A STUDY ON CLIMATE CHANGE IMPACT ON THE LIVELIHOODS OF THE PEOPLE IN TANGUAR HAOR, BANGLADESH

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Abstract

Bangladesh is widely recognized as one of the most climate vulnerable countries in the world. Previous studies reveal that Surma-Kushiyara river system known as *haor* basin is projected to be under additional stress due to climate induce changes in temperature and rainfall pattern. Tanguar *haor* which is located in the north-eastern region of Bangladesh is characterized by large round shaped floodplain depressions and marshy lands. This research focuses on the climate change impacts on the environment, water resources, flood, fisheries, cropping patterns etc. that effects the livelihoods of the people living in the Tanguar *haor* area. Primary data has been collected through field level questionnaire, key informant interviews and also from various government and non-governmental agencies. For secondary data source, peer-reviewed articles, a wide range of books, research documents and online databases have been reviewed. This paper tries to grasp and analyze the ongoing problems, with main concentration on climate change impacts on the livelihood of Tanguar haor people. This study reveals that the rainfall of Tanguar haor is decreasing, which affects the crops production and fisheries. This study also shows that the average temperature is rising, consequently, drought is frequent in this area which negatively affects the crops production in Tanguar Haor area. In conclusion, some recommendations were suggested for the community for mitigating and adapting with the climate change impacts and reducing climate change related vulnerabilities.

Keywords: Tanguar Haor, Bangladesh, Climate Change, Impact, Livelihood, Water Resources

1.0 Introduction

Climate change is an unavoidable challenge that society will have to deal with over coming decades. For developing countries like Bangladesh, the task is particularly daunting. Bangladesh is generally viewed as a vulnerable country with respect to climate change especially in *haor* areas because of its unique geographic location, dominance of flood plains, high population density, elevated level of poverty and overwhelming dependency on nature and its resources and services. *Haors* with their unique hydro-ecological characteristics are large bowl shaped floodplain depressions located in the north-eastern region of Bangladesh covering about 1.99 million hectares of area and accommodating about 19.37 million people (BHWDB, 2012).

Covering 9,727 hectares, Tanguar *Haor* in North-East part of Bangladesh, adjacent to the Indian border, is part of a wetland of the Surma-Kushiyara rivers basins (Figure 2.1). Tanguar *haor* exhibits a unique wetland ecosystem. Considering its ecological importance, it has been declared as the second Ramsar site of Bangladesh in 2000. The swamp forest land of the *haor* is another unique ecological feature of the *haor* ecology. It plays an important role in fish production as it functions as a 'mother fishery' for the country (Chowdhury, 2010).

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC-AR4) summarizes the scientific evidence on impacts up until 2006. The evidences demonstrate that composition of global atmosphere is changing, e.g. increasing atmospheric concentrations of greenhouse gases (GHG), such as carbon-di-oxide, methane, and nitrous oxide (IPCC, 2007). The IPCC-AR4 predicts that global average temperature is expected to increase by 0.2C per decade over the next two decades. If temperature continue to increase at this rate, it adds, global average temperature increase (from 1905) will reach 1.5°C by 2050. It also points out that larger increase (0.3°C - 0.4°C or greater per decade) are expected on cultivated land areas and large landmass (IPCC, 2007).

Since IPCC-AR4 scientific understanding of impacts of climate change has progressed significantly. These studies, amongst others, take advantage of development in climate and scientific modeling to provide a more specific picture of current impacts and predicted changes over the next several decades. For example, Stanford researchers recently published analysis in Nature documenting that from 1980-2008, due to rising of global temperatures, global maize and wheat production has already decreased by 3.8% and 5.5% respectively (Lobell *et al.*, 2011)

The variability of climate change has become a challenging issue for agriculture. Agricultural crops of Tanguar *haor* are especially sensitive to the different natural disasters including flash flood, drought, storm surges etc.

Rainfall and temperature are two climatic variables that shape the structure of socio-ecological system. Any alternation of rainfall and temperature cycle, as a result of climate change, hampers agriculture production significantly. For example, rice plant has nice growth stages with its three distinct growth phases and every stage has an optimum temperature range for its proper development. The critical temperature differ according to variety, duration of the critical temperature and physiological status of the plant (Yoshida, 1981). High temperature is a constraint to rice production and cause a significant yield reduction.

