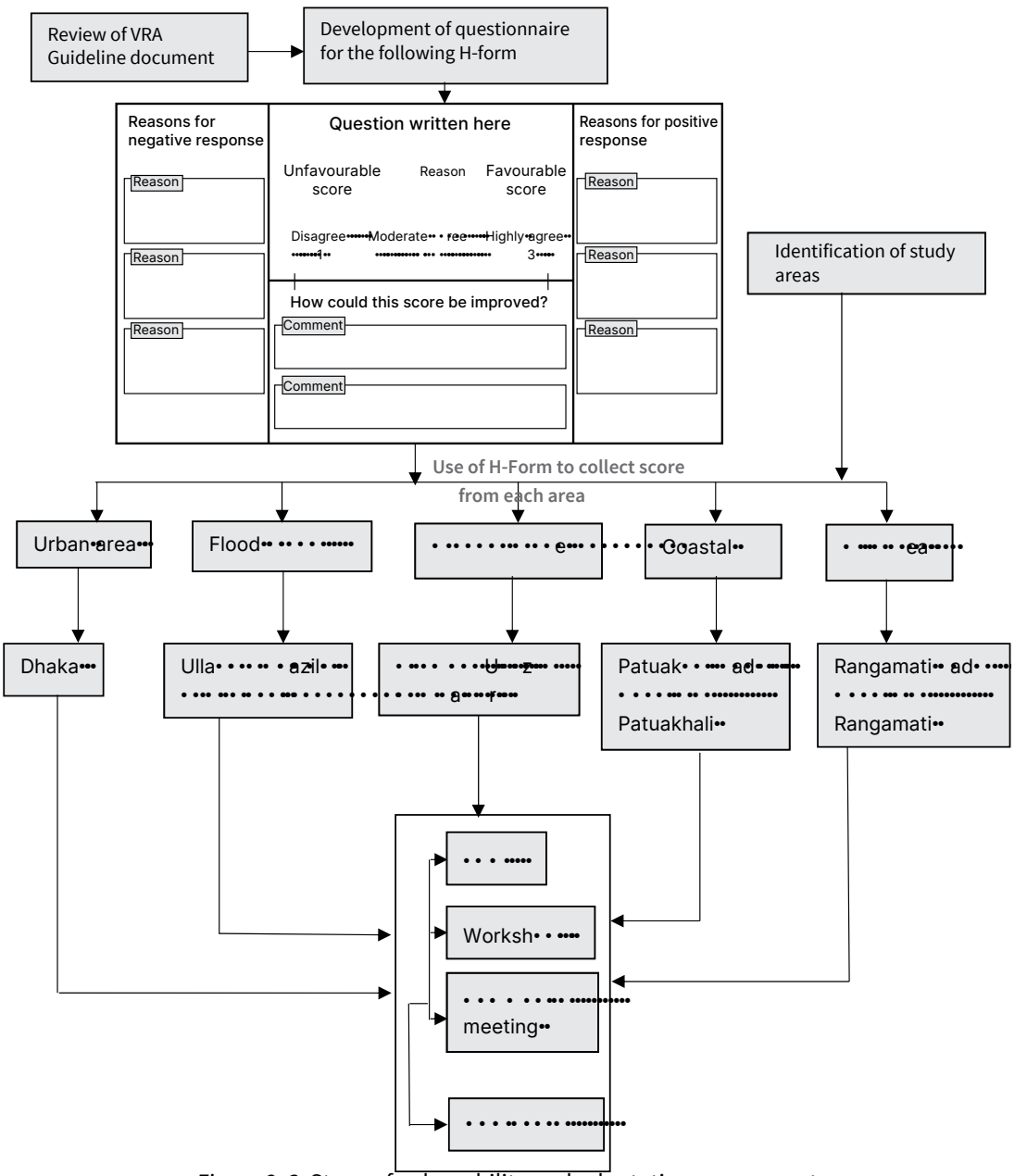


Figure 2. 3: Steps of vulnerability and adaptation assessment

Collection of Data/Information

This section provides details on various methods used for data collection for the V&A assessment.

Secondary data collection

Meteorological data

To carry out climatic analysis, the following data were collected from Bangladesh Meteorological Department (BMD) of nearby BMD weather stations of the study Upazilas:

- Daily temperature records of past 20 years
- Daily precipitation records of past 20 years
- Daily humidity data records of past 20 years

Disease data

Available databases for diseases were used to collect data on health outcomes on climate sensitive diseases in past years. These included (i) MIS, DGHS database (2015-2020), (ii) icddr,b database (2006-2020), (iii) IEDCR database (2015-2020), and (iv) DHIS2 database (2017-2020). Depending on the availability of data, the diseases considered in the study included:

- Water-borne and diarrheal diseases including-diarrhea, cholera, shigella.
- Vector borne diseases- malaria, dengue.

Data collection through PRA Process

A series of workshops, Focus Group Discussions (FGD) and community meetings were conducted, where data/information and other input from the stakeholders were collected to accomplish the goal of the study using the proposed approach and methodology. The list of the events to collect qualitative information from the study areas is provided in Table 2.2.

Table 2. 2: List of workshops, FGD and meetings in study areas

	Urban	Rural
District	Dhaka	Dinajpur, Sirajganj, Patuakhali, Rangamati
Geopolitical boundaries	City Corporations	Unions (outside Municipalities)
Workshops	1 workshop at national level representing different department and policy makers	4 (One Upazila level workshop per district), including district/Upazila/Union levelstakeholders
FGD	1 FGD	4 (Upazila level), with health professionals
Community meetings	1 for residents of Dhaka city corporation (participants were different from national level workshop)	4 (One Union per Upazila)

Each method of qualitative data collection was designed to collect different types of information. Workshops, for example, focused on getting input from the stakeholders on Upazila level health outcomes, policy and programmes, adaptation planning, health risk due to climate change, impact assessment, and how the study could support the H-NAP. The FGDs targeted health professionals at Upazila level where a checklist was used to capture the local level scenarios on health vulnerability. The community meetings were aimed at collecting information and opinions from the local people on climate change and its impact on health sector and public health. When conducting the workshops, FGDs and community meetings, special attention was given to ensure gender balanced participation.

Figure 2.4: Household survey (Location: Rangamati)

Figure 2.5: Focus Group Discussion (Location: Ullapara)

Figure 2.6: Community meeting (Location: Birampur)

Figure 2.7: Multi stakeholder workshop (Location: Patuakhali)

Household survey

The questionnaire survey was used to collect information from the households in the Upazilas, through structured questionnaire, on climate change and its impact on health outcomes, diseases, health system, water, etc. The sample size for each of the study area was estimated by using the following formula:

$$n = N * \frac{\frac{\{[Z^2 * p * (1-p)]\}}{e^2}}{\left[N-1+\left(Z^2 * P * \frac{(1-p)}{e^2}\right)\right]}$$

where,

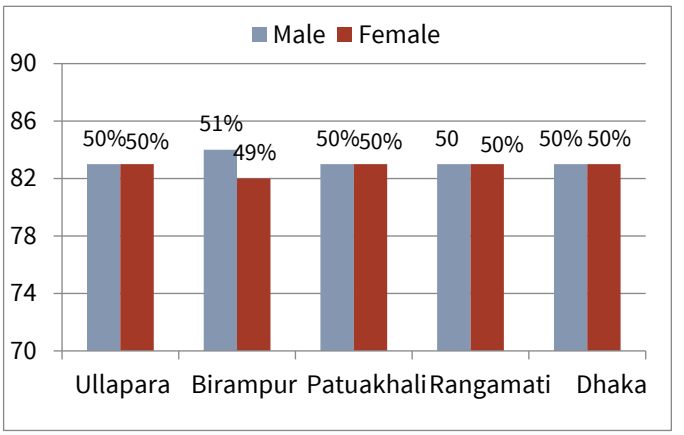
n = required sample size

z = confidence level at 99 percent (standard value of 2.576)

p = estimated prevalence of variable of interest (0.5)

e = margin of error (10%)

N = population size



The total sample size for each of the five areas was estimated at 166, among which 83 were male and 83 were female to get gender disaggregated scenario. In all five study areas, participating households were selected using systematic sampling, in which one person from one household was surveyed. The households were equally distributed among all the wards.

Different income level clusters were selected (e.g., slums, mid-level income community and high-level income community) in the study areas.

After preparing the survey questionnaire, it was pre-tested with a few respondents. Based on the feedback from the pre-test, the questionnaire was modified and then was finalized. In the survey, several types of questions were asked to the respondents to know their knowledge, perception, and practice in terms of diseases they are mostly affected by, health care status, adaptability, and climate change issues. Both open and close ended questions were asked to the respondents. The questionnaire form was divided into 5 different sections, and under each section there were several questions. The questionnaire is attached with this report in **Annex.**

- **Section 1: General information:** In this section, questions were asked about respondent's' age group, education, occupation, household members including number of male and female members in household, average monthly income, member with different kind of disability in household, etc.

- **Section 2: Health and other related issues:** This section includes questions related to any significant illness that members of household were affected during last 5 years, disease that affected male and/or female and specific age group, whether they were hospitalized due to that illness, where the respondents usually get their treatment from and their preferable place to get treated, respondent's annual average healthcare cost, distance of the nearest hospital from respondent's house and their mode of transport to reach there, whether the respondents are satisfied with indoor and outdoor treatment and the reason behind it, etc.

- **Section 3: Climate change and impact on livelihood:** In this section, questions were asked about people's knowledge on climate change, extreme weather events that the respondents have faced, consequences of climate change on health and livelihood, disease caused by impact of climate change on water, etc.

- **Section 4: Extreme event and health perspective:** In this section, questions were asked related to people's perception on influence of extreme weather event on health, extreme weather event that is responsible for specific health problems, information on healthcare expenditure, information on specific group of people that suffer most by extreme weather events, information on any specific illness that have increased during last 5 years, etc.

- **Section 5: Adaptability aspect:** In this section, questions were asked related to respondent's knowledge on what to do to prevent health issues caused by extreme weather event, how the respondents prepare themselves for extreme weather events and its probable effect on health, etc.

To assess existing health system vulnerability and level of preparedness to manage climate sensitive diseases, a few questions were asked during household survey to acquire the apprehension of the participants in different study areas. Thenceforth, the responses were analyzed to measure existing health system vulnerability from the respondent's perspective and their level of preparedness in the study areas. The questions include –

- Where do the respondents usually get treatment from?
- Are the respondents satisfied with the indoor and outdoor treatment related service from the hospital? What is the reason behind their answers?
- Do the respondents think their closest hospital will remain functional in the face of extreme weather events like flood or cyclone? What is the reason behind their answer?
- How far (km) is their house from the nearest hospital? And how long (hour) does it take to get there? Additionally, how do the respondents go there (transport)?
- What is the annual average cost of the respondents for healthcare support to their family?

The collected data from the questionnaire survey was entered in MS Excel for analysis. The findings from the analyses are presented in different sections of the report.

Data/Information Analysis and Triangulation

All data/information collected from secondary sources, PRA processes and household surveys were cleaned and entered in MS Excel for subsequent analysis. The data/information collected through qualitative tools provided the basis for contextual analysis, whereas quantitative data collected from questionnaire surveys, meteorological databases, and disease databases were used to triangulate the findings from the qualitative information.

The collected qualitative data/ information was organized by category and informant group under each output for the respective commune. Then those were summarized based on indicator and informant group. Qualitative data analysis was organized into four steps:

- Preliminary analysis of the findings from qualitative data collection in a separate session,
- Thematic coding of data according to content and specific categories,
- Compiling data by themes to systematically analyze qualitative data, and
- Compiling qualitative observations by themes and selecting issues and appropriate quotations.

The data analysis team analyzed the collected quantitative data from the targeted respondents by segregating the variables in different aspects to address the objectives following the research methodology. Descriptive statistical values included frequency counts, percentage, minimum value, maximum value, and the average, which were calculated to explain the distribution and general characteristics of each commune in the study areas.

To check the consistency of specific and factual data items, the quantitative data collected from questionnaire surveys were triangulated with the qualitative data collected from workshops, FGDs and community meetings. The information from different sources were analyzed and after triangulation, the

findings were used for understanding vulnerability of the areas of interest for the study and setting recommendations.

Limitations of the Study

Some of the limitations of the study has pulled down the study activities, such as, inadequate record keeping system in the hospitals, lack of easy access to existing data, and the situation during the COVID - 19 pandemic. The biggest limitation of this study was the lack of availability of hospital data. We could not find sufficient data for different diseases. To find out the impact of climate change on any sector, more than 10 years of data is required. But in this study, only 4 to 6 years of health data were available in rural areas which are not sufficient to analyze the impact of climate change on these health data. Besides, data of only a few CSDs were available for the study areas. For example, only 4 years (2017 - 2020) of diarrheal data of Ullapara, Birampur, Patuakhali and Rangamati, and 6 years (2015 - 2020) of malaria data of Rangamati have been collected. Moreover, the quality of the collected data of diseases is also a concern since data was missing for a few months.

Another limitation of the study was the extent of survey and structured meetings. We conducted the surveys and undertook the meetings in a few selected areas which may or may not represent the true situation of the whole country. A bigger survey or study might give us a better picture of the situation. The ongoing COVID-19 pandemic was also responsible for the delay and not being able to extend the survey further.

Chapter 3

Climate Change and Perception of Communities

Introduction

Natural and man-made disasters on earth have continued to take a heavy toll on communities in different parts of the world. During the period 2005-2015, over 0.7 million people died, over 1.4 million have been injured and approximately 23 million have been made homeless because of disasters all over the world. In addition, between 2008 and 2012, 144 million people were displaced by disasters (UNISDR, 2015). Overall, more than 1.5 billion people have been affected by disasters in various ways, with women, children, and people disproportionately in vulnerable situations. Natural disasters, many of which are accelerated due to climate change and are reported to increase in frequency and intensity, have substantially encountered the progress towards sustainable development. The exposure of persons and assets in all countries has increased faster than the increase in adaptation capacity, thus generating new risks and a slow rise in disaster-related losses, with a substantial economic, social, health, cultural and environmental adverse impacts in the short, medium, and long term, especially at the local and community levels.

Bangladesh, a South Asian developing country having large floodplain (around 80% of its total area) and a high population density (nearly 1,250 persons/km2 with a total population over 160 million), experiences frequent natural disasters of different kinds. The geographical distribution of the occurrence of natural calamities reveals that the north-eastern, northern, and central parts of the country are highly exposed to flooding, while the low-lying coastal areas are prone to cyclone cum storm surge, tidal surge, and salinity intrusion. The mighty Ganges, Brahmaputra and Meghna (GBM) rivers passing through the country make it highly susceptible to riverbank and coastal erosion and sedimentation process, while thousands of people get displaced as well as new land accumulates every year. The north-western and south-western parts of the country experience seasonal droughts that severely hamper crop production. Alongside, the north-eastern and south-eastern parts of the country are susceptible to earthquakes and landslide disasters. In addition to regular occurrence of these natural calamities, climate change, particularly gradual rise of temperature and resultant impact on erratic behavior of rainfall, is reported to negatively affect different sectors particularly agriculture, infrastructure, public health, etc., putting millions of people in vulnerable conditions. This chapter, based on a review of the existing state-of-the art information, explores the state of the occurrence, frequency and impacts of various natural and man-made disasters along with climate change and its variability in Bangladesh, with particular emphasis on the study areas.

Major disasters in Bangladesh

The major natural and man-made disasters in Bangladesh are flood, riverbank and coastal erosion, drought, cyclone and storm surges, drainage congestion and waterlogging, salinity intrusion, groundwater contamination and depletion, and land slide. In addition to climate change, anthropogenic interventions and unplanned development activities have exacerbated the complexity of these issues.

Floods occur mainly due to the monsoon climatic condition (80% of annual rainfall occurs in 3-4 months) and the country's unique geographical location, confined in the delta of Ganges-Brahmaputra-Meghna (GBM) river basin. The GBM river system is a transboundary river basin, consisting of a total area of 1.7 million km2, shared by India (64%), China (18%), Nepal (8%), Bangladesh (7%) and Bhutan (3%) (FAO, 2011). The three rivers of this system have distinct characteristics and flow through various regions for most of their lengths that is the third largest freshwater outlet to the oceans with mean annual discharge of more than 40,000 m3/sec, being exceeded only by the Amazon and the Congo River systems (Chowdhury & Ward, 2004; Wikipedia, 2021a).

The main causes of floods in Bangladesh are (i) widespread and heavy rainfall in the upstream catchment areas, and (ii) inadequate water carrying capacity of the rivers to contain flood water. Floods hit every year both in the form of flash and seasonal long-stay floods inundating an average of 26,000 km2 or 18% of total areas of Bangladesh (FFWC-GoB, 2019) as shown in Figure 3.1. Since 1954, flood of 1998 was the most devastating when 68% of the country remained under water. Besides, floods of 1988 (with 61% area inundated), and other years such as 2007 (42%), 1987 (39%), 2004

(38%) and 1974 (36%) are remarkable (FFWC-GoB, 2019) (Figure 3.2). Out of all these, 1974 flood is the deadliest in the history of Bangladesh with 28,700 deaths (Wikipedia, 2021b). The most flood affected districts in Bangladesh are Bogura, Faridpur, Gaibandha, Jamalpur, Kurigram, Lalmonirhat, Madaripur, Manikganj, Netrokona, Rajbari, Shariatpur, Sirajganj, Sunamganj and Sylhet (Reliefweb. 2020).

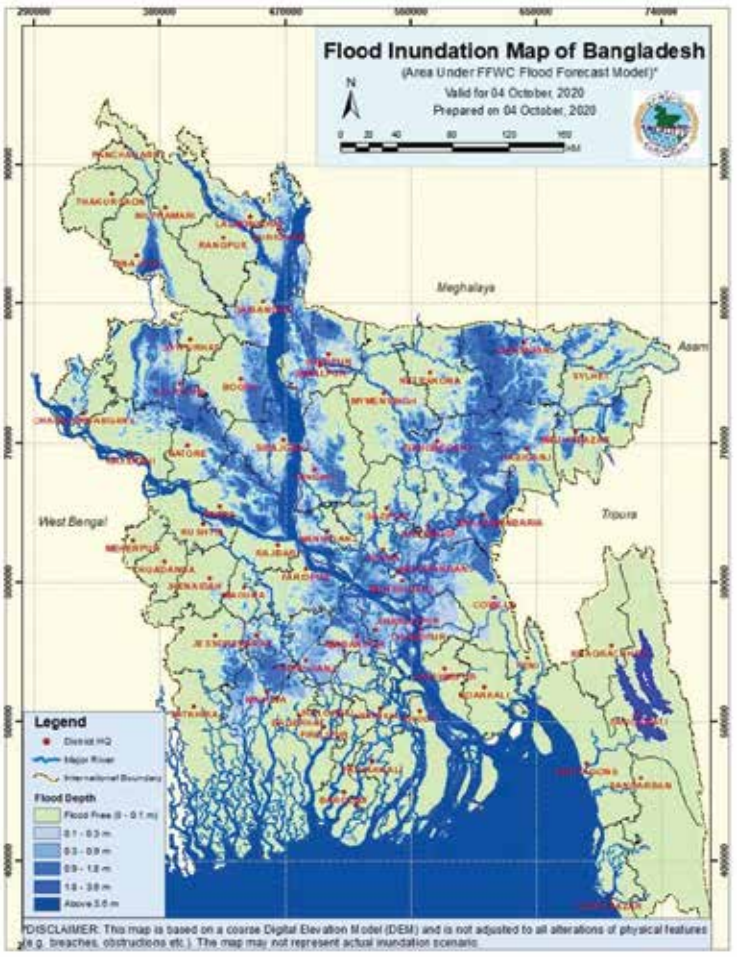


Figure 3.1: Flood depth map of Bangladesh on 4 October 2020 prepared by Flood Forecasting & Warning Centre of Bangladesh; the area inundated in this map is flooded every year (18% area)

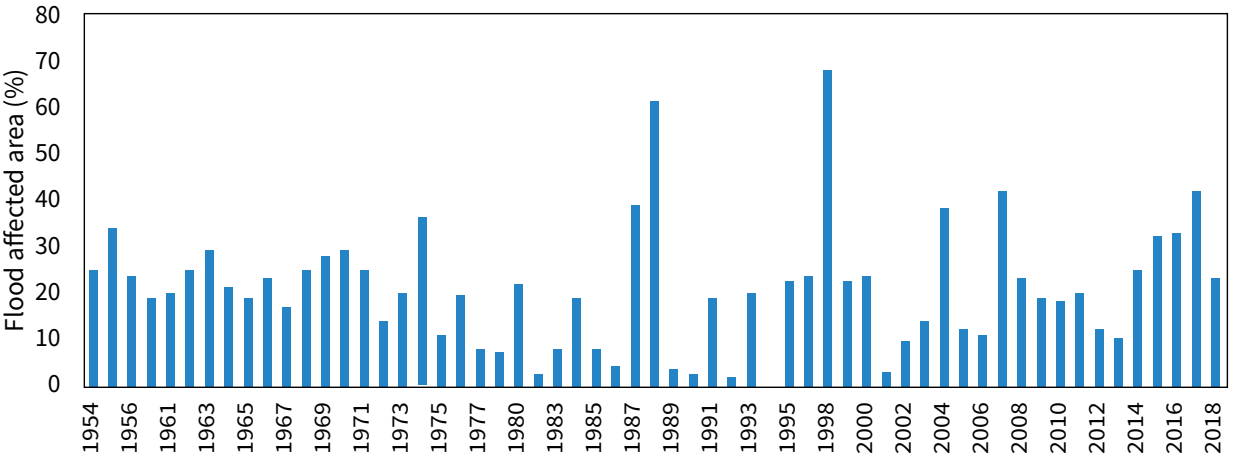


Figure 3.2: Affected area (% of total area of Bangladesh) during each flood in Bangladesh of last 65 years; data used from FFWC-GoB (2019)

Drought is prolonged shortage of water supply to an area that affects ecosystem, agriculture, and people and other living beings in that area. Drought might be of different kinds: meteorological, agricultural, hydrological, socio-economic, and stream health. Droughts occurring in Bangladesh are mainly meteorological and agricultural droughts that could be termed as severe moisture stress. Occurrence of drought as a major water deficiency related issue, is most profound in northwest region that receives the lowest annual mean rainfall in the country. The situation becomes severe during April-May due to cumulative effect of low moisture holding capacity of soils (<200 mm), large number of dry days, and extreme summer temperature of more than 40°C. The northwestern part is the driest part of the country with recurrent below-average rainfall which leads as drought-prone regions (Dinajpur, Rangpur, Pabna, Rajshahi, Chapai Nawabganj, Bogura, Joypurhat and Naogaon district) (Habiba et al. 2013). Past droughts have affected 47% of the country by area, while about 53% by population as out of past 50 years (1960 – 2010). 12 severe drought events hit most of the locations of Bangladesh in the years of 1963, 1966, 1968, 1973, 1977, 1979, 1982, 1989, 1992, 1994-1995, 1999, and 2006 (Alamgir et al., 2015). About 5.46 million

hectares of land have been estimated as drought affected area of Bangladesh (MoEF-GoB-IUCN, 2005) in various parts of the country as shown in Figure 3.3 (adapted from Kamruzzaman et al., 2019).

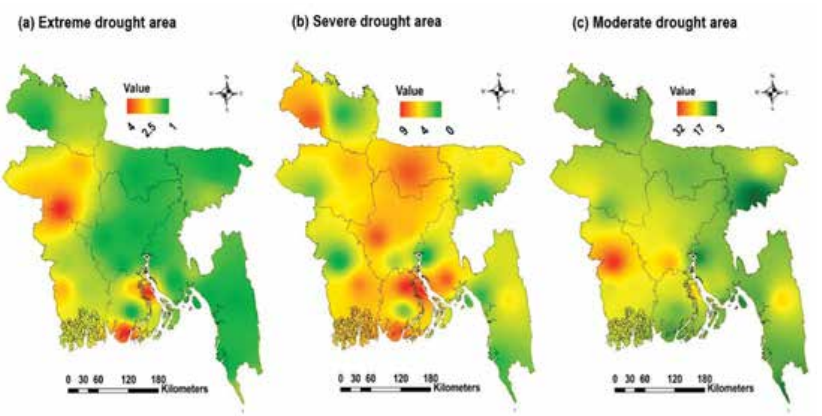


Figure 3.3: Spatial pattern of the averaged drought frequency during 1981 – 2015: (a) Extreme; (b) Severe; (c) Moderate severities (Kamruzzaman et al., 2019)

The entire southern coastal area of Bangladesh is exposed to severe and devastating cyclones along with storm surges that usually hit during pre- and post-monsoon causing loss of lives and properties (Figure 3.4). The most cyclone affected districts are Khulna, Patuakhali, Barishal, Noakhali and Chattogram (Reliefweb. 2018). The cyclone in 1970 at greater Barishal caused nearly 300,000 deaths while similar cyclone Sidr in 2007 took 3,406 lives. The cyclone preparedness has improved nowadays, which can be credited to improved cyclone warnings, more cyclone shelters, awareness building and high disaster risk management capabilities. After Sidr, the Comprehensive Disaster Management Programme was launched by the government to address all major hazards and to develop ways for disaster management in Bangladesh.

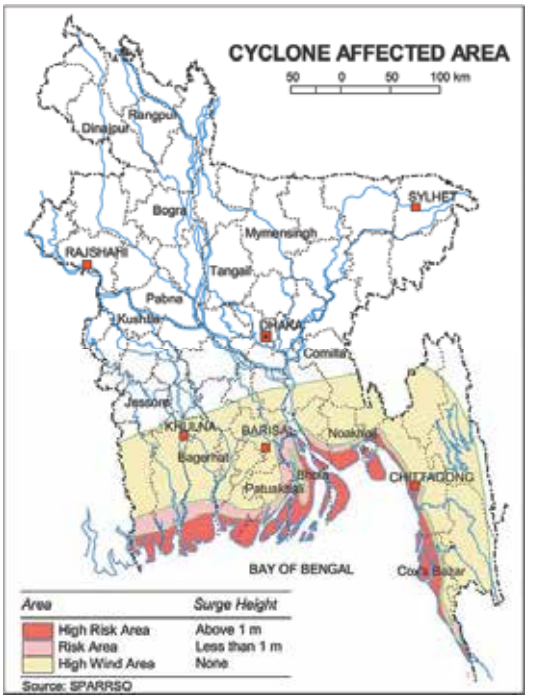


Figure 3.41: The cyclone affected area of Bangladesh

Riverbank and coastal erosion is an endemic and recurrent natural hazard in Bangladesh. When mighty GBM rivers enter the mature stage with huge sediments, they become sluggish and meander or braid that cause massive riverbank and coastal erosion and accretion process. During the monsoon, extensive overbank spills, bank erosion and bank line shifts are typical. Every year, millions of people are affected by erosion that destroys standing crops, farmland and homestead land affecting rural floodplain population, urban growth centers and infrastructure. It is estimated that about 5% land of Bangladesh is directly affected by erosion covering 94 out of 489 Upazilas of the country (Banglapedia, 2015). For the inland, the erosion and accretion of riverbank during 1973-2015 were 1,820 and 800 km2 respectively (GED-GoB, 2018b), while for coastal area, it was 1,448 km2 and 2,816 km2 respectively during 1973-2016 (Hassan et al., 2017). The most erosion prone districts are Bogura, Sirajganj, Kurigram,Lalmonirhat, Gaibandha, Rangpur, Jamalpur, Tangail, Rajbari, Manikganj, Shariatpur, Faridpur, Chandpur, Patuakhali, Bhola and Noakhali (Reliefweb, 2019). The riverbank and coastal erosion of the major rivers in Bangladesh is shown in Figure 3.5.

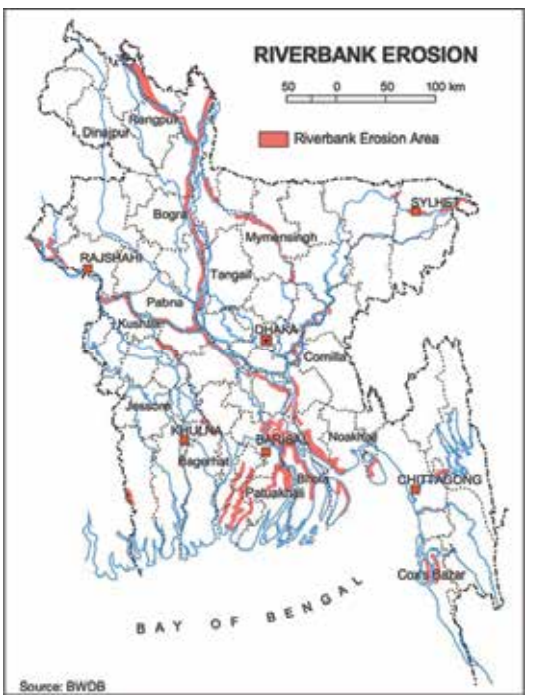


Figure 3.5: Major riverbank erosion-prone areas of Bangladesh

Waterlogging is a major issue in large parts of the coast, especially in the southwest (Satkhira, Jashore, Khulna and Bagerhat) and southeast (Noakhali and Feni) coastal areas. These areas are characterized by numerous morphologically active tidal rivers which are the main drainage network for coastal polders and low-lying wetland. Both tidal and upstream flow contains large quantity of sediment in the rivers. Before constructing polders in early 1960s and 1970s, major parts of incoming sediment deposited naturally in low-lying depression areas. Due to the reduction of dry season upstream flow in Ganges River and tidal flow from the Bay of Bengal, sedimentation process increased in the riverbeds outside the polder system that creates drainage congestion in these areas.

