Climate Change and Health Impacts in Bangladesh

June 2009

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Climate Change Cell
Department of Environment

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Foreword

The impacts of global warming and climate change are worldwide. For Bangladesh they are most critical because of its geographical location, high population density, high levels of poverty, and the reliance of many livelihoods on climate-sensitive sectors, such as agriculture, fisheries.

To address current impacts and manage future risks of climate change and variability towards development of a climate resilient Bangladesh, the government has established the Climate Change Cell (CCC) in the Department of Environment (DoE) under the Comprehensive Disaster Management Programme (CDMP). Climate change research, covering modeling and adaptation is one of the major activities of the Cell.

CCC in association with its Technical Advisory Group (TAG) and other stakeholders identified a set of research activities related to climate change in Bangladesh through a number of consultations. The activities have been prioritized and a number of projects have been commissioned in last few years.

Cell is facilitating adaptation research in order to, fill knowledge gaps in the arena of adaptation to climate change and its impacts on the life and livelihoods; explore options to adapt with the climate change; and contribute in better understanding of adaptation options. In this regard, a number of projects have been commissioned in the field of Crop agriculture, Crop Insurance, Health, Gender and disadvantaged groups.

Bangladesh is vulnerable to outbreak of infectious, water borne and other types of diseases. It has been predicted that due to climate change, combination of higher temperature and potential increase in summer precipitation, cause spread of many infectious diseases.

This study tries to find out the possible impacts of climate change on human health of Bangladesh. Findings of the study indicate that the changes in the climatic factors including temperature (maximum and minimum), rainfall (annual and seasonal) and salinity concentration increased the incidence of several infectious diseases such as diarrhea, skin diseases, kala-azar etc.

It is expected that the research will create a strong link between health service provider and other stakeholders to share research results and needs. This study was conducted in a pilot mode, given the wide ranging impacts of climate change on human health and growing importance of the issues, broad-based and in-depth study need to be undertaken for better understanding of the cause-effect relationship between climate change factors and human health. Such a study will facilitate policy makers and planners to formulate viable adaptation policies, strategies and action plan.

Zafar Ahmed Khan, Ph.D
Director General
Department of Environment

Acronyms and Abbreviations

ADB	:	Asian Development Bank
ARAC	:	Adaptation Research Advisory Committee
BCAS	:	Bangladesh Centre for Advanced Studies
BMD	:	Bangladesh Meteorological Department
CCC	:	Climate Change Cell
CDMP	:	Comprehensive Disaster Management Programme
CRED	:	Centre for Research on Epidemiological Disaster
DG	:	Director General
FGD	:	Focus Group Discussion
GoB	:	Government of Bangladesh
LGED	:	Local Government Engineering Department
MOEF	:	Ministry of Environment and Forest
NIPSOM	:	National Institute of Preventive and Social Medicine
UHC	:	Upazilla Health Complex
WB	:	World Bank
WHO	:	World Health Organization
SEARO	:	South East Asia Regional Office

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Executive Summary

Climate change impact on human health is a global concern. Various climate change related events like heat waves, cold waves, flood, drought, SLR, salinity intrusion, cyclone etc. have direct and indirect adverse impacts on human health. It has been estimated that climate change causes 2.4 per cent of all cases of diarrhea worldwide and 2 per cent of all cases of malaria. Climate change was responsible for at least 150,000 deaths and 5.5 million Disability Adjusted Life Years in the year 2000. It was estimated that about 119 million cases of malaria occur every year only in South East Asia.

A number of vector and water borne diseases including diarrhea, dysentery, skin diseases etc. are common in Bangladesh. In addition, mental disorders, malaria, dengue, and malnutrition problems affect many people of the country.

In order to explore and find correlation between climate change factors and incidence of human diseases, Bangladesh Centre for Advanced Studies (BCAS) and NIPSOM have carried out the research study. The research was supported by Climate Change Cell.

The methodology of the study includes analysis of secondary and primary data. Time series of climate factors data especially on temperature and rainfall were collected from Bangladesh Meteorological Department. Data on diseases were collected from the Upazilla Health Complex of the study location. Pearson's correlation coefficient was used to find the association between climate factors and incidences of diseases (diarrhea, malnutrition, skin disease and kala-azar). The primary data collection tools include household survey, Focus Group Discussion (FGD) and In-depth interview with villagers, health professionals and women in each study area. The main purpose of the sample survey, FGD and In-depth interviews were to collect data on health disorders (present and past), perception on climate factors (temperature, rainfall, salinity, flood, drought etc), seasonal changes of climate factors etc. Statistical techniques have been used for analyzing the relationship between climate change factors and health related variables.

The study has primarily been conducted in three different climatic zones representing drought prone Rajshahi district, flood prone Manikganj district and salinity affected Satkhira district of Bangladesh. Trend analysis of climate factors and diseases has been carried out based on available annual time series data. Seasonal index of diseases reflecting the monthly variations in the disease pattern has also been constructed using the time series data.

The study indicates that the climatic factors including temperature, rainfall (annual and seasonal) and salinity have positive correlation with diarrhea, skin diseases, kala-azar etc in the study areas. In Rajshahi and Satkhira, incidence of diarrhea shows positive correlation with total annual rainfall. Seasonal rainfall (monsoon) was also found to have positive correlation with diarrhea incidence in Rajshahi and Satkhira. Dry season rainfall was found to have positive correlation with diarrhea in Manikganj.

Skin diseases, diarrhea and malnutrition were found to be positively correlated with temperature (difference between maximum and minimum temperature based on daily records per year) in both Rajshahi and Satkhira, while these were negatively correlated in Manikganj study area.

Although time series data of both maximum and minimum temperatures show negative correlation with diarrhea, the correlation value becomes positive if temperature difference is used in place of maximum or minimum temperature. This is particularly evident in case of diarrhea of Rajshahi area.

The analysis of the primary data from household survey, reveals temperature is the main cause for most of the diseases (diarrhea, fever, malnutrition) as perceived by the highest percentage of the respondents. Rainfall variation comes next as main cause of such diseases and is followed by hazards/disorders.

The study reveals that the three study areas do not have equal access to safe water and sanitation facilities. The study population of Manikganj has greater accessibility to safe water and sanitation than Rajshahi and Satkhira areas. In addition, households located relatively near to health complex/centre enjoy better health facilities and lower incidence of diseases than those that are located far away from such health facilities. There is no denying to the facts that accessibility to clean water, sanitation, health facilities have important implications for the health status of concerned population groups. These non-climatic factors, however, is not the subject matter of the study.

To address existing and future impacts of climate change on human health, climate sensitive diseases surveillance, training of health professionals to deal with climate sensitive diseases, awareness of local community on climate change and its impacts on public health, improvement of water supply and sanitation, protection of water resources need to be considered immediately.

Chapter 1

Introduction

Climate change related impacts including flood, drought, sea level rise, salinity, temperature and rainfall variations etc. have become major concern for most countries of the world due to its long-term implications and adverse effects on development activities. Although both the developed and developing countries are being affected, the developing and underdeveloped countries are most vulnerable to climate change and climate variability of direct impact on economic, social and development sectors. It has further put additional pressure on the limited natural resources like water, land and biodiversity. In recent years, climate change related health impacts have also taken precedence. According to IPCC (2001), global warming would cause increase of vector borne and water borne diseases in the tropics (IPCC, 2001). All around the world, increased natural, technological and human induced hazards have brought along frequent epidemics, increased number of deaths, injuries and health problems of the human beings. Moreover, non-climate issues including poor housing, lack of safe water and sanitation facilities, inadequate or improper health care services would increase the adversity of health problems.

Many scientists have already anticipated that more frequent and more intense or severe weather events will result in increased deaths, injuries and diseases in developed countries like Canada, but the biggest impact will be felt in low-lying, heavily populated areas such as Bangladesh, particularly when coupled with sea level rise (Canadian Association of Physicians for the Environment, 2006). An estimation shows that at least 3000 million people of all tropical countries are exposed to the risk of dengue while 2400 million tropics and subtropics are at risk of malaria (IPCC, 2001; Githeko and Woodward, 2003). Other sources estimate that climate change causes 2.4 per cent of all cases of diarrhea worldwide and 2 per cent of all cases of malaria (WHO, 2006). It was also estimated that climate changes was responsible for at least 150,000 deaths and 5.5 million Disability Adjusted Life Years in the year 2000.

Bangladesh is one of the countries which has been significantly affected by natural disasters. A recent study shows that at least 174 natural disasters affected Bangladesh from 1974 to 2003 (Sapir et al, 2004). Extreme events such as floods, drought and cyclone etc. directly and indirectly affect health of people of this country almost every year (Annex-5). For example, the total death caused by flood in 2004 was about 800 while cyclone of 1991 killed 138,000 people of Bangladesh (ADB, 2004; BCAS, 1991).

There were some researches and studies on climate change and its impacts in Bangladesh at different times by both government and non-government organizations/institutions. But research on human health impacts due to climate change in Bangladesh has not gained much focus before 2006. Climate Change Cell (CCC) under Comprehensive Disaster Management Programme (CDMP) has brought climate change and health as priority issue for research in 2006.

1.1. Background of the Study

Bangladesh is already vulnerable to outbreaks of infectious, water borne and other types of diseases (World Bank, 2000). The record shows that the malaria incidences increased from

1556 in 1971 to 15375 in 1981, and 30282 in 1991 to 42012 in 2004 (WHO, 2006). Other diseases like diarrhea, dysentery, etc. are also on the increase especially during the summer months. It has been predicted that the combination of higher temperatures and potential increase in summer precipitation may cause spread of many infectious diseases (MoEF, 2005).Climate change also brings about additional stresses like dehydration, malnutrition and heat related morbidity especially among children and the elderly. These problems are thought to be closely interlinked with water supply, sanitation and food production. Climate change has already been linked to land degradation, freshwater decline, biodiversity loss and ecosystem decline, and stratospheric ozone depletion. Changes in the above factors may have a direct or indirect impact on human health as well.

Bangladesh carries the burden of high population, natural disasters, diminishing and polluted natural resources, and the further burden of increased health problems due to climate change and climate variability will push back its development achievements.

In order to have a better understanding of the possible link between climate change and human health the Climate Change Cell, Department of Environment of the Ministry of Environment and Forests under the Comprehensive Disaster Management Programme (CDMP) of the Government of Bangladesh (GoB) has initiated research on climate change and health impacts in Bangladesh.

Bangladesh Centre for Advanced Studies (BCAS) and National Institute of Preventive and Social Medicine (NIPSOM) were jointly assigned to carry out the study in three districts (Rajshahi, Manikganj and Satkhira). As mentioned above that the districts were identified keeping in mind the three major risks of climate change flood, drought and salinity intrusion.

Chapter 2

Objectives and Methodology

2.1. Objectives of the Study

The overall objective of the study is to find out impacts of climate change on human health of Bangladesh. However, the specific objectives are:

- ✓ Analyze climate and health related data for exploring correlation between them
- ✓ Assess current knowledge base and understanding on public health due to climate change, and create a database for further research in the area

2.2 Scope of the study

The study included the households at village levels in three different major climatic regions of the country. Three districts Rajshahi, Manikganj and Satkhira were selected to assess the health impacts due to climate change and climate variability as well as their correlation. These districts were selected based on the climate characteristics. For example Rajshahi was selected for drought impacts while Satkhira was selected for salinity and Manikganj for floods. All these three districts are also associated with other types of climate related hazards or disasters such as cyclone, sea level rise etc. From each district two villages were covered in the study. However, the following steps describe the scope of the study

- Identification of diseases and health problems that are most closely related to climate change and are prevalent in the study areas.
- Collection of yearly and seasonal data on the extent of salinity intrusion, flood and drought and find data on health related to safe drinking water and sanitation.
- Collection of annual and seasonal data on the occurrence of vector and water borne diseases in order to build up a database. These were related to specific climate data like temperature, rainfall, natural disasters etc. This secondary data were collected from Union health centres, Upzila health centres, district hospitals as well as private medical practitioners in the study areas. Secondary data were compiled based on climate specific diseases among different micro-economic groups.
- Interview and focus group discussion with health professionals which included doctors, nurses, health workers and NGO workers at the community level. Stakeholders and community people were included in the discussion.
- Study on existing knowledge base and capacity in health centres on climate change and its correlation with various health problems at the local level.
- Service delivery system including both preventive and curative measures for climate change related diseases were specifically dealt with under the study. Service delivery as practiced by union, upzila and district level health institutions/ organizations, to address climate change related morbidity, were assessed to identify the weakness and strengths of the delivery system.
- The study further looked into the existing activities at the community level to combat effects of flood, drought and the increased level of salinity in water and soil, and other adaptation measures taken by the community.

2.3. Approach and Methodology

The methodology for the study was based on methods, tools which are as follows:

2.3.1. Discussion and consultation with CCC personnel, advisory committee and the stakeholders

At the beginning of the study the BCAS and NIPSOM study team held discussions and consultation with CCC experts, members of the advisory committee and the stakeholders. Detail methodology and other aspects (e.g. study areas, team, budget, timeframe etc) related to this study were presented in inception meeting held in 13 August 2006 at LGED Building, organized by CCC. This was useful for conceptual, planning and methodological development of the study. The study methodology was also shared in the introductory meeting of ARAC (Adaptation Research Advisory Committee) members held on 18 October 2006. The major suggestion of this meeting was to give more emphasis on most sensitive diseases of climate change. Detail progress of the study was presented in the meeting of senior personnel of CCC, DoE and members of ARAC. Few limitations of the study were also shared in the meeting. Appropriate suggestions and comments of all these meetings have been followed in implementing the study.

2.3.2. Selection of the Study Area

Identifying flood, drought and salinity intrusion etc as climate change major impacts, three districts (Naogaon, Manikganj and Satkhira) were proposed by BCAS and NIPSOM for the study. The inception meeting suggested to include Rajshahi district instead of Naogaon as drought prone area for the study. However, the suggestions of the CCC personnel and the consultation meeting were well taken and finally Rajshahi (drought), Manikganj (flood) and Satkhira (SLR and salinity) were selected for the study (short profile of the study area is in chapter-3). The study then covered two villages of one upazilla of the respective district. One village was closer to UHC and the other village was quite far from UHC but both the villages were exposed to same climate related hazards. In fact, the major criteria for selecting the villages in each upazilla included distance and access to health services (primarily UHC) as well as exposure to climate related hazards. Upazilla Health Officer and Chairman of the Union Parishad were consulted before final selection of the villages.

2.3.3. Collection and Review of Secondary Data/Information

A number of climate change and health related documents were collected from concerned local, national, regional and international sources. Time series (30 years) rainfall and temperature data were collected from Bangladesh Meteorological Department (BMD). Health related documents were collected from Director General (DG) Health of the Ministry of Health and Family Welfare of the Government of Bangladesh (GoB). Moreover, efforts had been made to collect time series of diseases records from Upazilla Health Complexes (UHC) of the study districts. Time series of diseases were available for 10 years. These were collected and reviewed. Time series (1963-2004) of malaria and dengue incidences of Bangladesh were collected from WHO-SEARO (World Health Organization -South East Regional Office). The other major sources for secondary documents included MOEF, WHO, WB, ADB, CRED, BCAS etc.

2.3.4. Development of Data Collection Tools

Questionnaire for sample survey, checklist for FGDs and In-depth interviews were separately developed to collect the primary data/information from the study sites. A number of issues including health disorders (past and existing), seasonal changes, sources of water supply and

sanitation (pre, during and post hazard period), perception on climate changes and climate variability issues, perception on relationship between climate change and health impacts etc were emphasized in both the questionnaire and checklist. Details of these data collection tools are given in the following primary data collection section.

2.3.5. Primary Data Collection

The following steps were followed to collect primary data from the study sites:

2.3.5.1. Recruitment and training of the field staff for primary data collection

BCAS and NIPSOM deployed a field team comprising one field supervisor and two field investigators in each of the three study districts for primary data collection. All the field staff had a bachelor or higher degree and most of them had previous experience in field data collection through survey, FGD, etc. One of the three members for primary data collection in each study district was an MBBS doctor. In addition, an MBBS doctor was deployed for secondary data collection from the respective UHC of the study sites.

A two-day long training programme was organized for the field staff at BCAS headquarters before going to fields (5 and 8 October 2006). The training started at 10:00 am and ended at 4:00 pm in each day. The training was conducted by the experts of the study team (both from BCAS and NIPSOM) to explain the objectives and field research methodologies including interviews, FGDs and in-depth interview. The survey questionnaires, checklists, FGDs, in-depth interviews were discussed in detail during the training. The field staff were encouraged to take proactive role and ask questions for a clear understanding of their task. The experts explained all the issues and questions raised by the field staff during the training. The field staff also participated in role-play on field data collection methods which were carefully observed by the participants. The training exercise was fruitful in gathering field data/information. The fieldwork was monitored by the experts of BCAS and NIPSOM.

2.3.5.2. Methods of primary data Collection

Multiple methods were used to collect primary data. These are as follows:

- Sample survey
- Focus Group Discussion (FGD)
- In-depth interview

The sample survey was designed to gather information and data in a more structured format, the other methods including FGD and in-depth interview focused on open ended opinions and views of the target study groups (please see table-1).

Sample Survey

The sample survey was carried out in the households of two villages of each of the three study districts. The total respondent for sample survey in each village was 50. Thus 300 respondents were surveyed in six villages of three districts. The households in each village were randomly selected. The head of the family/household was given priority to respond to the questions. In absence of the head, other senior person of the family/household was requested to respond. However, in many cases either elder male or female responded in presence of all members of the family. Sometime they all discussed before responding to some question particularly on health disorders.

The questionnaire generally focused on the health disorders, seasonal variations of the diseases, water supply and sanitation related problems, perception on climate change and its impacts on human health of the study sites etc. The questionnaire was designed in such a way that each question was accompanied by one or more answers. The respondents were allowed to choose from the given answers or he/she could give own opinion. The questions were both open and closed ended. (Please see annex-1)

Focus Group Discussion (FGD)

Four FGDs were conducted in each of the three study districts. One with local health professionals (e.g. MBBS doctors, staff nurses, health assistants, laboratory technicians and village doctors (locally called as *kabiraj or palli chikitshak, homeopathic doctors* and health workers of NGOs etc); two were conducted separately with locally well-known knowledgeable persons of the selected two villages of each study district. The last one was conducted with women (priority of participation was given to child bearing age). Each FGD comprised of 10 to 14 members. One of the field investigators presented the issue from the FGD checklist and the other two members of the team recorded the responses of the participants on specific issue. FGD with women was conducted by women investigators. After the session of FGD, the field team of each district have reviewed the issue based responses and prepared the report on each FGD of the study (please see annex-2).

An FGD is in progress

In-depth Interview

A checklist was also developed for in-depth interviews. The interviews were taken to collect the information on the specific issues on climate change and health impacts. Two most well – known knowledgeable persons (e.g. teacher of school/college/madrasa, retired/ former government/non- government service holders etc) from each of the two villages of each study district were separately interviewed. Questions were asked by an investigator and responses were written down by others. (please see annex-3)

Household member is being interviewed

Table 1: Summary information of the study locations and respondents/participants covered by different methods

Study district	Name of the village	Number of participants		
		Sample survey	FGD	In-depth Interview
Manikganj	Nihanda and Raninagar	50+50 =100	4x14=56	4
Rajshahi	Faradpur and Charbhubanpara	50+50 =100	4x14=56	4
Satkhira	Jelekhali and Harinagar	50+50 =100	4x14=56	4
Total	6	300	168	12

Limitations of the study

One of the major difficulties of the work was the time inadequacy and information scarcity of time series data on some of the relevant issues especially health problems in study areas.

The study aimed to collect health data on climate sensitive diseases but data on some of the diseases like dengue, malaria were not available in any of the Upazilla Health Complex. Moreover, one of the UHC (Godagari, Rajshahi) was unable to provide time series health data for last 10 years. Therefore time series data of 7 years were available for this study area while 10 years time series data were used for two other study locations.

In case of disease related information for all household members during different seasons of the year and for a longer period (5 years), many respondents had to recall from memory. It is therefore not unlikely that the quality of such data/information especially of frequently occurring diseases may not be quite high.

Since the study was conducted in only two villages from each of three study districts, the study findings may not reflect the whole district. Again, the climate data including temperature, rainfall and salinity concentration used in the study were provided by the nearest stations. In this study, data of Khulna station was used for Satkhira while the data of Dhaka station was used for Manikganj. This might have implication in the findings. Given the scope of the study and its limitations, any attempt to generalize the findings for the whole country or similar other climatic zones need to be done with utmost caution.

Chapter 3

Description of the Study Area

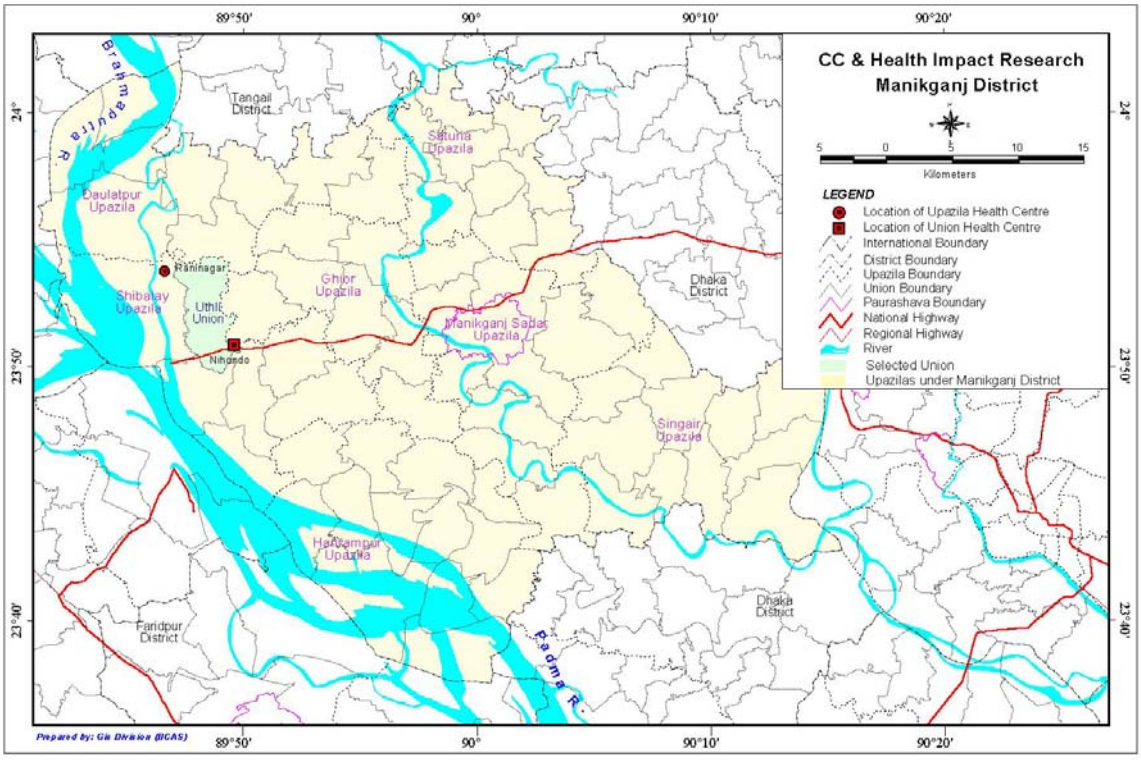
Description of the study area includes two sections which are as follows:

3.1 Short features of the study district/locations

Manikganj District: Nearly 1.3 million people live in an area of 1378.99 sq km. Main rivers are the Padma, Jamuna, Dhaleshwari, Ichamati and Kaliganga. Average literacy 26.9% (male 33.7%, female 20.1%). Main occupations include agriculture, fishing, agricultural laborer, wage laborer, industry, commerce, construction, service, transport etc.

Flood is one of the main hazards of the people of Manikganj.