Adaptive capacity is the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. In this way, enhancement of adaptive capacity reduces vulnerabilities and promotes sustainable development (Goklany, 1995; Burton, 1997; Cohen et al. 1998; Klein, 1998; Munasinghe, 2000; Smit et al., 2000). Therefore location-wise and scientifically based sustainable adaption practices are essential to cope up with the changing climatic conditions. Otherwise, it will be very difficult to make communities more resilient towards adverse impacts of climate change.

This study aims to find out the impacts of climate change on the livelihoods of the people in Tanguar *haor* area. The specific objectives are:

a) Analysis of major climate change parameters, e.g., Rainfall, Temperature, Water level.

b) Climate change impacts on agriculture, fisheries and severity of flash flood, cyclone, drought, and river erosion etc.

2.0 Methodologies

2.1 Selection of location

The research was conducted in the Tanguar *Haor*, Bangladesh. Tanguar *haor* is an important habitat in national levels not only for fish conservation and fish production but it is also a unique rendezvous of all kinds of beel organisms and its habitat in comparison to other beels in the country. It is also one of the six mother fisheries in the Northeast region. This not only supports fish but also other aquatic organism and vegetation.

Tanguar Haor, covering an area of 9,727 hectares, is located in the North-East part of Bangladesh, adjacent to the Indian border, is part of a wetland/floodplain complex of the Meghna and Surma river basin. These two rivers are among the main tributaries of the Meghna river. Administratively, one third of Tanguar Haor lies in the Tahirpur Upazilla and the remainder in Dharmapasha Upazilla, both within the Sunamganj District of the Sylhet Division. About 50% of the area of Tanguar Haor is water bodies, followed by 31% crop land (Choudhury, 2010).

In 1999, the Government of Bangladesh, recognizing the ecological importance of the area and the over-exploitation of resources declared the Tanguar *Haor* an “Ecologically Critical Area” in accordance with Article 5 of the Bangladesh Environmental Conservation Act (1995). In 2000, the Tanguar *Haor* was listed as the country’s second Ramsar site – wetland of international importance. The management of the haor was transferred from the Ministry of Land to the Ministry of Environment and Forests in 2001.

The most important “mother fishery” of Bangladesh, Tanguar *haor* is located in Sunamgonj. Geographical position of is at 25°06’ to 25°11’ N and 91°01’ to 91°06’ E. This site is influenced by Dhanu Baulai, Surma and Jadukata Rivers. Meghalayan Hills are in the North from where number of hill streams flows to the Haor. Other important haors like Matian, Shanir and Thapner are very nearby and have some dependency with some degree of variation.