Groundwater resources of Bangladesh is facing various challenges in many areas in terms of both quality and quantity. Large-scale groundwater abstraction from deep aquifers could eventually result in contamination of deeper fresh and safe groundwater by inducing downward flow from high-arsenic and saline regions (GED-GoB, 2018c). Moreover, with increasing demand on groundwater supplies, urban as well as rural Bangladesh have started facing water scarcity including drying up of wells during peak irrigation period due to continuous lowering of water table. This demand of water use has largely been increasing to meet planned irrigation, domestic and industrial needs in Bangladesh. In the drought prone area of High Barind Tract, BMDA's large-scale groundwater irrigation for last four decades caused decline of groundwater table significantly. In Dhaka, permanent declining trend of groundwater table is observed due to excessive withdrawal for city and industrial water supply.

Landslide is the process of displacement of soil and rocks on slopes and is one of the most common natural hazards in many mountainous areas, which greatly affect the social sustainability of human beings (Formetta et al., 2014; Jeong et al., 2017; Lee et al., 2017). Increases in pre-monsoon rains (7-8%) and monsoon rains (5-7%) (Ullah et al. 2017) could lead to a substantial rise in landslide incidence. The period of elevated landslide risk will lengthen because of increased pre-monsoon rain in April and May, which will cause soil moisture to build up sooner and may lead to a significant number of landslides if soils are near saturation.

Landslides occur almost every year but the severity of 2007, 2010 and 2017 landslides made them some of the worst occurring years. The landslides of June 2007 killed 135 people and affected 1.5 million people when heavy monsoon rainfall, intensified by a strong storm from the Bay of Bengal, caused abnormal precipitation in the landslide area (BBS, 2015). It was reported that during the landslides of June 2017, 80,000 people were affected, while the most affected districts were Chattogram, Rangamati and Bandarban. Among these affected people, 42,000 were considered severely impacted as their homes were destroyed. The landslide susceptible locations in the country are shown in Figure 3.6.

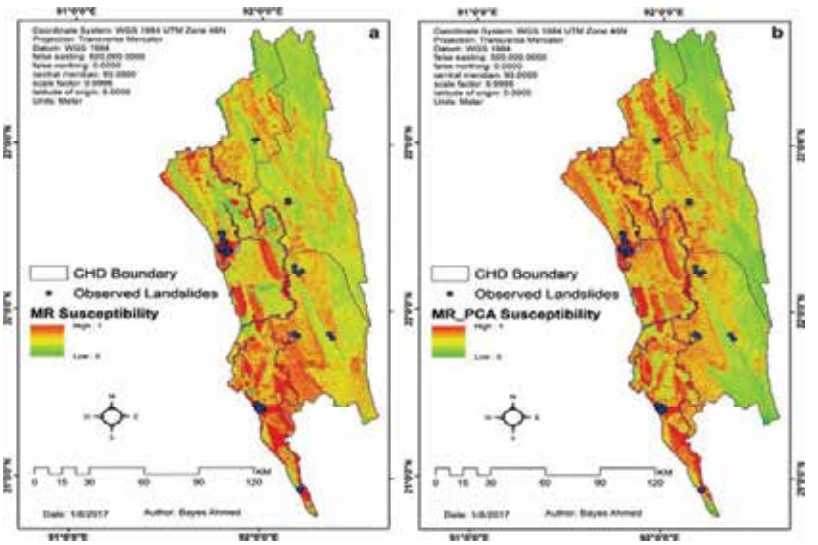


Figure 3.6: Landslide susceptibility map of the Chattogram hill districts (CHD) by applying (a) multiple regressions (MR) and (b) combined MR and principal component analysis (PCA) methods. (Source: Ahmed, 2017)

Lightning strike was declared as a disaster by Bangladesh Government in 2016. Holle and Islam (2017) documented 81 lightning-caused fatalities as reported in the media on 12 and 13 May 2016 with 153,621 and 242,570 strokes respectively detected over land mass (Figure 3.7). In recent years, lightning strike has become a major threat in almost all corners of the country.

Climate change and variability

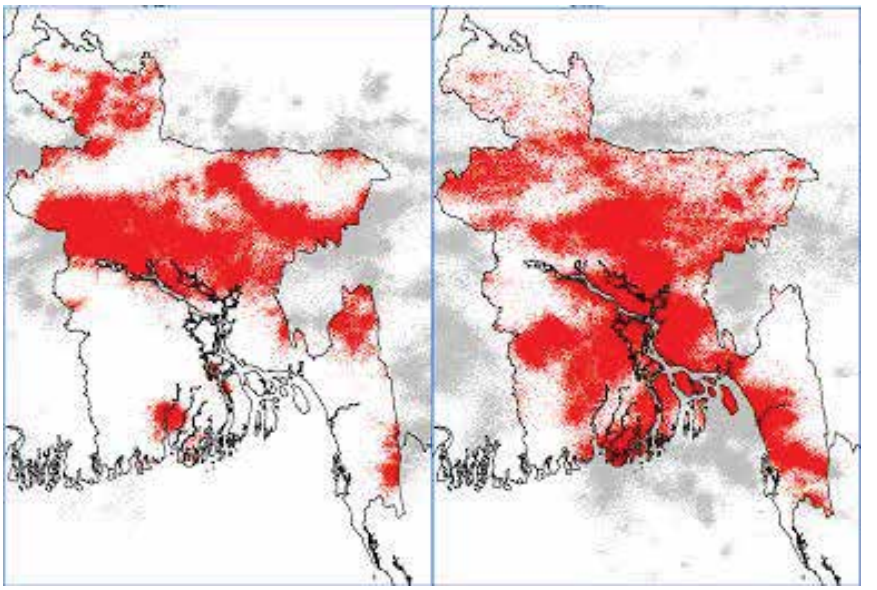


Figure 3.7: Locations of lightning strokes detected by Vaisala's Global Lightning Dataset on 12 May 2016 (left) and 13 May 2016 (right). [Source: Holle and Islam, 2017)]

Climate change is the long-term alteration of temperature and typical weather patterns in a place, which often overburdens the existing major disasters and increases the difficulty in their management. The Fifth Assessment Report of Intergovernmental Panel on Climate Change (IPCC, 2013) assessed the global mean combined land and ocean surface temperature increase of 0.85°C during 1880-2012 while projected a further rise of 1 - 3.7°C global mean by the end of this century. Due to continuous increasing of temperature, the Sixth Assessment Report of IPCC focused on a special issue for 1.5°C temperature (IPCC, 2018). According to IPCC (2014), climate change is likely to increase the frequency and intensity of drought at regional and global scales, and the increasing frequency and intensity of extreme rainfall is expected which may lead to severe flood events throughout the 21st century.

In spite of being a monsoon-dominated region, a noticeable regional variability in rainfall and temperature is observed in Bangladesh (Khan et al. 2019). There is an indication of increase of rainfall during pre- monsoon and monsoon while decrease in dry period (Figure 3.8). On an annual basis, rainfall is expected to increase in most regions by 2030 while by 2050 southern and eastern hilly parts may get reduced rainfall. Figure 3.9 shows that Bangladesh is also going to see more variability and erratic nature in day and night temperature in future due to increasing temperature.

The projection suggests that the extent and frequency of flood will increase in all areas of Bangladesh by 2050 while both banks of Brahmaputra River will severely be affected. Although the government interventions in Barind and similar drought-prone areas with irrigation transformed the area into an agrarian green field with diversified agriculture to lowering poverty, yet the drought risk may increase further due to climate change, surface water reduction from diversion of river water upstream, and continuous lowering of

groundwater table. Changes in the river flow and sediment transport due to multi- faceted impacts of climate change are expected to increase the dynamics of mighty rivers even more (Haque et.al., 2021).

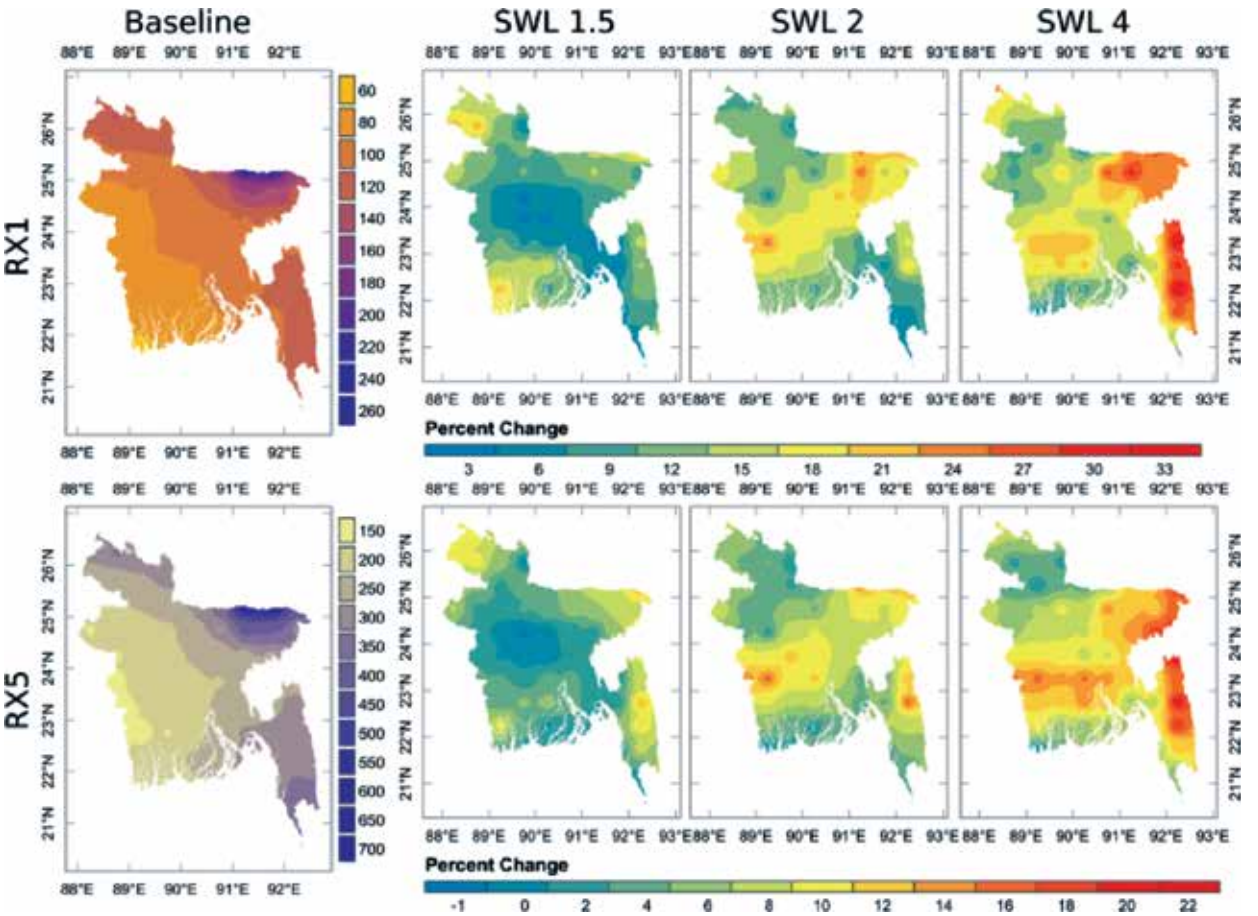


Figure 3.8: Spatial distribution and percentage change in 1-day (RX1) and 5-day maximum rainfall (RX5) [adapted from Khan et al. (2020)] (SWL = Specific Warming Level)

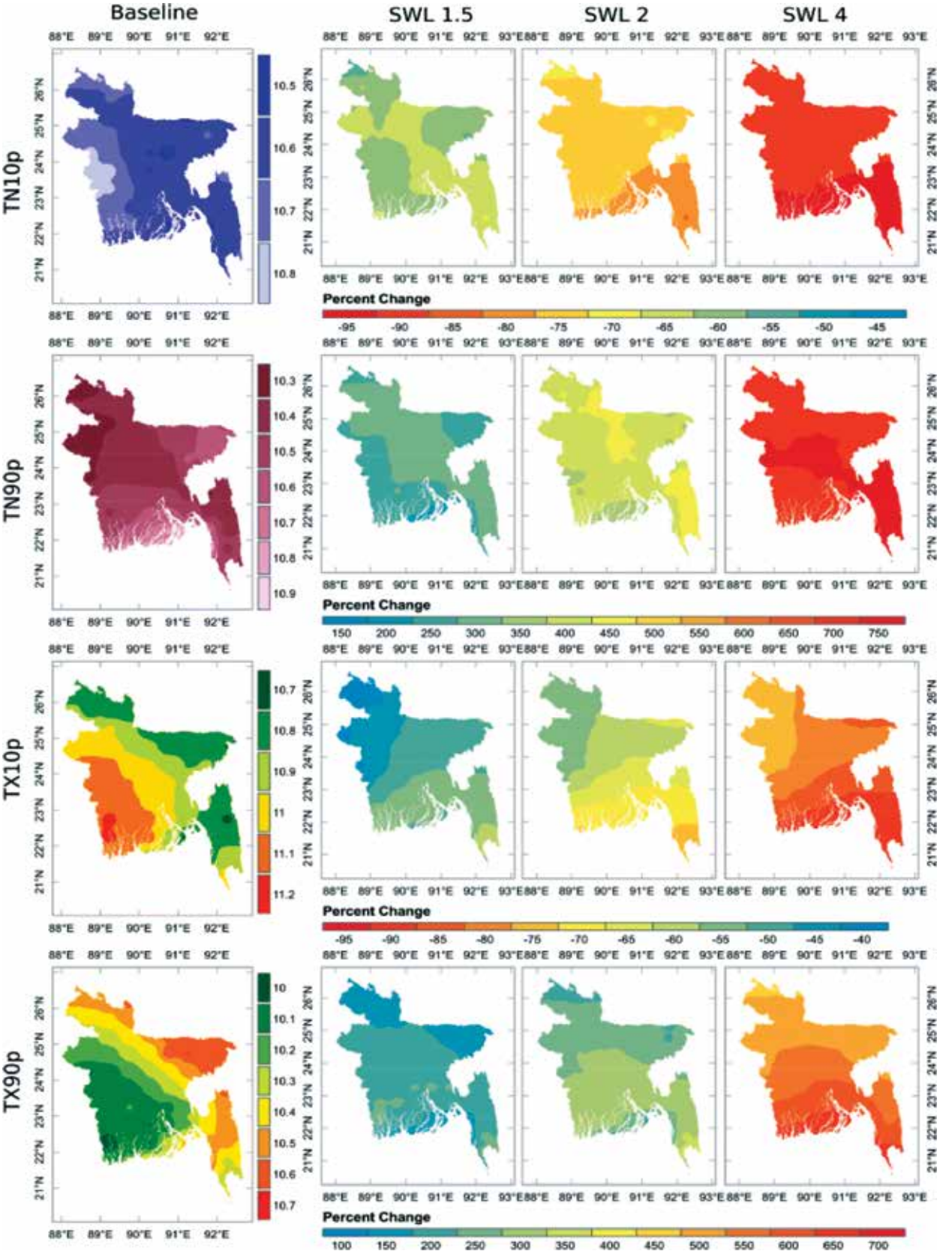


Figure 3.9: Spatial distribution and percent change in cold nights (TN10p), warm nights (TN90p), cold days (TX10p), and warm days (TX90p) [adapted from Khan et al. (2020)]

Sea level rise and consequently, salinity intrusion are the most prominent issues now in coastal areas of Bangladesh for its complex geographical position. IPCC (2013) predicts sea level rise from 0.2 to 1 meter for low to high emission scenarios by 2100 for the Bay of Bengal (Figure 3.10). The rising sea level impedes fresh water availability in coastal area expediting intrusion of salinity front both in surface and groundwater (Akter et al., 2019). Projections suggest that the present (2005) 1 ppt and 5 ppt salinity lines will encroach from 10% and 16% area of the country to 17.5% and 24% area of the country, respectively, by 2050 in extreme climate scenario. Climate change impact on future cyclonic storm surge and related coastal floods will likely become more severe as future tropical cyclones increase in intensity. In the extreme climate scenario, the areas with inundation depth more than 1 and 3 meter would be 14% and 69% higher than the baseline (2005) (GED-GoB, 2018a).

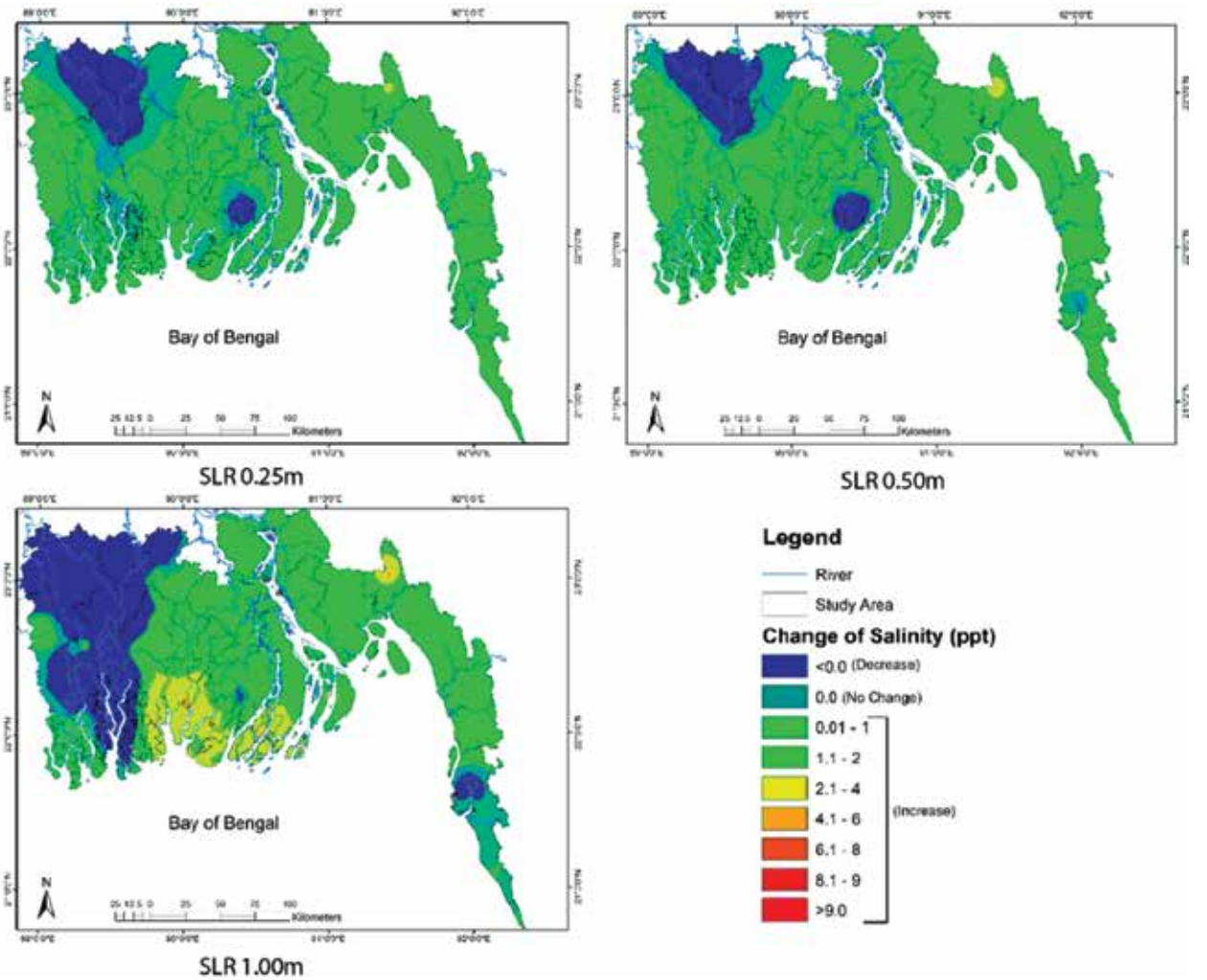


Figure 3.10: Change of salinity magnitude for sea level rise (0.25, 0.50, 1.00 m) [adapted from Akter et al. (2019)]

The climate change may have vast adverse impacts on the country's development in all the sectors and result in substantial losses. The most vulnerable sector is agriculture where high temperature and erratic rainfall reduce yields of high yielding varieties of Aus, Aman and Boro rice with the increase of incidence of insect pests, diseases, and microorganisms. Projection shows about 17% decline in overall rice production and 61% decline in wheat production by 2050 comparing baseline (2005). Other highly vulnerable sectors are forestry and ecosystem due to sea level rise, higher temperature, and increase of cyclone intensity damaging forest resources and putting pressure on many climate-sensitive species. World's largest mangrove forest, the Sundarbans with its diverse ecosystem, is extremely vulnerable to climate change due to sea level rise and salinity intrusion (Goosen et al., 2018).

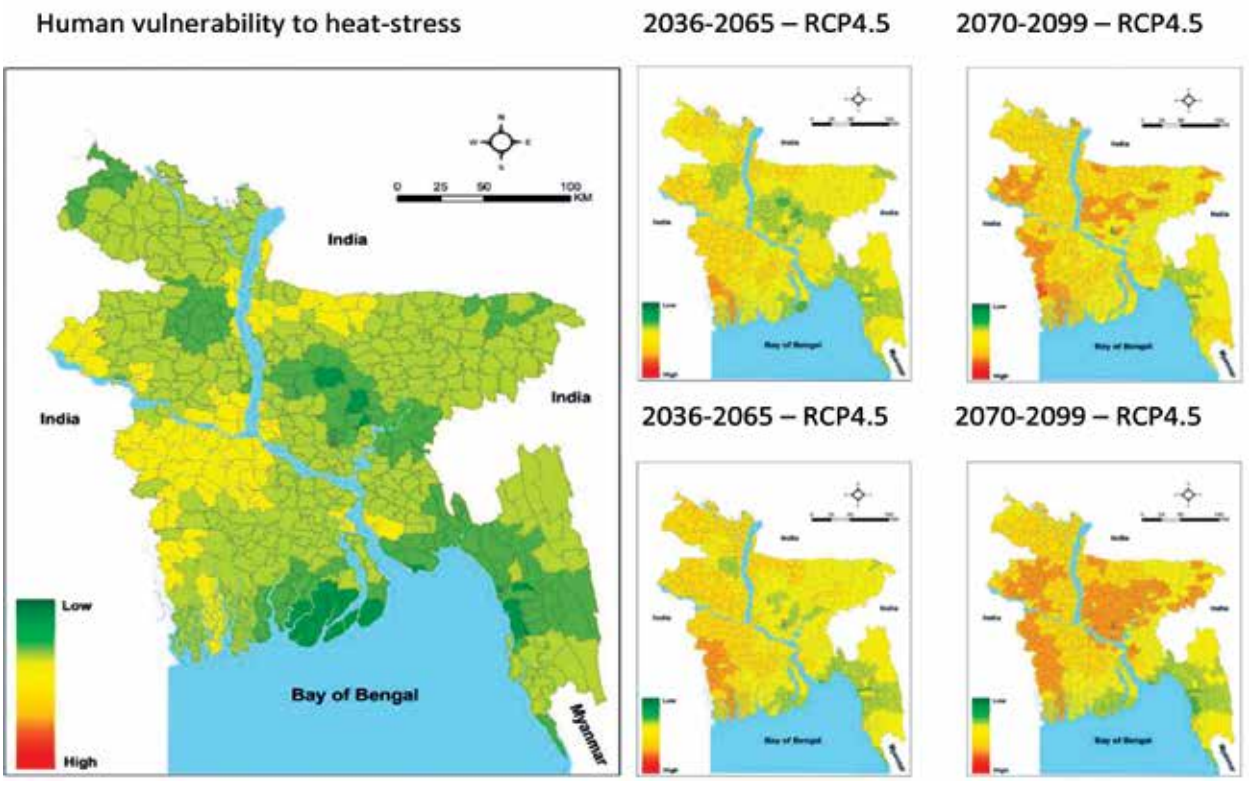


Figure 3.11: Assessment of the evolution of human vulnerability to increase in heat-stress in the future (Goosen et al. (2018)

Goosen et al. (2018) evaluated the human vulnerability to extreme heat under the moderate and extreme scenarios (Figure 3.11), based on climate change model-based future projections of exposure. The projection indicates that the northwest region of Bangladesh, the central southwest, and areas adjacent to Dhaka city may experience high levels of heat stress in future, especially in 2085, while the rest of the country may face relatively moderate and low levels of heat stress.

Climatic variability in selected study areas and local level perception

The study areas selected for the report represents five different types of climatic zones: flood prone (Ullapara Upazila under Sirajganj district), drought prone (Birampur Upazila under Dinajpur district), cyclone prone (Patuakhali Upazila under Patuakhali district), hilly area (Rangamati Upazila under Rangamati district), and urban center (Dhaka City Corporation). This section discusses the climatic variability in the selected study areas based on available meteorological data and literature. In addition, the perception of local people and their understanding of climate risks in their respective areas are also discussed.

During the household (HH) survey, FGD (focus group discussion), MSW (multi-stakeholder workshop) and CM (community meeting), various questions were asked to the participants to learn their perception on climate risks. According to household survey, perceived climate change and variability in five study areas for various extreme weather events that led to diseases or health problems in the communities are summarized in Table 3.1. The other primary data collected through FGD, MSW and CM depicted quite similar information of community's perception on climate change and its variability as shown in Table 3.2.

Table 3.1: Community's perception of climate change and variability according to the household survey (n=166 at each of five study areas)

Extreme events	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Increase of summer temperature	22 (13.3%)	50 (30.1%)	89 (53.6%)	15 (9.0%)	25 (15.1%)
Decrease of winter temperature	3 (1.8%)	14 (8.4%)	49 (29.5%)	10 (6.0%)	10 (6.0%)
Increase of irregular rainfall	20 (12.0%)	67 (35.5%)	102 (61.4%)	16 (9.6%)	18 (10.8%)
Increase of drought occurrence	4 (2.4%)	96 (57.8%)	5 (3.0%)	1 (0.6%)	10 (6.0%)
Increase of flood occurrence	23 (13.8%)	9 (5.4%)	8 (4.8%)	2 (1.2%)	8 (4.8%)
Increase of famine occurrence	1 (0.6%)	0	0	0	3 (1.8%)
Sea level rise	1 (0.6%)	1 (0.6%)	4 (2.4%)	0	1 (0.6%)
Increase of salinity intrusion	1 (0.6%)	0	50 (30.1%)	0	5 (3.0%)
Change of seasonal pattern	9 (5.4%)	3 (1.8%)	27 (16.3%)	13 (7.8%)	24 (14.5%)

Table 3.2: Climate change effect mentioned in FGD (focus group discussion), MSW (multi-stakeholder workshop) and CM (community meeting)

Study Areas	Ullapara			Birampur			Patuakhali			Rangamati			Dhaka		
Sources of Information	FGD	MSW	CM	FGD	MSW	CM	FGD	MSW	CM	FGD	MSW	CM	FGD	MSW	CM
Increase of summer temperature	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Decrease of winter temperature	√	√	√	√	√		√	√	√	√	√		√	√	
Shortening of winter duration						√			√	√	√	√			√
Increase of heat wave	√	√		√	√		√	√					√	√	√
Study Areas	**Ullapara**			**Birampur**			**Patuakhali**			**Rangamati**			**Dhaka**		
Sources of Information	FGD	MSW	CM	FGD	MSW	CM	FGD	MSW	CM	FGD	MSW	CM	FGD	MSW	CM
Massive change of rainfall pattern	√	√		√	√		√	√	√	√	√	√	√	√	√
Increase of humidity	√	√		√	√		√	√		√	√		√	√	√
Increasing frequency of flood	√	√						√							
Increasing intensity of flood	√						√								
Increase of cyclones							√	√							
Increase of saltwater intrusion							√	√							
Increase of river erosion	√	√		√	√		√	√							
Drying up rivers, lakes, canals and small fountains in mountains		√		√	√			√		√	√		√	√	
Increase of land slide										√	√				
Increase of lightning and thunder strike	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Increase of water logging										√	√		√	√	√
Increase of hailstorm			√			√			√						

Ullapara (flood prone area)

Ullapara Upazila under Sirajganj district of Bangladesh was selected as a flood prone area in this study. Sirajganj experience regular annual flooding during monsoon (June-September). The floods in recent years are changing their patterns, both in frequency and severity. For instance, devastating floods (>30% area of the country inundated) hit 7 times in 50 years (during 1954-2013) while hit 5 times in last 7 years (during 2014-2020). The most recent floods in 2020 and 2019 have some remarkable characteristics in comparison with major floods in recent past (e.g., 1988, 1998, 2004 and 2007). 2020 Flood started earlier than usual (late June). It lasted for more than 60 days in some areas which is the longest after 1998 flood. At Bahadurabad (Jamalpur, 90 km upstream of

Sirajganj), the Jamuna flowed at 21.16 and 20.79 m above sea level in 2019 and 2020 respectively that both broke the earlier highest flood level of 20.62 m recorded in 1988. The normal recovery cycle after a disaster is 3-5 years but due to back-to-back disaster, this recovery cycle was hampered for this area. The impacts of floods occurred in 2020 and 2019 are shown in Table 3.3.

Table 3.3: Impact of floods of 2020 and 2019

Particulars	Flood in 2020[1]	Flood in 2019[2]
Districts affected (out of 64)	33 (37% area of the country inundated)	28 (31% area of the country inundated)
Lives lost (died)	257	114
People affected directly (inundated their houses)	5.5 million	7.6 million
Household inundated and damaged	1.06 million	0.6 million
Household displaced	211,859	300,000
Crop damage	83,000 hectares	532,000 hectares

Figure 3.12 shows the monthly variation of rainfall and maximum temperature during 2009 – 2020 at Sirajganj station of BMD. Mean annual rainfall of 12 years (2009-2020) at Sirajganj is 2,760 mm of which 74% (2,050 mm) occurs in monsoon (June – September). Sirajganj's annual rainfall is quite larger than the annual mean of the country (2,200 mm) that may be linked to occurrence of floods due to local rainfall in addition to upstream river flow. High rainfall of 2020 might be linked to flood occurred as the monthly rainfall was more than 1,200 mm. Monthly maximum temperature in Sirajganj reaches frequently above 38°C (>38°C) that corresponds to medium heat wave set by BMD. From the household survey, we can find (Table 3.1) that 13.8% of total participants agreed to increase of the flood occurrence in recent years while similar response was received during the FGD and MSW.