The study villages of Manikganj district are Nihanda and Raninagar under Shivalaya upazilla (**please see map-1).**

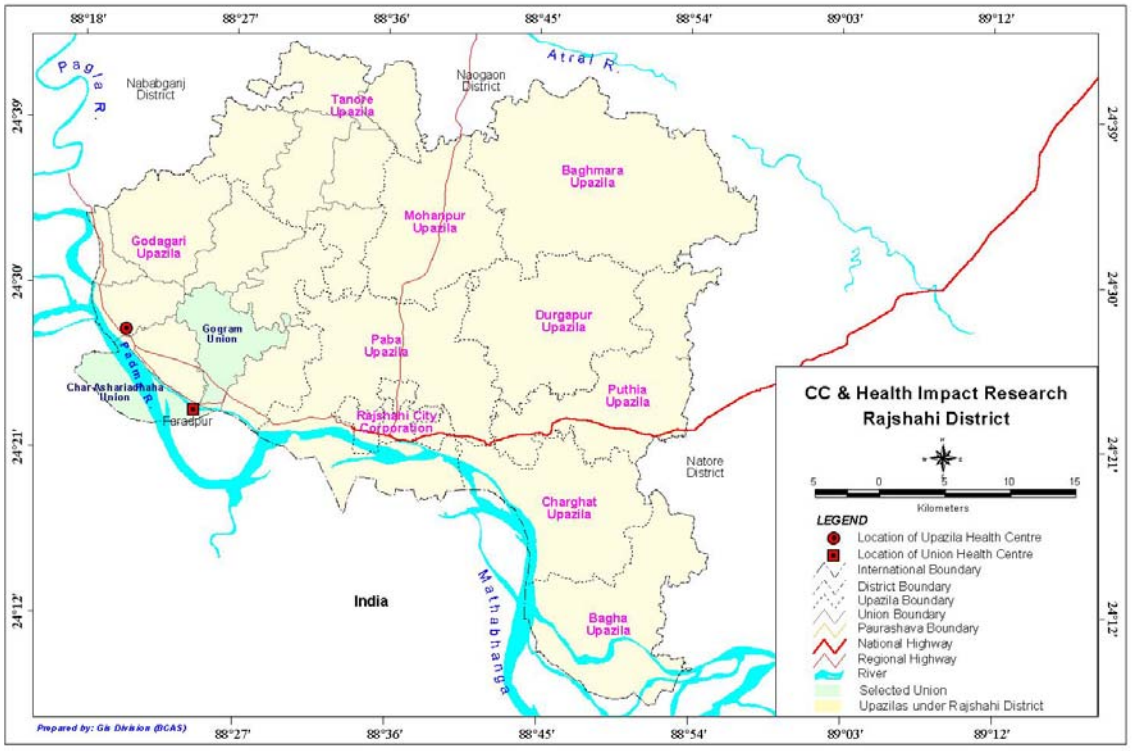


Map-1: Nihanda and Raninagar villages under climate change and health impact study

Rajshahi District: The population and area of Rajshahi district are about 2.3 millions and 2407.01 sq km respectively (Asiatic Society of Bangladesh, 2003). Main rivers in and around Rajshahi are (Ganges), Mahananda, Baral and Barnai. Annual average temperature: maximum 31.2°C, minimum 20.5°C; annual rainfall 1543 mm. Average literacy 30.61% (male 37.6% and female 23.2%). The main occupations include agriculture, wage laborer, commerce, service, transport etc.

People of Rajshahi have been suffering from drought for long. Godagari is one of the most drought affected upazilla in Rajshahi.

Two villages namely Faradpur and Charbhubanpara of Godagari upazilla under Rajshahi district were selected to conduct the study (**See Map-2).**

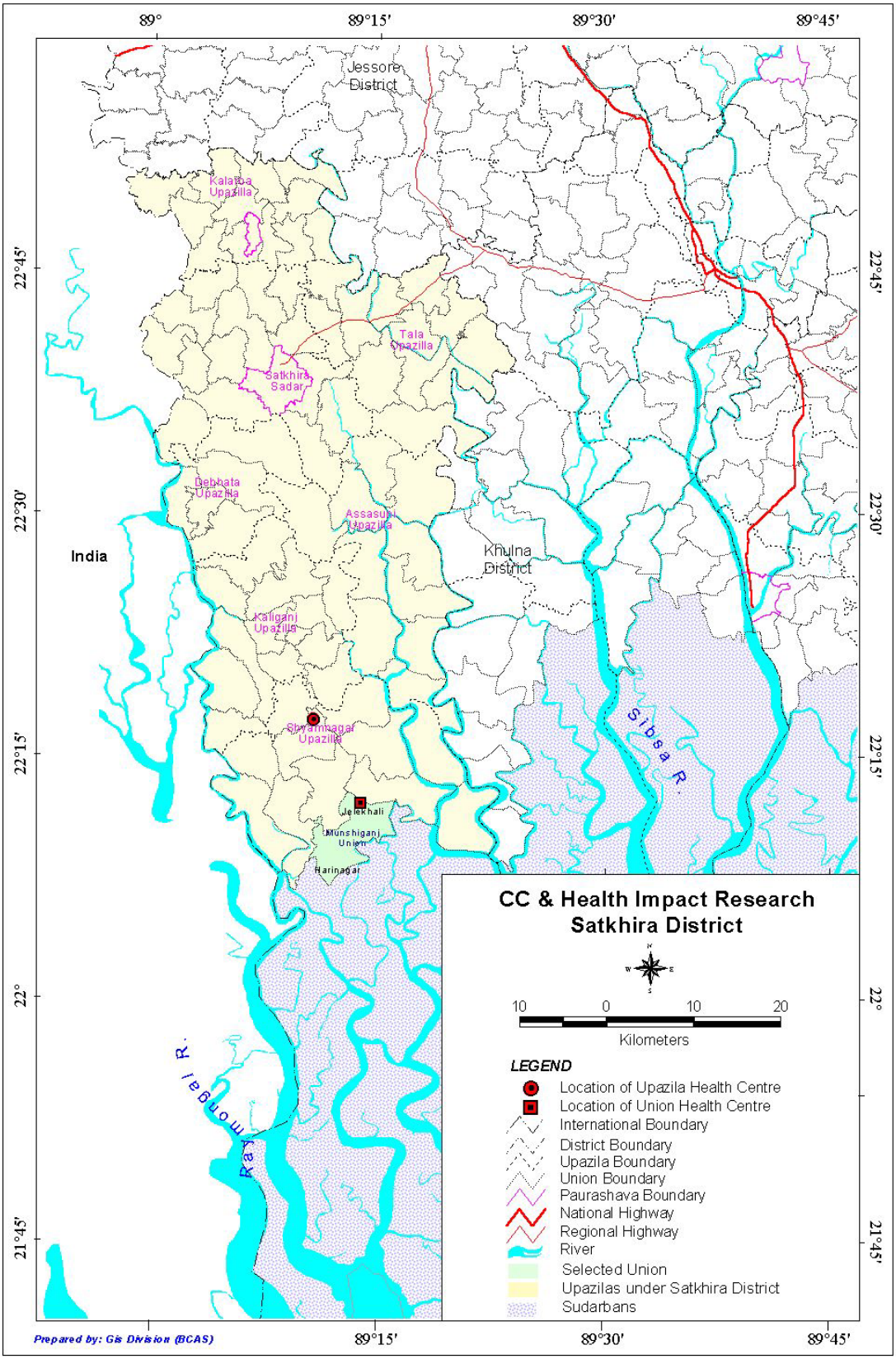


Map-2: Faradpur and Charbhubanpara villages under climate change and health impact study

Satkhira District: The area and population of Satkhira district is 3858.33 sq km and about 2 millions. Main rivers are Kobadak, Sonai, Kholpatua, Morischap, Raimangal, Hariabhanga, Ichamati, Betrabati and Kalindi-Jamuna. Annual average temperature is maximum 31.6°C, minimum 21.4°C and annual rainfall 1742 mm. Average literacy 30.35% (male 39.7% and female 21%). The main occupations are agriculture, fishing, pisciculture, agricultural laborer, wage laborer, commerce, industry, transport, service, etc.

Salinity intrusion, coastal flood, cyclone etc are the major hazards for Satkhira.

Jelekhali and Harinagar villages were covered in the survey at Satkhira district (**please see map-3).**



Map-3: Jelekhali and Harinagar villages of Munshiganj union under climate change and health impacts study

The following table shows the study villages under respective upazilla and district:

Table 2: Locations covered under the study on climate change impacts on human health

Study district	Name of the upazilla	Name of the union	Name of the village
Manikganj	Shibalay	Utholi	**1. Nihanda and** **2. Raninagar**
Rajshahi	Godagari	Gogram and Charasariadhada	**1. Faradpur and** **2. Charbhubanpara**
Satkhira	Shamnagar	Munshiganj	**1. Jelekhali and** **2. Harinagar**

3.2. Socio-demographic profile of the study area

The socio-demographic status of households in the study area has been investigated. The survey covered various kinds of information of households. The demographic factors of the households covered in the study area include age, sex, education, profession, health etc. However, the above mentioned variables have been described in the following sub-sections:

Household size and sex ratio by study location

In the study village of Rajshahi, the average household size (the number of persons per household) was found to use 5.2 while the sex ratio was 113.0. In Manikganj, the average family size was 5.2 while the sex ratio was 117.2. The family size and sex ratio of Satkhira study area was 5.2 and 107.6 respectively. Please see table-3 for details.

Table 3: Average household Size and sex ratio by three study areas

Area	Average household size	Sex ratio
Manikganj	5.2	117.2
Rajshahi	5.4	113.0
Satkhira	5.2	107.6
All	5.3	112.5

Household composition

The household survey reveals that the number of male members of households in each of the district were higher than the female. Male constituted 52.9 per cent of households members while 47.1 per cent were female. However, the survey reveals that the total number of members of households varies from site to site. In Manikganj it was 517 while it was 541 and 519 in Rajshahi and Satkhira. Details are in the following table.

Table 4: Distribution of household members by sex in study locations

Area	Sex		
	Male	Female	Both
Manikganj	279 (54.0)	238 (46.0)	**517** **(100.0)**
Rajshahi	287 (53.0)	254 (47.0)	**541** **(100.0)**
Satkhira	269 (51.8)	250 (48.2)	**519** **(100.0)**
All	835 (52.9)	742 (47.1)	**1577** **(100.0)**

Note: *Figures within parentheses represent per centages*

Age and sex: It was found that the age of the maximum household members (1036) of each study location ranged between 15 and 59 (**figure -1**). The second highest (19 per cent) category of the study households were between 5 to 14 years of age. However, the least household members (1 per cent) were over 70 years while 8 per cent were 0 to 4 years of age.

Table 5: Distribution of Household Members by Age and Sex in Three Study Areas

Age (Year)	Manikganj			Rajshahi			Satkhira			All		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Up to 4	16 (40.0)	24 (60.0)	40 (100.0)	27 (52.9)	24 (47.1)	51 (100.0)	18 (52.9)	16 (47.1)	34 (100.0)	61 (48.8)	64 (51.2)	125 (100.0)
5-14	50 (52.1)	46 (47.9)	96 (100.0)	56 (48.7)	59 (51.3)	115 (100.0)	38 (45.2)	46 (54.8)	84 (100.0)	144 (48.8)	151 (51.2)	295 (100.0)
15-59	176 (53.2)	155 (46.8)	331 (100.0)	188 (53.6)	163 (46.4)	351 (100.0)	184 (52.0)	170 (48.0)	354 (100.0)	548 (52.9)	488 (47.1)	1036 (100.0)
60-70	31 (75.6)	10 (24.4)	41 (100.0)	16 (72.7)	6 (27.3)	22 (100.0)	23 (60.5)	15 (39.5)	38 (100.0)	70 (69.3)	31 (30.7)	101 (100.0)
70 above	6 (66.7)	3 (33.3)	9 (100.0)	-	2 (100.0)	2 (100.0)	6 (66.7)	3 (33.3)	9 (100.0)	12 (60.0)	8 (40.0)	20 (100.0)
Total	279 (54.0)	238 (46.0)	517 (100.0)	287 (53.0)	254 (47.0)	541 (100.0)	269 (51.8)	250 (48.2)	519 (100.0)	835 (52.9)	742 (47.1)	1577 (100.0)

Note: *Figures within parentheses represent per centages*

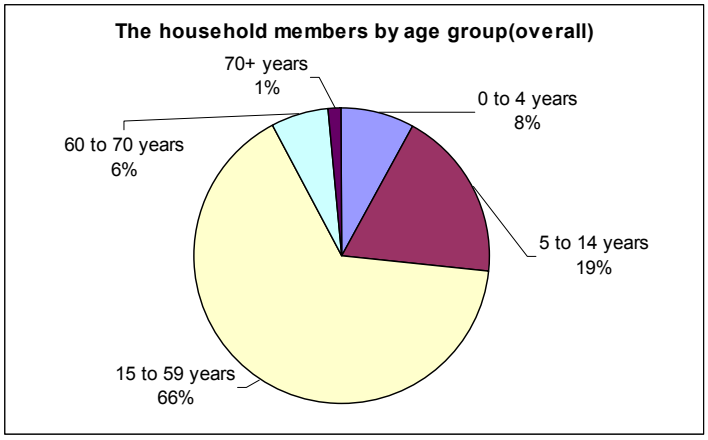


Fig-1. Age of household members in study area

Education by Gender

It was found that 23.6 per cent of the household members (altogether) were illiterate. Illiteracy among males and females were 18.7 per cent and 29.2 per cent. The highest illiteracy was 32.3 per cent, found in Rajshahi while the lowest was 13.5 per cent in Manikganj. The per centages of males and females having graduate and higher degrees were 4.4 per cent and 1.4 per cent. Please see the following table for details.

Table 6: Education level by gender

Level of Education	Area											
	Manikganj			Rajshahi			Satkhira			All		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Illiterate	10.1	17.6	13.5	31.6	33.0	32.3	14.2	35.8	24.6	18.7	29.2	23.6
Can sign only	6.6	11.4	8.8	1.6	0.9	1.2	0.8	0.9	0.8	3.0	4.2	3.6
Up to Class V	36.2	30.9	33.8	27.0	34.8	30.8	31.2	31.0	31.1	31.3	32.3	31.8
Below SSC	24.5	24.3	24.4	27.7	24.4	26.0	36.0	25.0	30.8	29.4	24.6	27.2
SSC and equivalent	8.2	7.1	7.7	7.0	3.9	5.6	6.9	3.0	5.0	7.4	4.6	6.1
HSC and equivalent	8.6	4.8	6.9	3.9	2.6	3.3	4.9	3.9	4.4	5.8	3.7	4.8
Bachelor and above	5.8	3.9	4.9	1.2	0.4	0.8	6.0	0.4	3.3	4.4	1.4	2.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Occupation

The occupation of household members was investigated under this survey. Among the total study population in three study districts 13.3 per cent were found involved in agriculture, 8.1 per cent involved in business sector, 4 per cent daily labor, 27.1 per cent were housewives, 25.2 per cent students and 0.8 per cent were unemployed. In addition to that 14.1 per cent population were either children or old people or have other occupation. Please see the following table for details.

Among the males, 25.2 per cent are engaged in farming, 15.2 per cent in business and 9.2 per cent in services (government and non-government). Of the female population, 57.3 per cent were housewives and only a small per centage (about 2 per cent) of them was engaged in services and labors. Students comprise 24.6 per cent of the males and 25.9 per cent of the females (please see table 7 for details).

Table 7: Occupation by gender and location

Occupation	Area											
	Manikganj			Rajshahi			Satkhira			All		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Government service	2.5	1.3	2.0	1.8	0.4	1.1	0.4	-	0.2	1.6	0.5	1.1
private service	14.2	2.1	8.6	2.5	0.4	1.5	6.3	-	3.3	7.6	0.8	4.4
NGO	0.4	0.4	0.4	-	-	-	-	0.4	0.2	0.1	0.3	0.2
Business	21.8	-	11.7	9.3	-	5.0	14.5	-	7.5	15.2	-	8.1
Farmer	18.2	-	9.8	35.7	-	18.8	21.6	-	11.2	25.2	-	13.3
Fisherman	0.4	-	0.2	-	-	-	9.7	-	5.0	3.3	-	1.7
Daily labor	3.6	0.4	2.2	10.7	-	5.6	6.7	1.2	4.0	7.0	0.5	4.0
Housewife	-	55.1	25.4	-	57.5	27.3	-	59.2	28.5	-	57.3	27.1
Student	26.2	24.6	25.4	24.3	27.8	25.9	23.4	25.2	24.3	24.6	25.9	25.2
Unemployed	0.7	-	0.4	1.8	-	0.9	1.9	-	1.0	1.5	-	0.8
Others	12.0	14.1	13.9	13.9	13.9	13.9	15.5	14.0	14.8	13.9	14.7	14.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Chapter 4

Health Impact due to Climate Change

Water borne (e.g. diarrhea, dysentery) and vector borne (e.g. malaria, dengue etc) diseases are climate sensitive. Nipah virus infection and Kala-azar (visceral leishmaniasis) are emerging infectious diseases which are sensitive to weather and climate variability. Hazards like flood cause diarrhea, skin diseases, mental disorders, typhoid, cholera while drought causes malnutrition, diarrhea and malaria. The climate factors like temperature and precipitation were considered as the key determinants of the distribution of many disease carrying vectors.

In Bangladesh, millions of people suffer from diarrhea, skin diseases, malaria, mental disorders and dengue. The annual incidence of diarrhea was 2841273 during 1988-2005 and that of skin disease was 2623092 during 1988-1996. Besides, malnutrition, hypertension, Kala-Azar also affect people of different regions of the country. However, the following table and figure show the incidences of some of the major climate sensitive diseases and their trend in last decades.

Table 8: Incidences of some major climate sensitive diseases during last decades in Bangladesh

SL	Disease	Incidences	Duration	Average incidences per year
1	Diarrhea	48,301,636	1988-2005	2841273
2	Skin Diseases	23,607,833	1988-1996	2623092
3	Malaria	1,018,671	1974-2004	33956
4	Mental disorders	201,881	1988-1996	22431
5	Dengue	19830	1999-2005	3305

Sources: SEARO-WHO, 2006; DG-Health, 1996, 1997; MoEF, 2005; BBS, 2005

The average annual incidence of malaria increased from 162898 during 1974 -1983 to 301651 during 1984-1993 and 301651 to 507485 during 1994-2003. In other words, the annual incidence of malaria increased by about 85 per cent during 1984-1993 over 1974-1983 and it increased by about 68 per cent during 1994-2003 over 1984-1993.

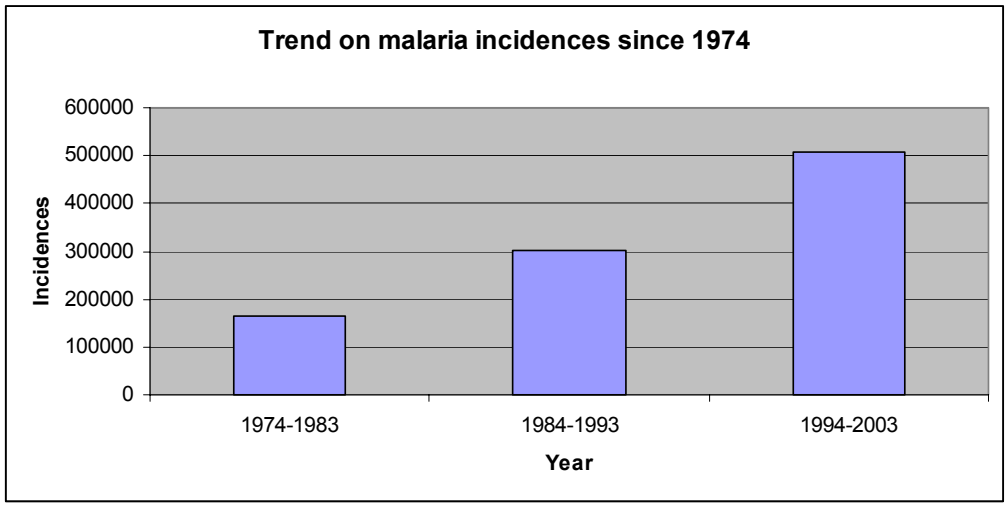


Fig-2. Trend of malaria in Bangladesh

The incidence of diarrhea is also marked by an increasing trend over the period 1995 through 2004**.** Highest incidences of diarrhea before 2000 were observed in 1998 (2027814 diarrhea cases) which corresponds to the year of the worst flood situation of the decade.

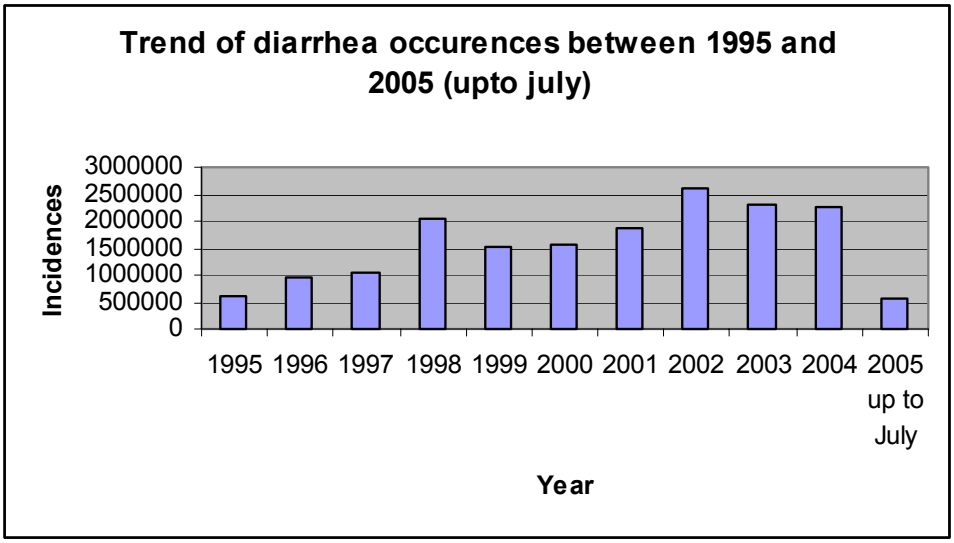


Fig-3. Trend of diarrhea in Bangladesh

Incidences of some of the diseases like diarrhea severely increase during hazard period. In addition to flood, drought, cyclone the other hazards like salinity intrusion, rainfall and temperature variation etc affect human health through a variety of pathways. These may include contamination of water, loss of food production, water and vector-borne diseases etc. However, health impacts due to climate change and climate variability issues and their correlation were analyzed under this study. The analysis was based on the areas prone to climate related hazards. Both secondary and primary data/information were analyzed to meet the objective of the study.

4.1 Results from Secondary Data/Information

4.1.1 Climate change and climate variability issues in Drought prone area: Impact on human health (Rajshahi)

Very severe drought hit the country at least 8 times between 1951 and 1989 (MoEF, 2005). The western districts especially Rajshahi were affected most of the times and also predicted to be at greater risk of drought in future. The study has analyzed time series data on climate factors like temperature and rainfall of Rajshahi district, and health disorders especially climate sensitive diseases like diarrhea, malaria, dengue, skin diseases, malnutrition, kala-azar. Detail analysis is given below:

4.1.1.1 Climate Characteristics (temperature and rainfall)

The climatic data comprised monthly and annual average maximum and minimum temperature for the period of 1976-2005 and monthly and annual rainfall for the period of 1990-2004. The data were analyzed to find intra-seasonal, seasonal, annual and decadal changes.

Five year average maximum temperature for the period of 1976-1980, 1981-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2005 of Rajshahi district were 31.052, 31.044, 31.288, 31.288, 31.094, 31.266 °C (**Figure-4).** The minimum annual average temperature for the mentioned period also shows clear variations (fig-5). During 1976-1980, the minimum annual average temperature was 20.94°C while during 1981-1995 it went down to almost 20 °C. Although the average minimum temperature for the next half of the decade (1996-2000) increased but again it declined during 2001-2005. On the other hand, long-term maximum monthly average temperature remained high during pre-monsoon (March-April-May) while minimum monthly average temperatures were high in monsoon. The data shows that the highest maximum monthly average temperature was in April.