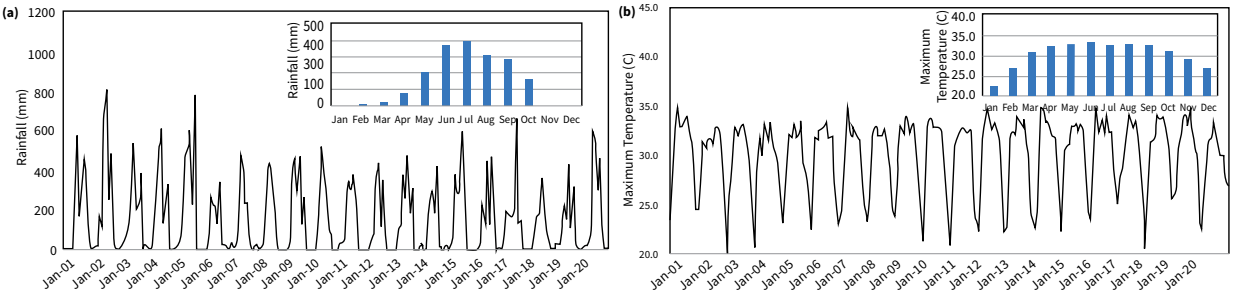


Figure 3.12: (a) Monthly rainfall and variation (index); and (b) monthly-mean maximum temperature and its variation (index) at Sirajganj BMD station during 2009 – 2020

[1] Source: https://reliefweb.int/report/bangladesh/bangladesh-monsoon-floods-final-report-n-mdrbd025
[2] Source: https://reliefweb.int/report/bangladesh/bangladesh-monsoon-floods-2019-final-report-n-mdrbd022

Among the respondents of household survey, 54% (90 HHs) said that they are aware of climate change, and they mentioned that children suffer most from climate change related health impacts. Among these households, 49 respondents (30%) suffered from flood event during their stay in the locality (Annex 1).

Respondents reported different types of changes occurred due to climate change, which are increase of temperature and rainfall, increase of frequency and intensity of floods, and changing of seasonal pattern (Table 3.1).

According to Focus Group Discussion (FGD), multi-stakeholder workshop and community meeting, all respondents mentioned that not only the temperature in summer is increasing but the duration of summer is also prevailing longer than before. The respondents also reported about very cold period during winter for a few days, and the massive change in rainfall pattern (Table 3.2). They also mentioned about the increase of lightning and thunder strikes recently in this area.

Birampur (drought prone area)

Birampur Upazila of Dinajpur district of Bangladesh was selected as a drought prone area in this study. This area receives low annual rainfall (1,845 mm, while Bangladesh average 2,200 mm) of which 73% (1,354 mm) occurs in four months (June – September) of the year. Figure 3.13 shows the monthly rainfall and maximum temperature of Dinajpur station of BMD during last 20 years (2001 – 2020). From the figure, it can be observed that there is a declining trend of monsoon rainfall (June – September) in some years while an increasing trend of summer temperature (April – September). There is a large change (19% decline) observed if decadal rainfall is compared (2,035 vs. 1,655 mm during 2001-2010 and 2011-2020, respectively). Maximum temperature increased by 0.2°C during decade of 2011-2020 compared to 2001- 2010 while by 0.3°C during Summer (April-September). Respondents of household survey mentioned about different types of changes occurred due to climate change in this area, which are increase of summer temperature, decrease of temperature in winter, sudden rainfall, decrease of average rainfall, more intense and longer droughts, and change of seasonal pattern (Table 3.1).

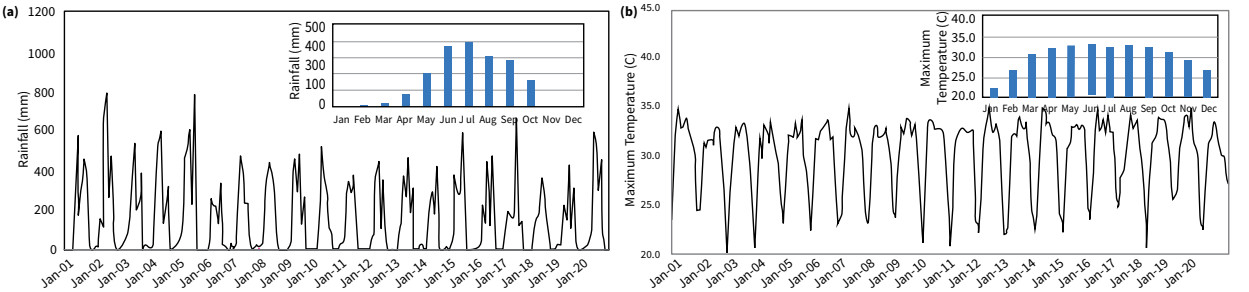


Figure 3.13: (a) Monthly rainfall and variation (index); and (b) monthly-mean maximum temperature and its variation (index) at Dinajpur BMD station during 2001 – 2020

According to Focus Group Discussion (FGD), multi-stakeholder workshop and community meeting, all respondents mentioned about the increase of temperature in summer, increase of number of thunder

strikes, and the sudden decrease of temperature for a short period in winter (Table 3.2). They also mentioned about the massive change in rainfall pattern in the last year as the annual average rainfall of Dinajpur is 1,600 – 2,000 mm but in 2020, it rapidly increased up to 3,028 mm.

Patuakhali Sadar (coastal area)

Patuakhali, selected as a cyclone and storm-surge prone coastal area, experiences frequent cyclones along with stormsurges that caused damage to both lives and livelihoods of people in this area. Figure 3.14 shows the monthly rainfall and maximum temperature of Patuakhali BMD station, where mean rainfall is 2,388 mm per year, of which 74% (1,769 mm) occurs in monsoon (June - September). The decadal rainfall has declined by 17% (2,613 vs. 2,163 mm during decades of 2001-2010 and 2011-2020) in the last decade compared to the previous one. The maximum temperature increased by 0.2°C during decades of 2001- 2010 and 20112020, which was supported by the findings from the household survey.

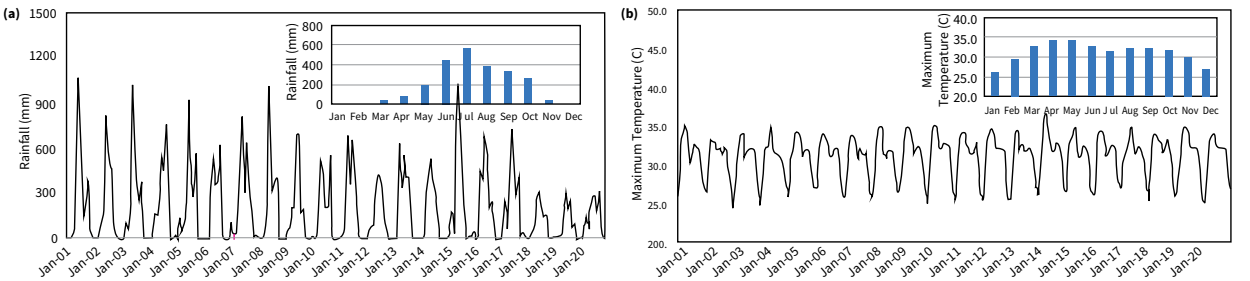


Figure 3.14: (a) Monthly rainfall and variation (index); and (b) monthly-mean maximum temperature and its variation (index) at Patuakhali BMD station during 2001 – 2020

Among the respondents of household survey, 106 households (64%) faced flood, 81 households (49%) faced cyclone and tidal surge during their stay in the locality (Annex 1). Respondents of the household survey mentioned about different types of changes occurred due to climate change, which are increasing of temperature, intense rainfall, sudden decrease of temperature in winter, decrease of average rainfall, increase of flood events, also change of seasonal pattern (Table 3.1). According to community meeting, respondents mentioned that “duration of winter has been shortened, previously the winter season was from October to February, but now winter is only 1-1.5 months long (December - January)”. In the Focus Group Discussion (FGD), multi-stakeholder workshop and community meeting, most of the respondents mentioned about the increase of temperature in summer, decrease of temperature for a short period in winter, massive change in rainfall pattern, and thunder strike (Table 3.2).

Rangamati Sadar (hilly areas)

Rangamati, selected as a hilly area, receives heavy rainfall (2,602 mm per year), of which 73% (1,904 mm) occurs during monsoon (June – September) that triggers land slide in the hilly areas. Figure 3.15 shows the monthly rainfall and maximum temperature at Rangamati BMD station. It can be observed that monthly rainfall is nearly 1,200 mm in some years that might be related to landslide in the hilly areas. The decadal rainfall increased by 10% (2,477 vs. 2,727 mm) from the decade of 2001-2010 to 2011-2020. The maximum temperature in this area increased by 0.1°C during summer (April – September) during the last two decades (2001-2010 and 2011-2020).

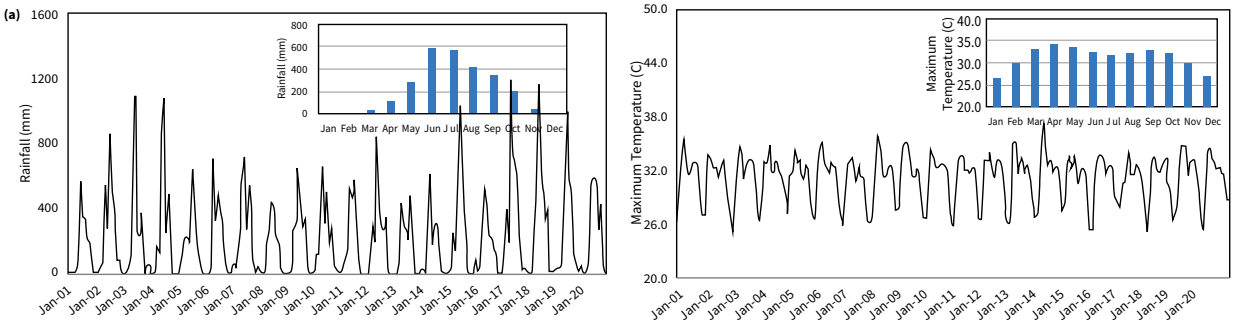


Figure 3.15: (a) Monthly rainfall and variation (index); and (b) monthly-mean maximum temperature and its variation (index) at Rangamati BMD station during 2001 – 2020

The respondents of household survey mentioned about different types of changes occurred due to climate change in this area which include increase of temperature, increase in intensity of rainfall but decrease of average rainfall, decrease of temperature in winter, and change of seasonal pattern (Table 3.1). During Focus Group Discussion (FGD), multi-stakeholder workshop and community meeting, most of the respondents mentioned about increase of temperature in summer, extremely cold days for a few days in winter, massive change in rainfall pattern, and thunder strike as the major signs of climate change in this area (Table 3.2).

Rangamati faces huge water crisis during dry season (December – May). Due to unavailability of groundwater in most of the aquifers, only surface water is used for all purposes including drinking water. Due to the filling up of the riverbed by the eroded soil for landslide, and drying up of small fountains in mountains, the storage of water has also reduced significantly over the last few years.

Dhaka (urban area)

Dhaka is one of the most-affected cities globally due to extreme heat caused by rapid population growth and global warming with an increase of 575 million person-days of extreme heat over the last 33 years (1983-2016), according to a latest study released in October, 2021[3]. Dhaka acts as an 'urban heat island' that is largely warmer than its surrounding rural areas due to human activities.

[3]Reference: https://www.dhakatribune.com/bangladesh/2021/10/05/study-dhaka-worst-hit-by-extreme-heat- from-urbanization-global-warming

Jacobs et al. (2019) recommended to cast heat warnings in terms of 'thermal indices' instead of just temperature after a detail study of heat indices on Dhaka city where conditions classified as dangerous to very dangerous, and likely to impede productivity, are observed almost every day of the measurement period (April-September 2016) during daytime, even when air temperature drops after the onset of the monsoon, while exposure to heat is the highest at the areas of low-income people comparing to other neighborhoods.

In Dhaka city, monthly rainfall might be related to floods recorded in 2004 and 2007 in the country (Figures

3.2 and 3.16). The monthly distribution of rainfall in Dhaka shows that most of the rainfall occurs in four months (June – September) of the year while the consecutive five months (November – March) are almost with no or very little rainfall. Maximum temperature varies between 24°C (December – January) and 35°C (May – June). However, maxima may rise to nearly 40°C on individual days. The extreme climatic events such as drought and heat waves are triggered during pre-monsoon to end of monsoon period (April – September). During last 20 years (2001-2020), annual rainfall is 1,984 mm of which, 69% (1,378 mm) occurs during monsoon (June-September). The decadal rainfall declined by 9% (2,079 mm vs. 1,889 mm) during the last two decades of 2001-2010 and 2011-2020. Maximum temperate increased by 0.3°C during decade of 2011-2020 compared to 2001-2010 while by 0.4°C during Summer (April-September).

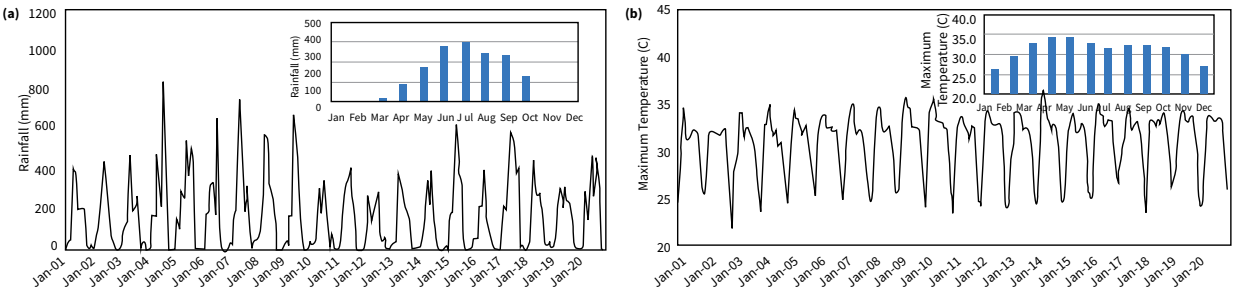


Figure 3.16: (a) Monthly rainfall and variation (index); and (b) monthly-mean maximum temperature and its variation (index) at Dhaka (Tejgaon) BMD station during 2001 – 2020

During the household survey, the respondents of Dhaka city mentioned about different types of changes occurred due to climate change, which are increase of temperature during summer, decrease of temperature in winter, increase of rainfall intensity, decrease of average rainfall, and change of seasonal pattern (Table 3.1). During the Focus Group Discussion (FGD), multi-stakeholder workshop and community meeting, most of the respondents mentioned about increase of temperature in summer, change in rainfall patterns and thunder strike (Table 3.2).

Local level assessment of climate change impacts on health and other sectors:

The communities in five study areas provided their opinion about the overall impact of climate change on human health which is shown in Fig. 3.17. A substantial percentage of respondents in all five study areas (26% to 36%) said that there is 'moderate impact' of climate change on human health. While

respondents in four areas reported very little (3 – 5% HH) 'severe impact', 20% respondents in Patuakhali said that there is severe impact of climate change on human health. Besides, various sectors including agriculture, food security, livelihood, health and health system were impacted. Alarge number of respondents also expressed their concern about social unrest as a result of climate change (Table 3.4). The respondents also identified various types of diseases caused, directly or indirectly, by climate change (Table 3.5 and Table 3.6). The area-wise discussion of climate change impacts on health and other sectors are discussed in this section.

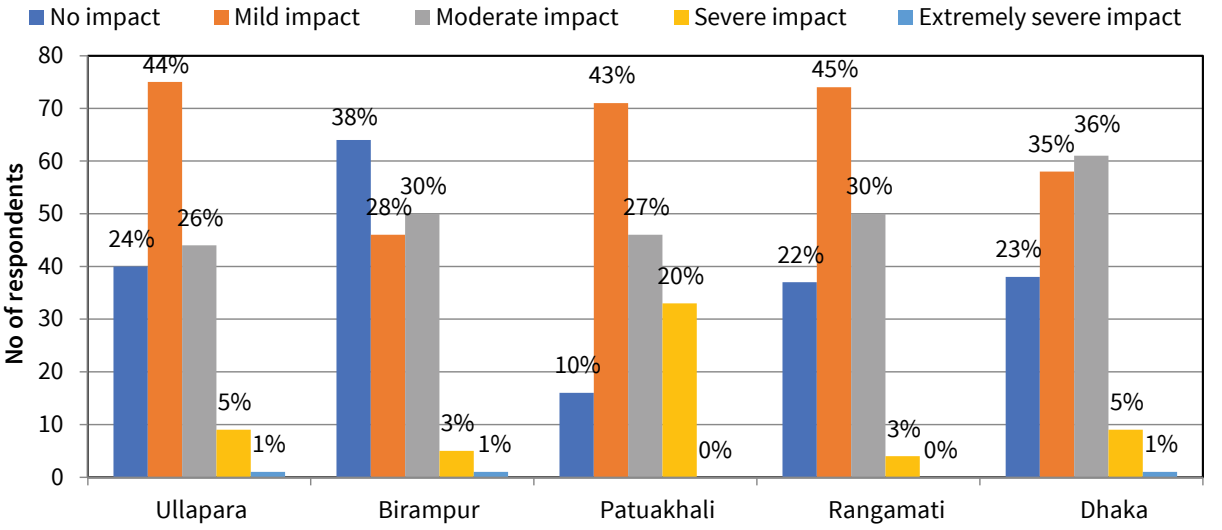


Fig 3.17: Overall impact of climate change on health according to household survey (n=166 at each of five study areas)

Table 3.4: Various sectors affected due to climate change according to household survey (n=166 at each of five study areas)

Sectors	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Agriculture	33 (20%)	25 (15%)	94 (57%)	15 ((9%)	16 (10%)
Food security	25 (15%)	9 (5%)	80 (48%)	18 (11%)	21 (13%)
Livelihood loss	36 (22%)	14 (9%)	79 (48%)	15 (9%)	22 (13%)
Social unrest	19 (11%)	5 (3%)	48 (29%)	4 (2%)	18 (11%)
Health & health system	30 (18%)	13(8%)	59 (36%)	13 (8%)	35 (21%)

Table 3.5: Community's perception on various extreme events responsible for diseases or health problems as per household survey (n=166 at each of five study areas)

Extreme events	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Flood	82 (49.4%)	32 (19.3%)	123 (74.1%)	-	-
Cyclone/storm surge	5 (3.0%)	5 (3.0%)	32 (19.3%)	23 (13.9%)	26 (15.7%)
Tidal flood	4 (2.4%)	4 (2.4%)	51 (30.7%)	5 (3.0%)	9 (5.4%)
Drought	9 (5.4%)	83 (50.0%)	1 (0.6%)	5 (3.0%)	16 (9.6%)
Heat wave	4 (2.4%)	2 (1.2%)	1 (0.6%)	1 (0.6%)	20 (12.0%)
Riverbank erosion	6 (3.6%)	2 (1.2%)	1 (0.6%)	12 (7.2%)	15 (9.0%)
Waterlogging	-	-	-	30 (18.1%)	142 (85.5%)

Table 3.6: Various diseases caused by the impact of climate change according to household survey (n=166 at each of five study areas)

Diseases	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Diarrhea	29 (17.5%)	36 (21.7%)	59 (35.5%)	7 (4.2%)	66 (39.8%)
Dysentery	17 (10.2%)	29 (17.5%)	54 (32.5%)	3 (1.8%)	64 (38.6%)
Fever	21 (12.7%)	21 (12.7%)	50 (30.1%)	5 (3.0%)	47 (28.3%)
Cold	6 (3.6%)	22 (13.3%)	25 (15.1%)	4 (2.4%)	41 (24.7%)
Skin diseases	16 (9.6%)	23 (13.9%)	5 (3.0%)	4 (2.4%)	31 (18.7%)
Hypertension	1 (0.6%)	4 (2.4%)	7 (4.2%)	0	5 (3.0%)
Kidney diseases	0	8 (4.8%)	5 (3.0%)	0	25 (15.1%)
Typhoid	8 (4.8%)	5 (3.0%)	2 (1.2%)	2 (1.2%)	30 (18.1%)
Stomachache	11 (6.6)	14 (8.4%)	0	3 (1.8%)	29 (17.5%)
Injury	0	0	2 (1.2%)	0	3 (1.8%)

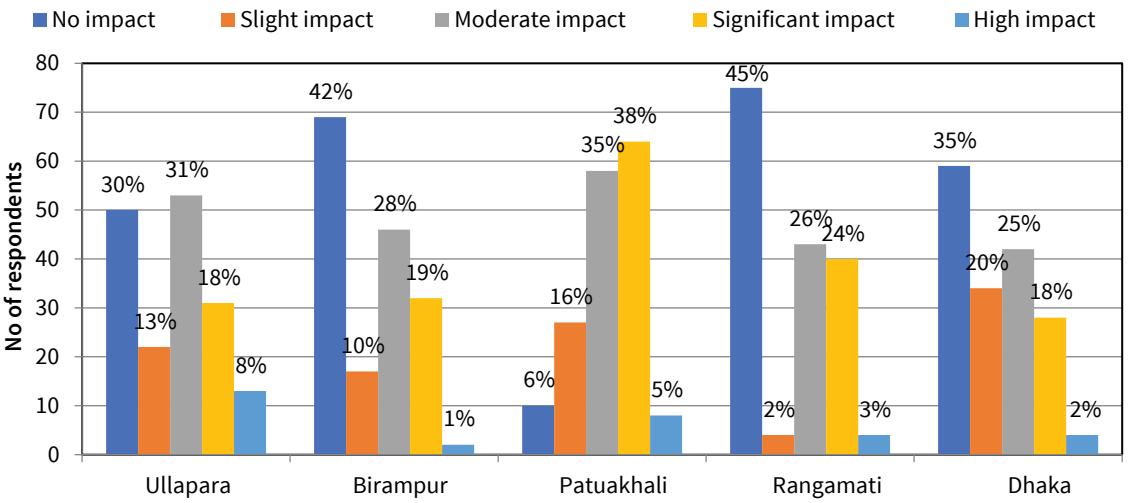


Fig 3.18: Impact of climate change on yearly health care expenditure of the respondents according to household survey (n=166 at each of five study areas)

Ullapara (flood prone area)

According to household survey, 18% of the respondents (30 participants) mentioned that health and health system is affected due to climate change (Table 3.4) in Ullapara. Half the respondents (n=82 respondents) think floods is the main reason among all the extreme weather events that is responsible for diseases or health problems, according to household survey (Table 3.5). Respondents think that impact of flood on food availability causes malnutrition problem during and post flood situation in Sirajganj. Diarrhea, dysentery, fever, and skin diseases were the common diseases identified by the respondents (Table 3.6). 119 respondents (70%) mentioned that their yearly health care expenditure is increasing due to climate change (Figure 3.18).

Besides health and health system, agriculture and livelihood loss are the most affected sectors caused by the impact of climate change (Table 3.4). During FGD and workshop, respondents mentioned about 'Kazipur' and 'Chouhali' areas where migration rate is comparatively higher due to extreme weather. According to respondents, increase of various new insects in crop land is one of the impacts of changed climate. Due to this increase of new insects, farmers need to use excessive amount of new type of pesticides which would affect the environmental and the crop.

Available of water is very important for public health which is used for drinking, domestic use or food production. Most of the households in Ullapara use shallow tube well as their drinking water source. 55 respondents (33%) mentioned that water sources are affected due to climate change (especially due to flood), and most of the respondents (33) thought that both quality and quantity of water degrades at the time of flood. 31 of the total respondents mentioned that water is responsible for the health problem and many diseases in this area (Annex A2).

Birampur (drought prone area)

Among the respondents of household survey, 8% (13 respondents) mentioned that health and health system is an affected sector due to climate change (Table 3.4). Half (50%) of the respondents (83 participants) mentioned that drought is the main reason among all the extreme weather events that is responsible for diseases or health problems in their area (Table 3.5). More than 12% respondents think that diarrhea, dysentery, fever, cold and skin diseases are the common diseases caused by the impact of changing climate (Table 3.6). 97 respondents (58%) mentioned that their yearly health care expenditure is increasing due to climate change (Figure 3.18).

Besides health and health system, agriculture and livelihood loss are the most affected sectors due to climate change, though the percentage of respondents in favor of this was comparatively lower. Respondents think that due to reducing scope of agricultural work, 'Santali' community and children along with elderly people are in high risk for climate change. Due to increase of various new insects in crop land, farmers need to use new type of pesticides which ultimately affect the health and environment. Respondents notified about the scarcity of water over the years, during summer and winter, which lead the increase of diarrhea and skin diseases. Due to the significant change (increasing/decreasing) in rainfall pattern over the years, ground water level is depleting, and surface water is becoming less available. 43 respondents (26%) mentioned that water resources are being affected due to climate change, and among them, 20 respondents reported that both quality and quantity of water are being degraded. 38 of the total respondents mentioned that poor water quality is responsible for the health problem in this area (Annex A2). They also mentioned about increase of mosquito due to the increase of temperature.

Patuakhali Sadar (coastal area)

Among the respondents of household survey, 36% (59) of the respondents mentioned health and health system as an affected sector due to climate change (Table 3.4). 74% of the respondents (123 participants) in Patuakhali think that flood and 51 respondents (31%) think tidal wave are the main reasons among all the extreme weather events that is responsible for diseases or health problems, according to household survey (Table 3.5). Among the diseases, diarrhea, dysentery, fever and cold are the common diseases caused by the changing climate (Table 3.6). 157 respondents (94%) mentioned that their yearly health care expenditure is increasing due to climate change (Figure 3.18).

According to HH survey, 57% respondents (94 participants) think that agriculture is one of the major affected sectors, and 48% respondents mention food security and livelihood loss as the affected sectors due to climate change (Table

3.4). Respondents think, “during extreme weather, nutritious food become less available in affected areas. Although a smaller number of malnutrition cases are found in normal time, but malnutrition from mal-feeding still exists due to lack of knowledge among rural people”. According to FGD and workshop, ‘Rakhain’ ethnic community in Kolapara and Rangabali, ‘Manta’ gypsy ethnic group near Char Montaz, people living in alluvial land, near embankment and low-lying area, farmers, fishing community, children, pregnant women and elderly people are mostly affected to extreme weather events.

It was reported by the local communities that Nor’wester (violent thunderstorms in the Gangetic plains which are locally known as “Kal Boishakhi”) is decreasing in this area but the number of tornadoes is increasing. Frequency and intensity of storm surges are increasing which often cause flood in this area. Saltwater intrusion in ground water and surface water is also increasing in this area, as reported during the FGD. Respondents from workshop mentioned, groundwater level is rapidly decreasing. Previously the average depth of deep tube well was 950-1,000 ft., but now the average depth is more than 1,100 ft. 67 respondents (40%) mentioned that water sources are being affected due to climate change, and most of the respondents (37) thought that the quality of water has degraded over the years. 65 of the total respondents mentioned that poor water quality is responsible for the health problem (Annex A2). During cyclone and storm surge, sanitation system is severely hampered in the affected areas as well.

From the discussion of community meeting, during February to April in previous years, 3-4 rainfall events per months were very common which helped land to grow more crops and dry weather of winter to became moisturized. It would also kill mosquito and other harmful insects. But over the last few years, there was almost no rainfall during this period of the year which affected the crops and overall environment of this area.

Rangamati Sadar (hilly areas)

In Rangamati, 8% of respondents (13) mentioned health and health system as the affected sector due to climate change (Table 3.4). 18% of the respondents (30 participants) think waterlogging (caused due to heavy rainfall) and 14% of respondents (23) think cyclone and storm surge are the main reasons among all extreme events that caused diseases or health problems (Table 3.5). Among various diseases, diarrhea, fever, cold and skin diseases are the common diseases caused by the changing climate in this area (Table 3.6). 91 respondents (55%) mentioned that their yearly health care expenditure is increasing due to climate change (Figure 3.18). Previously, malaria was seen in pre and post monsoon period but now malaria patient is seen round the year, according to the information collected during FGD and community meeting.

Besides health and health system, agriculture, food security and livelihood are the affected sectors due to climate change (Table 3.4) in Rangamati. Respondents from FGD and workshop mentioned that “migration of people from hilly area to plain land was mainly due to economic reasons, however, there might be some effect of climate change (e.g., water scarcity, change of cropping pattern, etc.) that also play a small role behind migration”. Due to surface water unavailability, more ground water is now used

in crop production. The amount of cultivable land is constantly decreasing. Landslides are increasing due to cutting trees and unplanned urbanization. Fish availability in Kaptai has been decreased over the year.

Dhaka (urban area)

In Dhaka city corporation, 35 respondents (21%) of household survey mentioned health and health system as the affected sector due to climate change (Table 3.4). 142 respondents (86%) in Dhaka city think that waterlogging is the main reason among all the extreme weather events that is responsible for diseases or health problems, according to household survey (Table 3.5). Among the diseases, most of the respondents mentioned about diarrhea, dysentery, fever, cold, skin diseases and typhoid as the common diseases caused by the impact of climate change (Table 3.6). 108 respondents (65%) mentioned that their yearly health care expenditure is increasing due to climate change (Figure 3.18).

The participants of FGD, workshop and community meetings said that scarcity of water and water logging are the most prominent effects of climate change in Dhaka city. They also mentioned that due to increase of mosquitoes, dengue and chikungunya and many other vector-borne diseases are highly increasing. Due to climate change, people from all over the country migrate to Dhaka in search of livelihood and as a result, now Dhaka city holds people beyond its capacity. In this way, Dhaka is also being affected by climate change indirectly. As Dhaka is highly populated city that has a very high demand of water, ground water level is rapidly depleting. The water sources are also being affected due to high demand and overextraction of groundwater.

Gender disaggregated perception:

In this section, gender disaggregated perception of impact of climate change on different sectors. Interestingly, the five sectors affected by climate change, according to the respondents, were same for all study areas: agriculture, livelihood, food security, social unrest, and health. Here the identified top diseases by the respondents caused by climate change are also discussed.

From Figure 3.19, it is quite clear that male respondents reported livelihood and agriculture as the most affected sectors whereas female respondents mentioned about food security, livelihood and social unrest as the most affected. In Ullapra, the top diseases are fever, common cold, diabetes, diarrhea, heart disease, stomachache, dysentry, malnutrition, skin disease and injury. While fever, common cold, diabetes, diarrhea was almost equally identified by male and female, heart disease were more reported by male than female respondents. Female were found to be more affected by dysentery and malnutrition than male.

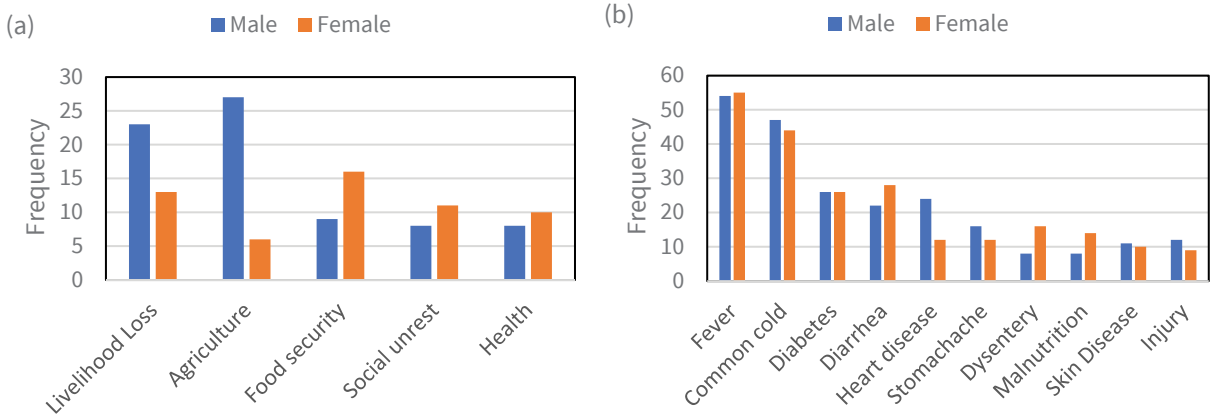


Figure 3.19: Gender disaggregated perception of (a) impact of climate change on various sectors, and (b) different types of diseases according to household survey in Ullapara Upazila

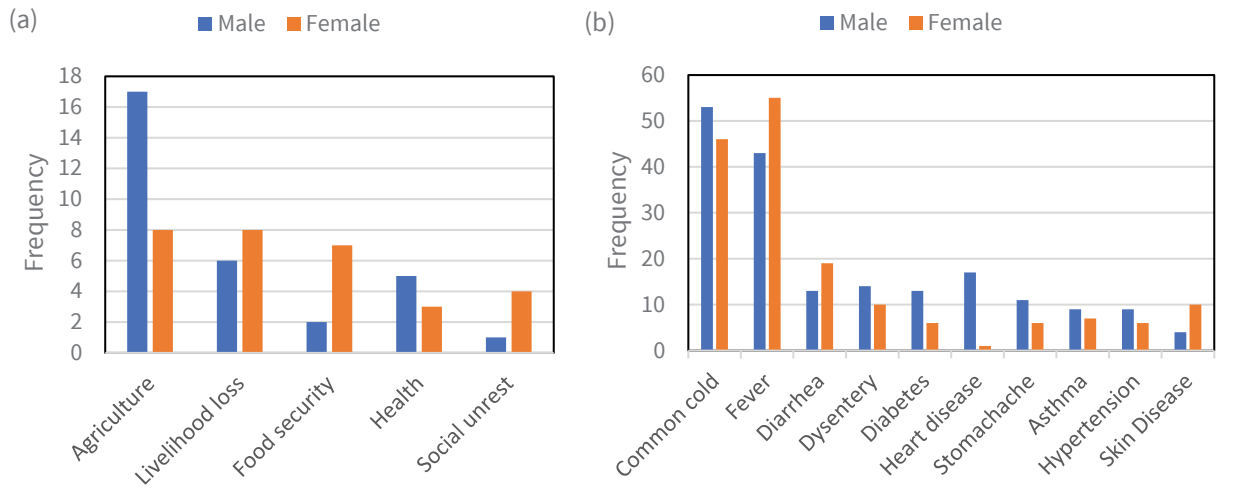


Figure 3.20: Gender disaggregated perception of (a) impact of climate change on various sectors, and (b) different types of diseases according to household survey in Birampur Upazila

In Birampur (Figure 3.20), agriculture was identified as the affected sector by the majority of the male respondents, whereas female respondents identified livelihood loss and food insecurity as the two more affected sectors than others. Among the diseases, common cold and fever were identified by the majority of the respondents, both male and female. In Birampur, women were found suffering for fever and diarrhea more frequently than male. Heart disease was found mostly among the male members of the families.

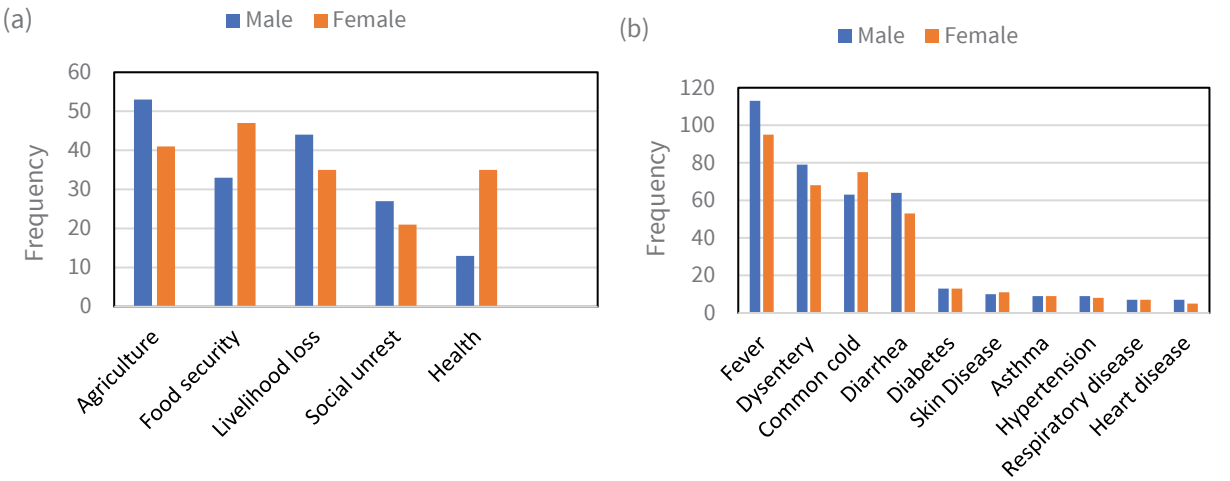


Figure 3.21: Gender disaggregated perception on (a) impact of climate change on various sectors, and (b) different types of diseases according to household survey in Patuakhali Sadar Upazila

In Patuakhali, male respondents were more worried about agriculture and livelihood loss than female respondents, as far as climate change impact is concerned, however, more female respondents identified food insecurity and social unrest than male respondents (Figure 3.21). The impact of climate change on health sector was identified by a substantially higher number of female respondents than male. In Patuakhali, the top diseases are fever, dysentry, common cold and diarrhea, for both male and female. Among these

four diseases, male members were found more affected by fever, dysentery and diarrhea than female members, whereas opposite scenario was found for common cold.

In Rangamati Sadar Upazila (Figure 3.22), the female respondents were found to be more responsive than male respondents when they were asked about the most affected sectors due to climate change in Rangamati. Higher number of female respondents raised their concern over food insecurity, livelihood loss, health issues and social unrest than male respondents. In Rangamati, the top diseases are fever, diarrhea and common cold, where the distribution seems to be equal among male and female members.

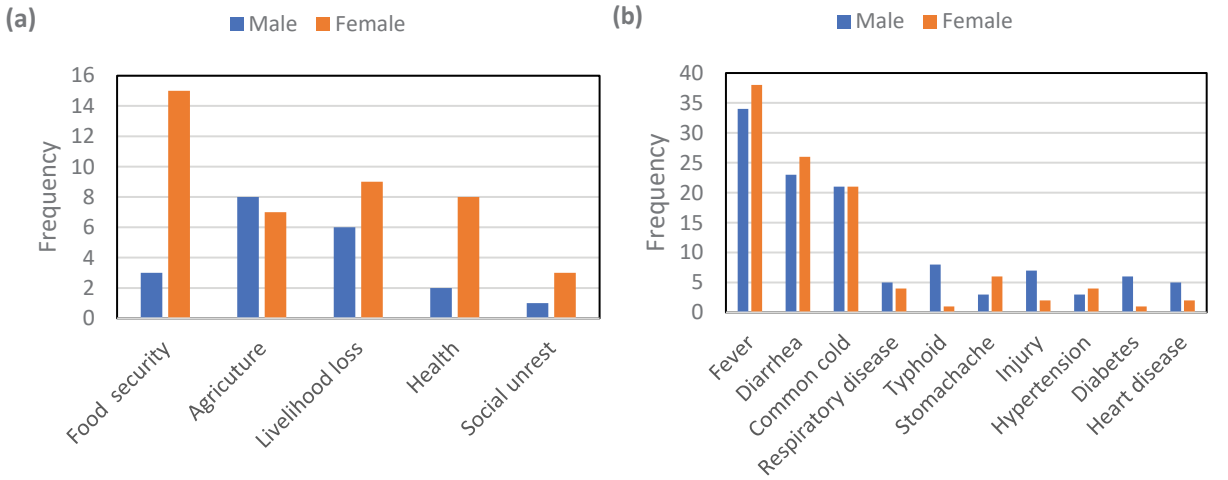


Figure 3.22: Gender disaggregated perception of (a) impact of climate change on various sectors, and (b) different types of diseases according to household survey in Rangamati Sadar Upazila

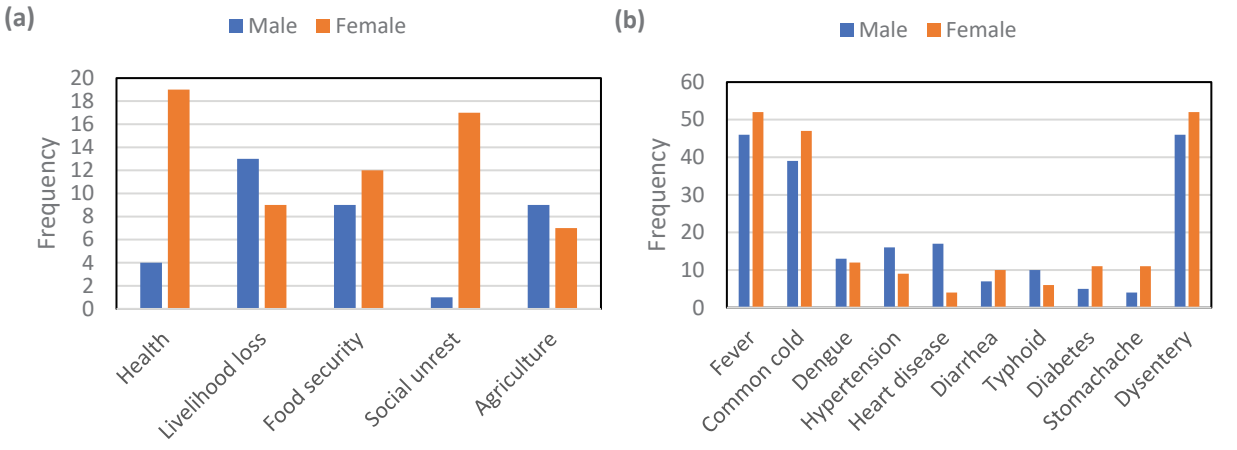


Figure 3.23: Gender disaggregated perception of (a) impact of climate change on various sectors, and (b) different types of diseases according to household survey in Dhaka City

In Dhaka City (Figure 3.23), health and social unrest were reported as the most affected sectors by female respondents due to climate change. Livelihood loss and food insecurity were reported as the most affected sectors by male respondents while many female respondents agreed with that as well. In Dhaka

city, the identified top diseases caused by cliamte change are fever, common cold and dysentry, for both male and female.

Conclusion

According to the household surveys, FGD, workshops and community meetings in all five study areas, most of the respondents agreed about the increase of temperature, longer duration of summers, and shorter period of winters. This can also be proved with the analysis of temperature data of Bangladesh Meteorological Department which shows that maximum temperature increased by 0.2°C to 0.4°C in various study areas during summer (April – September). The communities also mentioned about the changing rainfall pattern, i.e., increase of erratic rainfall and increase of torrential rainfall occurrence with longer gaps between two rainfall events. This erratic rainfall pattern was also supported by the available rainfall data which proves that the community perception in this regard was right.

Frequent flood events hamper the recovery cycle of the impact of flood in Sirajganj. In Ullapara Upazila of Sirajganj, participants of HH survey, FGD, workshop and community meeting mentioned the increase of flood occurrence in recent years. In Birampur, increase of summer temperature and decrease of rainfall causes frequent drought which effects human health severely. Respondents of household survey agreed about drought as a disaster for this area. In Patuakhali, respondents mentioned cyclone and storm surge as the disasters which often causes tidal flood in this area. In Rangamati, erratic heavy rainfall causes landslides and water logging (which respondents sometimes mentioned as flood), and survey respondents also agreed about these disasters. High temperature represents Dhaka as 'urban heat island', which was agreed by the informants and survey respondents, who considered this heat issue being a major concern for this area. In all the study areas, increase of lightning and thunder strikes was found a common disaster.

It is quite evident that for different Upazilas, the top five affected sectors are different, and they have different impact on male and female, according to the survey findings. For Ullapara, the top affected sector is livelihood loss. While health is the top affected sector in Dhaka, it is the least affected one in Ullapara. However, In Patuakhali and Birampur, agriculture is the most affected sector due to climate change, whereas food security is the most affected in Rangamati. The survey findings show that agriculture and livelihood loss have higher influence on male population than female whereas in case of health, food security and social unrest sectors the case is opposite.

All these factors are affecting different and new types of health problems (Table 3.6) in the study areas. According to the survey, it is evident that all five Upazilas have different types of diseases affecting people while fever and common cold are the most common diseases. Heart disease and hypertension are more

common among males than females in all the Upazilas. It was found from the survey findings that females are mostly affected by fever, common cold and skin disease.

Chapter 4

Major Climate Sensitive Diseases of Bangladesh

4.1 Introduction

There are range of diseases that are sensitive to climate change. Climate plays an important role in the seasonal pattern or temporal distribution of various infectituous diseases including vector-borne diseases like malaria, dengue, chikungunya, water-borne diseases like cholera and other diarrheal diseases, air-borne diseases, various non-communicable diseases (e.g., respiratory diseases, cardiovascular diseases, kidney diseases), skin diseases, mental health problems, pregnancy adverse outcome, etc. It also plays substantial role in various non-infectious diseases. Furthermore, the direct injury incidents from extreme weather events are also increasing as the number of these events are rising, which are sometimes related to the changing climate. At present, numerous research works are going on across the world to discover the pathway through which climate change is affecting human health.

The changing climate can help the expansion of the geographical distribution and increased incidence of vector-borne diseases; for example, rainfall can influence the transportation and dissemination of infectious agents while temperature affects their growth and survival. In Table 4.1, examples of how diverse environmental changes affect the occurrences of various infectious diseases in humans is shown (McMichael et al. 2003). The impact of climate change behind rising mental stress related disorders, premature labor, cardiovascular diseases, kidney diseases are already evident. However, the exact mechanism through which climate change exerts these effects are still being studied and requires separate discussion for each of these diseases. Furthermore, the migration of people, urban crowding, and change of agricultural practices due to climate change are other important factors. Similarly, use of pesticides and other related socio-demographic factors, caused by climate change, are behind the increase of water-borne diseases and air-borne diseases. In this chapter, some major climate sensitive diseases (CSD) in Bangladesh, such as diarrhea, cholera, malaria, dengue and their relationship with changing climate pattern are discussed.

Table 4.1: Examples of how diverse environmental changes affect the occurrence of various infectious diseases in humans.

Environmental changes	Example diseases	Pathway of effect
Dams, canals, irrigation	Schistosomiasis	↑ Snail host habitat, human contact
	Malaria	↑ Breeding sites for mosquitoes
	Helminthiasis	↑ Larval contact due to moist soil
	River blindness	↓ Blackfly breeding, ↓ disease
Agricultural intensification	Malaria	↑ Crop insecticides and ↓ vector resistance
	Venezuelan hemorrhagic fever	↑ Rodent abundance, contact
Urbanization urban crowding	Cholera	↓ Sanitation, hygiene; ↑ water contamination
	Dengue	↓ Water-collecting trash, ↑ Aedes aegypti mosquito breeding sites
	Cutaneous leishmaniasis	↑ Proximity, sandfly vectors
Deforestation and	Malaria	↑ Breeding sites and vectors, immigration of susceptible people
new habitation	Oropouche	↑ Contact, breeding of vectors
	Visceral leishmaniasis	↑ Contact with sandfly vectors
Reforestation	Lyme disease	↑ Tick hosts, outdoor exposure
Ocean warming	Red tide	↑ Toxic algal blooms
Elevated precipitation	Rift valley fever	↑ Pools for mosquito breeding
	Hantavirus pulmonary syndrome	↑ Rodent food, habitat, abundance

4.2 Analysis of climate sensitive diseases in study areas

In this section, the trend between major climate sensitive diseases (CSD) and climatic variables in study areas have been analyzed. Two statistical analyses, (a) Pearson's correlation coefficient (PCC) and (b) Spearman correlation coefficient (SCC), have been done to show the relationship between the diseases and climatic variables (maximum temperature, rainfall, and relative humidity). Here, the p-value represents the significance level for a given hypothesis test, and when p-value of a correlation coefficient is less than 5% ($p<0.05$), the value represents statistically significant association.

Diarrhea is usually a symptom of an infection in the intestinal tract which can be caused by a variety of bacterial, viral, and parasitic organisms. Diarrhea can be spread through contaminated food or drinking water, or from person-to-person because of poor hygiene. Global burden of 1.7 to 5 billion diarrheal cases is observed per year, out of which 2 million deaths are documented each year with majority occurring in children below 5 years of age.

Cholera is an infection of the small intestine; marked by profuse, watery, secretory diarrhea with or without vomiting; caused by the bacterium Vibrio cholerae, which may result acute dehydration and without treatment, it can even cause death within 24 hours. An estimated burden of 1.3 to 4.0 million cholera cases occurs annually in endemic countries (including Bangladesh), and among these cases, there are 95,000 with uncertainty of 21,000 to 143,000 deaths as of 2015 (Ali et al., 2015).

Malaria is a vector-borne disease with symptoms of fever, tiredness, vomiting and headache. The disease is endemic in 13 northern and eastern districts of Bangladesh and 90% of morbidity and mortality reported from Rangamati, Bandarban and Khagrachari. An increase in temperature, rainfall and humidity may cause a proliferation of malaria-carrying mosquitos at higher altitudes, which results an increase in malaria transmission. Rainfall plays an important role in the transmission of malaria, as mosquito need water to support the larval and pupal stages of development (Laneri, K. et al., 2010).

Dengue has become a serious public health concern with large-scale outbreak in Bangladesh since 2000 although sporadic outbreaks occurred between 1964 and 1999 (Hossain et al. 2003, Rahman et al. 2002). Bangladesh is situated in the dengue endemic zone of the South-East Asian region. Since the year 2000, dengue cases are reported every year in all major cities of Bangladesh and has experienced several outbreaks of dengue in last 20 years. The largest one occurred in 2019, peaked from July to October with more than 100 thousand cases and 164 deaths all over the country (Shirin et al., 2019). Rapid and unplanned urbanization without proper sanitation facilities and lack of awareness are contributing fertile breeding areas of Aedes aegypti mosquitoes.

4.2.1 Ullapara

From the findings from questionnaire survey and discussions with local communities and health professionals, we found that the respondents in Ullapara are to some extent aware of the adverse effect of climate change on health. Respondents think that due to use of unsafe water during flood and scarcity of water during summer and winter, diseases like diarrhea, dysentery, and skin diseases are common in this area. Overall sanitation situation in Ullapara is not in good condition, which also pollutes water sources. There are many people who drink groundwater containing iron which leads to abdominal pain and discomfort.

Respondents reported that the pattern of diseases in Ullapara has changed over the past 5-10 years, which includes increase in frequency of respiratory diseases, kidney diseases, non-communicable diseases, heart diseases, and mental disorders. Nutritional deficiency is not a major problem in this area, rather obesity has become a problem as far as human health is concerned. It was also reported during the FGD, workshop and community meeting that deaths due to thunder strikes and heart attacks are increasing in this area.

During flood, maternal mortality rate increases in this area as pregnant women with maternal complications suffer from lack of antenatal checkup and lack of doctors. Though vector borne diseases are not prominent in Ullapara, increase in mosquito has been reported by people in community meetings, and the local doctors also found a few cases of malaria and dengue in previous years. According to them, there are ‘Mahato’ indigenous people living in Tarash Upazila of Sirajganj, who are prone to kala-azar.

A few statistical analyses and plots of diarrheal cases of Ullapara Upazila have been shown in this section using data collected from DGHS (from 2017 to 2020),

where the boxplot represents the mean of the average number and the highest and lowest number of any dataset. Figure 4.1 shows the monthly variation of diarrheal cases in Ullapara. The monthly mean diarrheal cases recorded in Ullapara Upazila during this period (2017 to 2020) has been plotted in the boxplot (Figure 4.2), in which the highest mean was in December, which is the driest month (low rainfall and temperature) in Ullapara (Figure 4.3). From Figure 4.2, we can found that the highest cases occur in June because of long term less rainfall and high temperature, and also, mostly male suffered in diarrhea in this area. Both statistical analyses such as Pearson's correlation coefficient (PCC) and Spearman correlation coefficient (SCC) (Table 4.2) showed negative and a significant correlation with rainfall and diarrheal cases at 0- and 1- month lag (PCC = -0.33 at 0-month lag, and PCC = -0.31 at 1-month lag). A positive significant relationship was found with maximum temperature at 1- (PCC = 0.31) and 2-month lag (PCC = 0.34). No significant relationship was found in SCC analysis, and with relative humidity at any lag of PCC analysis.

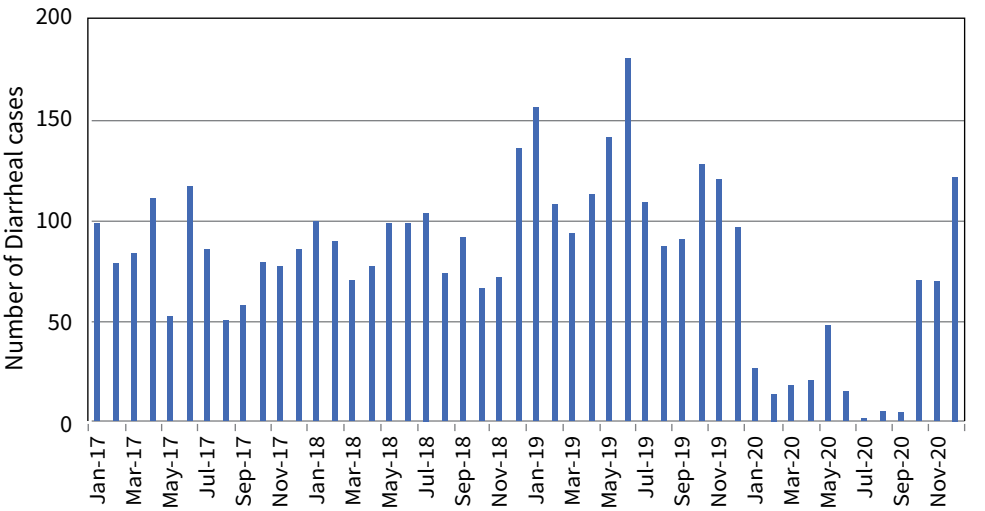


Figure 4.1: Monthly variation of diarrheal cases in Ullapara Upazila of Sirajganj District during the period of 2017 to 2020

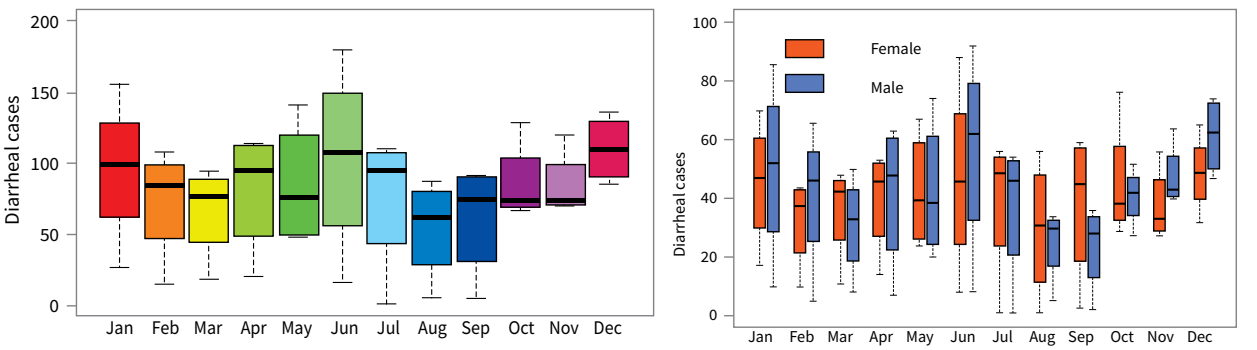


Figure 4.2: Boxplot of monthly mean diarrheal cases (left) and gender disaggregated diarrheal cases (right) in Ullapara Upazila of Sirajganj District during 2017-2020

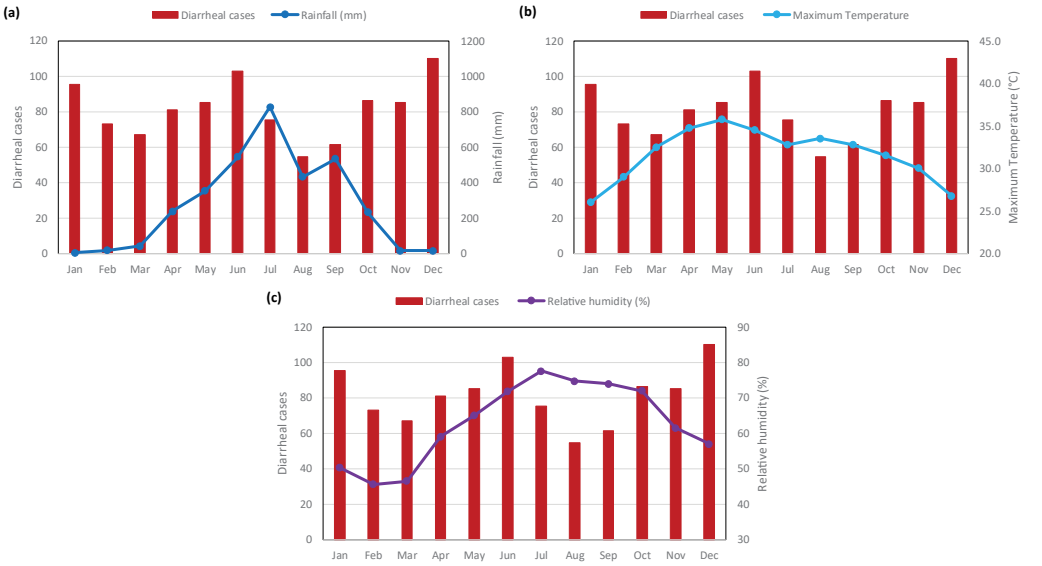


Figure 4.3: Monthly mean diarrheal cases, rainfall (mm), maximum temperature (°C) and relative humidity (%) in Ullapara Upazila during 2017 – 2020

Table 4.2: Cross-correlation of climatic variables and diarrheal cases in Ullapara with a lag of 0 to 2 months; [Pearson's correlation coefficient = PCC, and Spearman correlation coefficient = SCC]

Lag	0 month (no lag)		1 month		2 months	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	-0.33*	-0.18	-0.31*	-0.20	-0.28	-0.15
Maximum Temperature	0.16	0.10	0.31*	0.19	0.34*	0.24
Relative humidity	-0.21	-0.19	-0.22	-0.27	-0.20	-0.20

*Represents $p<0.05$

From section 3.5.1 (Table 3.6), we found that 18% of the respondents were affected by diarrhea, which is the highest number, and according to the hospital data, diarrhea is also the most common disease in this

area. The hospital data showed that diarrhea cases increase in summer and winter period (number of cases in June and December showed the higher points of diarrhea cases).

4.2.2 Birampur

According to the participants of FGD, workshop and community meetings, water-borne disease like diarrhea, respiratory diseases, skin diseases, mental health problems are major climate sensitive diseases in Birampur which are likely to increase in near future. Elderly people and farmers in this area are often affected by heat stroke due to prolonged drought. As heat/temperature is increasing during summer, more people are consuming cold drinks and energy drinks which the professionals think might create adverse health problems. During summer, many low-income people buy cheap oral electrolyte-based

drink from local stores and drink it regularly which might affect their health in long term. According to the household survey, more people were found to be affected by common cold and fever in Birampur.

It is evident from 3.5.2 section (Table 3.6) that respondents (22%) of Ullapara were affected mostly by Diarrhea, and from the hospital record, it was also found that diarrhea is the most common disease in this area. Figure 4.4 shows the monthly variation of diarrheal cases in Birampur Upazila which have been collected from DGHS for the period of 2017 to 2020. From the boxplot (Figure 4.5), the highest number of diarrheal cases showed in April when there is no or less rainfall for long period (Figure 4.6). In Birampur, male and female are almost equally affected by diarrhea (Figure 4.5). From the statistical analyses (Table 4.3), a negative and significant association with maximum temperature and diarrheal cases at both 1 month lag (PCC = 0.35) and 2 month lag (PCC = 0.47, SCC = 0.30) was found. A negative and significant relationship was found with relative humidity and diarrheal cases at 0month lag (SCC = 0.30).