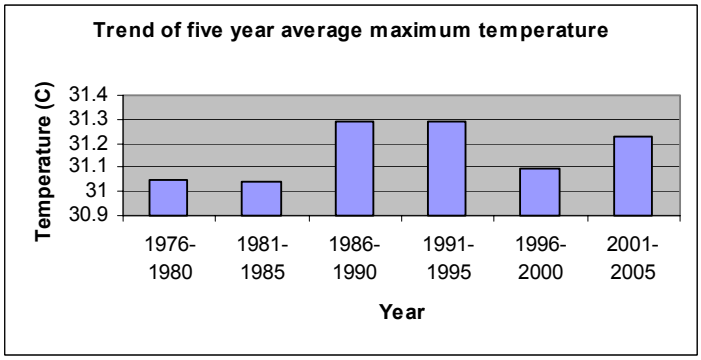


Fig-4. Trend of five year average maximum temperature

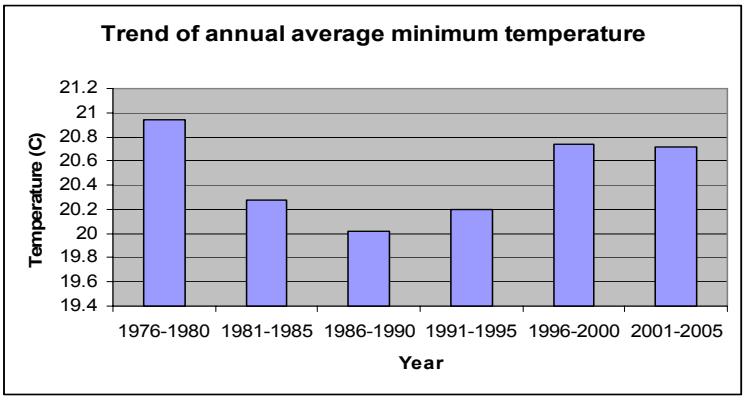
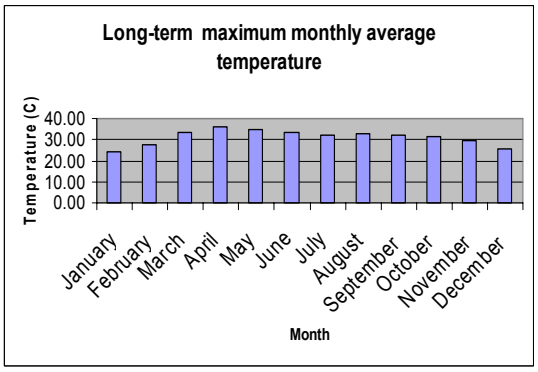


Fig-5. Trend of annual average minimum temperature in Rajshahi



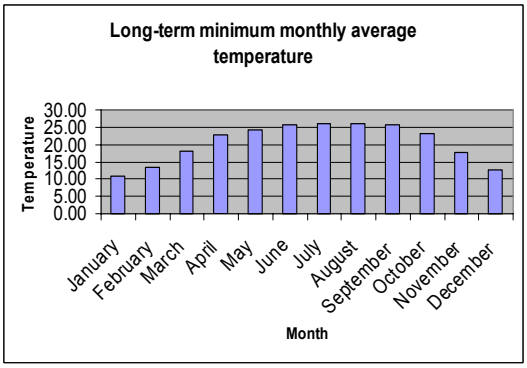


Fig.-6. Long-term Maximum and minimum monthly average temperature in Rajshahi

The long-term changes of annual maximum temperature shows an increasing trend over the study period (1976-2005) (Figure-7). The estimated simple regression of annual maximum temperature shows an average annual increase of 0.003°C over the mentioned period. The long-term changes in annual minimum temperature are also marked by a rising trend. It increased, on average, by 0.004°C.

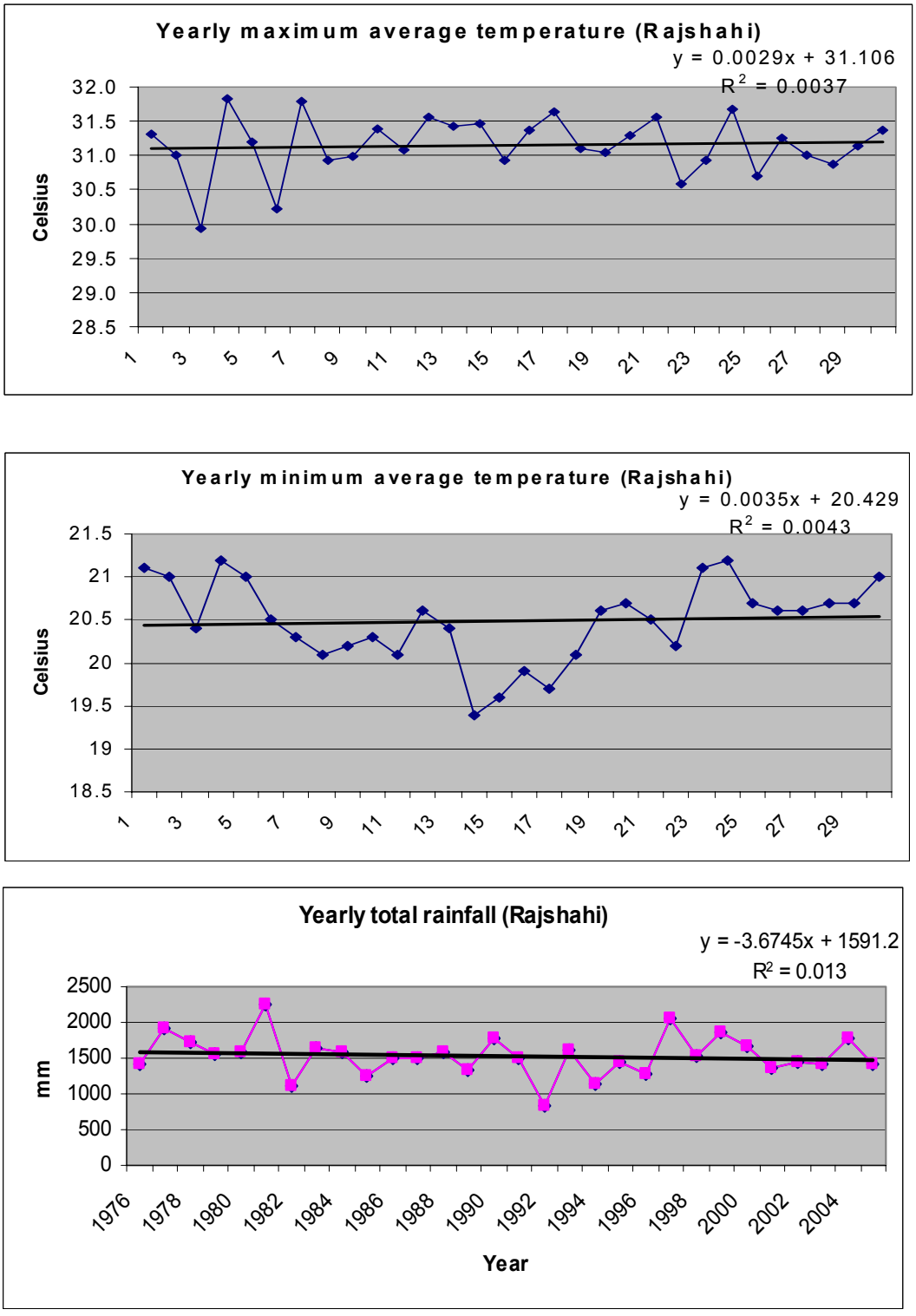


Fig.-7. Trend of long-term maximum, minimum temperature and annual rainfall in Rajshahi

The long-term changes in annual rainfall in Rajshahi are also marked by a declining trend. It declined, on average, by 3.7 mm

4.1.1.2. Disease profile

Secondary data/information on some of the major climate sensitive diseases were collected from local Upazilla Health Complex (UHC) and also from DG-Health, Dhaka office. It may be noted that data on vector borne diseases (e.g. malaria and dengue) of the study area was neither available in UHC nor in DG-Health office. The monthly incidence of diarrhea, malnutrition and skin diseases over the period 1995-2006 was provided by the UHC. The monthly incidence of kala-azar over the same period was collected from DG-Health, Dhaka.

The pattern of occurrences of all four types of diseases show increasing trend during 1999-2005. The following figure shows an increasing pattern of diarrhea, skin diseases, malnutrition and kala-azar. The highest incidence (2506) of diarrhea was observed in 2004 while the lowest occurrence (450) in 1999.

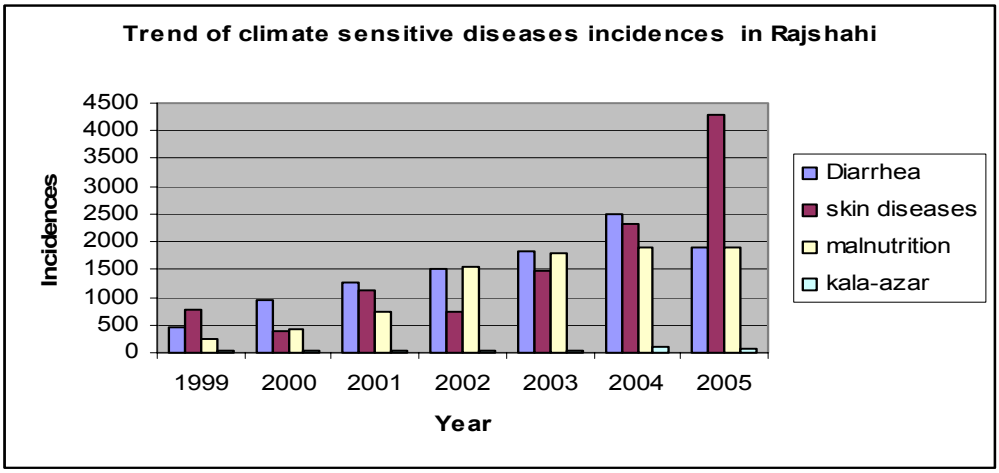


Fig.-8. Trend of climate sensitive diseases in Rajshahi

Seasonal occurrences of all four types of diseases in each year over the period 1999-2005 were also observed. Occurrences of diarrhea remained highest during monsoon in most of the year. Skin diseases incidences were observed with little variation for all the seasons of the year. However, total incidences (2942) of skin diseases during the reported period remained highest in monsoon followed by pre-monsoon (2806). Occurrences of diarrhea and kala-azar were found highest in 2004 while skin diseases and malnutrition remained highest in 2005 (figures-9A to 9D).

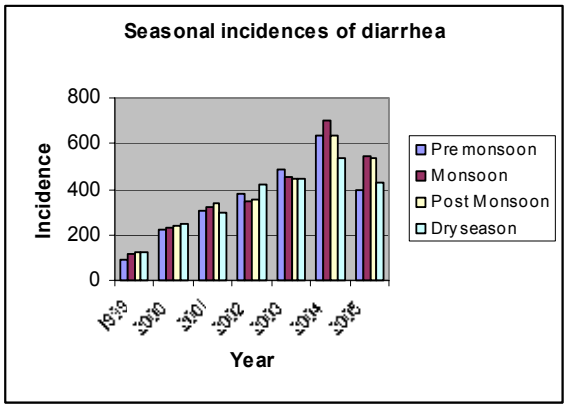


Fig-9-A.

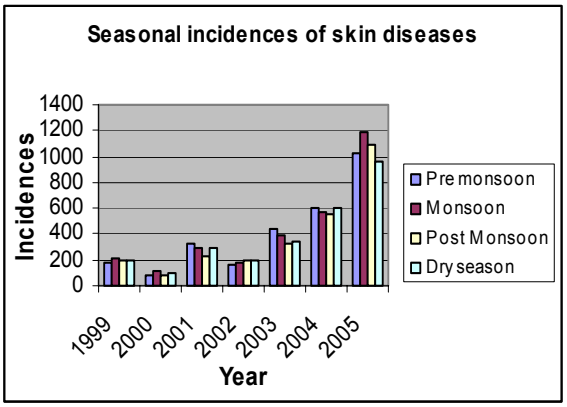


Fig-9-B

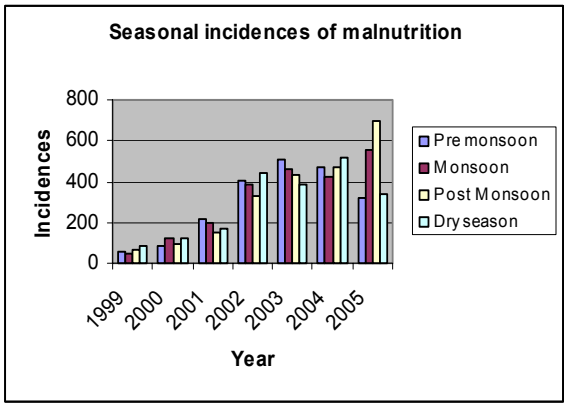


Fig-9-C

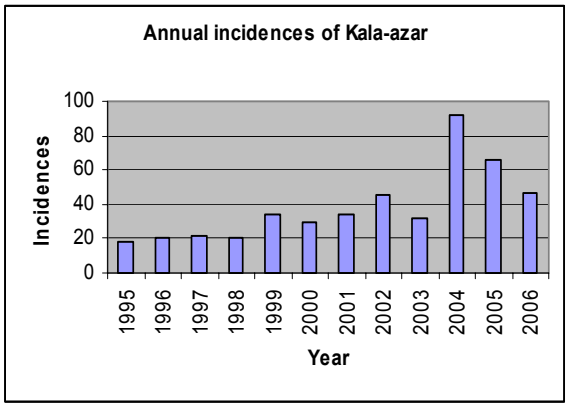


Fig-9-D

Fig.-9. Specific climate sensitive diseases in different seasons (A-D)

Seasonal (monthly) index reflecting the variations in the incidence of diseases for months of the year as calculated based on the time series data from the Upazilla health Complex is presented below:

Table 9: Seasonal (monthly) index of diseases in Rajshahi over the study period

Month	Index Value		
	Diarrhea	Malnutrition	Skin diseases
January	100.3	128.5	91.3
February	91.6	89.6	96.0
March	92.1	81.2	109.6
April	102.8	98.8	94.0
May	103.2	100.4	98.3
June	112.2	95.1	106.8
July	96.8	96.8	113.6
August	91.2	112.8	99.4
September	97.9	102.8	97.5
October	95.8	89.6	93.2
November	106.3	102.5	93.8
December	109.9	101.5	104.7

The monthly index value of diarrhea in Rajshahi varied from 91.2 in August to 109.9 in December. The index of malnutrition ranged from 81.2 in March to 128.5 in January and that of skin disease from 93.1 in January to 113.6 in July.

4.1.1.3 Correlation between human health impacts and climate variables

To explore the association between climate factors and health impacts correlation analysis was carried out using both secondary and primary data. The results of the analysis are discussed below:

Climate factors such as seasonal and annual rainfall, annual average maximum and minimum temperature and some of the available climate sensitive diseases were analyzed to find

association between human health impact due to climate change in the study areas. In fact, Pearson's correlation coefficient was applied to detect the extent of association between incidences of each of the diseases (e.g. diarrhea, skin diseases, malnutrition, and kala-azar) and climate factors (rainfall and temperature). Data on climate and incidences of diseases data from 1996 to 2005 were used to find the correlation (please annex-4 for detail). However, in Rajshahi study area, malnutrition and skin diseases data were available for the period of 1999-2005. Therefore the correlation between incidences of these two diseases and climate factors were found for this period only. The results of the correlation analysis between health disorders and climate factors are individually and specifically shown in table-10.

Correlation coefficients have been calculated between each disease with each of the three climate factors i.e. annual rainfall, annual average maximum temperature and annual average minimum temperature. In addition, seasonal rainfall and incidences of diarrhea were individually observed to explore the correlation.

The table-10 and figure-10 show that the incidences of diarrhea, malnutrition, skin diseases and kala-azar are positively correlated with at least one of the climate factors used in this study.

Kala-azar was found to have positive correlation with both annual average maximum and minimum temperature. Highest correlation (+ 0.45) of kala-azar incidence was observed with annual average maximum temperature while the lowest (+ 0.09) was with annual average minimum temperature.

Incidences of diarrhea were found to have positive correlation (+0.27) with total annual rainfall and total monsoon (+0.21) and dry (+0.03) seasonal rainfall over the reported period.

Incidence of skin diseases were observed to be positively correlated with both annual average maximum and minimum temperature. The findings show a high correlation (+0.62) between maximum temperature and skin diseases.

Incidences malnutrition were also found to have positive correlation (+0.03) with annual average maximum temperature.

Negative correlation was also found between incidences of these diseases and climate factors. Both incidences of skin diseases (-0.26) and malnutrition (-0.41) were negatively correlated with total annual rainfall over the given period. Incidence of diarrhea was found to have negative correlation with both annual average maximum temperature (-0.44) and minimum temperature (-0.13).

Table 10. Results of correlation analysis on some incidences of human health disorders and climate factors of Rajshahi study area.

SL	Climate Variables	Diseases	Value of Correlation Coefficient
A.	**Annual Rainfall**		
1	Total annual rainfall (n=10)	Diarrhea	**+0.27**
2	Total annual rainfall (n=7)	Skin diseases	-0.26
3	Total annual rainfall (n=7)	Malnutrition	-0.41
4	Total annual rainfall (n=10)	Kala-azar	**-0.06**
B	**Total seasonal rainfall (n=10)**		
1	Pre-monsoon (Mar-Apr-May)	Diarrhea	-0.24
2	Monsoon (Jun-Jul-Aug)	Diarrhea	**+0.21**
3	Post-monsoon (Sep-Oct-Nov)	Diarrhea	-0.41
4	Dry (Dec-Jan-Feb)	Diarrhea	**+0.03**

SL	Climate Variables	Diseases	Value of Correlation Coefficient
C	**Maximum temperature**		
	Annual average maximum temperature (n=10)	Diarrhea	-0.44
	Annual average maximum temperature (n=7)	Skin diseases	**+0.62**
	Annual average maximum temperature (n=7)	Malnutrition	**+0.03**
	Annual average maximum temperature (n=9)	Kala-azar	**+0.45**
D	**Minimum Temperature**		
	Annual average minimum temperature (n=10)	Diarrhea	-0.13
	Annual average minimum temperature (n=7)	Skin diseases	**+0.29**
	Annual average minimum temperature (n=7)	Malnutrition	-0.27
	Annual average minimum temperature (n=10)	Kala-azar	**+0.09**

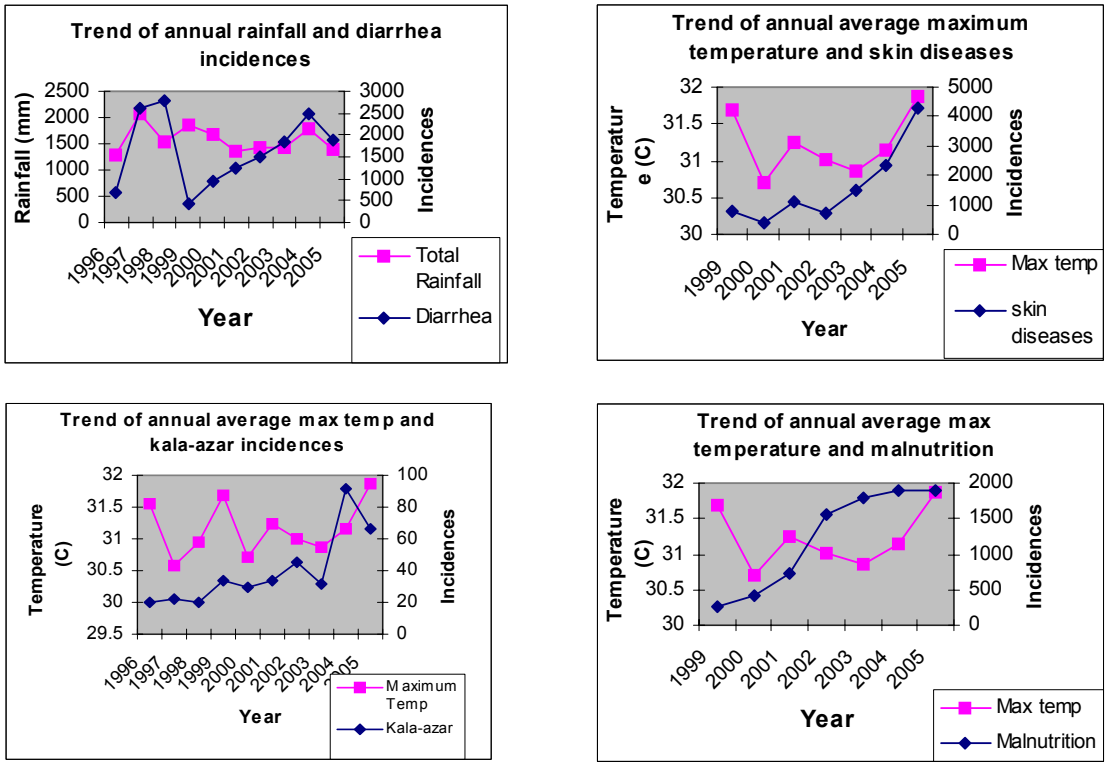


Fig.-10. Trend of climate factors and different diseases in Rajshahi study location for the period of 1996-2005.

For the sake of analysis, correlation coefficients have also been obtained between the annual incidence of diseases and the variation in temperature (difference between maximum and minimum temperature) in the given years. It is worth noting that the correlation coefficients are found positive for all the three diseases (diarrhea, malnutrition and skin diseases).

A positive correlation implies that the greater is the variation in temperature the larger the number of incidences of diseases.

The correlation coefficient is found to be 0.14 between variation in annual temperature and incidence of diarrhea and it is 0.15 between the former and malnutrition and 0.29 in case of skin diseases.

4.1.2. Climate change and climate variability issues in flood prone area: Impacts on human health (Manikganj)

4.1.2.1 Climate Characteristics (temperature and rainfall)

The climatic data for Manikganj district over the period 1976-2005 was provided by Bangladesh Meteorological Department (BMD). The climatic data included monthly and annual average maximum and minimum temperatures for the period of 1976-2005 and monthly and annual rainfall for the period of 1990-2004. The data were further analyzed to find seasonal, annual and decadal changes.

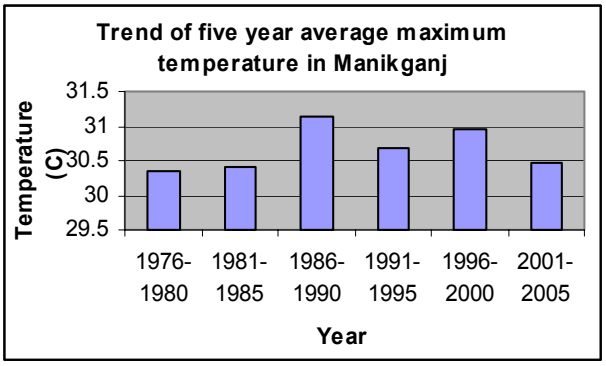


Fig.-11. Trend of five year average maximum temperature

Five year average maximum temperature for the period of 1976-1980, 1981-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2005 of Manikganj district shows clear variations. The average temperature of 1976-1980 was observed 30.35 °C while it was 30.64 °C for the period of 2001-2005. An increasing pattern was observed in each of the five year. However, the increasing pattern was sometime relatively sharp and sometime gradual.

During 1976-1980, the minimum average temperature was 21.24°C while it went up to 21.82 °C over the period 2001-2005. In addition to annual monthly maximum and minimum average was observed. Average of monthly minimum temperature shows higher in monsoon (June-July-August) whereas average of monthly maximum temperature remains higher in pre-monsoon (March-April-May) (**Fig-14**).