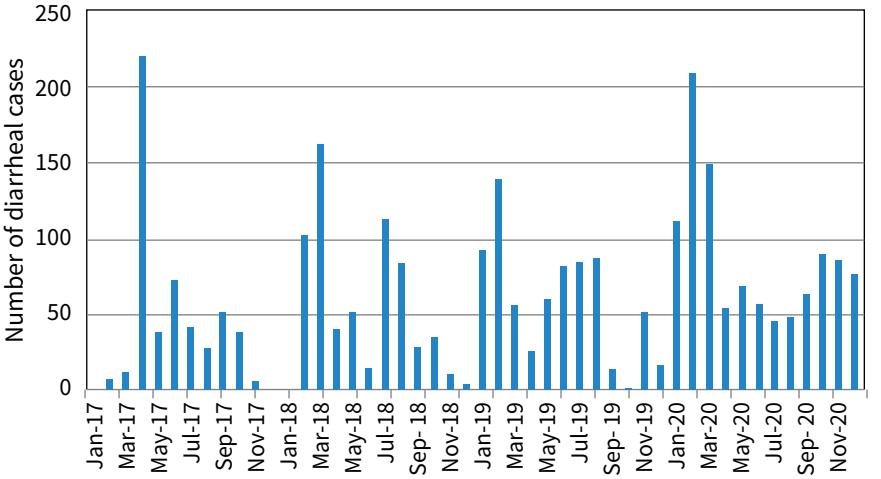


Figure 4.4: Monthly variation of diarrheal cases in Birampur Upazila of Dinajpur District during the period of 2017 to 2020

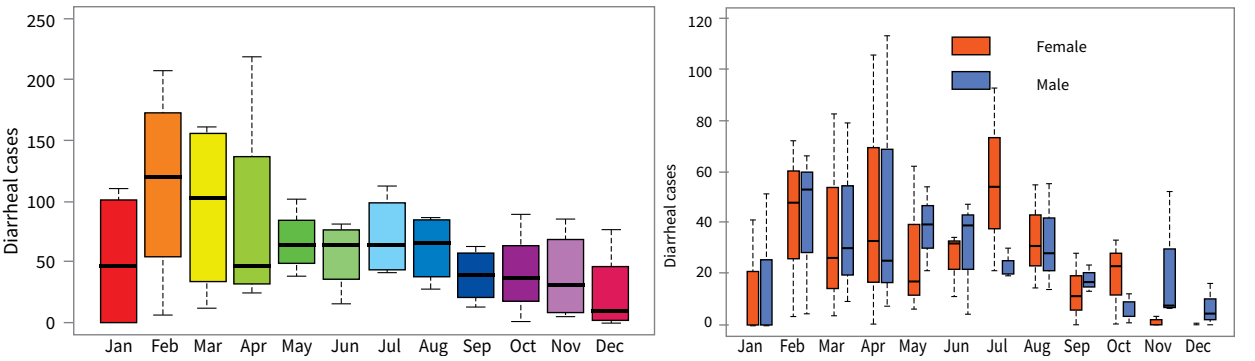


Figure 4.5: Boxplot of monthly mean diarrheal cases (left) and gender disaggregated diarrheal cases (right) in Birampur Upazila of Dinajpur District during 2017-2020

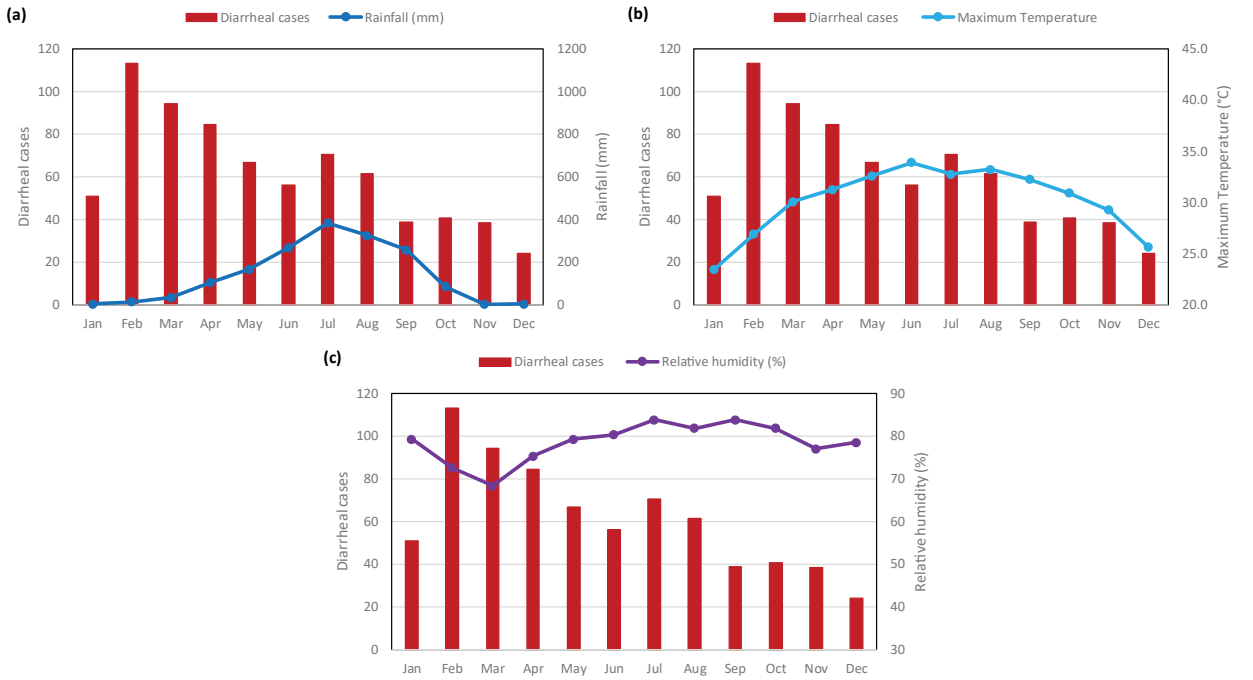


Figure 4.6: Monthly mean diarrheal cases, rainfall (mm), maximum temperature (°C) and relative humidity (%) in Birampur Upazila during 2017 – 2020

Table 4.3: Cross-correlation of climatic variables and diarrheal cases in Birampur Upazila with a lag of 0 to 2 months; [Pearson's correlation coefficient = PCC, and Spearman correlation coefficient = SCC]

Lag	0 month (no lag)		1 month		2 months	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	-0.02	0.17	-0.06	0.05	-0.18	-0.20
Maximum Temperature	0.04	0.13	-0.35*	-0.18	-0.47*	-0.30*
Relative humidity	-0.30*	-0.23	-0.17	-0.16	-0.13	-0.16

*Represents p<0.05

4.2.3 Patuakhali Sadar

According to community meeting, diarrhea and dysentery are increasing during summer and monsoon period in Patuakhali Sadar. Increase in number of cases of skin diseases, hepatitis, typhoid, kidney diseases were also reported by the community and health professionals. Elderly people and farmers being affected by heat stroke, dust allergy due to dryness are some other diseases that have been observed in recent past. It was reported that people in Patuakhali drink iron contained water, which creates abdominal pain and discomfort. The participants also highlighted the increase in mosquitoes, and doctors found a few cases of dengue back in 2019 and 2020. According to household survey findings, fever, dysentery, common cold and diabetes are most common diseases in this area.

In section 3.5.3 (Table 3.6), we found that 68% of the respondents suffered in diarrhea and dysentery in Patuakhali Sadar. According to record of local patients admitted in hospital, diarrhea is also found to be the most common disease in this area. The hospital data also showed that diarrheal cases increase in summer. Figure 4.7 shows the monthly variation of diarrheal cases in Patuakhali collected from DGHS for the period of 2017 to 2020. Using four years data of diarrheal cases, a boxplot has been plotted (Figure 4.8) where the highest mean and number of diarrhea cases showed in May. From figure 4.9, we found that there are two peaks, one is in the period of March to May (when rainfall is low, and temperature is high) and second one is in October and November (post monsoon period). From the statistical analyses (Table 4.4), we found a negative and significant association with rainfall and diarrheal cases at 0-month lag (PCC = -0.39) and 1-month lag (PCC = -0.33), which indicates that low rainfall or dry season may increase number of diarrheal cases in this area. From Figure 4.8, it is evident that the high variation shows in the month of April and May, where female and male are almost equally suffered by diarrhea.

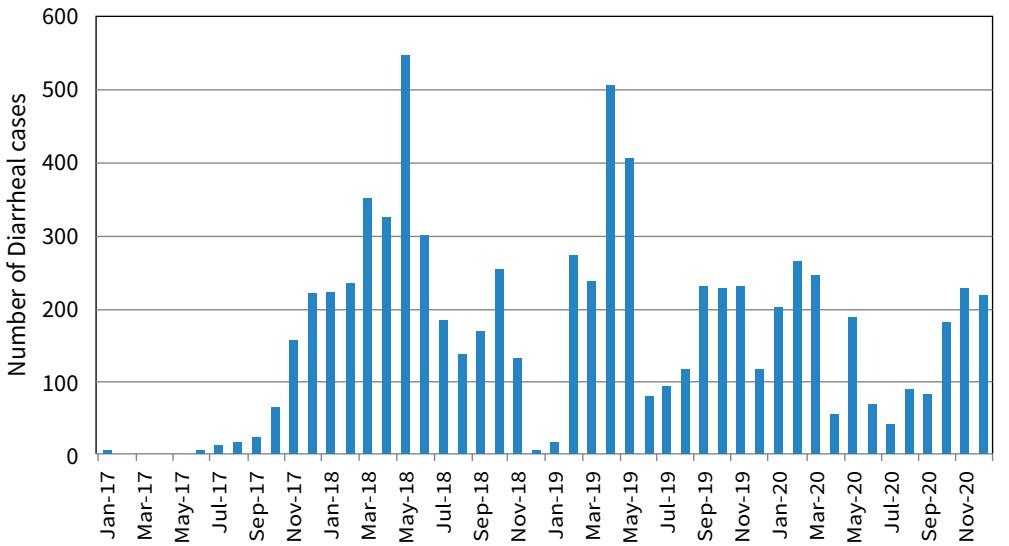


Figure 4.7: Monthly variation of diarrheal cases admitted in Patuakhali General Hospital during the period of 2017 to 2020

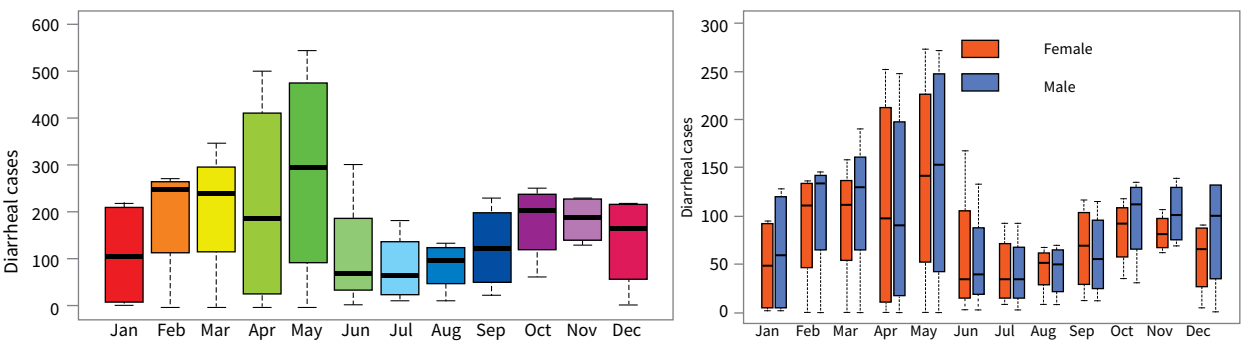


Figure 4.8: Boxplot of monthly mean diarrheal cases (left) and gender disaggregated diarrheal cases (right) admitted in Patuakhali General Hospital during 2017-2020

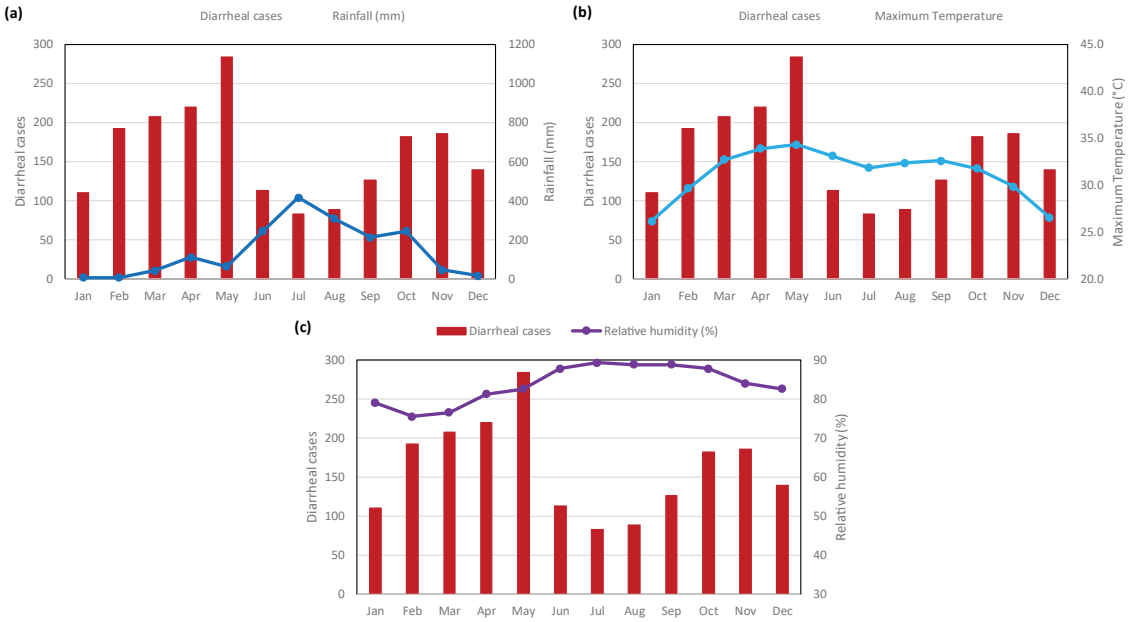


Figure 4.9: Monthly mean diarrheal cases, rainfall (mm), maximum temperature (°C) and relative humidity (%) in Patuakhali General Hospital during 2017 – 2020

Table 4.4: Cross-correlation of climatic variables and diarrheal cases in Patuakhali General Hospital with a lag of 0 to 2 months; [Pearson's correlation coefficient = PCC, and Spearman correlation coefficient = SCC]

Lag	0 month (no lag)		1 month		2 months	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	-0.39*	-0.28	-0.33*	-0.23	-0.24	-0.15
Maximum Temperature	0.15	0.13	0.03	0.01	-0.18	-0.16
Relative humidity	-0.21	-0.22	-0.24	-0.15	-0.20	-0.04

*Represents $p<0.05$

4.2.4 Rangamati Sadar

Among the climate sensitive diseases, diarrhea, hepatitis, typhoid, pneumonia, kidney disease were reported to be increasing over the years in this area, according to the participants of FGD, workshop and community meetings. One of the main reasons identified by them for diarrheal outbreak is lack of sufficient safe drinking water that forces the communities to consume unsafe water at times. Although Rangamati is known as a highly Malaria affected area, it was reported that the Malaria cases are decreasing here due to government initiatives. However, the respondents think that dengue and other Aedes mosquito related diseases will rise in near future. According to household survey findings, fever, diarrhea and common cold are most common diseases in this area.

Four years data (during 2017-2020) of diarrhea cases in Rangamati were collected from DGHS. Figure 4.10 shows the monthly variation of diarrheal

patients admitted at Rangamati General Hospital during the period of 2017 to 2020 while Figure 4.11 shows the boxplot of monthly mean of four years data. Monthly variation shows that during July – September, diarrheal cases were low. The cases start increasing in October, reach the peak in December-January, and continue till the end of dry season (May). Two seasonal variations of diarrheal cases may be attributed to its pattern: one is cold-diarrhea in December-January due to low temperature and fog, and the other is dry-diarrhea in March-May due to low rainfall and lack of safe drinking water availability. In Rangamati, female suffered most of all the months except February (Figure 4.11). This is also reflected in statistical analyses with climatic variables shown in Figure 4.12 and Table 4.5. Immediate reaction (no lag) of diarrheal cases were found showing quite remarkable relation with rainfall (PCC=-0.45, SCC=-0.47) and maximum temperature (PCC=-0.39).

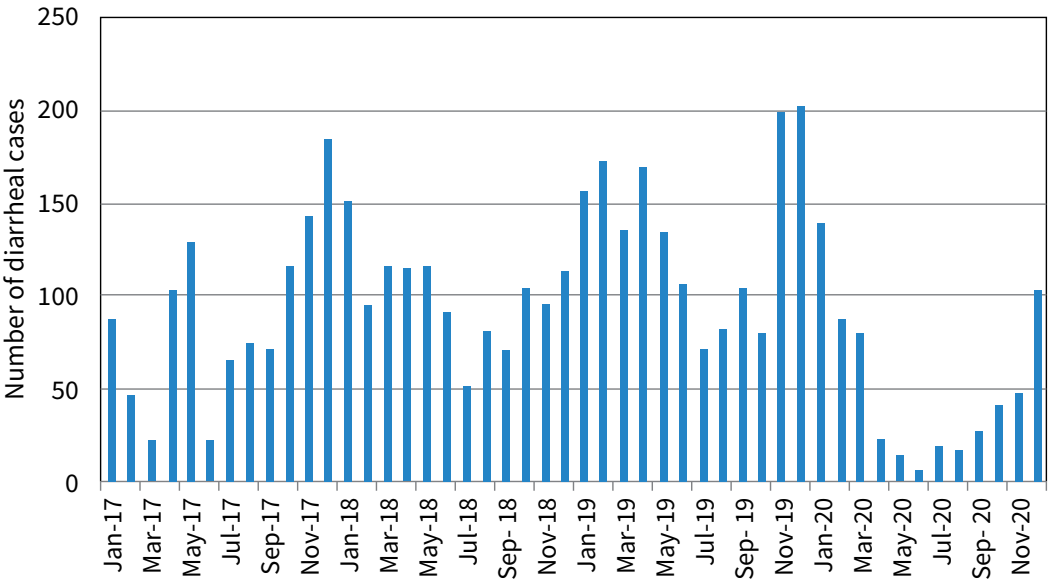


Figure 4.10: Monthly variation of diarrheal cases in Rangamati General Hospital during the period of 2017 to 2020

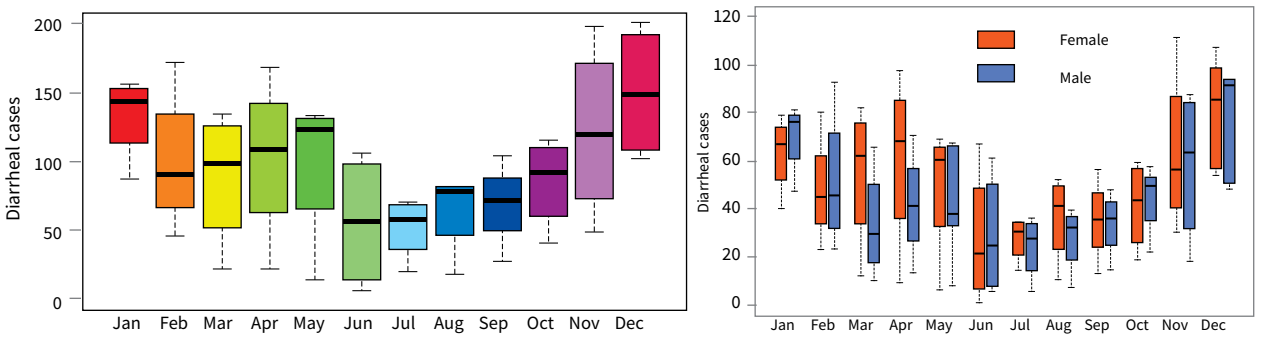


Figure 4.11: Boxplot of monthly mean diarrheal cases (left) and gender disaggregated diarrheal cases (right) admitted in Rangamati General Hospital during 2017-2020

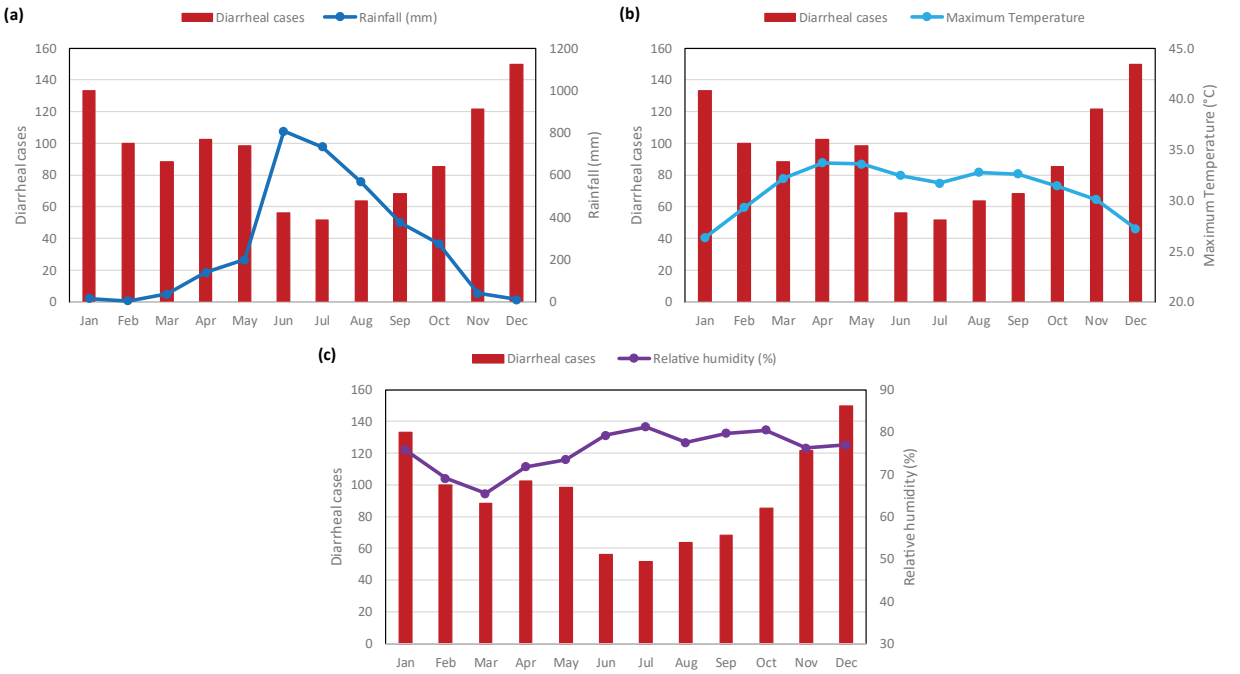


Figure 4.12: Monthly mean diarrheal cases, rainfall (mm), maximum temperature (°C) and relative humidity (%) in Rangamati during 2017 – 2020

Table 4.5: Crosscorrelation of climatic variables and diarrheal cases in Rangamati General Hospital with a lag of 0 to 2 months; [Pearson's correlation coefficient = PCC, and Spearman correlation coefficient = SCC]

Lag	0 month (no lag)		1 month		2 months	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	-0.45*	-0.47*	-0.36*	-0.36*	-0.14	-0.15
Maximum Temperature	-0.39*	-0.28	-0.31*	-0.32*	-0.17	-0.23
Relative humidity	-0.05	-0.10	0.10	0.03	0.16	0.13

*Represents $p<0.05$

Figure 4.13 shows the monthly variation of malaria cases admitted in Rangamati Sadar Hospital for the period of 2015 to 2020. From the boxplot (Figure 4.14), we found that the highest mean and number of malaria cases showed in the month of June and July, respectively, when rainfall and relative humidity were higher And in this area, male affected most in malaria. Figure 4.15 shows the monthly plot of relationship between malaria and climatic variables where it can be clearly observed that rainfall has significant relationship with malaria cases. From the statistical analyses (PCC and SCC) in Table 4.6, the largest and significant relationship was found with rainfall at 0 lag (PCC = 0.59, SCC = 0.49) while medium relationship was found with rainfall at 1 month lag and with relative humidity at both 0 and 1month lags.

Relation with temperature was also found quite significant at 1 and 2month lags ranging between 0.26 and 0.40.

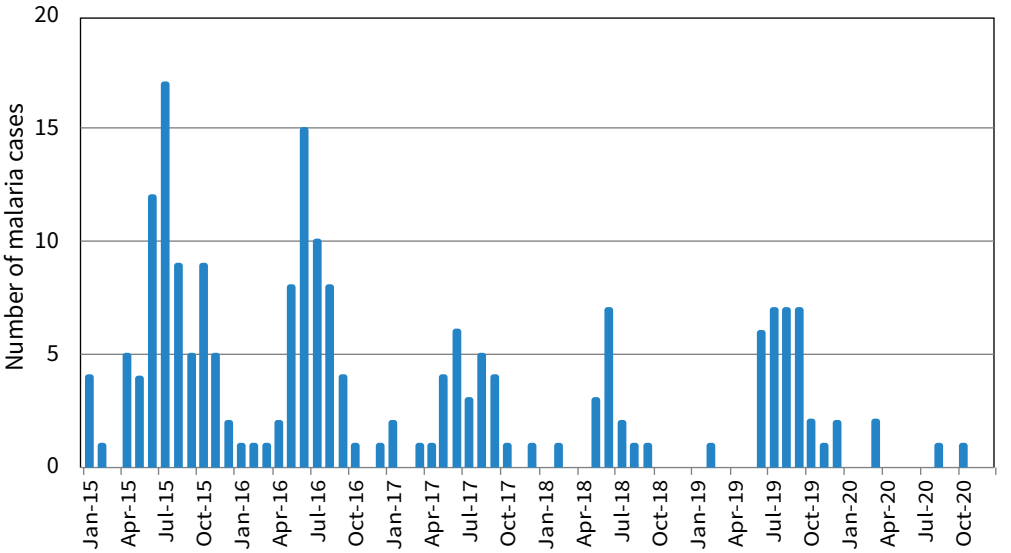


Figure 4.13: Monthly variation of malaria cases admitted in Rangamati Sadar Hospital during 2015 to 2020

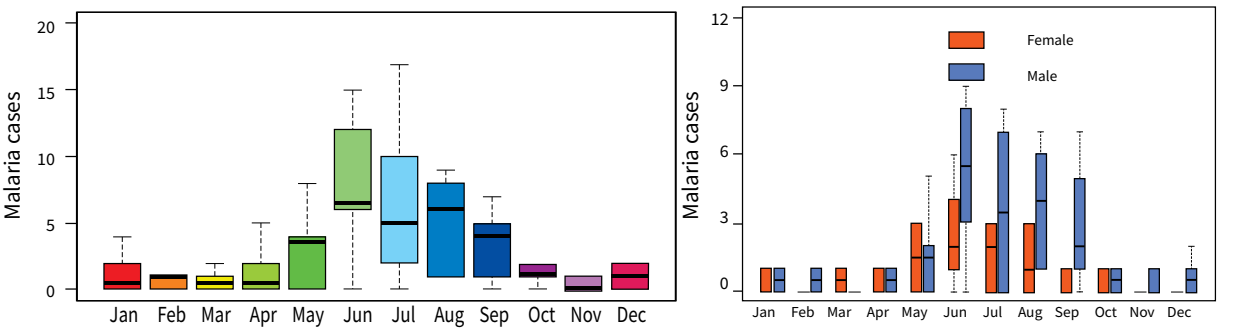


Figure 4.14: Boxplot of monthly mean malaria cases (left) and gender disaggregated malaria cases (right) admitted in Rangamati Sadar hospital during 2015-2020

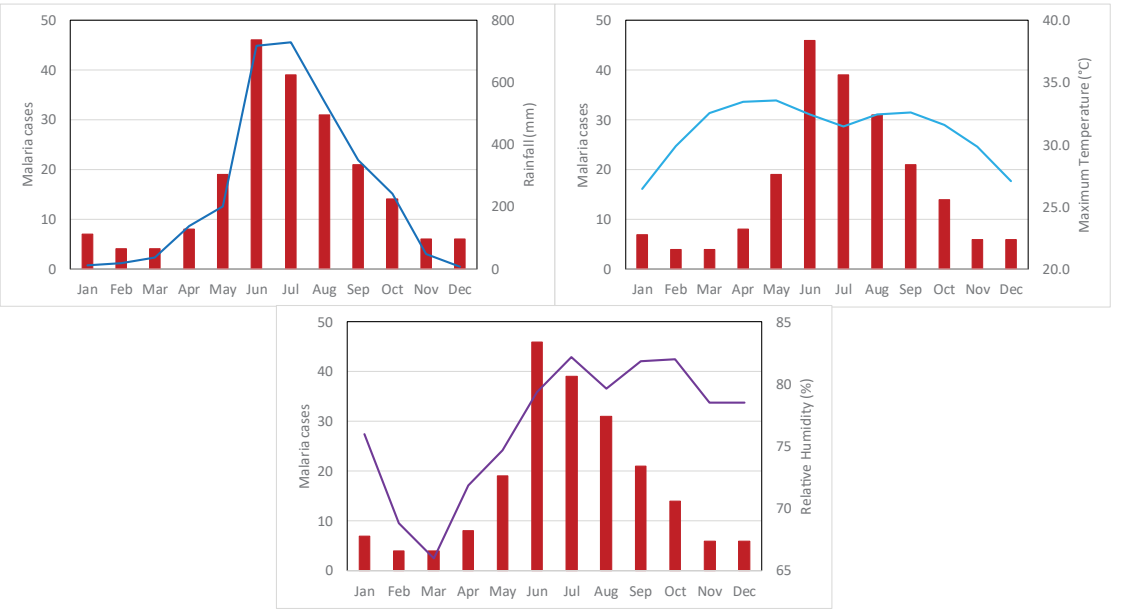


Figure 4.15: Relation between monthly (a) total malaria cases and mean rainfall (mm); (b) total malaria cases and mean maximum temperature (°C); and (c) total malaria cases and mean relative humidity (%) in Rangamati Sadar during 2015-2020

Table 4.6: Cross-correlation analysis of climatic variables (Pearson's and Spearman correlation coefficient) and malaria in Rangamati with a lag 0 – 2 months

Lag (month)	0		1		2	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	0.59*	0.49*	0.34*	0.40*	0.15	0.29*
Maximum Temperature	0.20	0.15	0.33*	0.26*	0.40*	0.36*
Relative humidity	0.46*	0.50*	0.24*	0.30*	-0.05	0.05

*Represents $p<0.05$

4.2.5 Dhaka City Corporation

The increase in vector/mosquito borne diseases in Dhaka city has been quite remarkable over the last 5-10 years, according to the FGD, workshop and community meeting. Diarrheal and cholera outbreaks were reported, especially in densely populated slum areas of Dhaka. Large number of cases of other water borne diseases like hepatitis and typhoid fever were also mentioned. Acute hepatitis, skin diseases in all age groups, malignancy, gastroenteritis, respiratory diseases, dust allergy during dry period, and heart disease were reported to be increasing in the last 10 years. Fever, common cold and dysentery are diseases found very common among the respondents of household survey.