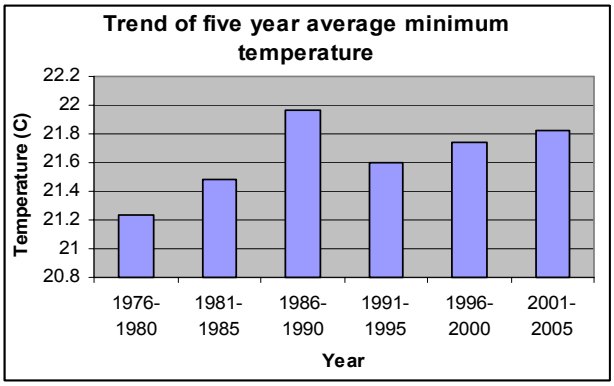
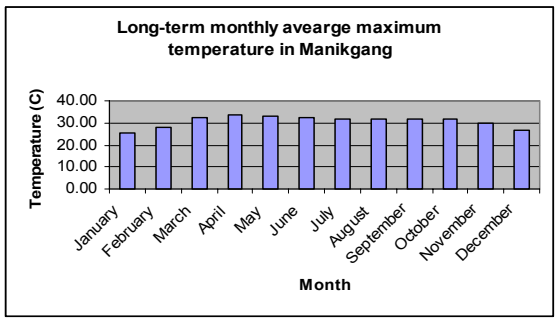


Fig.-12. Trend of five year average maximum temperature



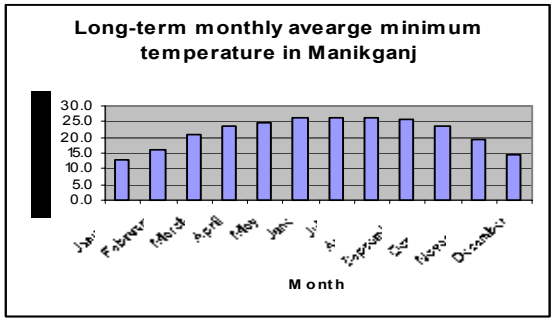


Fig.-13. Trend of long-term monthly maximum and minimum temperature

Estimated regression of yearly maximum temperature over the years reflects an average rise of 0.01°C per annum (please see figure-14) . The yearly minimum temperature is also marked by an increasing trend of 0.02°C during the study period. The rise in yearly maximum temperature is found to be twice as large as that of yearly maximum temperature. On the other hand, annual rainfall decreases by 2.9 mm.

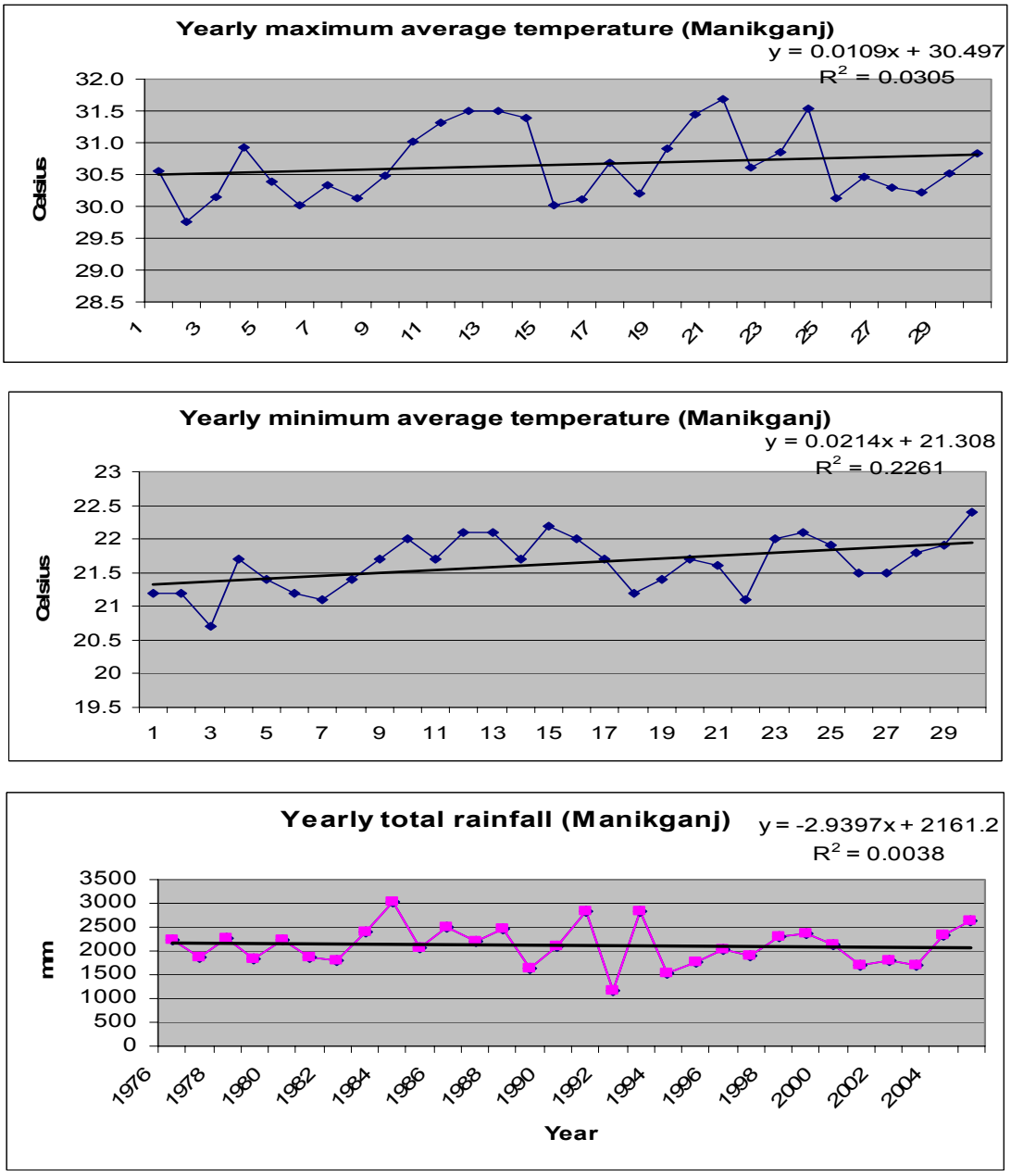


Fig.-14: Regression of yearly maximum and minimum temperature

Seasonal rainfall for the period of 1995-2005 was also observed in relation to this study. In every year (for the period of 1996-2005) except 2004 the highest rainfall was observed during monsoon. In 2004 the post-monsoon received the highest rainfall (1047 mm) while monsoon received 962 mm. However, the following figure shows variations of seasonal rainfall of each year for last decade.

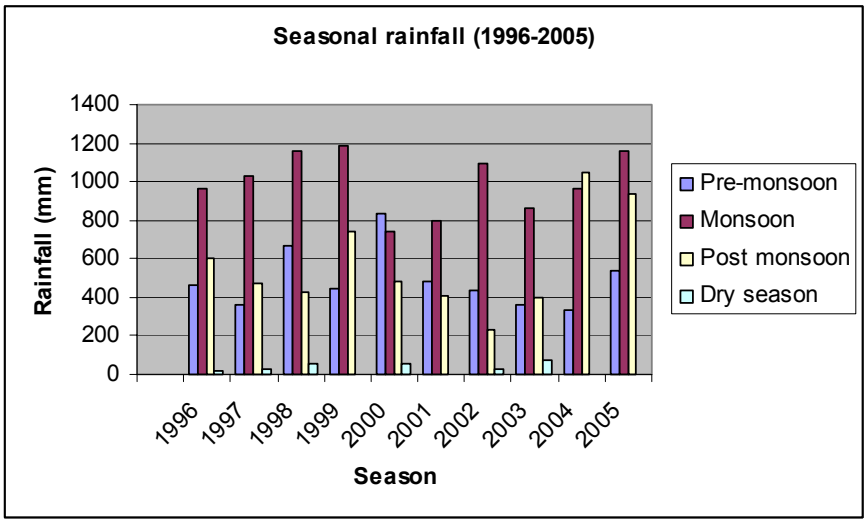


Fig.-15. Seasonal rainfall of each year for last decade

The total annual rainfall of Manikganj for the last 10 years also shows variations. The highest rainfall occurred in 2005 while the lowest was in 2001 (Fig-12).

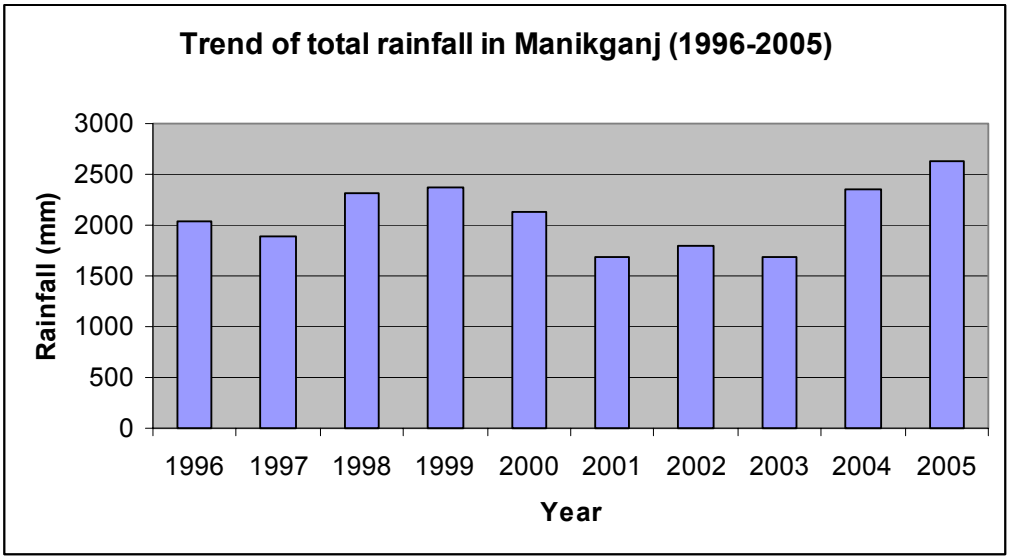


Fig.-16. Trend of total rainfall in Manikganj during 1996-2005

4.1.2.2. Disease profile

The monthly incidence of diarrhea, malnutrition, skin diseases and kala-azar over the period 1995-2006 was provided by the UHC and DG-Health, Dhaka office.

The pattern of occurrences of diarrhea, skin diseases and malnutrition show both sharp and gradual increasing trend. The highest occurrences of diarrhea and skin diseases were observed in 2002 while occurrences of malnutrition were found highest in 2004. The following figures show the trend of some of the major climate sensitive diseases in Manikganj district.

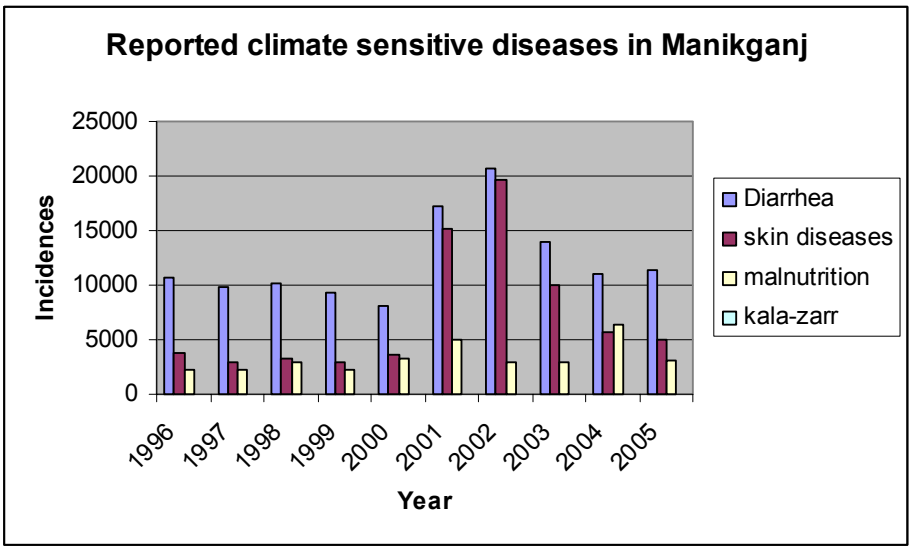


Fig.-17. Reported climate sensitive diseases for the last decade in Manikganj

Seasonal burden of the diseases for the last decade shows that diarrhea occurs more in post-monsoon while skin diseases and malnutrition were found highest occurrences in dry season. Skin disease and malnutrition occurrences show a gradual increasing pattern from pre-monsoon to dry season (please see following figure for details).

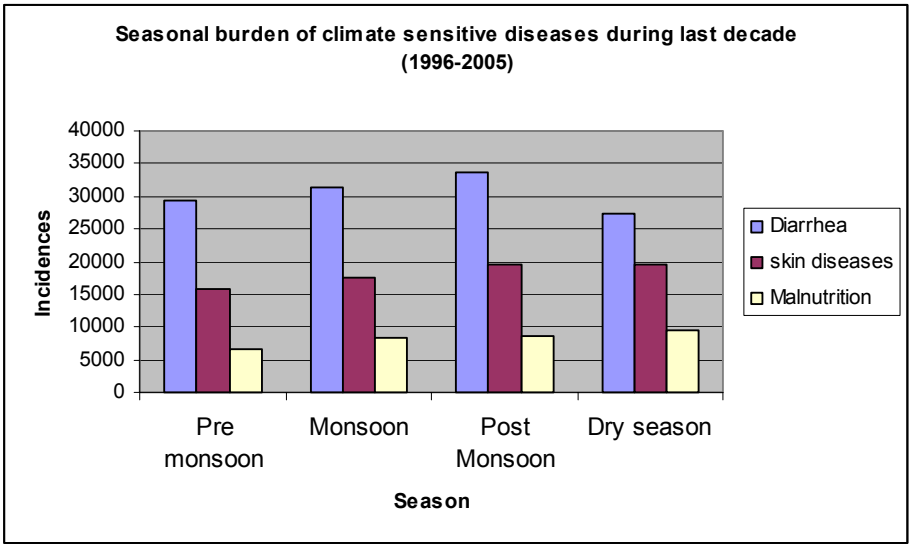


Fig.-18. Trend of climate sensitive diseases in different seasons

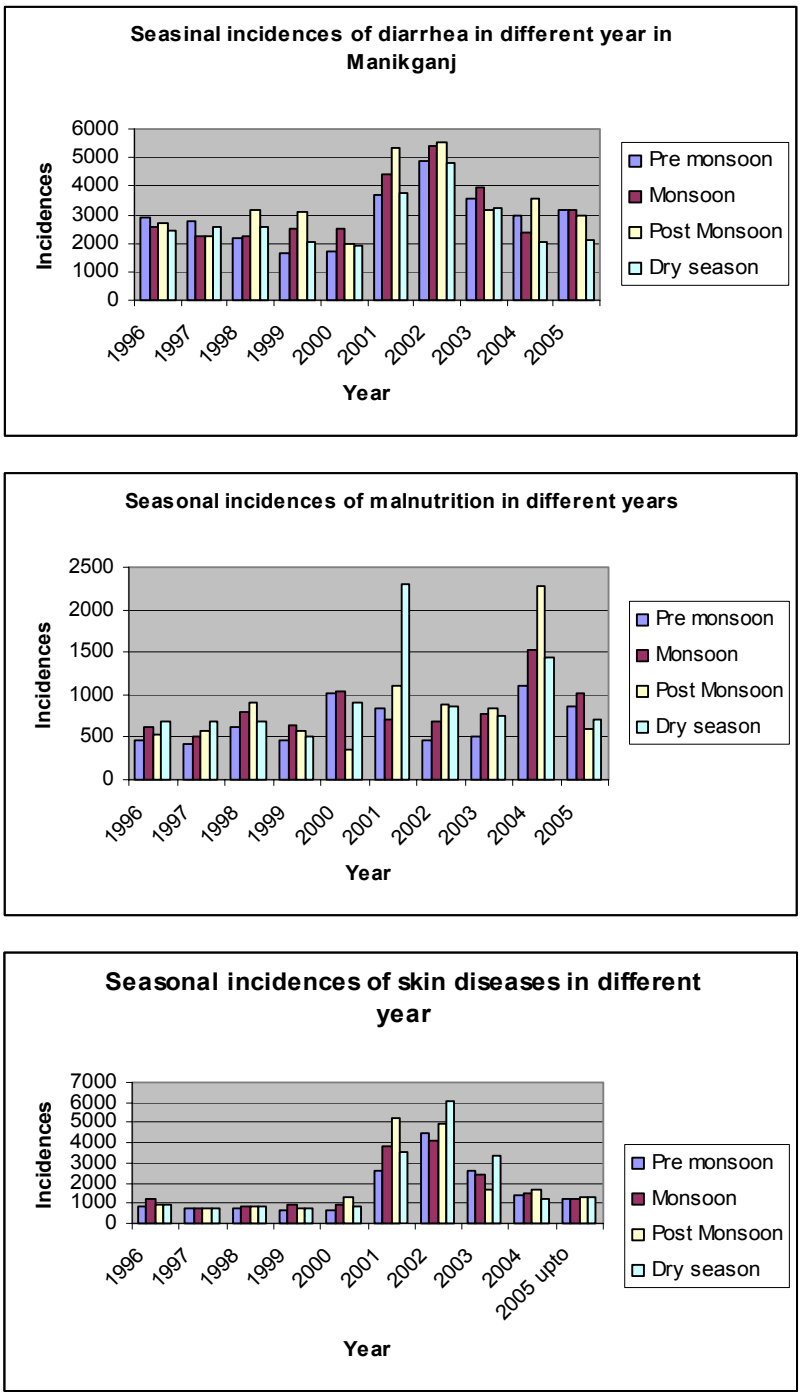


Fig.-19. Seasonal incidences of diarrhea, skin diseases and malnutrition in different years in Manikganj

Seasonal index representing the variation of incidences of the diseases in every month of the year over the last decade was calculated. The following table shows the incidences of diseases as index value:

Table 11: Seasonal (monthly) index of diseases in Manikganj study area over the last decade.

Month	Index Value		
	Diarrhea	Malnutrition	Skin Diseases
January	91.5	126.6	110.5
February	81.9	89.9	88.0
March	108.0	90.4	97.7
April	94.8	91.4	86.4
May	87.1	66.1	78.2
June	89.8	90.2	97.1
July	113.1	115.9	106.1
August	105.9	103.3	105.8
September	110.8	100.7	97.6
October	122.0	100.9	112.5
November	98.4	102.2	113.6
December	96.8	122.4	106.5

The highest occurrence of diarrhea was observed during October (122.0) whereas the lowest was during February (81.9). Malnutrition ranged between 66.1 and 126.6. The highest value was observed during January while the lowest in May. The highest index value for skin disease was 113.6 during November while lowest was 78.2 in May. However, incidences of all three diseases seem to be higher during late monsoon and early post-monsoon.

4.1.2.3. *Correlation between human health impacts and climate variables*

Statistical data from the year 1996 to 2005 were used to find the correlation between climate factors and diseases incidences (please see annex-4). The results of the correlation analysis between health impacts and climate factors are individually and specifically shown in Table-12.

In Manikganj study area, incidences of the four diseases and annual total rainfall, seasonal total rainfall, annual average maximum temperature and annual average minimum temperature was interpreted by using Pearson's correlation and coefficient (see Table-12).

The three climate factors i.e. annual rainfall, annual average maximum temperature and annual average minimum temperature and each of the diseases were used for the correlation analysis. Moreover, seasonal rainfall and incidence of diarrhea were observed individually to explore the correlation.

Table- 12 indicates the frequencies of diarrhea, malnutrition, and kala-azar is positively correlated with at least one of the climate factors used in this study.

One of the diseases like Kala-azar was found to have positive correlation with only one of the climate variables. The only positive correlation (+ 0.55) of kala-azar was observed with annual average maximum temperature while the negative correlation (-0.01) and (-0.43) was observed with annual rainfall and annual average minimum temperature respectively.

The incidence of diarrhea was found to have positive correlation (+0.10) with total rainfall during dry season over the mentioned period.

Skin diseases were found to be negatively correlated with all the climate change variables.

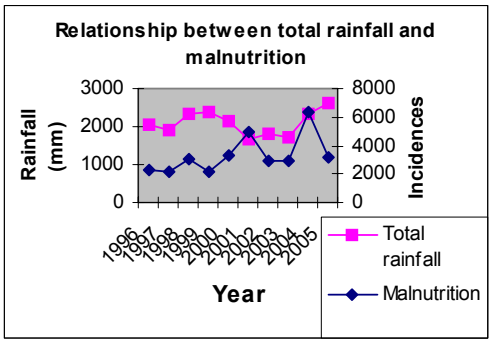
Malnutrition was found to have positive correlation (+0.06) with total annual rainfall and annual average minimum temperature (+0.10).

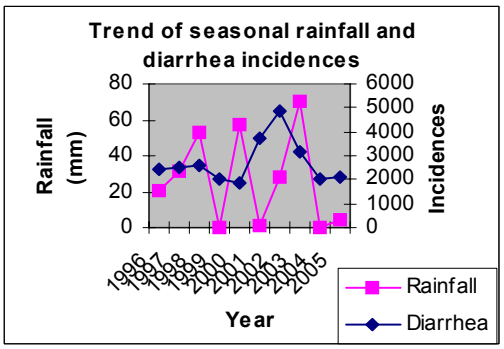
In Manikganj study, incidences of diseases and variation in temperature (difference between maximum and minimum temperature) were found to have negatively correlated. The highest negative correlation was 0.62 with skin disease while the lowest was 0.26 with malnutrition.

Table 12. Results of correlation analysis on incidence of some human health disorders and climate factors of Manikganj study area.

SL	Climate Variables	Diseases	Value of Correlation coefficient
A.	**Annual Rainfall**		
1	Total annual rainfall (N=10)	Diarrhea	-0.59
2	Total annual rainfall (N=10)	Skin diseases	-0.63
3	Total annual rainfall (N=10)	Malnutrition	+0.06
4	Total annual rainfall (N=10)	Kala-azar	-0.01
B	**Total seasonal rainfall**		
1	Pre-monsoon (Mar-Apr-May)	Diarrhea	-0.49
2	Monsoon (Jun-Jul-Aug)	Diarrhea	-0.15
3	Post-monsoon (Sep-Oct-Nov)	Diarrhea	-0.32
4	Dry (Dec-Jan-Feb)	Diarrhea	+0.10
C	**Maximum temperature**		
	Annual average maximum temperature	Diarrhea	-0.37
	Annual average maximum temperature	Skin diseases	-0.48
	Annual average maximum temperature	Malnutrition	-0.40
	Annual average maximum temperature	Kala-azar	+0.55
D	**Minimum Temperature**		
	Annual average minimum temperature	Diarrhea	-0.33
	Annual average minimum temperature	Skin diseases	-0.33
	Annual average minimum temperature	Malnutrition	+0.10
	Annual average minimum temperature	Kala-azar	-0.43

The trend of different diseases and climate factors for the period of 1996-2005 are also represented in graphs. However, the following graphs (figure-20) shows positive correlation between incidences of some of the diseases and climate factors.





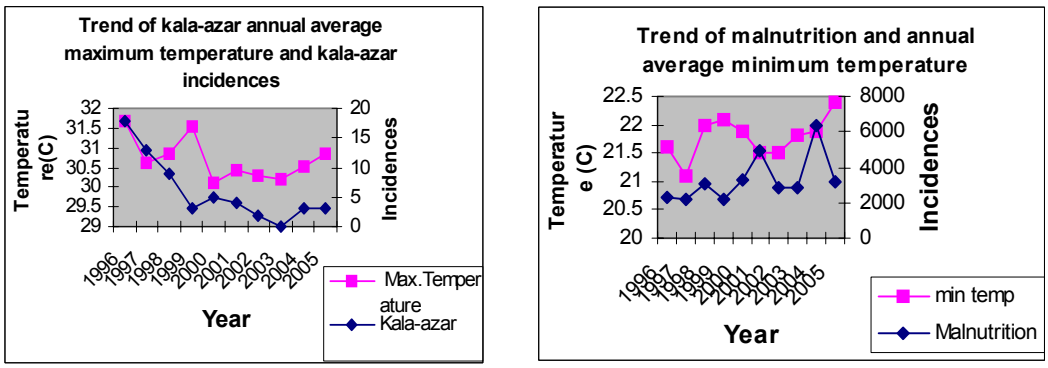


Fig.-20. Trend of climate factors and different diseases in Manikganj study location for the period of 1996-2005.

4.1.3. Climate change and climate variability issues in Salinity prone area : Impact on human health (Satkhira)

4.1.3.1. Climate Characteristics (temperature, rainfall and salinity)

The climatic data for Satkhira district over the period 1976-2005 was provided by Bangladesh Meteorological Department (BMD). The climatic data comprised monthly and annual average maximum and minimum temperature for the period of 1976-2005 and monthly and annual rainfall for the period of 1990-2005

The following figure (figure-21) shows that the five year annual average maximum temperature follows a declining trend between 1986 and 2005. The highest average (31.9 ° C) was observed during 1986-1990 while the lowest (31.16 ° C) was during 1981-1985.

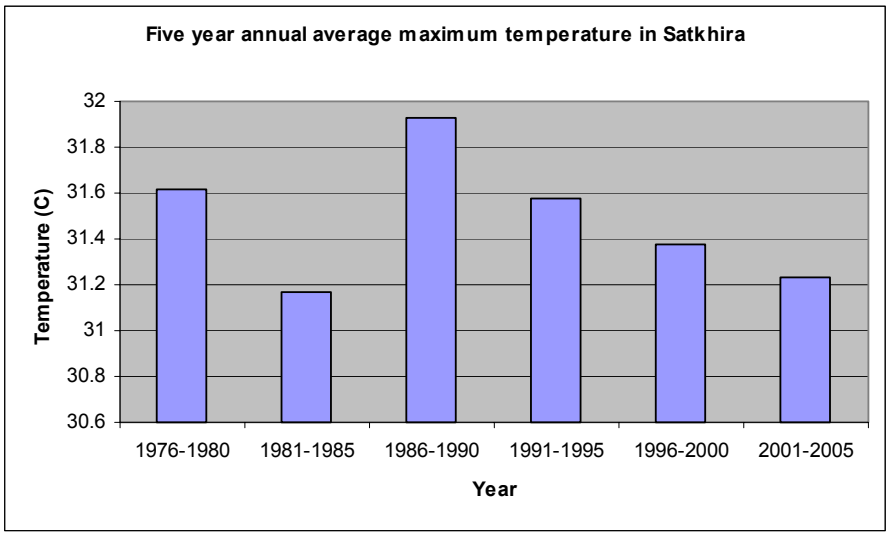


Fig.-21. Five year annual average maximum temperature in Satkhira study area

The long-term trend in average maximum temperature shows a decline over the years. It has, on average, reduced by 0.009°C per annum over the period (see following figure). The average annual minimum temperature in Satkhira region has also declined, on average, by 0.001°C over the period (1976-2005). In contrast, the annual rainfall increased by 9.5 mm.

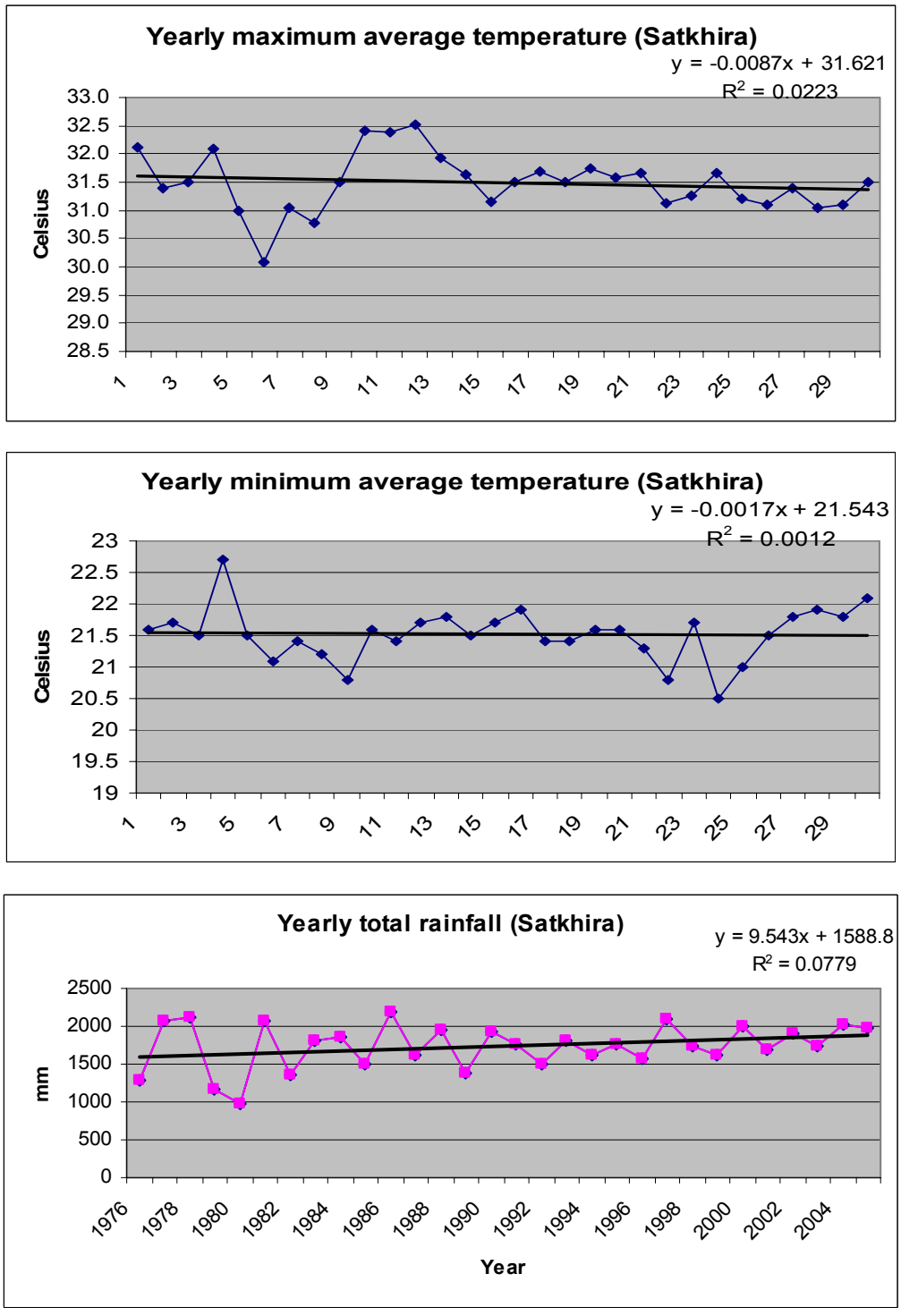


Fig.-22. Regression of yearly maximum and minimum temperature

Seasonal average maximum temperature for each year of the last decade was observed. The highest average maximum temperature was 35.0 ° C observed in pro-monsoon of 1996 and 1999. The lowest average was 26 ° C observed in dry season in 2003 (Fig-23).

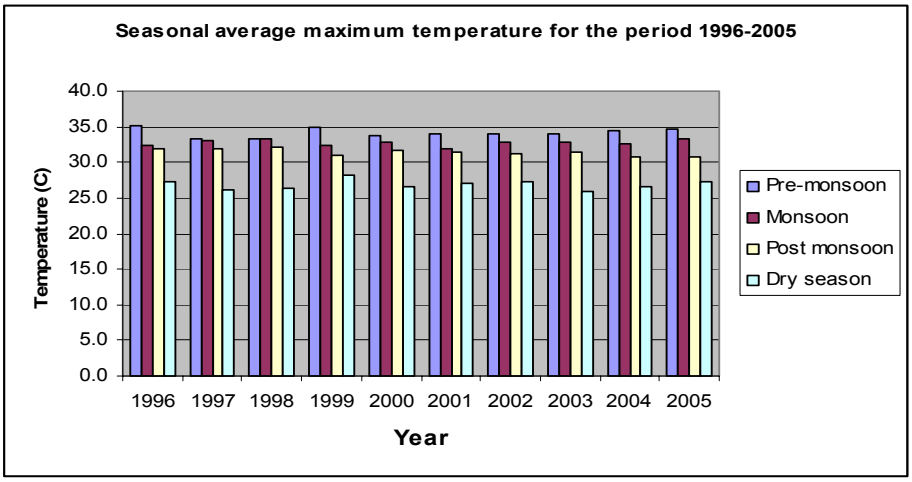


Fig.-23. Seasonal average maximum temperature in Satkhira study area during 1996-2005

Seasonal average minimum temperature for each year of the last decade was also observed. The highest average minimum temperature was 24.5 ° C observed in pro-monsoon of 2005. The lowest average was 12.4 ° C observed in dry season in 2000 (Fig-25).

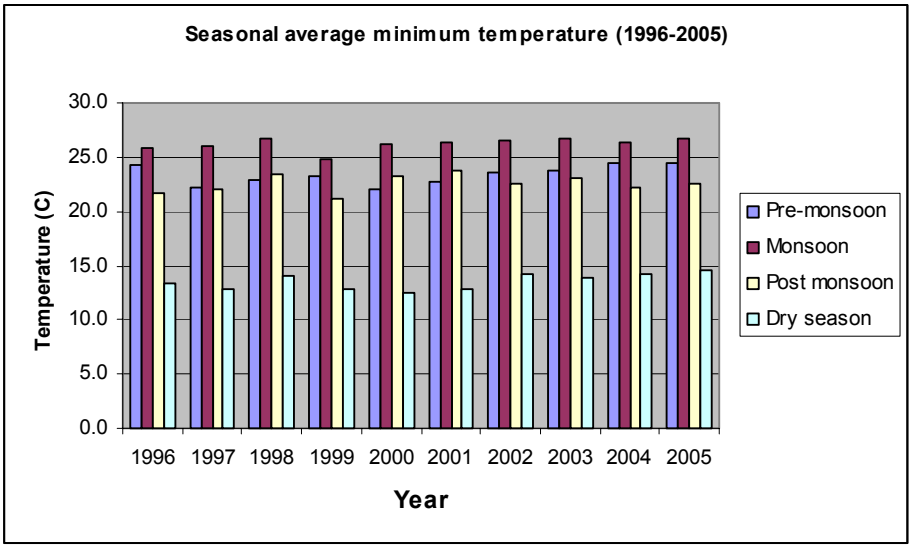


Fig.-24. Seasonal average maximum temperature in Satkhira study area during 1996-2005

The annual average minimum temperature of this study area shows variations. Most of the years of the first of the last three decades experienced less than 21.5 ° C of annual average minimum temperature. The lowest average was observed during first half of the last decade. However, from 2000 to 2005 the minimum average temperature followed an increasing pattern.

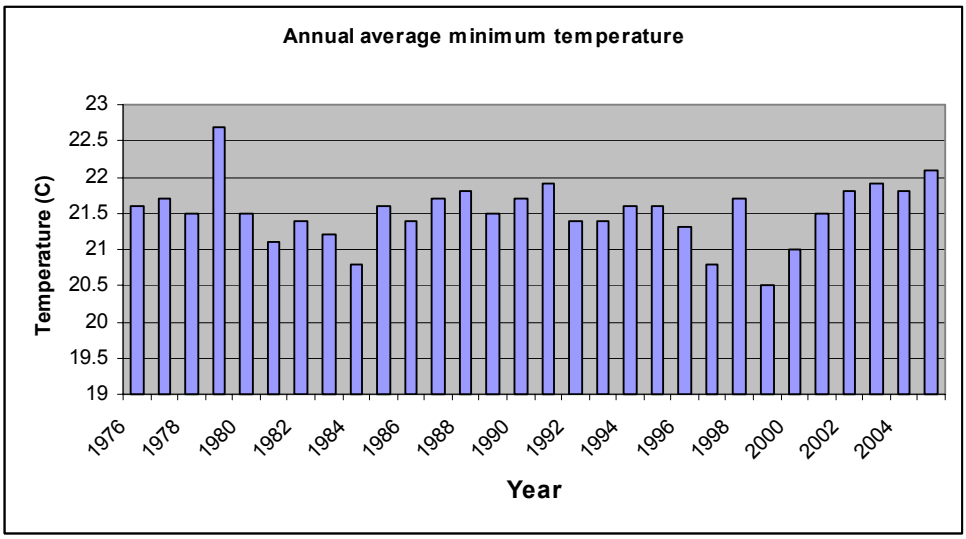


Fig.-25. Seasonal average minimum temperature in Satkhira study area during 1976-2005

Annual and seasonal total rainfall of the study area was observed. The pattern of total rainfall of different years of the last decade was quite irregular. Pre-monsoon rainfall followed a decreasing pattern (sharp and gradual) from 1997 to 2005. On the other hand, monsoon of 2002 received the highest (1271 mm) rainfall compared to other years of the last decade. A gradually decreasing pattern of pre-monsoon rainfall was observed from 1997 to 2005 while the total rainfall of post-monsoon shows an increasing pattern from 2002 to 2005 (Fig-27).

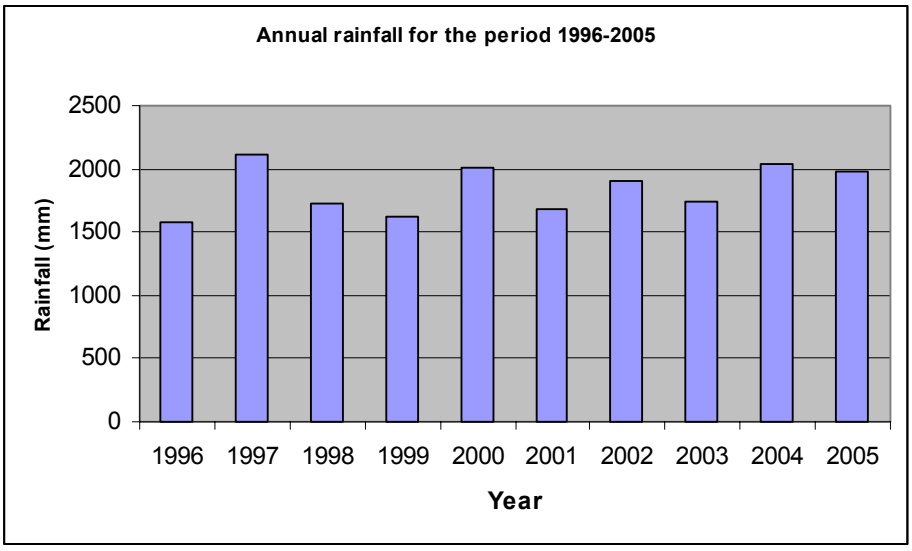


Fig.-26. Annual average rainfall in Satkhira study area during 1996-2005

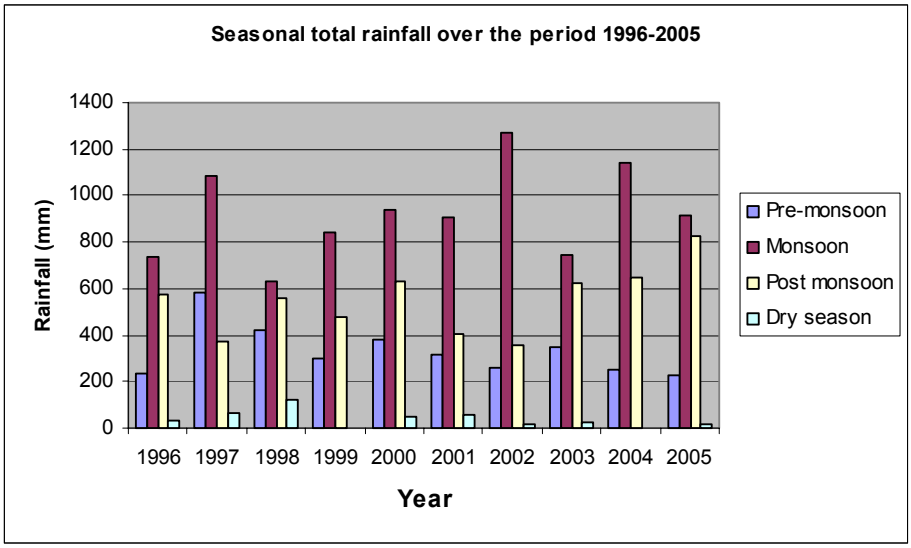


Fig.-27. Seasonal rainfall in Satkhira study area during 1996-2005

The highest salinity concentration from the nearest station of Satkhira study area was observed. The highest concentration was 29500 micro-mhos found in 1992 and 1996.

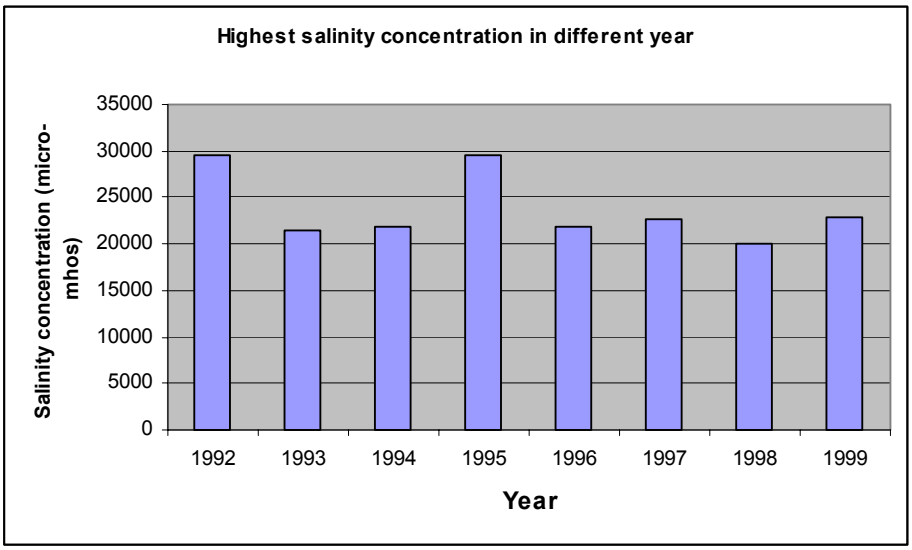


Fig.-28. Highest salinity concentration for the period 1992-1999 in the nearest station of Satkhira study

4.1.3.2. Disease profile

Some of the major available climate sensitive diseases including diarrhea, skin diseases and malnutrition record of UHC of Satkhira study area were observed. Annual burden of diarrhea was higher than the other sensitive diseases in each reported year. It was observed that the diarrhea occurrences ranged between 3210 and 6875 from 1996 to 2005. The highest occurrences were found in 2002 while the lowest was in 2000. Skin diseases were found to have an increasing trend from 1996 to 2005 while occurrences of malnutrition show irregular pattern (figure-29)

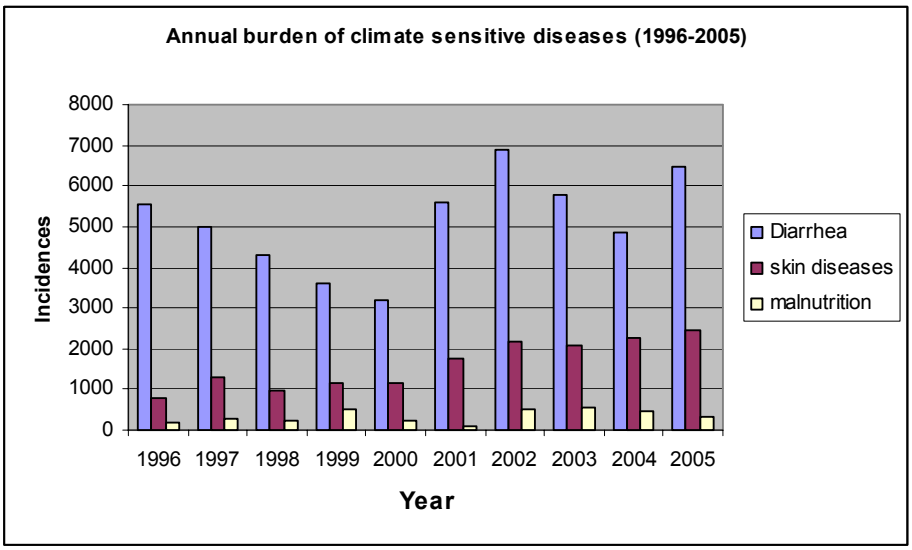


Fig.-29. Annual incidences of some climate sensitive diseases in Satkhira study area over the period 1996-2005

The following figure shows that diarrhea mostly occurs during monsoon. It was observed that during 2004 and 2005, occurrences of diarrhea in pre-monsoon were higher than the other seasons. However, the figure shows that diarrhea is a common disease for all seasons of the year.

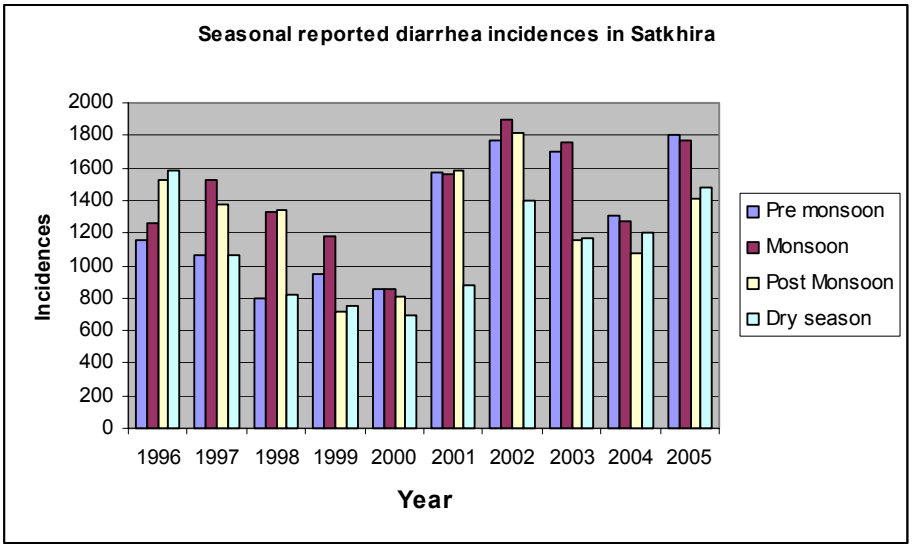


Fig.-30. Seasonal occurrences of diarrhea over the period 1996-2005 in Satkhira study area

Malnutrition was found to have highest occurrences during post-monsoon in early years of the last decade while it was highest in monsoon during 2nd half of the last decade except in 2002. However, the highest malnutrition disorders (198) was observed in 2004 during monsoon and the lowest was in 1996 (5) during dry (figure-31). On the other hand, skin diseases follow an increasing trend in almost every season in each year from 1996 to 2005 (Figure-32).

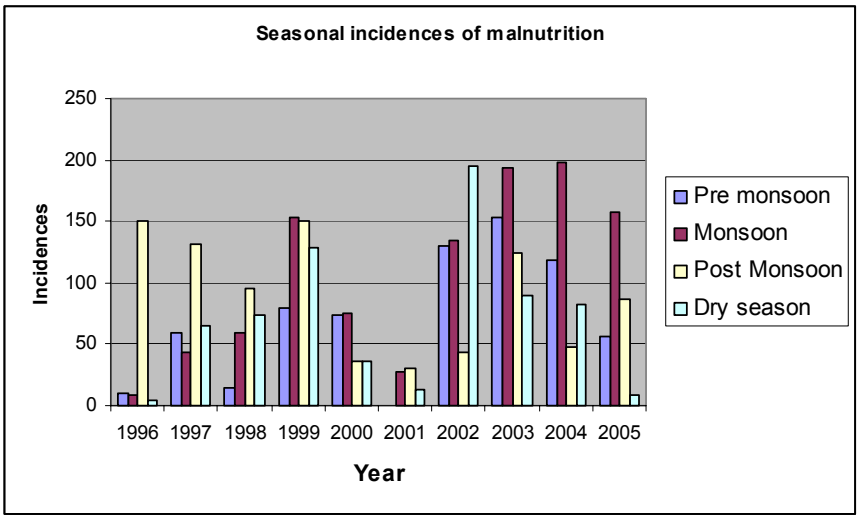


Fig.-31. Seasonal occurrences of malnutrition over the period 1996-2005 in Satkhira study area

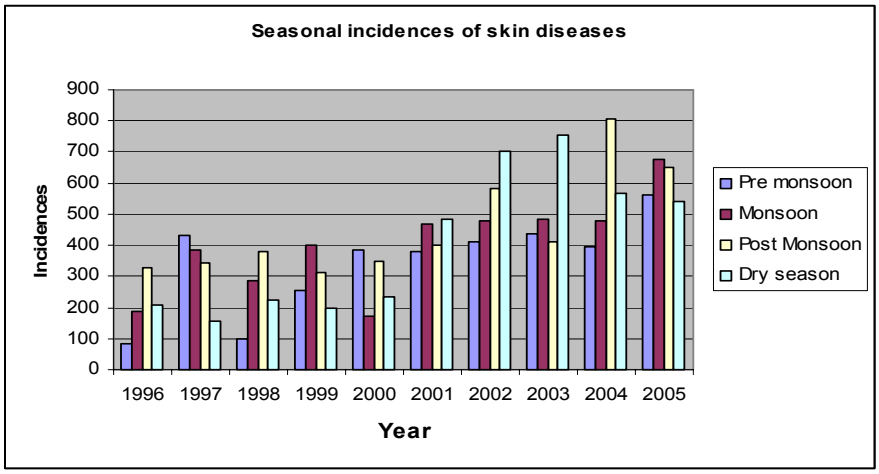


Fig.-32. Seasonal occurrences of malnutrition over the period 1996-2005 in Satkhira study area

Seasonal (monthly) incidences were also calculated to show the variations. The following table shows the variations in the incidence of diseases for month of the year over the decade.