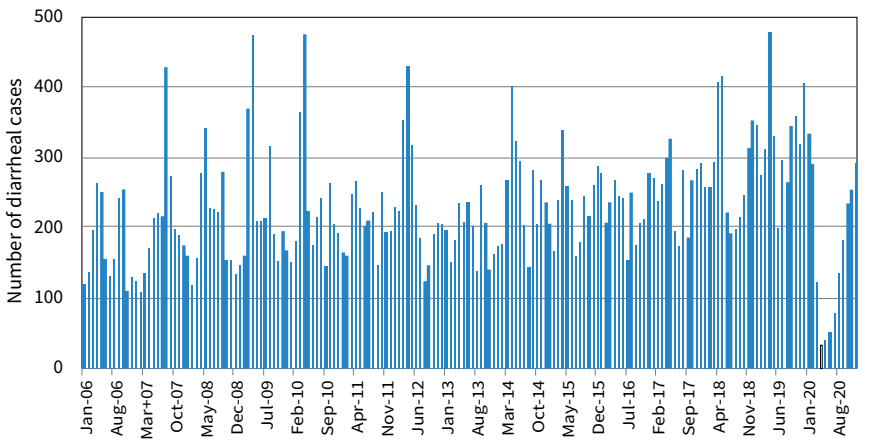


Figure 4.16: Monthly variation of diarrheal cases admitted in icddr,b, Dhaka during 2006 – 2020

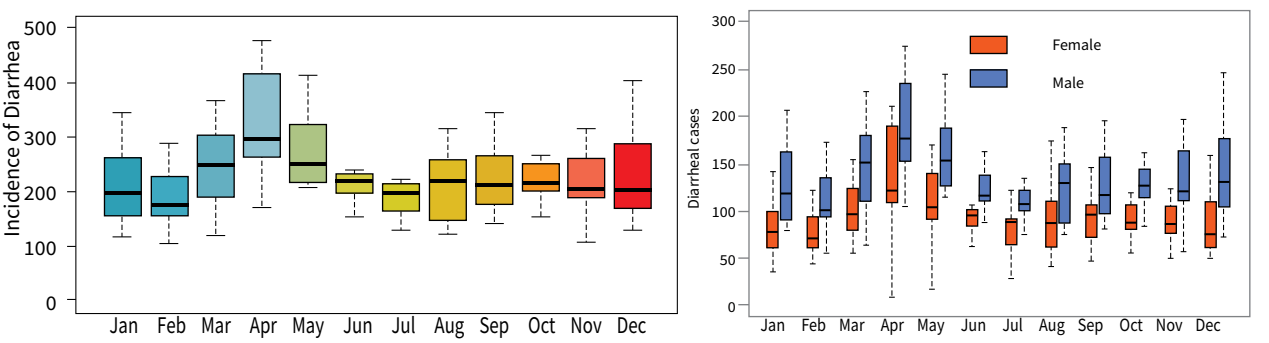


Figure 4.17: Boxplot of monthly mean of diarrheal cases (left) and gender disaggregated diarrheal cases (right) of Dhaka with data from icddr,b during 2006-2020

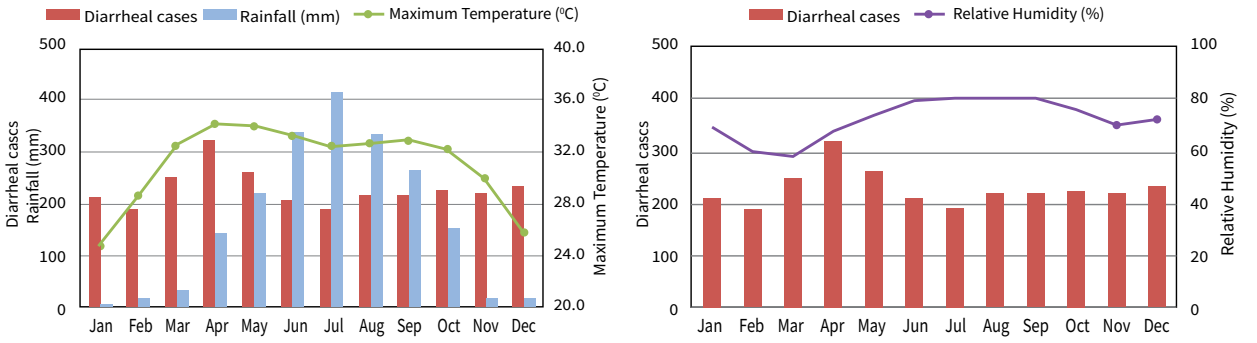


Figure 4.18: Monthly mean Diarrheal cases, rainfall (mm), maximum temperature (°C) and relative humidity (%) for 2006- 2020

Figure 4.16 shows the monthly variation of diarrheal cases admitted in icddr,b, Dhaka during 2006 – 2020. A large number of diarrheal patients were admitted in icddr,b, Dhaka for their treatment during this period. In Figure 4.17, monthly mean of diarrheal cases admitted in icddr,b during 2006-2020 has been plotted in the boxplot, in which the highest mean and number showed in April which is the warmest (high temperature) and driest (low rainfall and low humidity) month in Dhaka (Figure 4.18). In Dhaka, male admitted most for diarrhea in icddr,b all the round of the year (Figure 4.17). Both statistical analyses (PCC and SCC) (Table 4.7) showed a strong and significant correlation with maximum temperature and positive diarrheal cases at 0 lag (PCC = 0.42 and SCC = 0.46), and PCC of the same for 1 month lag showed low but significant relationship (PCC = 0.15). Very low but negative significant relationship was found with relative humidity at all lags ranging between -0.15 (PCC 0 lag) and -0.31 (PCC 1 month lag). No significant relationship was found with the rainfall at any lag of both PCC and SCC.

Table 4.7: Cross-correlation (Pearson's and Spearman correlation coefficient) of climatic variables and diarrheal diseases in Dhaka with a lag of 0 to 2 months

Lag	0 month (no lag)		1 month		2 months	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	-0.02	0.05	-0.05	-0.01	-0.10	-0.09
Maximum Temperature	0.42*	0.46*	0.15*	0.11	-0.06	-0.04
Relative humidity	-0.15*	-0.16*	-0.31*	-0.23*	-0.26*	-0.22*

*Represents p<0.05

During 2006-2020, out of all diarrheal cases recorded in icddr,b Dhaka, 13% were identified as cholera patients. Figure 4.19 shows the monthly variation of cholera cases admitted in icddr,b, Dhaka during 2006 to 2020. In Figure 4.20, monthly mean of cholera cases admitted in icddr,b Dhaka during 2006-2020 has been plotted in boxplot, in which the highest mean and number showed in April and May, and mostly male admitted for cholera. The relationship between cholera and climatic variables (maximum temperature, rainfall, and

relative humidity) during 2006-2020 has been shown in Figure 4.21. From this figure, we can see that long-term dry period (low rainfall and low humidity from November to February) and high temperature (starts in March) caused sudden increase of cholera cases in April. Both statistical analyses (PCC and SCC) in Table 4.8 showed a strong and significant correlation of cholera cases with both maximum temperature and rainfall found at 0- and 1-month lags ranging between 0.24 (PCC at 1 month lag) and 0.48 (SCC at 0 lag). The SCC at 2 months lag was found low but significant relationship with both rainfall and temperature was found. No or low relationship was found between humidity and cholera cases (significant SCC = 0.17 at 0 lag and -0.19 at 1 month lag).

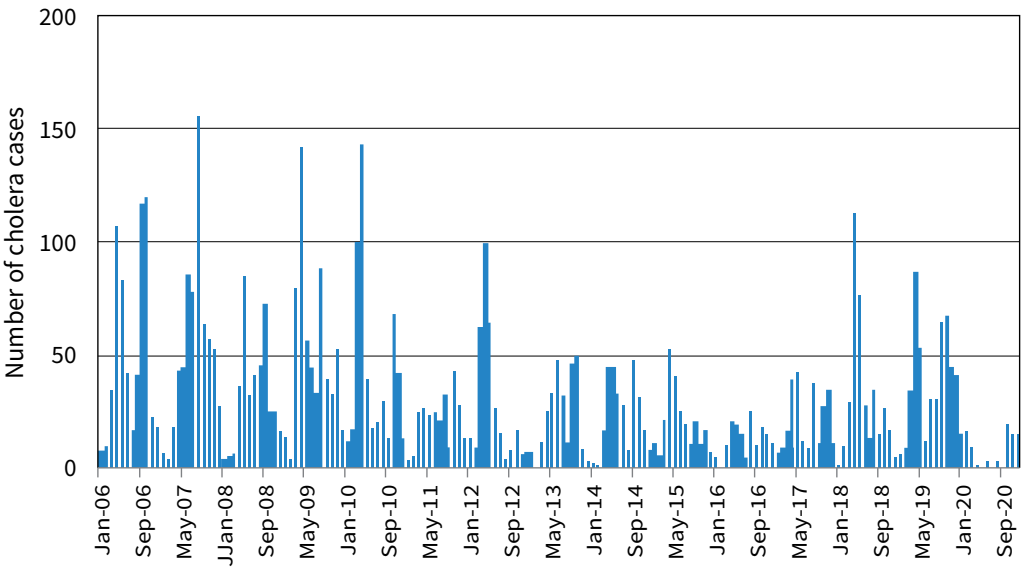


Figure 4.19: Monthly variation of cholera cases admitted in icddr,b, Dhaka during 2006 – 2020

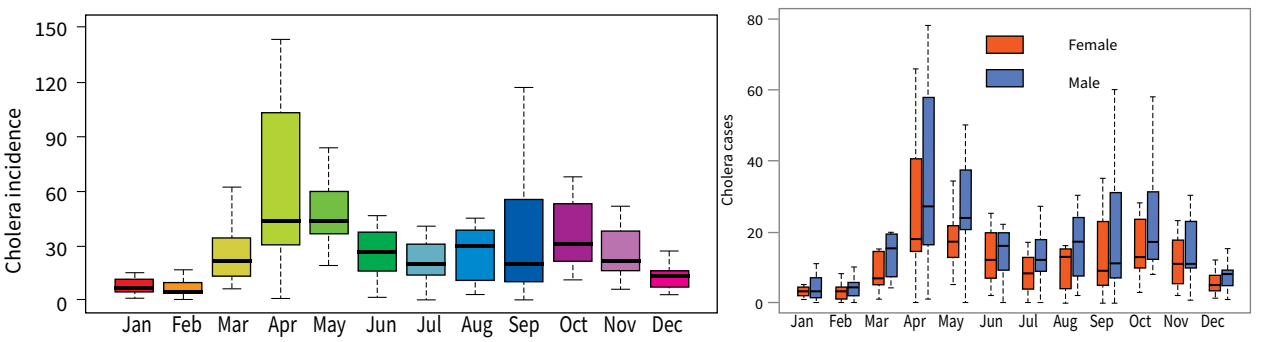


Figure 4.20: Boxplot of monthly mean cholera cases (left) and gender disaggregated cholera cases (right) admitted in icddr,b of Dhaka during 2006-2020

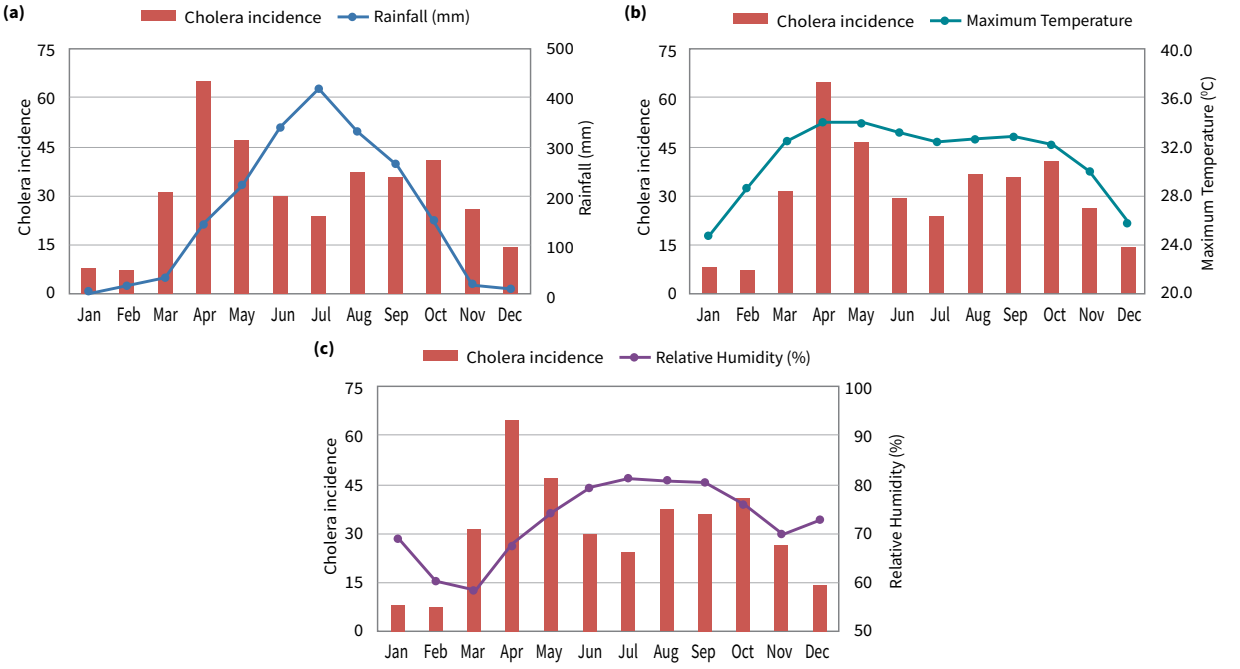


Figure 4.21: Relation between monthly mean (a) cholera cases and rainfall (mm); (b) cholera cases and maximum temperature (°C); (c) cholera cases and relative humidity (%) during 2006-2020

Table 4.8: Cross-correlation (Pearson's and Spearman correlation coefficient) of climatic variables and cholera cases in Dhaka with a lag of 0 to 2 months

Lag	0 month (no lag)		1 month		2 months	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	0.27*	0.35*	0.24*	0.32*	0.08	0.16*
Maximum Temperature	0.43*	0.48*	0.36*	0.40*	0.09	0.17*
Relative humidity	0.11	0.17*	-0.13	0.03	-0.19*	-0.09

*Represents p<0.05

Shigella is one of the leading bacterial causes of diarrhea worldwide, which causes an estimate of 80-160 million cases, and is mostly common in children. Out of all diarrheal cases admitted in icddr,b Dhaka, 2.5% were identified as shigella patients among which 54% were children below 5 years of age. Figure 4.22 shows the monthly variation of shigella cases admitted in icddr,b, Dhaka for the period from 2006 to 2020. Monthly mean of shigella cases admitted in icddr,b Dhaka during 2006-2020 has been plotted in boxplot (Figure 4.23), in which the highest mean and number showed in May. The relationship between shigella and climatic variables (maximum temperature, rainfall, and relative humidity) during 2006-2017 has been shown in Figure 4.24, in which the highest shigella cases occurred in May which is the month of high temperature, low rainfall and low humidity. From statistical analyses (PCC and SCC) in Table 4.9, maximum temperature and shigella cases showed moderate but significant correlation at all lags ranging between 0.22 (SCC at 2 months lag) and 0.31 (PCC at 1 month lag). No or low relationship was found for both rainfall and relative humidity.

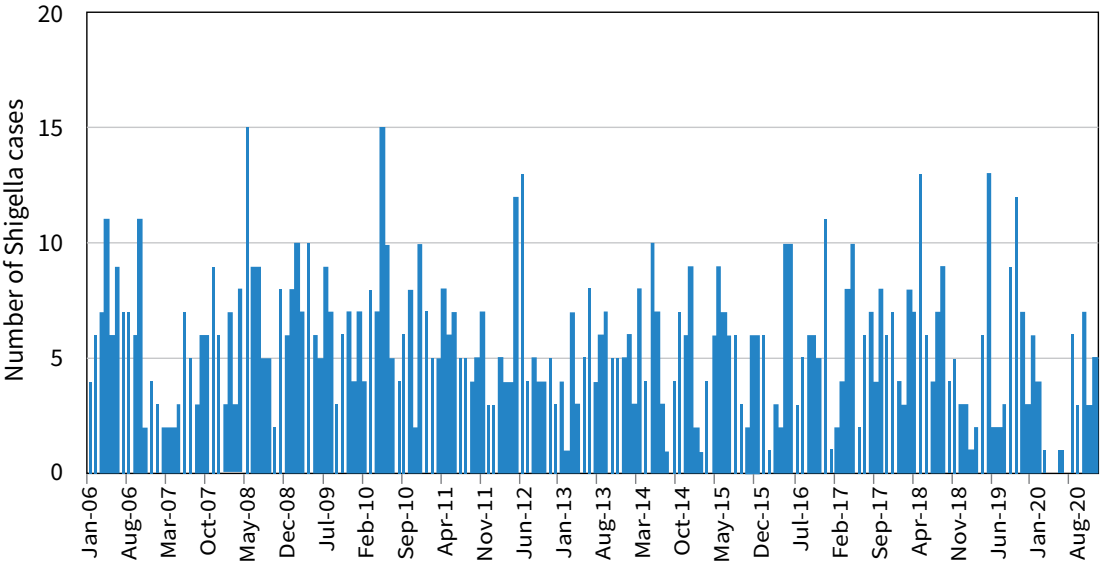


Figure 4.22: Monthly variation of shigella cases admitted in icddr,b, Dhaka during 2006 - 2020

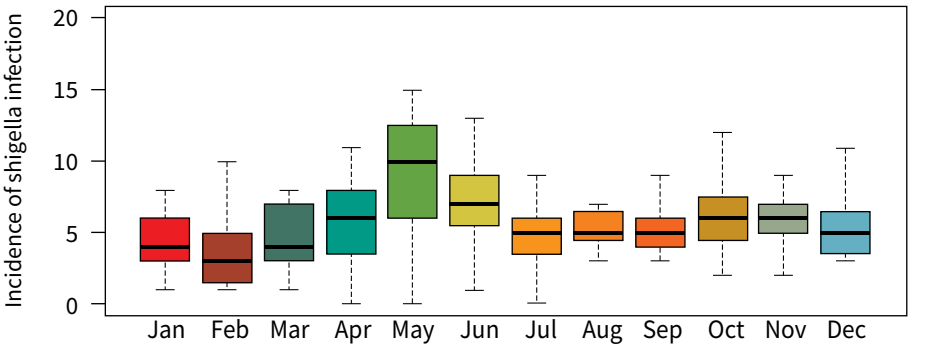


Figure 4.23: Boxplot of monthly mean incidences of Shigella-infection in Dhaka during 2006-20202006 - 2020

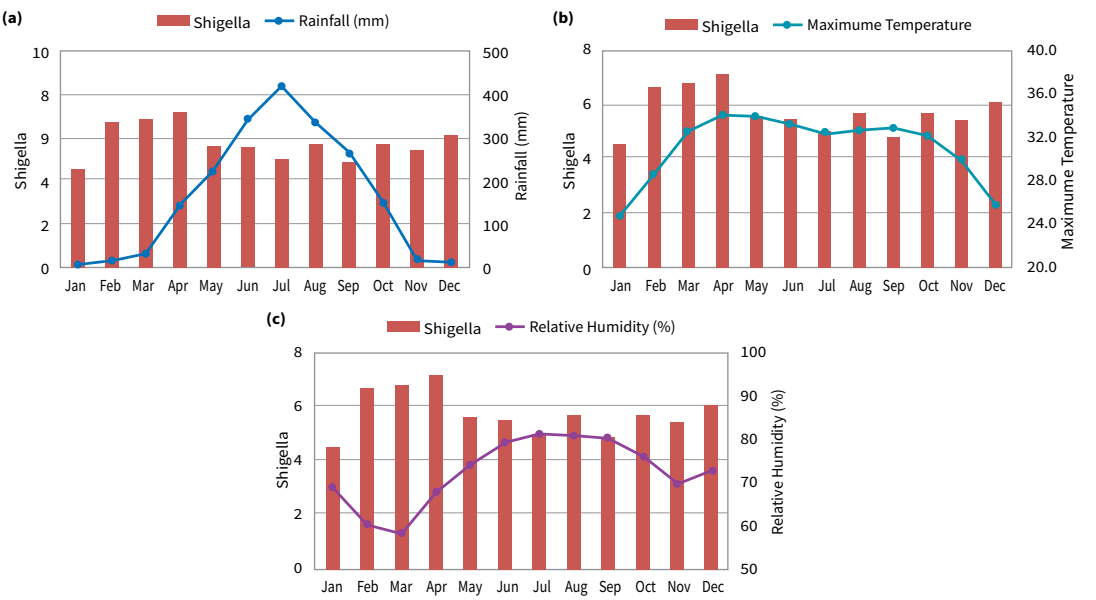


Figure 4.24: Relation between monthly mean (a) shigella cases and rainfall (mm); (b) shigella cases and maximum temperature (°C); and (c) shigella cases and relative humidity (%) during 2006-2020

Table 4.9: Cross-correlation analysis of climatic variables (Pearson's and Spearman correlation coefficient) and Shigella in Dhaka with a lag 0 – 2 months

Lag	0 month (no lag)		1 month		2 months	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	0.13	0.15	0.08	0.13	-0.07	0.01
Maximum Temperature	0.24*	0.25*	0.31*	0.25*	0.24*	0.22*
Relative humidity	0.12	0.11	-0.03	-0.01	-0.16*	-0.10

*Represents $p<0.05$

The annual variation of reported dengue cases and deaths during 2000 to 2019 is plotted in Figure 4.25, where it is seen that deaths decreased in relation to dengue cases over the years till 2014. However, dengue increased periodically from 2015, while in 2019 there was an outbreak of dengue all over the country (mostly Dhaka city). Figure 4.26 showed the monthly mean of dengue cases in Dhaka city during 2000 to 2019 as a boxplot, in which dengue cases in the pre-monsoon (January-May) were found negligible in number, while most cases were reported during monsoon and post-monsoon seasons (June to December). The relationship between dengue and climatic variables (maximum temperature, rainfall, and relative humidity) during 2000-2019 is shown in Figure 4.27, where it can be observed that after long- term dry period (low rainfall and low humidity for November to February) and high temperature (starts in March), there was sudden increase of dengue cases from July that continues till December. Statistical analyses (PCC and SCC) are shown in Table 4.10. A strong and significant correlation (SCC) with rainfall and relative humidity was found at all lags (0, 1 and 2 month), while strong and significant SCC was found for maximum temperature at 2-month lag only. However, PCC was found low for all variables at all lags. This is due to high dengue cases in 2019 comparing to other years. The calculation method of PCC and SCC is another reason for this variability. PCC evaluates the linear relationship between two continuous variables, while SCC is based on the ranked values for each variable rather than the raw data.

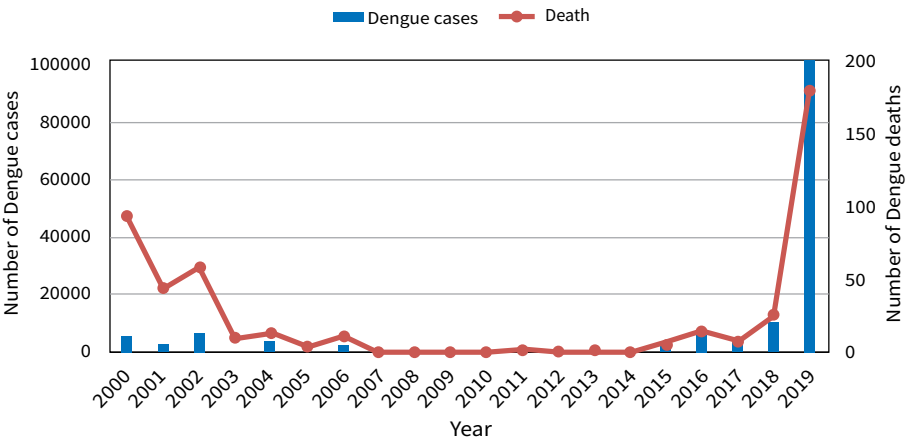


Figure 4.26: Boxplot of monthly mean incidences of dengue in Dhaka during 2000-2019

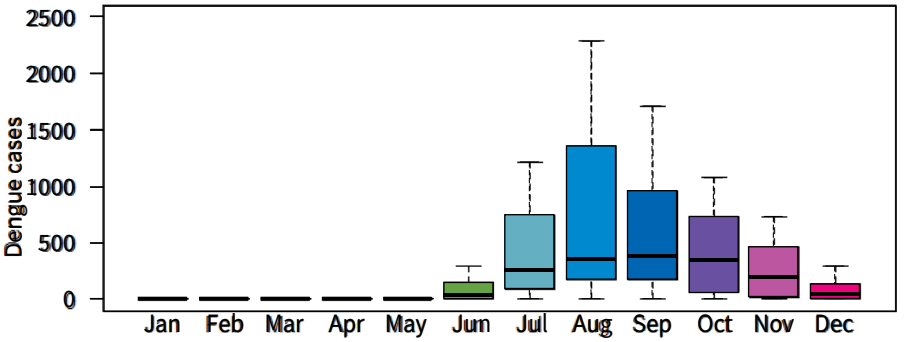


Figure 4.26: Boxplot of monthly mean incidences of dengue in Dhaka during 2000-2019

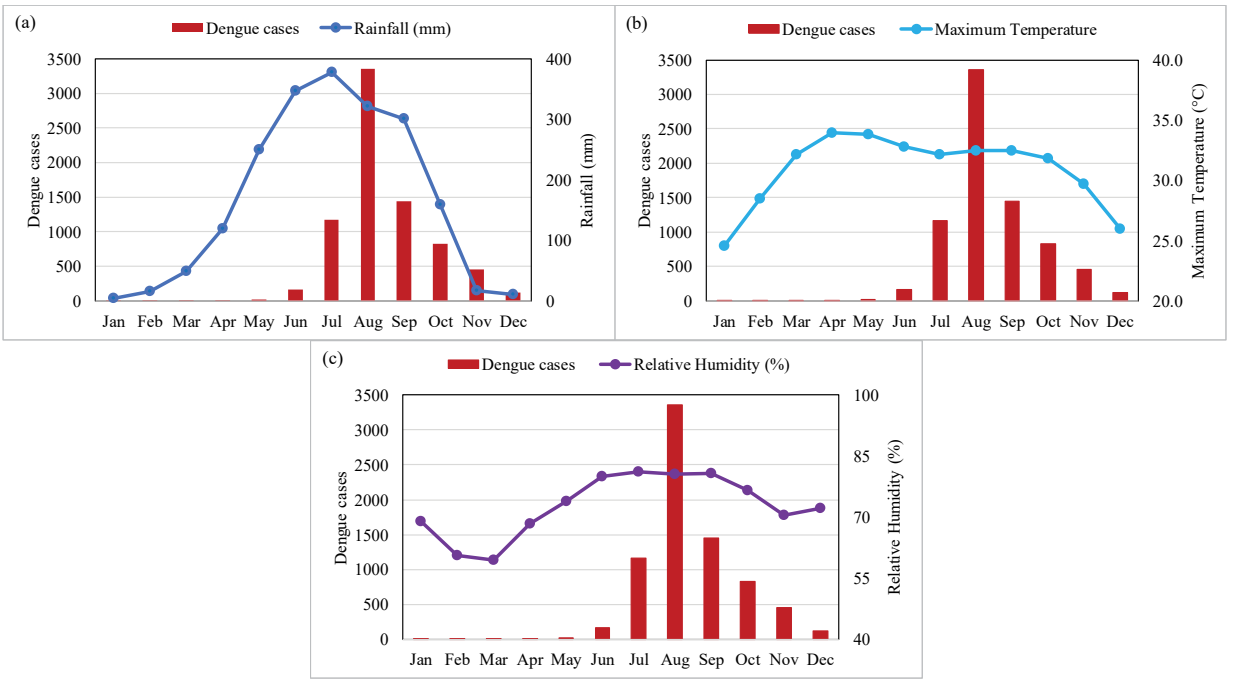


Figure 4.27: Relation between monthly mean (a) dengue cases and rainfall (mm); (b) dengue cases and maximum temperature (°C); and (c) dengue cases and relative humidity (%) during 2000-2019

Table 4.10: Cross-correlation analysis of climatic variables (Pearson's and Spearman correlation coefficient) and dengue in Dhaka with a lag 0 – 2 months

Lag (month)	0		1		2	
	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient	Pearson's correlation coefficient	Spearman correlation coefficient
Rainfall	0.07	0.38*	0.11	0.61*	0.10	0.69*
Maximum Temperature	0.11	0.12	0.12	0.34*	0.14*	0.51*
Relative humidity	0.13*	0.55*	0.16*	0.63*	0.12	0.54*

*Represents $p<0.05$

4.3 Conclusions

In Ullapara, most diarrheal cases were found in June because of long term low rainfall and high temperature (Figure 4.2, Table 4.2). In Birampur and Dhaka, diarrhea affected most in April, but the statistical analyses showed different reason behind the highest number of diarrheal cases in similar month. The analysis showed that the reason for the highest number in April and the highest mean in February is the low temperature at 1- and 2-month lag and dry weather (that means low relative humidity) (Table 4.3). But in Dhaka, the analysis showed that high temperature and low humidity (Table 4.7) caused the peak diarrheal cases in April (Figure 4.17). In Patuakhali, the peak of diarrheal cases is in May (Figure 4.8), because of low rainfall for long time (Table 4.4). The diarrheal cases showed peak in Rangamati in December (Figure 4.11) because of low rainfall and low temperature (Table 4.5). In Dhaka, the peak of

cholera cases is in April (Figure 4.20), because of high temperature (Table 4.8). Malaria cases for 6 years (2015 – 2020) in Rangamati general hospital have been analyzed, where it was found that high rainfall, high temperature and high humidity cause peak of malaria cases in June to August (Figure 4.14, Table 4.6).