Table 13: Seasonal (monthly) index of diseases in Manikganj study area over the last decade.

Month	Index Value		
	Diarrhea	Malnutrition	Skin Diseases
January	89.8	60.2	95.8
February	92.9	40.2	71.9
March	101.8	76.1	88.1
April	93.4	65.5	96.3
May	107.1	72.1	69.6
June	111.8	82.1	75.1
July	123.9	138.2	132.1
August	104.0	143.3	95.4
September	115.1	123.4	114.6
October	106.1	171.9	116.9
November	78.5	98.5	122.1
December	75.7	128.3	122.0

4.1.3.3. Correlation between incidence of human health diseases and climate variables

Satkhira was one of the three areas where the study was undertaken to find the association between incidences of human health and climate change (please see annex-4 for details). Climate factors such as seasonal and annual rainfall, annual average maximum and minimum temperature, salinity concentration and some of the climate sensitive incidences of diseases were compared and analyzed. To find the primary association for the frequency of each of the diseases (diarrhea, kala-azar, malnutrition and skin diseases) and climate factors (rainfall and temperature) the Pearson's correlation was applied. Data from the year 1996 to 2005 were used to find the correlation. The correlation between the incidences of these two diseases and climate factors were found for this period only.

However, results of the correlation analysis between health impact and climate factors are shown in Table-14.

Table-14 presents that the occurrence of diarrhea, malnutrition, and skin-diseases are positively correlated with most of the climate factors used in this study.

One of the diseases like malnutrition was found to have correlation with all of the climate variables. The highest positive correlation (+ 0.58) of malnutrition was observed with salinity concentration while the lowest correlation (+0.04) was observed with annual average maximum temperature.

The incidences of diarrhea were found to have positive correlation with total annual rainfall (+ 0.05) and total monsoon rainfall (+0.27) over the reported period. Diarrhea was also found positively correlated (+0.69) with annual average minimum temperature

Skin diseases were observed to be positively correlated with annual rainfall, annual average minimum temperature and salinity concentration. The highest correlation (+0.70) was observed with annual average minimum temperature while the lowest correlation (+0.43) was found with annual rainfall.

Negative correlation was also observed between the diseases and climate factors. Diarrhea was found to have negative correlation (-0.05) with highest salinity concentration. The correlation between skin disease and annual average maximum temperature was also negative (-0.29).

Table 14. Results of correlation analysis on human health disorders and climate factors of Satkhira study area are shown below

SL	Climate Variables	Diseases	Value of correlation coefficient
A.	**Annual Rainfall (n=10)**		
1	Total annual rainfall	Diarrhea	**+0.05**
2	Total annual rainfall	Skin diseases	**+0.43**
3	Total annual rainfall	Malnutrition	**+0.11**
B	**Total seasonal rainfall (n=10)**		
1	Pre-monsoon (Mar-Apr-May)	Diarrhea	-0.49
2	Monsoon (Jun-Jul-Aug)	Diarrhea	**+0.27**
3	Post-monsoon (Sep-Oct-Nov)	Diarrhea	-0.33
4	Dry (Dec-Jan-Feb)	Diarrhea	-0.40

C	**Maximum temperature (n=10)**		
	Annual average maximum temperature	Diarrhea	**+0.02**
	Annual average maximum temperature	Skin diseases	-0.29
	Annual average maximum temperature	Malnutrition	**+0.04**
D	**Minimum Temperature (n=10)**		
	Annual average minimum temperature	**Diarrhea**	**+0.69**
	Annual average minimum temperature	**Skin diseases**	**+0.70**
	Annual average minimum temperature	**Malnutrition**	**+0.10**
E	**Salinity Concentration** (n=4)		
	Annual highest salinity in nearest station	**Diarrhea**	-0.05
	Annual highest salinity in nearest station	**Skin diseases**	**+0.51**
	Annual highest salinity in nearest station	**Malnutrition**	**+0.58**

The trend of different diseases and climate factors for the period of 1996-2005 are also represented in the graphs. However, the figure-34 shows some of the positive correlation between incidences of some of the diseases and climate factors in Satkhira study area.

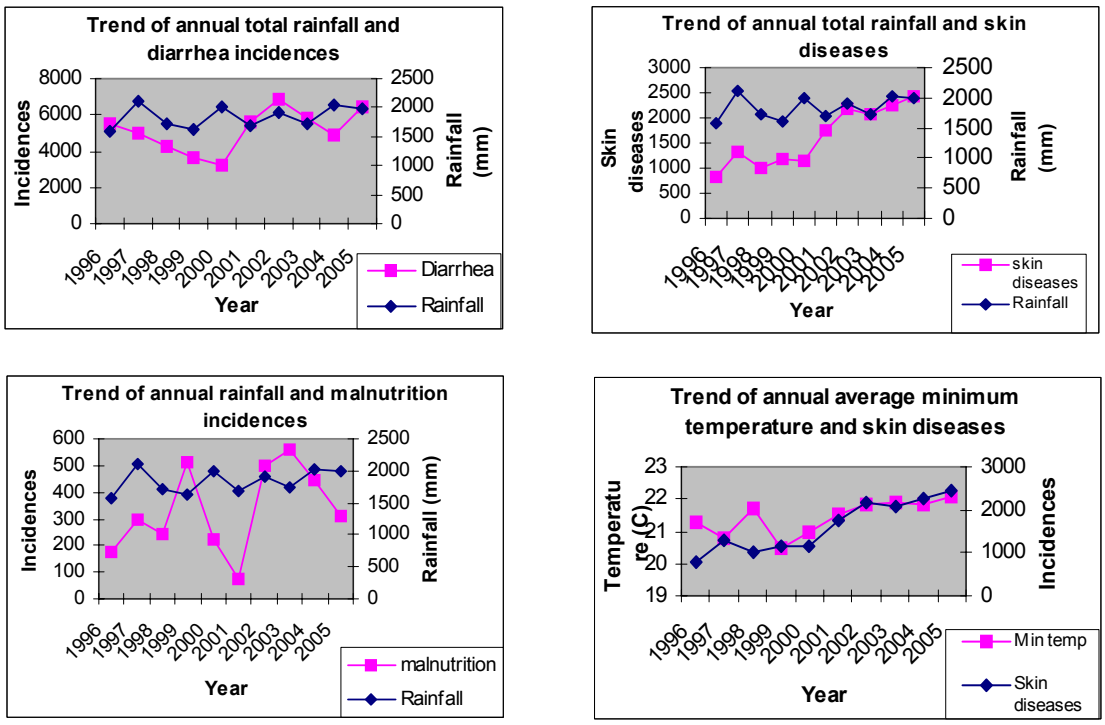


Fig.-33. Positive correlation between climate factors and diseases in Satkhira

The correlation between incidences of diseases and variations in temperature was also estimated. All three types of diseases (diarrhea, skin diseases and malnutrition) were found to have positive correlation with variation in temperature. The highest correlation was found +0.40 with diarrhea and the lowest was +0.25 with malnutrition. Correlation with skin diseases was +0.29.

4.2. Results from Primary Sources

This section deals with findings of the study conducted in the three districts prone to climate related hazards. The findings of the study have been qualitatively and quantitatively assessed to find correlation between climate change and health disorders. The sample survey included 300 households altogether. Each of the study districts comprises 100 households.

The findings of the survey have been considered from two viewpoints-

4.2.1 Comparative analysis of findings: The responses of the questions of three study locations were analyzed together in order to compare the findings.

4.2.1.1 Separate analysis of findings: Some of the questions that were specific and location based. These were analyzed separately

4.2.2. Comparative analysis among study districts

Common diseases that affect household members: The households in the study areas were affected by various diseases including diarrhea, dysentery, dengue, malaria, skin diseases, mental disorders, malnutrition, common cold/cough/fever, typhoid, asthma, jaundice. Although the household respondents identified various diseases, the analysis was mainly on climate sensitive diseases. According to response of the households, diarrhea were identified as common diseases by 85 per cent respondents of Manikganj while 82 per cent and 55 per cent respondents of Rajshahi and Satkhira respectively mentioned the same. It was found that overall 74 per cent respondents mentioned diarrhea as common diseases. However, 30 per cent respondents of all the study locations together mentioned that skin diseases usually affect them while only 6 per cent of 94 per cent of respondents were for malnutrition. On the other hand, most of the participants from all three study locations identified cold/cough/fever as common diseases.

Table 15. Per centage of household respondents having response on common diseases

Name of disease	Area			
	Manikganj (N=100)	Rajshahi (n=100)	Satkhira (n=100)	All (n=300)
Diarrhea diseases	85.0	82.0	55.0	74.0
Dengue	1.0	-	-	0.3
Malaria	-	1.0	-	0.3
Skin disease	31.0	35.0	24.0	30.0
Malnutrition disease	-	9.0	9.0	6.0
common cold/cough/fever	97.0	98.0	87.0	94.0

During FGD and in-depth interviews, the health professionals of the respective study locations, villagers and women identified a number of common diseases which include diarrhea, dysentery, fever/cold/cough, skin diseases, malnutrition, jaundice, gastric problems, pneumonia etc. In addition, menstruation problems, cholera, anemia etc were also mentioned as common problems in some area. However, diarrhea, dysentery, skin disease, malnutrition

and common cold/fever/cough were mentioned by all FGD groups (health professionals, women and villagers) as common diseases in each study locations.

Health problems during hazard period: In response to a question on the health problems of the households during hazard period, most of the respondents in every site mentioned about diarrhea, dysentery, common cold/fever etc. In Manikganj, common cold/fever (30 per cent) and diarrhea (29 per cent) got almost same per centage in terms of incidences during hazard period. On the other hand, 38 per cent respondents of Satkhira said they suffer from diarrhea during hazard while 17 per cent of the respondents of Rajshahi said the same (Details in the following figure).

FGD and in-depth interviews also indicate almost similar findings as found in the survey. Water borne diseases including diarrhea, dysentery, skin diseases mostly affect people during hazards like flood, drought etc.

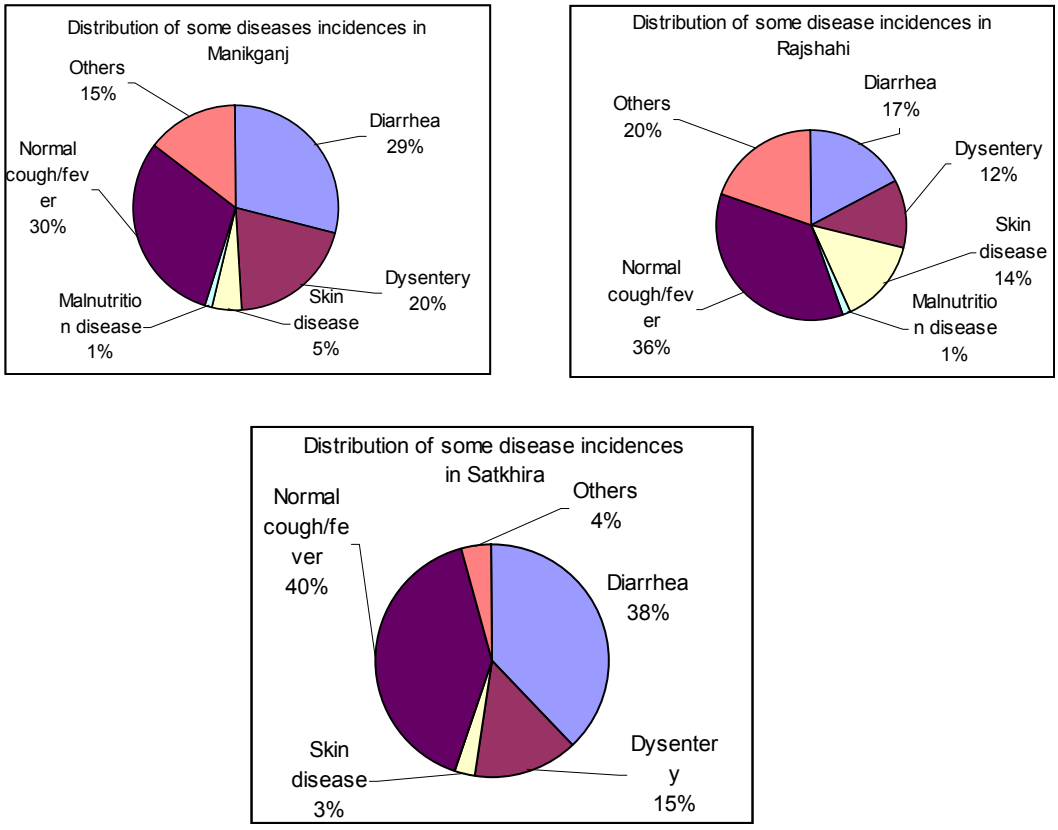


Fig.-34. Per centage distribution of household respondents having response on health problems faces during hazard period

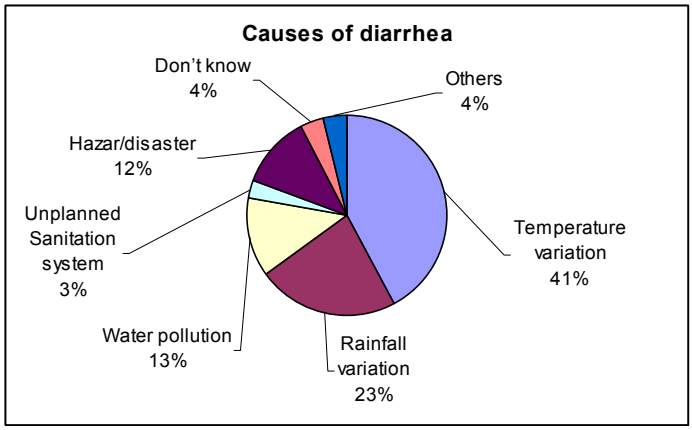
Household's opinion on possible reasons for disease incidences: The possible reasons for some of the major diseases mentioned by respondents for all the study locations were analyzed together. This overall analysis shows that most of the respondents mentioned about common cold/fever/cough, diarrhea and skin diseases. According to the respondents of all three districts, temperature variation causes most of these diseases incidences. The other significant reasons include rainfall variation, hazard/disaster and water pollution. With regard to causes of diarrhea incidences, 42.1 per cent are attributable to change in temperature, followed by 22.9 per cent to rainfall variation and 11.9 per cent to hazard/disaster. Regarding

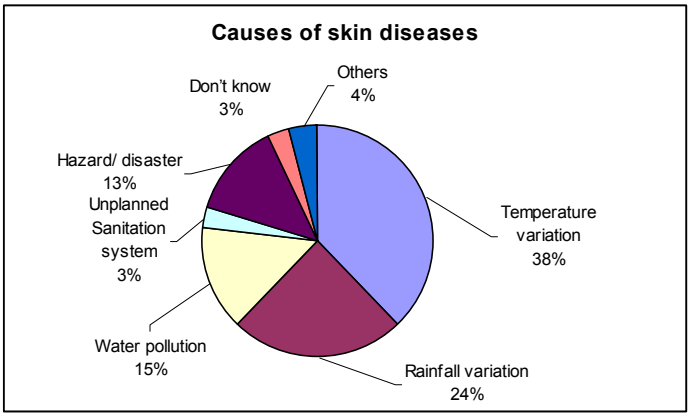
skin diseases, again, most of the respondents (37.9 per cent) mentioned temperature variation as cause of skin disease. Rainfall variation causes skin diseases, mentioned my 24.1 per cent respondents while 14.8 per cent and 13.3 per cent said water pollution and hazard are correspondingly causes of it. For common cold/fever/cough, temperature and rainfall variation, water pollution and hazard are the causing factors mentioned by 41.2 per cent, 22.5 per cent, 11.2 per cent and 14.2 per cent respectively. (Details are in table 16 and figure 35).

During FGD and in-depth interviews, most of the participants mentioned that there is change in seasonal weather, rainfall, humidity etc. Many of the participants specifically said that the length of summer and winter nowadays have been changed compared to the past. Ambient temperature is felt to be increasing in both summer and winter in Rajshahi and Manikganj. In Satkhira, most of the participants said that just 10-20 years ago, the length of winter was no less than 2 months and now it is no more than 25 days. Almost all the participants in each study location gave same opinion on rainfall and temperature variations. They also mentioned that the intensity of flood and drought has increased. It was stated that the increase of diseases can be attributed to changes of climate factors or hazards.

Table 16: Per centage of household respondents having response on possible reasons for disease incidences

Reason	Name of Major diseases					
	Diarrhea diseases (n=215)	Skin disease (n=98)	Malnutrition disease (n=23)	Common cold/fever/cough (n=270)	Typhoid (n=16)	Asthma (n=42)
Temperature variation	42.1	37.9	40.5	41.2	30.8	43.4
Rainfall variation	22.9	24.1	18.9	22.5	25.6	26.3
Water pollution	12.7	14.8	5.4	11.2	15.4	11.8
Unplanned Sanitation system	2.9	3.0	2.7	2.5	7.7	-
During hazard/ disaster	11.9	13.3	10.8	14.2	10.3	9.2
Don't know	3.6	3.0	8.1	3.8	5.1	3.9
Others	3.9	3.9	13.6	4.6	5.1	5.4





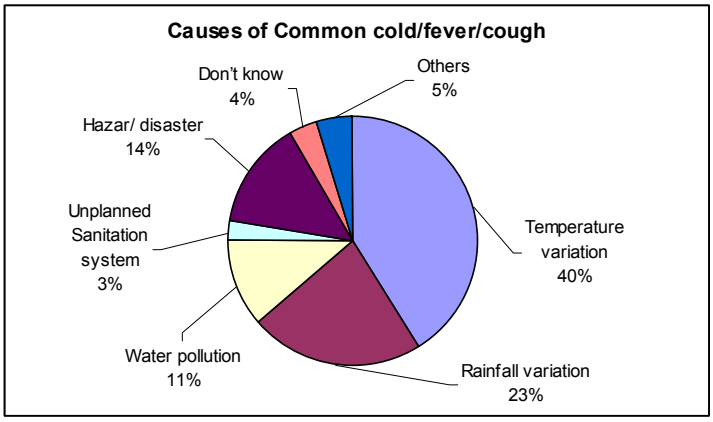


Fig.-35: Per centage of household respondents having response on possible reasons for disease incidences (in three districts together)

Sources of drinking water during hazard period: According to the survey, tube-well is the major source (over 95 per cent) for drinking water during hazard/disaster period. Only 4 per cent respondents of Rajshahi said deep tube-well while 1 per cent mentioned the same in Manikganj. Satkhira was found different. Here, 54 per cent depends on pond and only 29 per cent go for tube-well. However, in three districts together, 74 per cent respondents mentioned tube-well as source of drinking water during hazards while 18 per cent, 5 per cent, 2 per cent and 1 per cent are for pond, rain water, deep tube-well and others respectively (details in the following figure).

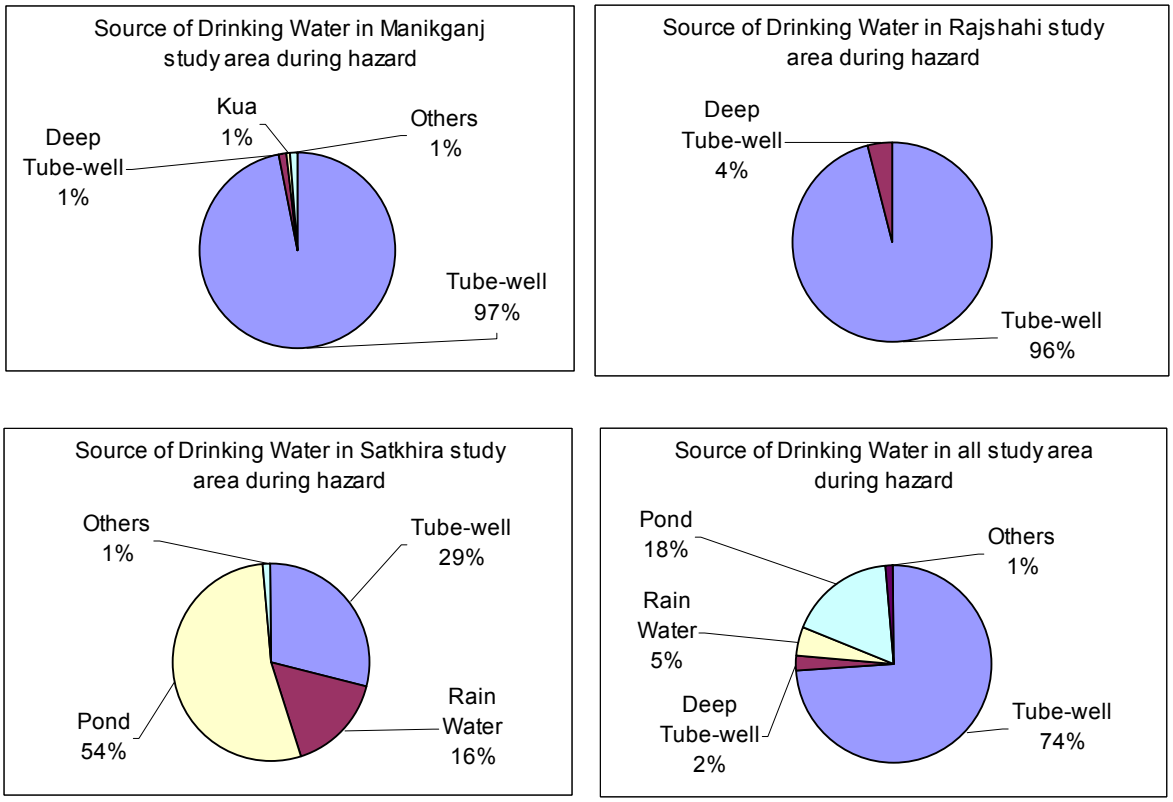


Fig.-36. Per centage of household by sources of drinking water during hazard/disaster.

Most of the participants in FGD and in-depth interviews mentioned that tube-well is the major source of water for drinking in all the study locations during hazard period. They also use flood water after filtration.

Availability of water for household activities: Findings on availability issues of safe water for drinking and household activities to some extent were different among the three districts**.** In Manikganj, 80 per cent respondents mentioned that safe water is adequate for drinking whereas 64 per cent in Rajshahi and 65 per cent in Satkhira said the same. In all three districts together, 69.7 per cent respondents said that water is adequate for drinking. On the other hand, 65.3 per cent respondents said water is adequate for household activities. In contrast, more than 30 per cent respondents said water is inadequate in both the mentioned purposes.

In Manikganj, participants use water from ponds/canal, rain water or flood water for sanitation purposes, mentioned during FGD and In-depth interviews. According to women group of Manikganj, the main sources of water for household activities including sanitation are tube-well, pond and river. On the other hand, Rajshahi women group said about the scarcity of water is quite inadequate particularly during pre-monsoon. Satkhira was found to have scarcity of water for household activities, according to FGDs and in-depth interviews.

Table 17: Per centage of household respondents having response on availability of safe water for drinking and household activities (e.g. sanitation, cooking, gardening etc)

Type of use	Study Areas							
	Manikganj		**Rajshahi**		**Satkhira**		**All**	
	Adequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate
Drinking water	80.0	20.0	64.0	36.0	65.0	35.0	69.7	30.3
Household work	73.0	27.0	49.0	51.0	74.0	26.0	65.3	34.7

Trend of incidences of diseases: According to the respondents in different study locations, the incidence of diseases is on the rise. The increasing trend of diseases is found to be predominantly high in the villages which are far away from the health complex compared to the villages close to the health complex. This means that more people are affected by diseases in areas far away from the health complex/centre. For all three districts, 68 per cent respondents living close to health centre/complex mentioned that the incidences of diseases are increasing while 80 per cent of the respondents living far away said the same (details in the following table).

In all the study locations, most of the participants during FGD and in-depth interview mentioned about the increasing trend of diseases. The FGDs and in-depth interviews conducted with health professionals indicate that the incidences of these diseases have increased in each of the study location. According to health professionals children and women are the main victims. Similar findings were present in other FGD and in-depth interview groups.

Table 18: Per centage of household respondents (living close and far away from the health complex) having response on trend of diseases

District	**Village**	Per centage				
		Increasing	Decreasing	Same as	Don't know	**Total**
Manikganj	**Nihanda** (Near health centre)	56.0	30.0	12.0	2.0	**100.0**
	Rani Nagar (Far from health centre)	76.0	20.0	4.0	-	**100.0**
Rajshahi	Faradpur (Near health centre)	82.0	4.0	6.0	8.0	**100.0**
	Charbhuban (Far from health centre)	98.0	2.0	-	-	**100.0**
Satkhira	**Jelekhali** (Near health centre)	66.0	26.0	8.0	-	**100.0**
	Harinagar (Far from health centre)	66.0	22.0	10.0	2.0	**100.0**
All	Near health centre	68.0	20.0	8.7	3.3	**100.0**
	Far from health centre	80.0	14.7	4.7	0.6	**100.0**

Incidence of diseases over the last decade: Regarding incidences of diseases in last ten years, the responses varied from place to place. In Manikganj, most of the respondents mentioned about highest incidences of diarrhea (77 per cent) and common cold/fever/cough (83 per cent) while only 26 per cent, 2 per cent and 1 per cent respondents identified skin diseases, malaria and malnutrition respectively which affected them in last ten years. In Rajshahi, most of the respondents mentioned that diarrhea (81 per cent) and common

cold/fever/cough (96 per cent) mostly affected them in the mentioned period. On the other hand, 27 per cent respondents of Satkhira mentioned about higher incidences of diarrhea (Details in the following table).

Table 19: Per centage of household respondents having response on incidences of some diseases in last ten years

Name of disease	Study Area			
	Manikganj	Rajshahi	Satkhira	All
Diarrhea diseases	77.0	81.0	27.0	61.7
Malaria	1.0	-	-	0.3
Skin disease	26.0	43.0	5.0	24.7
Malnutrition	2.0	8.0	3.0	4.3
cold/fever/cough	83.0	96.0	29.0	69.3

Knowledge and understanding on climate change

Per centage of respondents having clear understanding on climate change: Understanding on the term "climate change" among the households in the study areas was not very satisfactory. The findings show that 54 per cent respondents of Manikganj could appropriately mentioned about the term of climate change while it was only 16 and 10 per cent in Rajshahi and Satkhira respectively. On the other hand, overall appropriate respondents for all three study areas were 26.7 per cent.

Table 20: Per centage of household respondents having response on term of "climate change"

Study Location	Per centage of respondents having clear understanding on climate change
Manikganj	54
Rajshahi	16
Satkhira	10
All	26.7

Knowledge base and capacity of health centers (Upazilla Health Complex) and health professionals on climate change and its impacts on human health

During FGD and In-depth interview, the health professionals were asked about the climate change issues and its impacts on human health. It was observed that only few of the participants could appropriately mention about the term of climate change. For example, 1 out of 10 participants was appropriate on this in Rajshahi. They were also found to have very little knowledge about climate sensitive disease issues. However, FGDs and in-depth interviews with health professionals, villagers and women identified a number of problems related to capacity of the health centers and service delivery system. These are as follows:

- Lack of skilled/specialized health professionals (doctors, nurses, technicians etc)
- Lack of medical equipments (X-ray, pathological tests etc)
- Insufficient medicines
- Lack of capacity to provide hospital admission
- Availability of doctors is inadequate

- Data recording system is not common in all areas (for example in some area data on diarrhea and dysentery were found separately while it was found together in other areas)
- Some of the climate sensitive diseases (e.g. malaria, dengue etc) records are not available

Existing coping strategies to deal with health impacts due to climate change events especially flood, drought and salinity etc

According to respondents of the study areas, they were not aware about any particular coping strategy/project/programme to deal with health impacts due to climate change. However, many of the respondents mentioned that they used to drink filtered water during flood hazard to prevent infections of microorganisms. In Satkhira, many of the respondents usually drink filtered water to avoid salinity.

4.2.3. Separate analysis for the study areas

Manikganj Study Area

Seasonal health disorders: In response to the question "which of the diseases mostly affect your family members in particular season?" 62 per cent household respondents in Manikganj study area identified diarrhea for monsoon while 59, 50 and 40 per cent respondents were for pre-monsoon, post-monsoon and dry season. Only 2 per cent of the respondents said dengue occurs in pre-monsoon while 1 per cent mentioned malaria for post-monsoon. Incidences of skin diseases were found to be the highest (36 per cent) during dry season followed by post-monsoon (20 per cent). However, incidences of common cold/fever/cough are higher in every season, according to respondents.

Table 21: Per centage of household respondents having response on incidence of diseases during different seasons?

Name of disease	Manikganj Study Area			
	Pre-monsoon	Monsoon	Post-monsoon	Dry
Diarrhea diseases	59.0	62.0	50.0	44.0
Dengue	2.0	-	-	-
Malaria	-	-	1.0	-
Skin disease	15.0	15.0	20.0	36.0
Malnutrition disease	-	-	-	-
common cold/cough/fever	71.0	66.0	61.0	67.0

Household's opinion on possible reasons for specific disease incidences: The household respondents of Manikganj were asked about their perception on the possible reasons of the incidences of various diseases. A number of possible reasons including temperature variation, rainfall variation, unplanned sanitation system, during hazard/disaster were given. In addition, 'don't know' and 'others' were also included as options. It was found that 80 per cent respondents identified different reasons for diarrhea. It shows that 42.9 per cent of these respondents said temperature variation was the possible reason for diarrhea diseases while 20.2 per cent and 15.5 per cent of them mentioned rainfall variation and hazard/disaster as the possible cause of diarrhea. Many of the respondents mentioned the reasons of other diseases like skin diseases and common cold/fever/cough Details in the following table).

In Manikganj, FGDs and in-depth interviews identified number possible reasons for the incidences of diseases. It includes temperature and rainfall variation, hazards like flood, cold waves etc.

Table 22: Per centage of household respondents having response on possible reasons for disease incidences

Possible Reason	Name of Major diseases					
	Diarrhea diseases (n=80)	Skin disease (n=34)	Malnutrition disease (n=4)	Common cold fever/cough (n=94)	Typhoid (n=8)	Asthma (n=10)
Temperature variation	42.9	36.0	42.9	41.4	31.8	47.6
Rainfall variation	20.2	22.1	28.6	19.7	27.3	19.0
Water pollution	14.3	19.8	-	13.1	22.7	19.0
Unplanned sanitation system	3.6	3.5	14.3	4.0	9.1	-
During hazard/disaster	15.5	17.4	14.2	17.7	4.5	9.5
Don't know	1.8	-	-	2.5	-	-
Others	1.7	1.2	-	1.6	4.6	4.9
Total	100.0	100.0	100.0	100.0	100.0	100.0

Incidences of diseases during flood: In response to a question on incidences of diseases during hazard/disaster like flood the respondents of Manikganj mentioned that occurrences of diarrhea, dysentery and normal fever are higher than the other diseases. In fact, 32 per cent household respondents mentioned diarrhea as common diseases during flood while 28 per cent were for both dysentery and normal fever/cough. Besides, 9 per cent respondents mentioned skin diseases that occur during flood.

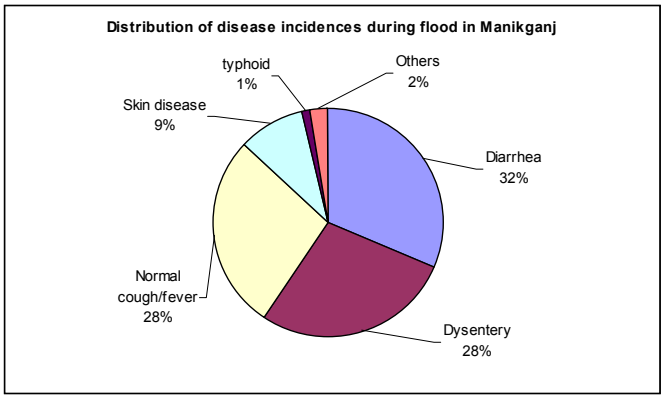


Fig.-37. Per centage of household respondents having response on incidences of diseases during flood

Rajshahi Study Area

Seasonal health disorders: The analysis shows that most of the respondents (65 per cent) of Rajshahi indicated incidences of diarrhea in monsoon followed by post-monsoon (60 per cent). It also shows that incidences of skin diseases during post-monsoon correspond with maximum respondents (53 per cent). Only 3 per cent and 9 per cent respondents mentioned malaria in pre-monsoon and malnutrition in dry season. However, responses on incidences of common cold/cough/fever were found to be high (88 per cent) especially in monsoon.

Table 23: Per centage of household respondents having response on incidences of diseases during different seasons in Rajshahi area

Name of disease	Rajshahi Study Area			
	Pre-monsoon	Monsoon	Post-monsoon	Dry
Diarrhea diseases	50.0	65.0	60.0	18.0
Dengue	-	-	-	-
Malaria	3.0	-	-	-
Skin disease	13.0	45.0	53.0	17.0
Malnutrition disease	1.0	1.0	3.0	9.0
common cold/cough/fever	44.0	88.0	45.0	59.0

Household's opinion on possible reasons for specific diseases incidences:. Out of 83 respondents, 46.8 per cent mentioned that the possible reason for diarrhea would be temperature variation while 29.2 per cent respondents said rainfall variation causes diarrhea. Regarding causes of skin diseases, 43 per cent said temperature variation and 32.6 per cent mentioned rainfall variation. Temperature and rainfall variation also causes common cold/fever and cough, mentioned by most of the respondents (details in the following table).

Table 24: Per centage of household respondents having response on possible reasons for disease incidences

Reason	Name of Major diseases					
	Diarrhea diseases (n=83)	Skin disease (n=45)	Malnutrition disease (n=9)	Common cold/fever/cough (n=95)	Typhoid (n=6)	Asthma (n=16)
Temperature variation	46.8	43.0	50.0	44.9	33.3	43.8
Rainfall variation	29.2	32.6	14.3	30.3	25.0	37.5
Water pollution	5.2	4.7	-	5.6	-	6.3
Unplanned sanitation system	3.2	2.3	-	2.2	8.3	-
During hazard/disaster	9.1	11.6	14.3	10.1	16.7	9.4
Don't know	3.9	3.5	14.3	3.4	8.3	3.0
Others	2.6	2.3	7.1	3.5	8.4	-
Total	100.0	100.0	100.0	100.0	100.0	100.0

The FGDs and in-depth interviews conducted in Rajshahi also identified some major possible reasons for incidences of specific diseases. Hazards like drought, temperature variation in different seasons and rainfall variation were identified as the major possible reasons for incidences of the diseases.

Incidences of diseases during flood and drought: Regarding incidences during flood, most of the respondents in Rajshahi study area mentioned diarrhea, dysentery, normal fever/cough and skin diseases as common during flood situation. The following table shows that diarrhea was pointed out by 17.6 per cent respondents while it was 21.8 per cent, 31.9 per cent and 17.1 per cent for dysentery, normal cough/fever and skin diseases respectively. A small per centage of respondents was also for malnutrition, typhoid, malaria and other diseases. On the other hand, according to the respondents incidences of both diarrhea and dysentery is higher during drought than in flood. The per centages of respondents for diarrhea and dysentery that occur during drought period were 23.1 and 23.9 respectively. Again, the highest number of respondents (27.3 per cent) was for normal cough/fever (details in the following table).

Table 25: Per centage of household respondents having response on incidences of diseases during different hazard/disaster period

Name of Disasters	Name of diseases							
	Diarrhea	Dysentery	Normal caugh/fever	Skin disease	Malnutrition disease	Typhoid	Malaria	others
Flood	17.6	21.8	31.9	17.1	2.8	0.9	0.5	7.4
Drought	23.1	23.9	27.3	14.7	2.1	-	0.4	8.5

Satkhira Study Area

Seasonal health disorders: The analysis for Satkhira area shows that 32 per cent respondents of Satkhira mentioned diarrhea mostly affect in monsoon while 10, 17 and 11 per cent said that it affects in pre-monsoon, post-monsoon and dry season respectively. It was also found that incidences of skin diseases during monsoon were higher than any other season.

Table 26: Per centage of household respondents having response on incidence of diseases during different seasons in Satkhira area

Name of disease	Satkhira Study Area			
	Pre-monsoon	**Monsoon**	**Post-monsoon**	**Dry**
Diarrhea diseases	10.0	32.0	17.0	11.0
Dengue	-	-	-	-
Malaria	-	-	-	-
Skin disease	4.0	9.0	7.0	5.0
Malnutrition disease	2.0	-	-	3.0
Normal cough/fever	20.0	41.0	33.0	35.0

Household's opinion on possible reasons for specific disease incidences: Most of the respondents mentioned the possible reasons of diarrhea, skin diseases and common cold/fever/cough in response to question on "what are the possible reasons for particular diseases incidences in this area?". Out of 52 respondents, 32.6 per cent mentioned that the possible reason for diarrhea would be temperature variation while 16.9 per cent respondents said rainfall variation causes diarrhea. Regarding causes of skin diseases, 29 per cent said temperature variation and water pollution. Temperature and rainfall variation also causes common cold/fever and cough, mentioned by most of the respondents (details in the following table).

Table 27: Per centage of household respondents having response on possible reasons for disease incidences

Reason	Name of Major diseases					
	Diarrhea diseases (n=52)	Skin disease (n=19)	Malnutrition disease (n=10)	Common cold/fever/cough (n=81)	Typhoid (n=2)	Asthma (n=16)
Changing temperature	32.6	29.0	31.3	36.1	20.0	39.1
Changing rainfall	16.9	6.5	18.8	16.7	20.0	17.4
Water pollution	22.5	29.0	12.5	15.3	20.0	13.0
Unplanned sanitation system	1.1	3.2	-	0.7	-	-
During disaster	10.1	6.5	6.3	14.6	20.0	8.7

Don't know	6.7	9.7	6.1	6.2	20.0	8.7
Others	10.1	16.1	25.0	10.4	-	13.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

In Satkhira, FGDs and in-depth interviews identified some major possible reasons for incidences of specific diseases. Salinity concentration, temperature and rainfall variation were mentioned as the major possible reasons for incidences of the diseases.

Incidences of diseases during specific hazards (flood, salinity intrusion, cyclone, heavy rainfall etc): The respondents of Satkhira gave detail information on the incidences of diseases during different types of hazards/disasters. At least 31.3 per cent and 31.2 per cent respondents mentioned diarrhea as common diseases during flood and salinity intrusion respectively. On the other hand, salinity concentration was mentioned as a cause of diarrhea, skin diseases and dysentery etc by many of the respondents. At least 31.2 per cent respondents said salinity concentration causes diarrhea while 25 per cent believed that it causes skin diseases as well. Most of the respondents (42.1 per cent) said dysentery is a common disease during heavy rainfall in Satkhira.

Table 28: Per centage of household respondents having response on incidences of diseases during different hazard/disaster period in Satkhira

Name of Disasters	Name of diseases							
	Diarrhea	Dysentery	Normal caugh/fever	Skin disease	Malnutrition disease	Typhoid	Malaria	Others
Flood	31.3	19.4	20.9	13.4	6.0	-	3.0	6
Salinity	31.2	12.5	6.2	25.0	6.2	-	-	18.9
Storm	15.5	11.1	44.4	20.0	4.4	2.2	-	2.4
Cyclone	29.0	12.9	38.7	12.9	-	-	-	6.5
Heavy rainfall	5.3	42.1	42.1	-	-	-	-	10.5

4.3. Intensity of impacts of climate and social (non-climate) factors on human health disorders and projections

It is expected that climate change would have adverse impacts on human health in Bangladesh. In addition, non-climate/social factors would also contribute to aggravate the situation. However, the current state of knowledge of association between health disorders and climate factors, and social factors may be outlined as follows:

- Climate may play an important role in the in the morbidity and mortality due to malaria, dengue, cholera, Kala-zar, malnutrition and cardio-respiratory infections in Bangladesh.
- Episodes of diarrhea diseases may be synergistically increased in case of extreme events related to climate change.
- Social or non-climate factors including poverty, living condition, population density, migration, water quality, sanitation and lack of health services may catalyze the sufferings

The following table shows initial thoughts of intensity of impact of climate and social factors on human health disorders. This might be considered for further evaluation and research to explore actual and factual relationship between incidences and the factors.

Table 29: Intensity of impacts of climate and social (non-climate) factors on human health disorders

Increasing Human Health Disorders	**VULNERABILITY CONTEXT**												
	Climate Change Factors						**Social (Non-Climate) Factors**						
	Temperature	Rainfall	Sea Level Rise	Drought	Flood	Cyclone and Storm Surge	Living Condition	Poverty	Education	Migration	Population Density	Water quality (domestic purpose)	Food Insecurity
Cholera	+++		+		+++	+	++	+	+	+	+	++	
Diarrhea	++	++	+	++	+++	+++	++	++	+	+	+	+++	++
Malaria	++	+++					++	+	+		+		
Dengue	+++	+					++		+		+		
Kala-zar	+++						+						
Malnutrition	++	+	++	+++	++	++		+++	+		+		+++
Cardio-respiratory diseases	++			++		+	++	+	+		+		

Note: +++ refers high, ++ refers to moderate and + refers to low level relationship; developed by BCAS climate change and health research team

Chapter 5

Conclusions and recommendations

The study, in addition to climate variability, has found changes of the trend of climate factors particularly yearly maximum and minimum temperature over the last three decades. Rajshahi and Manikganj were found to have an increasing trend in both maximum and minimum temperature while in Satkhira the trend was declining over the period.

The results of the study indicate that the climatic factors including temperature (maximum and minimum), rainfall (annual and seasonal) and salinity concentration are factors for causing diarrhea, skin diseases, kala-azar etc in the study areas. In addition, climate factors are associated with malnutrition problems.

The correlation coefficients between climate factors and health disorders varied among the study locations. Incidence of diarrhea was found to have positive correlation with total annual rainfall in Rajshahi and Satkhira. Monsoon's total rainfall was also found to have positive correlation with diarrhea in Rajshahi (+0.21) and Satkhira (+0.27). In contrast, dry seasonal rainfall was found to have positive correlation in Manikganj study area.

The difference between annual maximum and minimum temperature was found to be positively correlated with the incidence of diarrhea in two study locations i.e. Rajshahi and Satkhira. However, the correlation was found negative in Manikganj.

A positive correlation implies that the incidence of diarrhea increases as the variation in temperature increases. A negative correlation means decrease in the incidence of diarrhea when temperature differential is less.

Skin diseases and malnutrition were also found to be positively correlated with temperature differential in both Rajshahi and Satkhira, while these were negatively correlated in Manikganj study area. The negative correlation of diarrhea, skin diseases with temperature variation in Manikganj might have happened due to non-climatic factors as well as improved health services. The survey shows that the households in Manikganj have better accessibility to safe water and sanitation and health services.

In spite of the apparent discrepancy in the correlation in the time series data among the three study locations, variation in temperature has been identified by the survey respondents as major cause of diarrhea, skin diseases and malnutrition in all the three locations of the survey.

The study also shows that the climate factors of Satkhira are sensitive to diarrhea, skin disease and malnutrition as each of these diseases was found to have positive correlation with at least one of the climate variables mentioned in the study. Moreover, skin disease and malnutrition are more or less highly correlated (positive) with all three climate variables (rainfall, temperature and salinity).

The study in spite of various limitations and constraints shed light on the correlations between climatic factors and human health in the context of specific locations of Bangladesh. Given the wide ranging impacts of climate change on human health and growing importance of the issues, broad-based and in-depth study should be undertaken for better understanding of the cause- effect relationship between climate change factors and human health. The findings from such a study would be valuable for policy and decision making process relating human health and sustainable

development. However, the following specific activities/programmes/measures may be taken to address health impact due to climate change:

- The study indicates that water borne diseases remained a major public health problem in Bangladesh with changes of climate factors
- To address such problems and reduce incidences of any climate sensitive diseases, some of the initiatives including policy decisions, scientific tasks and broad research to confirm earlier findings, institutional capacity building to handle consequences needs to be considered.
- The government agencies (e.g. DG-Health) may initiate climate sensitive diseases surveillance separately or can include a separate component on this in existing national diseases surveillance programme.
- The government should develop climate sensitive diseases dataset and vector data based on geographical distribution for further research and prediction
- Health professionals need to be trained on climate change and its impact on human health to deal with future adversity
- The government in association with NGOs/research organizations working on climate change and health issues should initiate training programmes for health professionals.
- Awareness programme on climate change impact on human health would build resilience of the community
- Considering all relevant climate factors and non-climate factors, adaptation strategies on health to climate change can be developed. Climate Change Cell (CCC) can initiate developing this strategy in association with relevant partners GOs/NGOs.
- Improvement of water supply and sanitation management
- Protection of water resources
- Improvement of hygienic practices at individual and community level

Both GOs and NGOs can initiate programmes on water supply, sanitation and hygienic practices.

References

Asian Development Bank (ADB). Bangladesh: 2004 flood, response, damage and recovery needs. ABD, 2004.

Asiatic Society of Bangladesh (ASB). Banglapedia: National Encyclopedia of Bangladesh. Dhaka, Bangladesh, 2004.

Bangladesh Centre for Advanced Studies (BCAS). Cyclone 1991 (Revised): A follow up study. BCAS, 1991.

Bangladesh Bureau of Statistics (BBS). Compendium of Environment Statistics of Bangladesh 2005. BBS, 2005.

Canadian Association of Physicians for the Environment (CAPE). Climate Change. Available at http://www.cape.ca/climate.shtml

Director General of Health Services (DG-Health). Bangladesh Health Bulletin 1997. Ministry of Health and Welfare, Government of Bangladesh, 1999.

Director General of Health Services (DG-Health). Bangladesh Health Bulletin 1996. Ministry of Health and Social Welfare, Government of Bangladesh, 1998.

Githeko, A.K. and Woodward, A. International consensus on the science of climate and health: the IPCC Third Assessment Report. In Climate Change and Human Health: Risk and Responses. World Health Organization, p. 43-60, 2003.

Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2001: third assessment report, impacts, adaptations and vulnerability of climate change.* Cambridge University Press, 2001.

Ministry of Environment and Forests (MOEF). National Adaptation Programmes of Action (NAPA) Study Note. MOEF, 2005.

Sapir, D.G., Hargitt, D., Hoyois, P. Thirty Years of Natural Disaster 1974-2003: the numbers. Centre for Research on the Epidemiology of Disasters. Universities the Lovain Press, Belgium, 2004.