Through the gender disaggregated data analysis for four years for diarrhea and six years for malaria, it was found that in Birampur and Patuakhali, male and female admitted almost equally in hospital due to diarrhea. In Rangamati, female admitted most in hospital for diarrheal cases whereas male was affected most in malaria in this area. In Ullapara, male was affected most in diarrhea. From the analysis of 15 years of icddr.b of Dhaka for diarrheal and cholera cases, it is clearly found that male patients were admitted most in hospitals.

The limitation of the analyses presented here is lack of disease data as the data were available only for four years in Ullapara, Birampur, Patuakhali and Rangamati, which may not be sufficient to find the real scenario. To present a comprehensive analysis and find a definite relationship, 15 years of data needed to be analyzed which was only found for Dhaka. Therefore, it is recommended that the disease database should be improved at both local and national level to help similar research works in future.

Chapter 5

Health System Vulnerability and Preparedness

5.1 Introduction

A health system consists of all organizations, people, and actions whose primary intent is to promote, restore or maintain health. This includes efforts to influence determinants of health as well as more direct health-improving activities (WHO, 2000). According to the World Health Organization (WHO), a well- functioning health care system requires a financing mechanism, a well-trained and adequately paid workforce, reliable information on which to base decisions and policies, and well maintained health facilities to deliver quality medicines and technologies. An efficient health care system can contribute to a significant part of a country's economy, development, and industrialization.

One of the main aspects of effective health care delivery system is good governance. Strengthening the health system through better management and organization, and effective use of resources can improve health conditions and enhance the quality of health care delivery. The Government or public sector is the key actor which by constitution is responsible not only for developing policy and regulation, but for ensuring provision of comprehensive health services, including financing and employment of health staff.

In Bangladesh, the Ministry of Health and Family Welfare, through the two Directorates General of Health Services (DGHS) and Family Planning (DGFP), manages a dual system of general health and family planning services through district hospitals, Upazila Health Complexes at sub-district level, Union Health and Family Welfare Centers at union level, and community clinics at ward level. In addition, the Ministry of Local Government, Rural Development and Cooperatives manages the provision of urban primary care services. Quality of services at these facilities, however, is quite low due to insufficient allocation of resources, institutional limitations and absenteeism or negligence of providers (WHO, 2015).

The Bangladesh public health system remains highly centralized, with planning undertaken by the Ministry of Health and Family Welfare and little authority delegated to local levels. The statutory health system, in principle, covers all citizens with a range of services. However, many sick people every year are left untreated in practice. Furthermore, Bangladesh is characterized by "shortage, inappropriate skill mixes and inequitable distribution" of its health workforce (WHO, 2015). These centralized, statutory health system and inappropriate skill mix, and inequitable distribution are somehow affecting delivery of quality and efficient services.

In chapter 4 of this report, discussion of some of the climate sensitive diseases such as malaria, dengue fever, diarrhea, etc., and the relationship between the patterns of these diseases with different climatic parameters was discussed. In this chapter, a discussion of the current health care system and thus health system vulnerability and preparedness of climate sensitive diseases from the community point of view is presented.

To examine the health system vulnerability and its preparedness, a few indicators were considered in the study. During the household questionnaire survey, the respondents were asked to express their opinion on these indicators, which include:

- Type of treatment facilities availed by the community (e.g., government, private),
- Quality of treatment services (outdoor and indoor service),
- Cost involvement to get the services,
- Accessibility to health facilities and travel time,
- Human resources involved for providing health care delivery
- Preparedness of the health system (availability of services, infrastructure, savings, etc.) in relation to extreme weather events such as cyclone, floods and so on.

In addition to collecting opinions of the respondents from household level, these points were also discussed during the FGD and workshops to get feedback from the health professionals and other relevant stakeholders. The findings for all five study areas are presented in this chapter.

5.2 Treatment providers in study areas

It was found from the household survey that government and private hospitals play a significant role for providing health care to the community (Table 5.1). The results show that large percentage of the respondents in Patuakhali (72%) and Rangamati (69%) Upazilas reported that they mostly depend on government hospitals, while half of the respondents in Ullapara (50%) and Birampur (56%) go to government hospitals. In Dhaka (urban area), one third of the respondents (30%) go to government hospitals for treatment. However, private hospitals are also playing a vital role for providing health care in these areas. In Ullapara, Birampur, Patuakhali and Rangamati, 37%, 34% and 26%, and 16% respondents mostly go to private healthcare facilities, respectively, while it is 32% in Dhaka City Corporation. Another big aspect of health care provider is registered doctors' chamber. In Ullapara, Birampur, Patuakhali, Rangamati and Dhaka, 8%, 10%, 14%, 19% and 29% respondents mostly go to them for their health care needs, respectively. Interestingly, it appears from the table that pharmacy (local medicine sellers) stores

are playing a vital role for providing health care in the community by selling unprescribed medicine, although it is not officially accepted by the current health system of Bangladesh. Table 5.1 shows the detail relating treatment providers in those respective localities.

The current circumstances of treatment facilities and preferences remain almost similar comparing to the report published by Environmental Health Unit of WHO Bangladesh in 2015. The report highlighted that a significant percentage of surveyed community people (51%) visited the Upazila Health Complexes, which is the secondary level of government service, followed by the community health center (28%).

Table 5.1: Treatment provider at the selected community (n=166 at each of five study areas)

Treatment Provider	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Government hospital	83 (50%)	93 (56%)	119 (72%)	114 (69%)	50 (30%)
Private hospital	62 (37%)	57 (34%)	43 (26%)	26 (16%)	53 (32%)
Community clinic	6 (4%)	4 (2%)	3 (2%)	13 (8%)	2 (1%)
Union health care center	3 (2%)	0 (0%)	1 (1%)	6 (4%)	0 (0%)
NGO healthcare center	3 (2%)	0 (0%)	0 (0%)	5 (3%)	1 (1%)
Pharmacy	12 (7%)	11 (7%)	22 (13%)	6 (4%)	40 (24%)
Registered doctors chamber	13 (8%)	17 (10%)	23 (14%)	19 (11%)	48 (29%)
Village physician	7 (4%)	4 (2%)	2 (1%)	0 (0%)	0 (0%)

The respondents were also asked if they prefer the same service provider for availing treatment that they are mostly dependent on. For example, the respondents who said that they mostly depend on the government hospitals were asked if they prefer the same service provider or they would prefer any other service providers. Except for Dhaka City Corporation, no significant difference was found as the respondents who said are mostly dependent on government hospital also prefer government hospital in other four study areas. However, in Dhaka City Corporation, while 30% respondents were found mostly dependent on government hospital, only 13% reported that it is their preferred option. In contrast, 32% respondents said that they mostly depend on private hospitals whereas 53% said that they would prefer private hospitals.

It can be observed from the studies that respondents preferring government hospitals in Dhaka are less than those of rural areas. The findings indicate that people in rural areas are more reliant on government hospital than private, whereas in Dhaka, higher percentage of people visit private hospitals to get health care service. A reason for this could be the high population density in Dhaka where number of government hospitals are insufficient to serve the huge population of the city. This may have some relationship with the financial ability as well as quality of service too as people in Dhaka have the ability to afford the services of private hospitals.

Table 5.2: Respondents preference for getting service in study areas (n=166 at each of five study areas)

Treatment Provider	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Government hospital	80 (48%)	91 (55%)	91 (55%)	109 (66%)	22 (13%)
Private hospital	61 (37%)	54 (33%)	54 (23%)	23 (14%)	88 (53%)
Community clinic	0 (0%)	0 (0%)	0 (0%)	11 (7%)	0 (0%)
Union health care center	1 (1%)	0 (0%)	0 (1%)	3 (2%)	0 (0%)
NGO healthcare center	1 (1%)	0 (0%)	0 (0%)	3 (2%)	0 (0%)
Pharmacy	10 (6%)	5 (3%)	5 (9%)	4 (2%)	5 (3%)
Registered Doctors chamber	13 (8%)	16 (10%)	16 (12%)	13 (8%)	51 (31%)
Village physician	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

5.3 Perception on outdoor and indoor service

In Bangladesh, public hospital provides treatment in two ways, outdoor and indoor services. Short and outpatient consultations are known as outdoor

services whereas the service provided to the patients who are admitted and stay in the hospital for curative or diagnostic purposes is known as indoor services. Surgical, medical, and diagnostic services are included in the indoor services. Secondary and tertiary hospitals provide outdoor patients services beyond their capacity in terms of qualified health care professionals or medicines or diagnostic services and thus, the issue of quality of services and patients satisfaction comes up.

In response to satisfaction with outpatient health services of these health facilities, some of the respondents were unable to answer as they did not have any experience of getting outdoor/indoor service from the hospitals. Among those respondents who have had such experience, most of the respondents have expressed their satisfaction (Table 5.3) because of good treatment, associated with health services, and availability of medicine (Table 5.4). In Patuakhali, 75% of the total respondents were satisfied with outdoor treatment, which is the highest among all the study areas, with only 8% expressing their dissatisfaction over the outdoor service. However, a significant percentage of the respondents in areas of Ullapara (23%) and Birampur (21%) expressed their dissatisfaction. The reasons for dissatisfaction are poor service at the hospital, lack of quality treatment and unavailability of medicine (Table 5.5). In general, among the respondents who had experience of outdoor service in the hospitals, one in every three respondents in Ullapara and Birampur, one in every six in Rangamati, and one in every ten in Patuakhali and Dhaka expressed their dissatisfaction.

Table 5.3: Satisfaction, dissatisfaction of the outdoor treatment service (n=166 at each of five study areas)

Response	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Yes	74 (45%)	78 (47%)	125 (75%)	66 (40%)	81 (49%)
No	38 (23%)	35 (21%)	14 (8%)	14 (8%)	9 (5%)
Not applicable[4]	54 (33%)	53 (32%)	27 (16%)	86 (52%)	76 (46%)

Table 5.4: Reason for satisfaction of the outdoor treatment service (n=166 at each of five study areas)

Response	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Good Treatment	32	34	85	36	16
Overall service is good	28	29	29	18	65
Medicine is available	14	15	11	12	0

Table 5.5: Reason for dissatisfaction of the outdoor treatment service

Response	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Treatment is not good	10	10	1	5	2
Overall service is not good	18	14	9	6	2
Doctor is insufficient	4	9	3	1	1
Medicine is not available	3	2	1	1	2
No one wants to work without money	3	0	0	1	2

[4] The respondents who never went to the health care facilities by themselves and hence, were unable to comment.

In response to satisfaction over indoor treatment services, the percentage of respondents satisfied with indoor service facilities was found slightly lower (Table 5.6) than the satisfaction percentage for outdoor services, except for Patuakhali where the percentage of satisfied respondents is the highest. The reason behind satisfaction is good treatment, medical services by the providers, associated health services, and availability of medicine (Table 5.7). However, there is a significant percentage of respondents, 27% in Ullapara and 23% in Birampur, have expressed their dissatisfaction of currently available health services (Table 5.6). According to them, the main reasons for dissatisfaction are lack of quality treatment, insufficient doctors, and unavailability of medicine and health care facilities (Table 5.8), which is almost similar to their responses for outdoor hospital services. Interestingly, the satisfaction level of outdoor and indoor services remains almost similar like a previous study (EHU, WHO, 2015).

Table 5.6: Satisfaction, dissatisfaction of the indoor treatment service (n=166 at each of five study areas)

Response	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Yes	67 (40%)	75 (45%)	124 (75%)	60 (36%)	70 (42%)
No	45 (27%)	38 (23%)	15 (9%)	20 (12%)	20 (12%)
Not applicable[5]	54 (33%)	53 (32%)	27 (16%)	86 (52%)	76 (46%)

Table 5.7: Reason for satisfaction of the indoor treatment service (n=166 at each of five study areas)

Response	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Good Treatment	34	38	81	12	16
Medical Service is good	28	19	34	35	51
Medicine is available	5	18	9	13	3

Table 5.8: Reason for dissatisfaction of the indoor treatment service

Response	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Treatment is not good	11	3	1	1	4
Overall service is not good	20	16	11	4	11
Doctor is insufficient	9	6	3	13	2
No one wants to work without money	3	5	0	1	1
Unhelpful	2	6	0	1	1
Corruption	0	2	0	0	1

5.4 Health system during extreme weather events

Climate change has been obvious in different forms of extreme weather events such as heat waves, floods, and cyclones, which are causing major loss of life, injury, and damage to critical infrastructures. All these extreme events have direct and indirect impact on health services' capacity. Furthermore, displacement and loss of livelihood due to sea level rise, riverbank erosion

[5] The respondents who never went to the health care facilities by themselves and hence, were unable to comment.

and other extreme events are leading to increased poverty, damage of water source, food insecurity due to impact on agriculture, and ultimately towards poorer health. Trauma associated with deaths during cyclones and illness, loss of employment and loss of community can cause mental health issues. Moreover, water-borne or food-borne diseases along with infectious disease are increasing more than before due to the impact of the extreme events. Therefore, it is important to keep the health care facilities functional along with other necessary services during the extreme weather events.

In all five study areas, most of the respondents reported that the nearby hospitals (government or private) in their respective localities remained open and functional during extreme weather events such as flood or cyclone (Table 5.9). However, 8% respondents in both Ullapara and Birampur, and 11% in Dhaka reported that the nearest hospitals in their localities were not providing normal service during such events. The main reasons of this were either lack of water or power supply, or insufficient number of doctors and support staff. Since power outage or lack of water supply is a common phenomenon in Bangladesh during the extreme weather events, this finding is also reflecting the health system vulnerability to some extent. It is quite evident that there is not much difference in the responses about the functionality of hospitals during extreme weather conditions between urban and rural areas.

Table 5.9: Functionality of the closest hospital during extreme weather events like flood or cyclone (n=166 at each of five study areas)

Response	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Yes	153 (92%)	164 (99%)	164 (99%)	152 (92%)	147 (89%)
No	13 (8%)	2 (1%)	2 (1%)	14 (8%)	19 (11%)

5.5 Accessibility to nearest health care facility

Quicker access to the health services saves lives especially in acute cases, such Eclampsia, Myocardial Infarction, or Stroke. Therefore, short distance traveled, and less time required by the communities to reach the nearest hospitals is an indicator of better health system. To get the health services in the study areas, participants travel 1 to 2 km (Table 5.10) and in most of cases it requires around half an hour to an hour (Table 5.11). However, in Rangamati hilly area, 41% participants needed to travel more than 5 km to get the medical services although they require less time to reach to the facilities as there are less traffic on the road. Rickshaw (a three-wheeler operated by human) and paddle van are the main mode of transport to go to the health facilities in the rural areas except in Rangamati, where most of the respondents used CNG (four stroke three wheeler vehicle) to go to the health facilities (Table 5.12). The percentage of respondents who have hospitals within less than 0.5 km was highest in Dhaka city (96%), while in all other study areas more than 80% respondents have a hospital within this distance.

Table 5.10: Distance to the nearest hospital (n=166 at each of five study areas)

Distance (km)	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
≤0.5	34 (21%)	63 (38%)	35 (21%)	32 (19%)	29 (17%)
1	77 (46%)	50 (30%)	45 (27%)	24 (14%)	67 (40%)
2	38 (23%)	16 (10%)	39 (23%)	8 (5%)	36 (22%)
3	17 (10%)	37 (22%)	47 (28%)	29 (17%)	18 (11%)
4	0	0	0	5 (3%)	16 (10%)
>5	0	0	0	68 (41%)	0

Table 5.11: Time required to reach the nearest hospital (n=166 at each of five study areas)

Time (hour)	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
≤0.5	137 (83%)	139 (83%)	144 (87%)	140 (84%)	160 (96%)
1	29 (17%)	26 (16%)	16 (10%)	20 (12%)	6 (4%)
2	0	1 (1%)	0	5 (3%)	0
3	0	0	6 (4%)	1 (1%)	0

Table 5.12: Mode of transport used by respondents to reach nearest hospital (n=166 at each of five study areas)

Mode of transport	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
Bus	10 (6%)	0	0	0	36 (22%)
Rickshaw	139 (84%)	140 (84%)	145 (87%)	0	135 (81%)
Paddle Van	82 (49%)	69 (42%)	57 (34%)	29 (17%)	57 (34%)
Private Car	5 (3%)	3 (2%)	0	1 (1%)	56 (34%)
On foot	40 (24%)	24 (14%)	1 (1%)	9 (5%)	23 (14%)
Boat	0	0	0	19 (11%)	0
Others (CNG)	0	0	0	130 (78%)	0

5.6 Out of pocket expenditure

Out of pocket expenditure for getting health services represents another important aspect of health system. Although health services are supposed to be free in the public hospitals of Bangladesh but still people spend a significant amount of money for getting their service either by paying for medicine or investigation or going to private hospital.

The income level of the respondents in the study areas are presented in Figure 5.1. The figure indicates that most of the surveyed respondents have income within the range of BDT 60,000 to 6,00,000 per year. Only in Dhaka, a high percentage of respondents (25%) were found earning more than BDT 6,00,000 per year reflecting the higher affordability of the city dwellers in Dhaka compared to other aeras.

Higher expenditure for health need increases the vulnerability of people. The study found that 19% of the respondents of Ullapara, 18% respondents of Birampur, 13% respondents of Patuakhali, 17% respondents of Rangamati and only 5% respondents of Dhaka city are likely to spend more than BDT 35,000 (US$ 450) for their health services (Table 5.13) in a year.

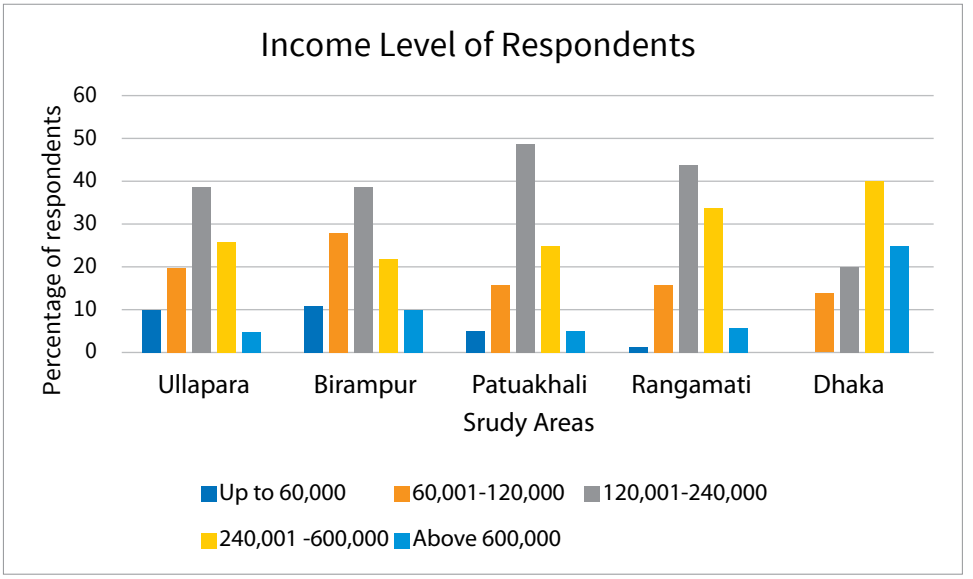


Figure 5.1: Income level of the respondents in study areas

Table 5.13: Respondents annual average cost for healthcare support (n=166 at each of five study areas)

Expenditure Range (BDT)	Ullapara	Birampur	Patuakhali	Rangamati	Dhaka
< 5,000	26 (16%)	16 (10%)	26 (16%)	8 (5%)	41 (25%)
5,000-10,000	32 (19%)	32 (19%)	55 (33%)	50 (30%)	40 (24%)
10,000-20,000	37 (22%)	45 (27%)	41 (25%)	48 (29%)	42 (25%)
20,000-35,000	39 (23%)	43 (26%)	22 (13%)	31 (19%)	35 (21%)
> 35,000	32 (19%)	30 (18%)	22 (13%)	29 (17%)	8 (5%)

5.7 Assessment of health professionals

In terms of health system vulnerability and preparedness, the previous study (EHU-WHO, 2015) did not focus much on this aspect. However, the study report mentioned that health system was not sufficient considering staff number, monitoring and supervision, data recording system, and health prevention activities to deal with the health effects during extreme weather events. The report (EHU-WHO, 2015) also mentioned that there was not many relevant health sector activities on adaptation in the study areas (such as Zianagar Upazila under Pirojpur District, Patharghata Upazila under Barguna district, and Sapahar Upazila under Naogaon district). The study also identified the shortage of health staff and specialists in the community clinics and hospitals. However, the health staff (doctors, nurses, and technicians) from those study areas mentioned that the infrastructure and health system was adequate although there was insufficient technical and support staff and medicines.

From our group discussions and workshops with health professionals and other stakeholders, we found some recurring findings regarding the health system vulnerability. Skilled manpower shortage was the

most common finding. There were no dedicated personnel at local level to work on impact of climatic issues or extreme weather events on health and

health system. Another major issue found was the lack of coordination between various stakeholders. There is no regular in-service training or coordination meeting for healthcare professionals on the discussed topic. Local public health budget constraints were another major issue found to have negative impact on health system vulnerability, particularly on the areas of mass awareness, program sustainability and emergency management fund.

Other common issues found in each study area were the lack of initiative to improve the Infection Prevention Control aspect of healthcare facilities, lack of dedicated ward for infectious diseases, lack of proper diagnostic machineries, over dependance of health system on clinicians (absence of manpower in some disciplines like epidemiologist, nutrition specialist, data management officer, etc.) and lack of a proper public health surveillance system. Overall, in most places, respondents mentioned that road communication has been much improved than before and does not pose a big issue for the health system now. However, respondents of Rangamati mentioned that a better communication network (road infrastructure) for remote hilly places is needed to improve the health system's adaptability for the hard- to-reach areas.

5.8 Conclusion

A high percentage of the community people in all the study areas go to public hospitals followed by private hospitals for their health need. In addition, registered doctors and pharmacies are still playing a big role for providing immediate health care in the community (Table 5.1), where the latter is an issue of concern, especially in Dhaka city. Respondents in rural areas were found preferring the government hospitals more compared to Dhaka city dwellers, which could be due to higher number of private hospitals in Dhaka city to serve the need of a large population. However, most of the participants are satisfied with current outdoor and indoor hospital services (Table 5.3, 5.4).

The communication system has improved significantly in the recent past as people can travel to the hospitals quickly nowadays, except for the hard-to-reach areas. While the health professionals said that the health systems are prepared for extreme weather events such as floods or cyclones (Table 5.6), the survey respondents opined that there are still some limitations such as lack of water supply, insufficient number of doctors in the hospitals. It is evident from the household survey findings that the health system's response to extreme weather at the local level is yet to reach at effective level. The study finds

that although the health system has improved since the last study published in 2015, it is still in vulnerable condition to meet the needs during the extreme weather events.

There is a need for capacity building of the health professionals on climate change related health issues to better deal with the climate sensitive diseases. Training programs for the health professionals on identifying climate sensitive diseases, awareness campaigning at local level, better coordination among the stakeholders, and resource allocation for facilitating the activities throughout the year, especially to deal with emergency, are the major requirement to improve the preparedness of health system at the local level.

Chapter 6

Vulnerability and Adaptation Assessment

6.1 Introduction

In the previous three chapters, statistical as well as perceived impacts of climate change on different sectors including health (chapter 3), relationship between changing climate and climate sensitive diseases (chapter 4), and health system vulnerability and preparedness in the face of changing climate and major disasters (chapter 5) in the study areas were discussed. While all those discussions provide the background information required to understand the vulnerabilities of the communities and health system, and current adaptative system in the focused areas, this chapter will discuss the results of the vulnerability and adaptation assessment (VAA) for the five study areas using a scoring tool. The methodology used for the assessment followed the scoring system used in Vulnerability Reduction Assessment (VRA) by Crane Doesh, A. (2008). The scores have been obtained through discussions in groups with necessary caution during the FGD, workshop and community meetings. During the discussions, 10 questions were asked to the participants of each event, who were told to use the H-form for scoring where they responded to each question on a 3-point scaling system such as highly agree (score=1), moderately agree (score=2), and disagree (score=3). After compiling the responses of the participants, the scoring on VAA was calculated based on the following equation:

$$\text{VAA score} = \sum (s_1 n + \cdots s_i n_i) / N \qquad (1)$$

where:

s= nominated scale (i= 1 to 3)

n= number of respondents for scale i

N= total number of respondents

The total score was then allocated for each area by averaging the scores from three sources, as follow:

$$\text{Total Vulnerability} = \textit{Score of \{FGD + Workshop + Community\}} / 3 \qquad (2)$$

In this method, a low score indicates high vulnerability and/or low adaptive capacity, and the high score indicates low vulnerability and/or high adaptive capacity.

6.2 VAA score of Ullapara Upazila

The summary of VAA scores for different communities of Ullapara Upazila is presented in Table 6.1. According to FGD, the VAA score is 1.5 which indicates mid-point of high to moderate vulnerability due to climate change. From both workshop and community meeting, the VAA scores was found 1.21. The total vulnerability score of the Upazila is **1.31** which indicates that the area belongs to high vulnerability areas due to climate change as far as health and health system is concerned.

Table 6.1: Summary of the VAA scores of Ullapara Upazila (Highly agree = S1, moderately agree = S2, Disagree =S3)

Questions	FGD (n=8)	Workshop (n=21)	Community meeting (n=10)
There are new types of health issues currently (last 5-10years) that have not been noted before in this area	-	-	-
There are increases in particular health conditions thathas been observed over time	1	1	1
There are particular geographical areas within the community that have suffered for climate change	1	1	1
There are CSD identified in the community that have impacted current health condition and will impact futurehealth condition as well	1	1	1.5 (S1=5, S2=5)
Currently there are significant problems with waterquality/water quantity in this area	2	1.28 (S1=18, S2=3)	2
There are particular CC related phenomena (e.g., temperature rise, irregular rainfall, sea level rise, etc.) that are important from a health perspective	1	1	1
There are CC impacts on current sanitation system	1	1.19 (S1=19, S2=2)	1.2 (S1=6, S2=4)
There are CC impact on nutrition and food availability	2.5 (S2=4, S3=4)	1.33 (S1=14, S2=7)	1.2 (S1=8, S2=2)
The current health structure and system is adequate tosupport the needs of the community	2	2.28 (S1=15, S3=6)	1
The management structure for programs relevant to climate sensitive health outcomes for future need toimprove	2	2	1
VAA =	=13.5/9 =1.5	=10.9/9 =1.21	=10.9/9 =1.21
Total Vulnerability = (1.5 + 1.21 + 1.21) = 1.31			

6.3 VAA score of Birampur Upazaila

The summary of VAA scores for different communities of Birampur Upazila is presented in Table 6.2. According to FGD, the VAA score is **1.54** which indicates mid-point of high to moderate vulnerability due to climate change. From the workshop and community meeting, the VAA scores were found 1.42 and 1.35, respectively. The total vulnerability score of the Upazila is 1.44 which indicates that the area belongs to high vulnerability areas due to climate change as far as health and health system is concerned.

Table 6.2: Summary of the VAA scores of Birampur Upazila (Highly agree = 1, Moderately agree = 2, Disagree = 3

Questions	FGD (n=8)	Workshop (n=15)	Community meeting (n=8)
There are new types of health issues currently (last 5- 10 years) that have not been noted before in this area	-	-	-
There are increases in particular health conditions thathas been observed over time	1	1	1
There are particular geographical areas within the community that have suffered for climate change	1	1	1
There are CSD identified in the community that have impacted current health condition and will impactfuture health condition as well	1	1	1.5 (S1=4, S2=4)
Currently there are significant problems with water quality/water quantity in this area	1	1	1

There are particular CC related phenomena (e.g., temperature rise, irregular rainfall, sea level rise, etc.) that are important from a health perspective	1	1	1
There are CC impacts on current sanitation system	1.75 (S1=2, S2=6)	1	1
There are CC impact on nutrition and food availability	2.5 (S2=4, S3=4)	2.33 (S2=10, S3=5)	2.5 (S2=4, S3=4)
The current health structure and system is adequate tosupport the needs of the community	2.5 (S2=4, S3=4)	2.27 (S2=11, S3=4)	2.125 (S2=7, S3=1)
The management structure for programs relevant to climate sensitive health outcomes for future need toimprove	1.125 (S1=7, S2=1)	2.2 (S2=12,S3=3)	1
VAA =	1.54	1.42	1.35
Total Vulnerability = (1.54 + 1.42 + 1.35) = 1.44			

6.4 VAA score of Patuakhali Sadar Upazila

The summary of VAA scores for different communities of Patuakhali Sadar Upazila is presented in Table According to FGD, the VAA score is 1.58 which indicates mid-point of high to moderate vulnerability due to climate change. From the workshop and community meeting, the VAA scores were found 1.46 and 1.44, respectively. The total vulnerability score of the Upazila is **1.49** which indicates that the area belongs to high vulnerability areas due to climate change as far as health and health system is concerned.