World Bank. Bangladesh: Climate Change & Sustainable Development, report prepared by South Asia Development Team. Report No. 21104 BD, 2000

World Health Organization (WHO). Climate change impacts on health. Available at http://www.who.int/mediacentre/news/releases/2003/pr91/en/

Annexure

Rjevqi cwieZb Ges ¯v¯¨MZ cfve

wmwWGgwc-wmwmwm-wewmGGm-wbcmg

K. DËi`vZvi cwiPq

1. DËi`vZvi bvg :

Mvg : BDwbqb : Dc‡Rjv : †Rjv :

2. cwiev‡ii m`m¨

bs	eqm	wj½ (c:1, g:2)	m¤úK	wk¶vMZ †hvM¨Zv	†ckv (†KvW emvb)	Avcbvi cwiev‡ii †Kvb m`m¨ wK eZgv‡b AmL wem‡L fM‡Q? n¨v=1, bv=2	n¨v n‡j, †iv‡Mi ‡KvW wjLb
01							
02							
03							
04							
05							
06							
07							
08							
09							
10							
11							
12							

†ckvi †KvW :

miKvix PvKix = 1, †emiKvix PvKix = 2, GbwRI PvKix = 3, ¶` e¨emv = 4, gvSvix e¨emv = 5, eo e¨emvqx = 6, KIK = 7, grm¨Rxwe = 8, w`bgRi = 9, Mwnbx = 10, QvÎ = 11, †eKvi = 12, wkï (5 eQ‡ii bx‡P) = 13, Ab¨vb¨ (wbw`ó Ki“b) = 14|

†iv‡Mi †KvW mgn :

Wvqwiqv- 1, wW‡m›Ux / Avgvkq- 2, †W½- 3, g¨v‡jwiqv- 4, Pg‡ivM- 5, gvbwmK mgm¨v-6, Acwó RwbZ †ivM- 7, mvavib VvÛv / mw` / Kwk / Ri- 8, UvBd‡qW- 9, kvmRwbZ †ivM / G¨vRgv- 10, RwÛm- 11, Ab¨vb¨ (wbw`ó Ki“b)- 12|

L. ¯v¯¨MZ mgm¨v

3. Avcbvi cwiev‡ii m`m¨‡`i mvavibZ †Kvb ‡Kvb †ivM †ekx nq?

†KvW bs	†iv‡Mi aib	cavb wZbwU †iv‡Mi †KvW bs emvb (cvavb¨ Abhvqx)
1	Wvqwiqv	
2	wW‡m›Ux / Avgvkq	
3	†W½	
4	g¨v‡jwiqv	
5	Pg‡ivM	
6	gvbwmK mgm¨v	
7	Acwó RwbZ †ivM	
8	mvavib VvÛv / mw` / Kwk / Ri	
9	UvBd‡qW	
10	kvmRwbZ †ivM / G¨vRgv	
11	RwÛm	
12	Ab¨vb¨ (wbw`ó Ki“b)	

4. Avcbvi cwiev‡ii m`m¨iv †Kvb FZ‡Z / mg‡q me‡P‡q †ekx †fv‡Mb|

bs	FZi aib	cvavb¨ Abhvqx cavb wZbwU †iv‡Mi bvg wjLb (c‡Z¨K FZi †¶‡Î)		
1	elvi c‡e			
2	elvi mg‡q			
3	elvi c‡i			
4	ïKbv †gŠm‡g (kx‡Z)			

†iv‡Mi †KvW mgn :

Wvqwiqv- 1, wW‡m›Ux / Avgvkq- 2, †W½- 3, g¨v‡jwiqv- 4, Pg‡ivM- 5, gvbwmK mgm¨v-6, Acwó RwbZ †ivM-7, mvavib VvÛv/mw`/Kwk / Ri- 8, UvBd‡qW- 9, kvmRwbZ †ivM/G¨vRgv- 10, RwÛm- 11, Ab¨vb¨ (wbw`ó Ki“b)- 12|

5. MZ cvP eQ‡ii g‡a¨ Avcbvi cwiev‡ii ‡KD wb‡æv³ †Kvb †iv‡M Avµvš n‡qwQj wK?

n¨v = 1 bv = 2 ☐

hw` n¨v nq, Z‡e AšZ wZbwU †iv‡Mi bvg D‡jL K‡ib|

†KvW bs	†ivM mgn	cavb¨ Abmv‡i cavb wZbwU †iv‡Mi ‡KvW bs wjLb
1	Wvqwiqv	
2	wW‡m›Ux / Avgvkq	
3	†W½	
4	g¨v‡jwiqv	
5	Pg‡ivM	
6	gvbwmK mgm¨v	
7	Acwó RwbZ †ivM	
8	mvavib VvÛv / mw` / Kwk / Ri	
9	UvBd‡qW	
10	kvmRwbZ †ivM / G¨vRgv	
11	RwÛm	
12	Ab¨vb¨ (wbw`ó Ki“b)	

6. Avcbvi cwiev‡ii m`m¨‡`i g‡a¨ †K †ekx Am¯ n‡qwQj / †iv‡M Avµvš n‡qwQj?

ci“l ☐ gwnjv ☐ wkï (14 eQ‡ii bx‡P) ☐

eq¯‹ (50 eQ‡ii Dc‡i) ☐ Ab¨vb¨ (wbw`ó Ki“b) ☐

†KvW bs : ci“l = 1, gwnjv = 2, wkï = 3, eq¯‹ = 4, Ab¨vb¨ = 5

7. GBme †ivM e¨wa m¤ú‡K Avcwb gše¨ Ki“b?

†ivMe¨wa †e‡o‡Q = 1 ☐ †ivMe¨wa K‡g‡Q = 2 ☐ GKB iKg = 3 ☐ Rwb bv = 4 ☐

8. Dc‡i D‡jwLZ †ivM mg‡ni m¤úve¨ Kvib wK n‡Z cv‡i (GKwaK DËi Mnb‡hvM¨)

†KvW bs

1 ZvcgvÎvi ZviZg¨ (AwaK Mig / AwaK kxZ) ☐

2 ewócv‡Zi ZviZg¨ (AwZ ewó / Abvewó / Amg‡q ewó) ☐

3 cwb `lb ☐

4 AcwiKwíZ cq:wb®wkb e¨e¯v ☐

5 `‡hvM gûZ (eb¨v, Liv, So, R‡jv”Qvm, jebv³ Zv BZ¨w`) ☐

6 Rwb bv ☐

7 Ab¨vb¨ (wbw`ó Ki“b) ☐

9. MZ cvP eQ‡i Avcbvi cwievi †Kvb Avc‡` (**Hazard**) Avµvš n‡qwQj wK Ges n‡q _vK‡j KZevi?

K) eb¨v ☐ ☐

L) Liv ☐ ☐

M) So ☐ ☐

N) R‡jv”Qvm ☐ ☐

O) jebv³Zv ☐ ☐

P) Ab¨vb¨ (wbw`ó Ki“b) ☐ ☐

10. D³ Avc`Kvjxb (**During Hazard Period**) mg‡q Avcwb wK †Kvb ai‡bi ¯v¯¨MZ mgm¨v †gvKv‡ejv K‡i‡Qb / ¯v¯¨MZ mgm¨vq f‡M‡Qb?

n¨v = 1 bv = 2 ☐

hw` n¨v nq, Avc`Kvjxb gû‡Z Avµvš AšZ wZbwU ¯v¯¨MZ mgm¨v ev ‡iv‡Mi K_v D‡jL Ki“b|

1)
2)
3)

11. Avc` ev `‡hv‡Mi mg‡q Avcbvi Lvevi cwbi Drm wK wQj?

1) wUDe l‡qj
2) Mfxi bjKc
3) b`x / Lvj
4) cKi
5) ewói cwb
6) Kqv
7) Ab¨vb¨ (wbw`ó Ki“b)

cavb¨ Abmv‡i ‡KvW bs wjLb|

☐
☐
☐

12. Avc` ev `‡hv‡Mi mg‡q (eb¨v, Liv, So BZ¨w`) Avcbvi Mn¯vjx Kv‡Ri Rb¨ (cwi¯wi cwi”QbZv, ivbv cq:cbvjx) cwbi Drm wK wQj?

†KvW bs	cvbxq R‡ji Drm	Avc` / `‡hv‡Mi c‡e (cvavb¨ Abmv‡i †KvW bs emvb)	Avc` / `‡hv‡Mi mg‡q (cvavb¨ Abmv‡i †KvW bs emvb)
1	wUDe l‡qj		
2	Mfxi bjKc		
3	b`x / Lvj		
4	cKi		
5	ewói cwb		
6	Kqv		

☐
☐
☐

☐
☐
☐

†KvW bs	cvbxq R‡ji Drm	Avc` / `‡hv‡Mi c‡e (cvavb¨ Abmv‡i †KvW bs emvb)	Avc` / `‡hv‡Mi mg‡q (cvavb¨ Abmv‡i †KvW bs emvb)
7	Ab¨vb¨ (wbw`ó Ki“b)		

13. wbivc` Lvevi cwlb, ivbv, cq:cbvjxi Rb¨ cvß cwlbi chvßZv?

e¨envi¨‡ii aib	†KvW bs
Lvevi cwlb	
Mn¯vjx (ivbv I Ab¨vb¨)	

†KvW bs : chvß = 1, Achvß = 2

14. Lvevi cwlb Ges Ab¨vb¨ Mn¯vjx Kv‡Ri Rb¨ cwlbi AchvßZvi Kvi‡b †Kvb ¯v¯¨MZ mgm¨v n‡”Q wKbv?

n¨v = 1 bv = 2 ☐

hw` n¨v nq, Z‡e cwlbi AchvßZvi Rb¨ mó cavb ¯v¯¨MZ mgm¨vi K_v D‡jL Ki“b|

1)

2)

3)

4)

15. G ai‡bi ¯v¯¨MZ mgm¨vi m¤§Lxb n‡j Avcwb / Avcbviv wK ai‡bi e¨e¯v Mnb K‡ib ev Kvi Kv‡Q hvb?

†KvW bs :

1 wKQB Kwi bv ☐

2 wbR¯ wPwKrmv c×wZ ☐

3 Jl‡ai †`vKvb ☐

4 KweivR / Mvg¨ Wv³vi ☐

5 GgweweGm Wv³vi ☐

16. Avcwb / Avcbvi cwiev‡ii ‡KD wPwKrmvi Rb¨ wM‡q _vK‡j Wv³vi / ¯v¯¨Kgx Avcbvi / Avcbvi cwiev‡ii m`m¨‡`i wK ai‡bi †ivM n‡qwQj Zv e‡jwQ‡jb wK?

n¨v = 1 bv = 2

hw` n¨v nq, Z‡e MZ 10 eQ‡ii g‡a¨ wbæ wjwLZ †Kvb †ivM¸‡jv †ekx mbv³ n‡qwQj?

†KvW bs	†ivM mgn	cavb¨ Abmv‡i cavb wZbwU †iv‡Mi ‡KvW bs wjLb
1	Wvqwiqv	
2	wW‡m›Ux / Avgvkq	
3	†W½	
4	g¨v‡jwiqv	
5	Pg‡ivM	
6	gvbwmK mgm¨v	
7	Acwó RwbZ †ivM	
8	mvavib VvÛv / mw` / Kwk/ Ri	
9	UvBd‡qW	
10	kvm RwbZ †ivM / G¨vRgv	
11	RwÛm	
12	Ab¨vb¨ (wbw`ó Ki“b)	

M) Rjevq cwieZb m¤ú‡K avibv

17. ÔÔRjevq cwieZbÓ ej‡Z mvavibZ wK eSvq?

†KvW bs

1 Rjevqi †h †Kvb cwieZb `xN mgq a‡i, cvKwZK wfbZvi Kvi‡b A_ev gvb‡li KvhKjv‡ci Kvi‡b

2 ïagvÎ ZvcgvÎv Ges ewócv‡Zi AvÂwjK cwieZb

3 Ab¨vb¨ (wbw`ó Ki“b)

4 Rwb bv

18. Rjevqi cwieZ‡bi d‡j wKwK ai‡bi mgm¨v ev Avc` mwó n‡Z cv‡i? (GKwaK DËi n‡Z cv‡i)

†KvW bs

1	mg‡`i cwbi D”PZv ew×	☐
2	*Liv / ï®Zv*	☐
3	eb¨v	☐
4	jebv³Zv	☐
5	So	☐
6	R‡jv”Qvm / mvB‡Kvb	☐
7	Ab¨vb¨ (wbw`ó Ki“b)	☐

19. Avc‡`i mgq mvavibZ †Kvb †Kvb †ivM / e¨wa †ekx nq ev fwel¨‡Z n‡Z cv‡i e‡j Avcwb g‡b K‡ib?

Avc` mgn (**Hazards**)	†ivMe¨wa (**Diseases**)
mg‡`i cwbi D”PZv ew×	☐ ☐ ☐
2. Liv / ï®Zv	☐ ☐ ☐
eb¨v	☐ ☐ ☐
jebv³Zv	☐ ☐ ☐
So	☐ ☐ ☐
R‡jv”Qvm / mvB‡Kvb	☐ ☐ ☐
AwZ ewó	☐ ☐ ☐
Ab¨vb¨ (wbw`ó Ki“b)	☐ ☐ ☐
	☐ ☐ ☐

†iv‡Mi †KvW mgn :

Wvqwiqv- 1, wW‡m›Ux / Avgvkq- 2, †W½- 3, g¨v‡jwiqv- 4, Pg‡ivM- 5, gvbwmK mgm¨v-6, Acwó RwbZ †ivM-7, mvavib VvÛv/mw`/Kwk/Ri- 8, UvBd‡qW- 9, kvmRwbZ †ivM / G¨vRgv- 10, RwÛm- 11, Ab¨vb¨ (wbw`ó Ki“b)- 12|

20. Avcwb wK g‡b K‡ib Rjevq cwieZ‡bi Kvi‡b Avcbvi GjvKvq gvb‡li ¯v¯¨MZ mgm¨v ev †ivMe¨wa nq?

n¨v = 1 bv = 2 ☐

hw` n¨v nq, Zvn‡j Rjevqi cwieZ‡bi Kvi‡b †Kvb †ivMwU Avcbvi GjvKvq (Mv‡g) me‡P‡q †ekx nq e‡j g‡b K‡ib?

Z_¨ msMnKvixi gše¨ :

Z_¨ msMnKvixi bvg : ZwiL :

mcvifvBRv‡ii ¯v¶i : ZwiL :

`jxq Av‡jvPbvi welqe¯

1. Mvgxb GjvKv, RbmsL¨v, emZevox, Av_-mvgwRK Ae¯v |
    * Av‡qi Drm, ‡jvK msL¨v (gwnjv / ci"l), †ckv (PvKix, grm¨, †R‡j, KIK, kwgK BZ¨w`)
    * wk¶v : (wk¶v cwZôvb - ¯‹j / K‡jR, gv`vmv cfwZ msL¨v, wkw¶‡Zi nvi BZ¨w`)
    * hvZvqvZ e¨e¯v
    * ¯v¯¨ ‡mev (nvmcvZvj, wKwbK, Wv³vi, dv‡gmx mn wPwKrmvi m‡hvM msµvš)
2. Avenvlqv msµvš avibv|
    * Zvcgv‡Îv : MZ `k eQ‡ii aviv
        1. VvÛv- kxZKv‡ji ¯wqZ, Zvcgv‡Îvi ZviZg¨
        2. Mig- Mx®§Kv‡ji ¯wqZ, Zvcgv‡Îvi ZviZg¨
    * ewócv‡Zi aviv
        1. ewócv‡Zi ZviZg¨
        2. ¯í mgq AwaK ewócvZ A_ev `xN mgq a‡i ewócvZ nqbv|
3. MZ `k eQ‡i G GjvKvq wK wK ai‡bi Avc` **(Hazards)** / `‡hvM †`Lv w`‡q‡Q / AvNvZ K‡i‡Q? KZ evi G ai‡bi `‡hvM n‡q‡Q / AvNvZ K‡i‡Q Ges G¸‡jvi ZxeZv †Kgb wQj|
4. gvbe ¯v‡¯¨i Dci Avc‡`i **(Hazards)** cfve : aib Ges cfve|
    * †iv‡Mi bvg / cKvi‡f`
    * Kviv †ewk Avµvš nq (†Q‡j / †g‡q, wkï) BZ¨w`
    * †iv‡Mi cv`fve Av‡Mi Zjbvq †ewk / Kg?
5. cwb mieivn Ges cq:wb®wkb e¨e¯v|
    * cwbi Drm
    * cwbi cwigvb Ges ¸bMZ gvb
6. Rjevq cwieZb I ¯v¯¨ mgm¨v|
    * Rjevq cwieZb ej‡Z Avcwb wK g‡b K‡ib?
    * Rjevq cwieZ‡bi mv‡_ ¯v¯¨MZ wK wK mgm¨v n‡Z cv‡i?
    * wK wK Dcv‡q GB mgm¨v †_‡K Avgiv g³ n‡Z cv‡i?
7. Am¯Zv I wPwKrmv msµvš |
    * Am¯ n‡j †Kv_vq, Kvi Kv‡Q wPwKrmvi Rb¨ hvb?

Rjevqi cwieZb Ges ¯v¯¨MZ cfve

wmwWGgwc-wmwmwm-wewmGGm-wbcmg

[In depth Interview Guideline]

DËi`vZvi bvg :

1. Mvg : BDwbqb : Dc‡Rjv : †Rjv :

2. Avcbvi cwiev‡ii m`m¨‡`i mvavibZ †Kvb ‡Kvb †ivM †ekx nq?

3. Avcbvi cwiev‡ii m`m¨iv †Kvb FZ‡Z / mg‡q me‡P‡q †ekx †iv‡M †fv‡Mb|

4. MZ cvP eQ‡ii g‡a¨ Avcbvi cwiev‡ii m`m¨iv wK wK †iv‡M †ekx Avµvš n‡qwQj?

5. Avcbvi cwiev‡ii m`m¨‡`i g‡a¨ †K †ekx Am¯ n‡qwQj / †iv‡M Avµvš n‡qwQj (gwnjv / ci“l / wkï)?

6. GBme †ivM e¨wa m¤ú‡K Avcwb gše¨ Ki“b? (c‡ei Zjbvq Kg †ekx)

7. †ivM mg‡ni m¤ve¨ Kvib wK wK n‡Z cv‡i

8. MZ cvP eQ‡i Avcbvi cwievi †Kvb †Kvb Avc‡` (Hazard) Avµvš n‡qwQj?

9. D³ Avc`Kvjxb (During Hazard Period) mg‡q Avcwb wK †Kvb ai‡bi ¯v¯¨MZ mgm¨v †gvKv‡ejv K‡i‡Qb / ¯v¯¨MZ mgm¨vq f‡M‡Qb?

10. Avc` ev `‡hv‡Mi mg‡q Avcbvi Lvevi cwbi Drm wK wQj?

11. Avc` ev `‡hv‡Mi mg‡q (eb¨v, Liv, So BZ¨w`) Avcbvi Mn¯vjx Kv‡Ri Rb¨ (cwi¯‹vi cwi”QbZv, ivbv cq:cbvjx) cwbi Drm wK wQj?

12. wbivc` Lvevi cwb, ivbv, cq:cbvjxi Rb¨ cwbi cvc¨Zv KZLwb mnRjf¨? (chvß / Achvß)

13. Lvevi cwb Ges Ab¨vb¨ Mn¯vjx Kv‡Ri Rb¨ cwbi AchvßZvi Kvi‡b †Kvb ¯v¯¨MZ mgm¨v n‡”Q wKbv?

14. G ai‡bi ¯v¯¨MZ mgm¨vi m¤§Lxb n‡j Avcwb/Avcbvi wK ai‡bi e¨e¯v Mnb K‡ib ev Kvi Kv‡Q hvb?

15. Avcwb / Avcbvi cwiev‡ii ‡KD wPwKrmvi Rb¨ wM‡q _vK‡j Wv³vi / ¯v¯¨Kgx Avcbvi/ Avcbvi cwiev‡ii m`m¨‡`i wK ai‡bi †ivM n‡qwQj Zv e‡jwQ‡jb wK?

16. ÔÔRjevq cwieZbÓ ej‡Z mvavibZ wK eSvq?

17. Rjevqi cwieZ‡bi d‡j wK wK ai‡bi mgm¨v ev Avc` mwó n‡Z cv‡i?

18. Avc‡`i mgq mvavibZ †Kvb †Kvb †ivM/e¨wa †ekx nq ev fwel¨‡Z n‡Z cv‡i e‡j Avcwb g‡b K‡ib?

19. Avcwb wK g‡b K‡ib Rjevq cwieZ‡bi Kvi‡b Avcbvi GjvKvq gvb‡li ¯v¯¨MZ mgm¨v ev †ivMe¨wa nq?

Z_¨ msMnKvixi bvg : ZwiL :

Summary of climate factors and incidences of diseases

Table-1.: Climate sensitive diseases incidences and climate factors of Rajshahi district for the period of 1996-2005

Year	***Climate factors***			***Incidences***			
	Yearly Rainfall	***Maximum Temperature (Annual average)***	***Minimum Temperature (annual average)***	***Diarrhea***	***Skin Diseases***	***Malnutrition***	***Kala-azar***
1996	1269	31.56	20.5	687	DNA	DNA	20
1997	2062	30.59	20.2	2600	DNA	DNA	22
1998	1540	30.94	21.1	2791	DNA	DNA	20
1999	1862	31.68	21.2	450	760	248	34
2000	1670	30.7	20.7	941	384	424	30
2001	1363	31.25	20.6	1260	1125	734	34
2002	1444	31.01	20.6	1498	730	1563	45
2003	1412	30.86	20.7	1826	1479	1794	32
2004	1786	31.15	20.7	2506	2322	1884	92
2005	1405	31.86	21	1907	4272	1897	66

DNA:Data Not Available

Table-2.: Climate sensitive diseases incidences and climate factors of Manikganj district for the period of 1996-2005

Year	***Climate factors***			***Incidences***			
	Yearly Rainfall	***Maximum Temperature (Annual average)***	***Minimum Temperature (annual average)***	***Diarrhea***	***Skin Diseases***	***Malnutrition***	***Kala-azar***
1996	2044	31.69	21.6	11447	4969	3176	18
1997	1896	30.62	21.1	10964	5684	6336	13
1998	2310	30.85	22	13891	10015	2867	9
1999	2374	31.54	22.1	20663	19589	2888	3
2000	2121	30.13	21.9	17159	15186	4950	5
2001	1685	30.45	21.5	8165	3674	3307	4
2002	1789	30.31	21.5	9293	3000	2185	2
2003	1693	30.22	21.8	10153	3295	3015	0
2004	2347	30.51	21.9	9775	2993	2182	3
2005	2637	30.83	22.4	10633	3836	2284	3

Table-3.: Climate sensitive diseases incidences and climate factors of Satkhira district for the period of 1996-2005

Year	***Climate factors***			***Incidences***			
	Yearly Rainfall	***Maximum Temperature (Annual average)***	***Minimum Temperature (annual average)***	***Diarrhea***	***Skin Diseases***	***Malnutrition***	***Kala-azar***
1996	1575	31.65	21.3	5532	807	173	0
1997	2107	31.12	20.8	5013	1312	299	0
1998	1727	31.26	21.7	4279	993	243	0
1999	1616	31.65	20.5	3587	1164	511	0
2000	2002	31.21	21	3210	1142	221	0
2001	1683	31.09	21.5	5587	1735	72	0
2002	1903	31.38	21.8	6875	2178	502	0
2003	1737	31.06	21.9	5770	2088	561	0
2004	2033	31.11	21.8	4862	2248	445	0
2005	1982	31.51	22.1	6462	2430	308	0

Year wise data on occurrences of different hazards in Bangladesh

Year-wise Flood Affected Area and Country Per centage in Bangladesh

Year	Flood affected area		Year	Flood affected area		Year	Flood affected area	
	Sq.Km	%		Sq.Km	%		Sq.Km	%
1954	36,920	25.64	1973	29,900	20.76	1991	28,600	19
1955	50,700	35.21	1974	52,720	36.61	1992	2,000	1.4
1956	35,620	24.74	1975	16590	11.52	1993	28,742	20
1960	28,600	19.86	1976	28418	19.73	1994	419	0.2
1961	28,860	20.04	1977	12548	8.71	1995	32,000	22
1962	37,440	26.0	1978	10832	7.52	1996	35,800	24
1963	46160	29.97	1980	33077	22	1998	100,250	68
1964	31200	21.67	1982	3149	2.19	1999	32,000	22
1965	28600	19.80	1983	11,114	7.72	2000	35,700	24
1966	33540	23.39	1984	28314	19.66	2001	4,000	2.8
1967	25740	17.87	1985	11427	7.93	2002	15000	10
1968	37440	26.0	1986	4589	3.19	2003	21500	14
1969	41600	28.89	1987	57491	39.92	2004	52000	36
1970	42640	29.61	1988	120973	84.0			
1971	36475	25.33	1989	9000	6.20			
1972	20,800	14.44	1990	3,500	2.4			

Source: Compendium of Environmental Statistics of Bangladesh, BBS, 2005

N.B. Please note that most of flood events in the history of Bangladesh hit Manikganj area

3. Major Drought in Bangladesh

Bangladesh has experienced droughts of major magnitude in 1973, 1978, 1979, 1981, 1982, 1989, 1992, 1994 and 1995. The northwestern districts of Rajshahi, Dinajpur, Rangpur, Bogra, and Pabna are particularly drought-prone area. Besides them some of the districts of Chittagong and Khulna division also suffer from droughts (Source: MOEF, 2005).

Level of observed highest salinity concentration at Khulna station

Station	Electric Conductivity in micro-mhos							
	1992	1993	1994	1995	1996	1997	1998	1999
Khulna	29500	21500	21800	29500	21800	22600	20000	22860

Source: Bangladesh Water Development Board

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