Table 6.3: Summary of the VAA scores of Patuakhali Sadar Upazila (Highly agree = 1, Moderately agree = 2, Disagree = 3)

Questions	FGD (n=8)	Workshop (n=16)	Community meeting (n=9)
There are new types of health issues currently (last 5- 10 years) that have not been noted before in this area	-	-	-
There are increases in particular health conditions thathas been observed over time	1	1	1
There are particular geographical areas within thecommunity that have suffered for climate change	1	1	1
There are CSD identified in the community that have impacted current health condition and will impactfuture health condition as well	1.75 (S1=2, S2=6)	1.625 (S1=10, S2=6)	1.77 (S1=7, S2=2)
Currently there are significant problems with waterquality/ water quantity in this area	2	1	1
There are particular CC related phenomena (e.g., temperature rise, irregular rainfall, sea level rise, etc.) that are important from a health perspective	1	1	1
There are CC impacts on current sanitation system	2	2	2
There are CC impact on nutrition and food availability	2.5 (S2=4, S3=4)	2	1.77 (S1=4, S2=3, S3=2)
The current health structure and system is adequateto support the needs of the community	2	2.5 (S2=8, S3=8)	2.44 (S2=5, S3=4)
The management structure for programs relevant toclimate sensitive health outcomes for future need toimprove	1	1	1
VAA =	1.58	1.46	1.44
Total Vulnerability = (1.58 + 1.46 + 1.44) = 1.49			

6.5 VAA score of Rangamati Sadar Upazila

The summary of VAA scores for different communities of Patuakhali Sadar Upazila is presented in Table According to FGD, the VAA score is 1.48 which indicates mid-point of high to moderate vulnerability due to climate change. From the workshop and community meeting, the VAA scores were found 1.52 and 1.47, respectively. The total vulnerability score of the Upazila is **1.49** which indicates that the area belongs to high vulnerability areas due to climate change as far as health and health system is concerned.

Table 6.4: Summary of the VAA scores of Rangamati Sadar Upazila (Highly agree = 1, Moderately agree = 2, Disagree = 3)

Questions	FGD (n=9)	Workshop (n=15)	Community meeting (n=8)
There are new types of health issues currently (last 5- 10 years) that have not been noted before in this area	-	-	-
There are increases in particular health conditions that has been observed over time	1.33 (S1=6, S2=3)	2	2
There are particular geographical areas within thecommunity that have suffered for climate change	1	1	1
There are CSD identified in the community that haveimpact-ed current health condition and will impact future health condition as well	1.44 (S1=6, S2=3)	1	1
Currently there are significant problems with waterquality/ water quantity in this area	1.33 (S1=6, S2=3)	1.6 (S1=6, S2=9)	1
There are particular CC related phenomena (e.g., temperature rise, irregular rainfall, sea level rise, etc.)that are important from a health perspective	1	1	1
There are CC impacts on current sanitation system	2.33 (S2=6, S3=3)	1.33 (S1=9, S2=6)	2
There are CC impact on nutrition and food availability	1.44 (S1=5, S2=4)	1.67 (S1=5, S2=10)	2
The current health structure and system is adequateto sup-port the needs of the community	2	2.4 (S2=9, S3=6)	2.25 (S2=6, S3=2)
The management structure for programs relevant toclimate sensitive health outcomes for future need toimprove	1.44 (S1=5, S2=4)	1.67 (S1=5, S2=10)	1
VAA =	1.48	1.52	1.47
Total Vulnerability = (1.48 + 1.52 + 1.47) = 1.49			

6.6 VAA score of Dhaka City Corporation

The summary of VAA scores for different communities of Patuakhali Sadar Upazila is presented in Table According to FGD, the VAA score is 1.72 which indicates the vulnerability is more skewed towards the moderate vulnerability level due to climate change than other four study areas. From the workshop and community meeting, the VAA scores were found 1.72 and 2.04, respectively. The total vulnerability score of the city is **1.83** which indicates that the area belongs to moderate vulnerability zone due to climate change as far as health and health system is concerned.

Table 6.5: Summary of the VAA scores of Dhaka City Corporation (Highly agree = 1, Moderately agree = 2, Disagree = 3)

Questions	FGD (n=6)	Workshop (n=6)	Community meeting (n=8)
There are new types of health issues currently (last 5-10 years) that have not been noted before in this area	2	2	2
There are increases in particular health conditions that has been observed over time	1	1	2
There are particular geographical areas within the community that have suffered for climate change	1.33 (S1=4, S2=2)	1.33 (S1=4, S2=2)	3
There are CSD identified in the community that have impacted current health condition and will impactfuture health condition as well	1	1	1.25 (S1=6, S2=2)
Currently there are significant problems with water quality/water quantity in this area	1	1	1
There are particular CC related phenomena (e.g., temperature rise, irregular rainfall, sea level rise, etc.) that are important from a health perspective	2	2	1
There are CC impacts on current sanitation system	2.83 (S2=1, S3=5)	2.83 (S2=1, S3=5)	3
There are CC impact on nutrition and food availability	2.83 (S2=1, S3=5)	2.83 (S2=1, S3=5)	3
The current health structure and system is adequate to support the needs of the community	2.167	2.167	2.75 (S2=2, S3=6)
The management structure for programs relevant to climate sensitive health outcomes for future need toimprove	1	1	2
VAA =	1.72	1.72	2.05
Total Vulnerability = (1.72 + 1.72 + 2.05) = 1.83			

6.7 Conclusion

The VAA score of the study areas represent the vulnerability of these areas in terms of health and health system. In all five study areas, the VAA scores were found lower than 2 (moderately agreed). Out of five locations, the VAA scores was the lowest in flood prone Ullapara (1.31) indicating that the health system is the least capable to address the issues raised due to its climatic conditions. The VAA score of drought- prone (1.44), coastal (1.49) and hilly (1.49) areas show close to mid-point of high and moderate vulnerability. However, Dhaka city's overall VAA score is 1.83, which indicates that Dhaka city is less vulnerable compared to the rural areas. The improved health infrastructure and health system is contributing to high VAA score in Dhaka city. Better sanitations and food availability in Dhaka compared to other study areas is also contributing to its moderate VAA score (1.83).

The VAA score is a score the combines the vulnerability in terms of current climate sensitive diseases, climatic conditions, current health system, nutrition status, water quality and quantity, and the future predictions of climate change in a particular area. Participants of the study areas responded as per their best knowledge and experiences without any interference. Furthermore, this study also did research on health system vulnerability and preparedness (Chapter 5) of those communities to know the current infrastructure, human resources and other necessary services related to health care delivery. Findings from both these chapters indicate high vulnerability and less adaptability to health issues due to

climate change. Especially, the health systems in rural areas are more vulnerable and thus needs adequate programs to improve and more resources to cope the climate change impact. This VAA score also indicates that direct health care services such as identification of climate sensitive diseases, and associated services such as ensuring water quality and quantity need priority attention in rural areas.

As this VAA score is indicative of and representing the current health circumstances and future health issues related to climate change, policy makers, implementers, planners, and community people could take this into account for future planning and designing of future programs. However, as it was conducted in a very small scale, thus it may not be representative of the whole country. Thus, it is recommended to conduct a representative VAA scoring for a larger sample size (areas) for better understanding and future planning.

Chapter 7

Health Sector Policies and Programmes

7.1 Introduction

Bangladesh is well oriented with natural disasters and the effect of climate change, which is evident in different national policy documents as most of these policies have recognized the disastrous effect of climate change and addressed those effects in their respective sectors. Therefore, it is expected that the health sector policies and its development program planning documents have given a greater emphasis on building a resilient health system to combat the impact of climate change on health. However, not all policies have addressed the climate change related factors and effects on health sector adequately yet. Furthermore, the implementation of a policy is influenced by various factors and activities of varying cross-cutting issues involving different sectors, which also need to be addressed in the policies for effective implementation at the filed level.

The central planning document that is guiding the current development programs of Bangladesh is the '8th Five-year plan'. This plan is influenced by the Sustainable Development Goals and various national policies. In addition, different sectors of the Government have their own policies and development programs. In this chapter, we will discuss the significant policies and programs that shape the development trajectory of the health sector and evaluate them on addressing climate sensitive health outcomes.

7.2 National Policies:

There are several national policies addressing the health issue in Bangladesh. For our review, we identified major policy documents related to or that address the impact of climate change on health and discussed in brief how these policies are addressing climate change. Apart from the 8th five‐ yearplan, additional relevant policies like National Agriculture Policy, National Food policy, National Climate Change Strategy, and Action Plan will also be discussed briefly, highlighting the sections related to health. Although the effectiveness of these policies are discussed based on the outcomes as a whole, measuring the effectiveness of policies in addressing the climate change is not straightforward, as so many other sectors remain involved in the scenario that also need to be assessed, which is difficult.

7.2.1 8th fiveyear plan

The Eighth Five-year plan of Bangladesh is considered as the key document that illustrates the strategy and action plan of the country to achieve its development goals, which is also aligned with the Sustainable Development Goal (SDG) targets. This document addresses the effect of climate change in detail. Regarding the impact of climate change on health, this planning document has prioritized strengthening of all tiers of the health system and better prepare it for emergency response, increasing the capacity of the health sector for coordinated post-disaster management and protecting people's

health from climate change (chapter 10, page-593). This document has also stressed the importance of health research to evaluate the adverse effect of climate change on health. Overall, considering the above statements, we think this plan has listed the essential activities regarding the health system's adaptability to climate change. Relevant Ministries will now need to adapt these strategic plans into their work plan, and then the impact of these activities will start to materialize. As a part of this national planning document, the health sector has its own sector plan,' 4th Health Nutrition and Population Sector Program (HPSNSP)'. This health sector program will be discussed in the next section.

7.2.2 Health policy 2011

National health policy 2011 has identified climate change and related natural disasters as critical challenges for better health. It plans to have a coordinated effort to mitigate climate change's effect on health (goal number 18). To assess climate change's long-term or short-term impact on health, this document suggested having regular assessments (action plan 34). Another directive of this policy is to have a separate program to control the burden of climate-sensitive diseases (action plan 34). Following this health policy, the climate change and health promotion unit under the health ministry was established. Although this policy addresses some critical aspects of the impact of climate change on health, the action plans are not specific enough to guide the health system to adapt to climate change. We recommend updating this policy with a definite action plan on climate sensitive health outcomes.

7.2.3 National Urban Health Strategy 2014

A significant portion of the Bangladeshi population lives in urban cities. However, the public health aspect of urban health has not seen a coordinated approach since there is a separate governance structure for cities. National Urban Health Strategy was developed to address this gap. This strategy discussed the effect of climate change on the urban population, like the migration of people from highly affected areas. However, it fails to address the rise of climate-sensitive diseases like mosquito-borne diseases (i.e.,

dengue, chikungunya). It also was unable to address the vulnerability of the health system and the importance of coordinated efforts between different sectors to protect the people from climate-sensitive harmful health outcomes. A new urban health strategy is being developed, which might address these gaps in the current strategy.

7.2.4 Other relevant policies

7.2.4.1 Bangladesh Climate Change Strategy and Action Plan 2009:

This strategy provided direction to Bangladesh's climate change adaptation activities in 2009. It was the first comprehensive and focused strategy and action plan on climate change. However, it provided very few strategic directives on the health aspect. It provided strategic guidance on improving access to basic health services, implementing a surveillance system to detect the emergence of diseases, and improving the WASH status of vulnerable populations. It also stressed the importance of research on the impact of climate change on health. However, it paid little attention to emerging climate-sensitive health outcomes.

Also, the effect of migration and urbanization on health is not discussed here. Moreover, it lacked a costing part and did not identify the roles of different stakeholders, which is a significant limitation of this plan.

7.2.4.2 National Food and Nutrition Security Policy of Bangladesh (NFNSP) 2020:

This latest policy by the Government addresses the effect of climate change on nutrition in several ways. First, this policy suggested strengthening social protection and safety nets for people vulnerable to climate change and natural disasters. Second, to prevent food insecurity, it focuses on several fronts: introducing climate-smart technologies that are tolerant of drought, flood, heat, cold weather, and salinity; raising improved breeds of livestock and poultry that can withstand climatic extremes; and strengthening regulatory management, climate resilience and gender roles and regulations (strategy 4). However, the impact of those newer technologies or breeds on human health should be assessed before introducing, which the policy failed to address. Moreover, this policy was unable to address climate-sensitive nutritional disorders.

7.2.4.3 National Agriculture Policy 2018 and National Agricultural Mechanization Policy 2020:

These two strategic documents addressed the adaptability of the agriculture sector to the disastrous effect of climate change and extreme weather events. The sustainability of the agriculture sector is crucial to meet the nutritious demand of the population. The agriculture policy addresses climate change by focusing on strengthening research on the effect of climate change on crops and developing innovative

technologies suitable to the changing environment. This policy also focused on sustainable development, heat/cold/flood/salinity tolerant crop production, and the translation of the latest scientific knowledge to increase production. The National Agricultural Mechanization Policy also focused on sustainability, advocating using the newest technologies to make agricultural work more efficient and resilient to natural disasters and climate change.

7.2.4.4 National Plan for Disaster Management (2016-2020):

This national document has addressed the health system's vulnerability to and resiliency from extreme weather events. This comprehensive document highlighted the importance of the health system strengthening across all tiers by capacity building, leadership development, and community engagement. In addition, this document has stressed the importance of a resilient health system in dealing with disaster-induced health events. The importance of coordinated, comprehensive effort is also rightly mentioned in the mission statement: "To achieve a paradigm shift in disaster management from conventional response and relief to a more comprehensive risk reduction culture, and to promote food security as an important factor in ensuring the resilience of communities to hazards." In a nutshell, we think this could be a highly effective policy document to guide health-related activities during disasters, if followed properly.

7.2.4.5 Long term strategic documents of Bangladesh:

There are several documents denoting the long-term development strategies of Bangladesh. Notable of those documents are Vision 2041 and Bangladesh Delta plan 2100. In the planning document of Vision 2041 a lot of emphasis has been provided in creating a climate resistant nation (chapter 12). However, health system adaptability issue is not directly addressed. Health system strengthening is mentioned as a vital issue in the chapter 5, however, the importance of this in the context of health system vulnerability due to climate change is not linked directly. Bangladesh Delta plan 2100 is more focused on planning to mitigate the overall effect of climate change. This document too does not directly address the health system vulnerability and adaptability. Nevertheless, in chapter 8 of this document, the issue of food security and sustainable nutrition has been discussed. Our recommendation will be to plan future strategic documents with clear objectives regarding health system adaptability through health system strengthening using latest evidence on health system vulnerability, which has been missing in the planning documents mentioned above.

7.3 National Programmes and Implementation:

The health sector of Bangladesh has seen significant improvement over the last 30-40 years. Most of the health indicators have greatly improved and achieved the millennium development goals before due time. For example, neonatal mortality is now 16 per 1,000 live births, and the maternal mortality ratio has gone down to 169 per 100,000 live births (BBS, 2019). Many of the communicable diseases of the past is now near elimination, partly because of the phenomenally successful child immunization program. Overall, the population's health has been improved, and this success can be attributed to its long list of development programs over the last two decades. Many of these development programs are being conducted under a health sector program. This sector program and an additional program dedicated to climate change adaptability under the health ministry are discussed here. Also, implementation of the programs at local level are discussed in brief.

7.3.1 4th Health Nutrition and Population Sector Program (HPSNSP)

Bangladesh has been following a Sector-Wide Approach (SWAp) in the health sector since 1998. The sector wide approach (SWAp) is an approach that brings together the Government, development partners (DPs) and other stakeholders within a single sector policy and expenditure program under Government leadership, adopting common approaches across the sector and progressing towards relying on Government procedures to disburse and account for all funds. Currently, from 2017, the 4th HPSNP is being implemented, which will end in 2023. The objectives and activities of this program can be considered as the national health sector development strategy of Bangladesh.

This sector program has a strategic implementation plan (SIP) and a project implementation plan (PIP). From the PIP, we can see that climate change has been given importance in this program. According to this document, Bangladesh plans to respond to 'the threats of climate change on health in several different ways; by developing programmatic activities that address key priority areas (e.g., early warning systems, desalinization) or by strengthening the health systems

in a horizontal manner'. This program has several operation plans, and different aspects of climate change are addressed in the respective programs.

This program is being implemented for more than 4 years now. A mid-term review of the program has been conducted, and this review has allowed us to evaluate this program. According to the mid-term review, the program has spent around 90% of its allocated money in its three years of operation, which signifies the implementation success. The health system strengthening components have used over 94% of its allocated money. Increased utilization of allocated money is a good indicator of program management capacity, and it predicts a better future for this sector. A significant amount of that money was spent on human manpower development, capacity building, medicine procurement, vaccine, logistics, and conducting various research studies. Regarding specific outcome-based programmatic indicators, by the end of 2019, this program achieved 84 indicators (74%) and partially achieved 15 indicators (13%).

As per the operational plans, significant work has been done in those three years on many areas related to climate change, such as control of climate-sensitive diseases, improvement of nutrition status, increasing the capacity of hospitals system, etc. The activities include training, surveillance, supervision, guidelines development, treatment support, logistics support, direct financial support, mass awareness and advocacy activities. However, the major indicators like maternal mortality ratio, neonatal mortality ratio is still yet to reach their targets. And the enormous challenge of ensuring essential basic health service package in all health facilities is still not met. The report did not highlight the activities related to community engagement and public awareness regarding the effect of climate change on health. From the multistakeholder workshops and FGDs, it is evident that much more work is needed in community engagement and public awareness activities. However, in terms of operational indicators, this program has seen success in most of its indicators.

This mid-term review also describes some of the big challenges in the implementation of this program. Workforce shortage in the health system is one of the significant challenges in strengthening and making a resilient health system. While a lot of work has been done in the rural sites, urban areas are left out because of the local government system, which controls the health system of the cities separately. This dual system has a negative impact on the implementation of the program.

Under this program, specific operation plans that are related to climate change are:

- Communicable Disease Control: This operational plan addresses different communicable diseases, including climate sensitive diseases. Some of the planning and works have been done on vector-borne diseases like malaria, dengue, and other neglected tropical diseases in high-risk areas of the whole country. In addition, this national program has recently started to address food-borne diseases like cholera, diarrhea, hepatitis, etc. Also, this national program has been working on improving the IPC (infection prevention and control) system of hospitals.

- Non-communicable Disease Control: This program has a specific component to address the health issues from natural disasters and climate change. Mostly, training of the healthcare workers and community awareness activities has been done from this program.

- Hospital Service Management and Community Based Health Care: These two programs have been addressing the strengthening of the country's hospital system. A lot of works has been done on providing logistics, machineries, training of the human manpower, waste management system improvement, etc.

Overall, 4th HPNSP is addressing several crucial aspects of the health system's adaptability to climate change. However, we believe a separate operational plan on climate change adaptability within this sector program and in the future sector programs with separate budget is essential to control climate sensitive health outcomes effectively. This operational plan can work on public awareness activities, health manpower orientation activities, surveillance, epidemiological research, disaster response etc. Special attention is needed to enhance the surveillance of climate sensitive diseases and manage those cases early. Specific public health measures should be directed to overall systems strengthening and also to particular climate sensitive diseases.

7.3.2 Climate change and health promotion unit of MOHFW

Different programs under the Ministry of Health are working on the various aspects of health related to climate change separately. For example, there is a program for addressing nutritional issues, controlling vector-based infections, strengthening hospital capacity, etc. However, one specific program under the Ministry of Health is dedicated to coordinating the activities called 'Climate Change and Health Promotion Unit'. This unit was established with the objective of capacity building and health system strengthening to combat the health impact of climate change. Major activities of this unit are coordination of different ministerial or sectoral programs related to climate change, promoting health awareness, conducting research on the effect of climate change on health and planning, and implementing climate change related health programs. After establishing this cell, few research works and health promotional activities (e.g., providing safe drinking water facility such as Reverse Osmosis plant for school children and health care centers) have been conducted through this cell. However, detailed activity or achievements of this unit in addressing climate-sensitive health outcomes was not found on their website or in any report.

7.4 Implementation at Local Level:

We reviewed how local health authority and other relevant authorities plan and to address the effect of climate change and implement the above discussed strategies. From our workshop with local health authorities during the FGDs, it became clear that the authorities have detailed ideas about handling a disaster and post disaster health management. However, there is a lack of knowledge on the effects of climate change on health, especially on identifying the climate sensitive diseases, and required planning of activities to reduce the effect of climate change on health system. Most of the authorities lack knowledge on the abovementioned national strategies and planning as well. It was found during the FGDs and workshops that field level health workers and

health managers also have less idea about how these health sector policies or programs are addressing climate change adaptability. There was no yearly planning found regarding adaptation to or mitigation of natural disasters or climate change either. Furthermore, it was evident from the discussion that the local health administration is involved with various activities with acute manpower shortage. Thus, it becomes very difficult for them to pay attention to climate change related health system vulnerability issues, unless there is a particular program in the system related to this. Our recommendation will be to regular orient the local health managers by a dedicated program of the health sector on climate change. Ministry of Health and Family Welfare should solve the manpower crises at the field level and they should create a designated public health officer post in every tier of health administration (Upazila Health Office, Civil surgeon office and divisional health office) to work on this specific targeted area.

7.5 Conclusion and Recommendation:

From our review, we have found several strategies or policies addressing health system's adaptability to climate change. Completing the ongoing programs should strengthen the country's health system to better prepare for dealing with climate sensitive health outcomes. However, some of the major public health indicator is still not improving as per the target. Advocacy of health managers, community awareness and surveillance activities considering climate change adaptation also need significant strengthening. There is no dedicated single strategic action plan for coordinating and supervise (from the perspective of climate change) all these activities. We recommend formulating a precise and objective- oriented dedicated action plan, which should include necessary aspects of health system's adaptability including the followings:

- Urban health program with special attention to health workers working at the community/ward level.
- Integrated public health surveillance program.
- Identifying and mitigating health impact of migration.
- Coordination between different programs and the communication between the field and central levels.
- Orientation of the health managers is also crucial for the successful implementation of those policies and programs.

Limited data on the impact of climate change on health is a big challenge while developing these strategic documents. Our recommendation will be to conduct more operational and epidemiological research works to provide specific data needed for developing specific planning. For example: regular VA assessment, impact of climate change on migration health, epidemiology of emerging diseases across the country etc. Another recommendation will be to strengthen the ongoing activities of 4th HPNSP related to health system strengthening. The 5th HPNSP is going to be in the planning phase from 2022. This is the best place to include activities related to health system's adaptability with dedicated budget. Our recommendation will be to involve the climate change public health specialists in the planning of this program. We also recommend having a strong, financially sustainable dedicated program with dedicated manpower under the health sector to coordinate all these activities in relation to the effect of climate change on health.

Chapter 8

Conclusions and Recommendations

8.1 Introduction

In 2011 VAA study, water-borne diseases, vector-borne diseases, and mental health due to climate change, and some policy implications in Bangladesh were discussed. However, there was no vulnerability and adaptation assessment in this report. In 2015 VAA study, geographically two distinct areas (drought prone area and coastal area) were selected, where health profile and trends were discussed. In this report, vulnerability and adaptation assessment was discussed based on the WASH programs in the selected areas. The current study was focused on health risk factors in a few of the climate vulnerable regions of Bangladesh.

During the household survey, FGD, workshop and community meeting in all five study areas, most of the respondents reported about the increase of temperature, prevailing longer summer, and shorter winter period than before that has also been proved with the meteorological department data showing 0.2-0.4°C increase of maximum temperature during summer (April – September) in the study areas. Community people also mentioned about the changing of rainfall pattern with more cases of erratic rainfall that has also been found while checking with the available rainfall data. These factors affected various sectors, for example, due to increase of temperature, presence of different and new types of insects are being found in agriculture and lack of availability of fresh water has affected food security. These factors are affecting the health sector as well, as some of the health issues are being found related to the changing climate. The analysis of some reported water-borne and vector-borne disease data showed that temperature and rainfall variability are causing increase of specific diseases.

Among the climate sensitive diseases (CSDs) analyzed in the study areas, most diarrheal cases have been found in June in Ullapara due to low rainfall and high temperature while in Birampur and Dhaka, people suffer in diarrhea mostly in April; in Patuakhali in May and in Rangamati in December. However, statistical analyses showing variability of lags of 0 – 2 months of low rainfall, high/low temperature and low humidity may cause peak diarrhea at various study areas. Peak malaria cases have been found during June – August due to high rainfall, humidity and temperature. However, lack of availability of sufficient diseases data also limits the statistical analyses towards establishing a good relationship with climatic variables. Male and female suffered in diarrhea almost equally in all areas, and male suffered most in malaria in Rangamati. In Dhaka, male admitted most in icddr,b for diarrhea and cholera. However, health vulnerability of male and female were found almost equally vulnerable in the study areas.

Vulnerability, and adaptation assessment (VAA) score estimated in the study describes vulnerability of the health sector of various study areas. All VAA scores were found lower than 2 (moderate) which is quite alarming. Out of

five locations, the summarized VAA scores show the lowest in flood-prone Ullapara (VAA = 1.31) that needs to address the health-related issues most. In drought prone Birampur, the VAA score of 1.44 ranked the second lowest while coastal Patuakhali Sadar and hilly Rangamati Sadar areas both scored VAA = 1.49 showing quite close to mid-point of high and moderate vulnerability. Dhaka city shows low vulnerability (VAA = 1.83) compared to the other study areas because of improved health structure and system. The findings indicate that the rural areas' health system and other sectors that have direct/indirect impact on health sectors (e.g., sanitation, food security, water) need more attention from the government to adapt with the adverse impact of climate change and variability.

In all the study areas, high percentage of the community people go to public hospitals followed by private hospitals for their health need. Respondents in rural areas were found preferring the government hospitals more compared to Dhaka city dwellers, which could be due to higher number of private hospitals in Dhaka city to serve the need of a large population. However, most of the participants are satisfied with current outdoor and indoor hospital services. In addition, registered doctors and pharmacies are playing a big role for providing immediate health care in the community, where the latter is an issue of concern, especially in Dhaka city. The communication system has improved significantly in the recent past as people can travel to the hospitals quickly nowadays, except for the hard-to-reach areas. While the health professionals said that the health systems are prepared for extreme weather events such as floods or cyclones, it is evident from the household survey findings that the health system's response to extreme weather at the local level is yet to reach at effective level. The study finds that although the health system has improved since the last study published in 2015, it is still in vulnerable condition to meet the needs during the extreme weather events.

The review of the strategic documents shows that Bangladesh is actively considering climate change as an increasing threat to its citizens health and health system. Several of these documents have detailed planning for health system adaptability and strengthening from the documents purview. However, there is a lack of a consolidated single document which combines all the activities concerning the effect of climate change on health. Furthermore, we found a few key areas requires that would require more attention: surveillance, community awareness and manpower development. Coordination is another area which will require further strengthening to implement the policy and programs.

8.2 Recommendations

As this VAA is indicative of and representing the current health circumstances and future health issues related to climate change, policy makers, implementers, planners, and community people could take this into account for future planning and designing of future programs. However, as it was conducted in a very small scale, thus it may not be representative of the whole country. Thus, it is recommended to conduct a representative VAA scoring for a larger sample size (areas) for better understanding and future planning. Based on the findings from the study, a few recommendations for consideration for the policy makers in the health sector of Bangladesh are discussed below that have been discussed in different chapters of this report.

- There is a need for capacity building of the health professionals on climate change related health issues to better deal with the climate sensitive diseases. Training programs for the health professionals on identifying climate sensitive diseases, awareness campaigning at local level, better coordination among the stakeholders, and resource allocation for facilitating the activities throughout the year, especially to deal with emergency, are the major requirement to improve the preparedness of health system at the local level.
- From the review of the strategic documents and public health programs, we recommend formulating a single policy document to plan all the relevant public health actions in a coordinated manner. We also recommend for a separate, independent program to tackle the issue of climate change in relation to public health. This program will be vital to strengthening of the climate sensitive disease surveillance, mass awareness and health system strengthening activities with the aim of making the nation's health system more adaptable to climate change. Training of sector professionals on these issues will be required as trained and oriented health manpower will be necessary to realize these plans.
- We recommend formulating a precise and objective-oriented dedicated action plan, which should include necessary aspects of health system's adaptability including the followings:
    - Urban health program with special attention to health workers working at the community/ward level.
    - Integrated public health surveillance program.
    - Identifying and mitigating health impact of migration.
    - Coordination between different programs and the communication between the field and central levels.
    - Orientation of the health managers is also crucial for the successful implementation of those policies and programs.
- Limited data on the impact of climate change on health is a big challenge while developing these strategic documents. Our recommendation will be to conduct more operational and epidemiological research works to provide specific data needed for developing specific planning. For example: regular VA assessment, impact of climate change on migration health, epidemiology of emerging diseases across the country etc. Another recommendation will be to strengthen the ongoing activities of 4th HPNSP related to health system strengthening. The 5th HPNSP is going to be in the planning phase from 2022. This is the best place to include activities related to health system's adaptability with dedicated budget. Our recommendation will be to involve the climate change public health specialists in the planning of this program.
- We also recommend having a strong, financially sustainable dedicated program with dedicated manpower under the health sector to coordinate all these activities in relation to the effect of climate change on health.

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