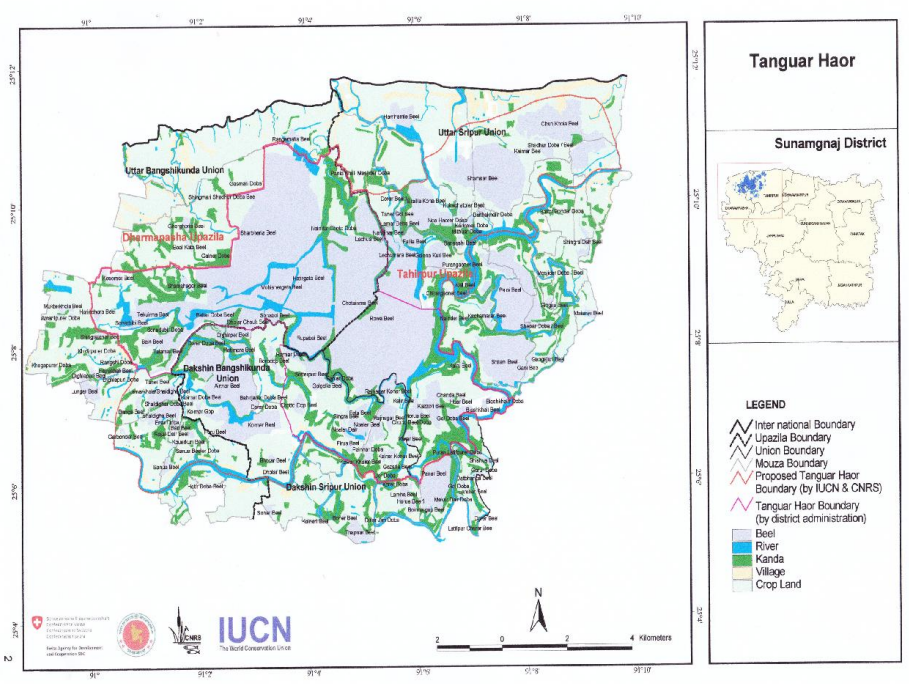

Figure 2.1: Location of Tanguar Haor

Source: IUCN, 2014

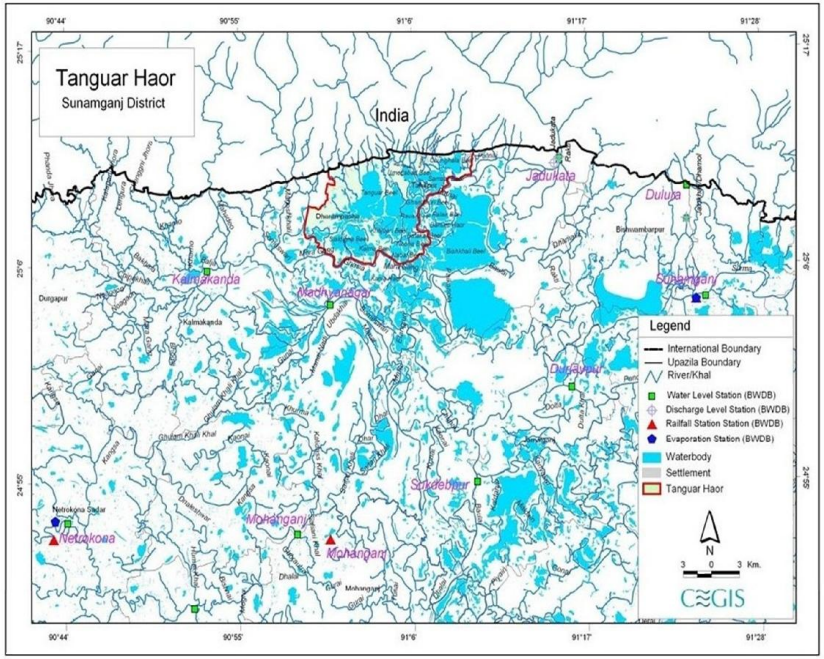

Figure 2.2: Map showing WL, Discharge, Rainfall and Evaporation Stations of Tanguar Haor

Source: IUCN, 2014

2.2 Data collection and analysis

2.2.1 Sources of data

The primary data were collected from International Union for Conservation of Nature (IUCN), Bangladesh and field level questionnaire survey. Secondary data were also studied, acquired from different reports, published and unpublished documents, presentations, from individuals, experts and organizations related to environment and related websites.

2.2.1.1 Collection of climate change parameter's data from IUCN

From IUCN, the researcher collected primary data on Rainfall (1980-2008), Temperature (1981-2010), Evaporation (2007-2010), and Water Level (1981-2010) for this study.

Table 2.1: Hydro-meteorological stations with periods of records in Tanguar Haor area

Data Type	Station No. (Name)	District / River (water level and discharge)	Period
Rainfall	CL 127 (Sunamganj)	Sunamganj	1980-2008
Evaporation	CL 127 (Sunamganj)	Sunamganj	2007-2010
Temperature	----------	Sylhet	1981-2010
Water Level	SW 269 (Sunamganj)	Surma-Meghna (Sunamganj)	1981-2010

Source: IUCN, 2014

2.2.1.2 Questionnaire survey

Structured questionnaires were prepared to generate primary data from the study area of Tanguar *Haor* A two weeks field study has been conducted in the study area during August 2014The informants were interviewed on the impact of climate change, biodiversity, impact on human health, impact on agriculture and overall impact on their livelihood. The focus of this questionnaire survey is to determine which climate change parameters are affecting their crop production, fisheries, emigration and also how to improve or mitigate those impacts. The adaptability of haor people is also a concern.

2.2.1.2.1 Sampling size and sampling procedure

The communities of Tanguar haor were the respondents of the study. Structured questionnaires were prepared to generate primary data from the study area. Sampling size of the study was 95. The respondents were taken from three different villages of both Uttar and Dakhsin Sripur Union in Tanguar *Haor* area located in Sunamganj district of Bangladesh (see figure 2.1). The three villages were Manikila, Patabuka, and Uttar Tahirpur. The selection of the family member was

random sampling. In three villages, 95 people were interviewed that included both male and female. Most of them are farmers, some are shopkeepers and businessman.

3.0 Results

3.1 Rainfall

Tanguar Haor region is a high rainfall area. More than 80% of annual total rainfall occurs during May to October period.

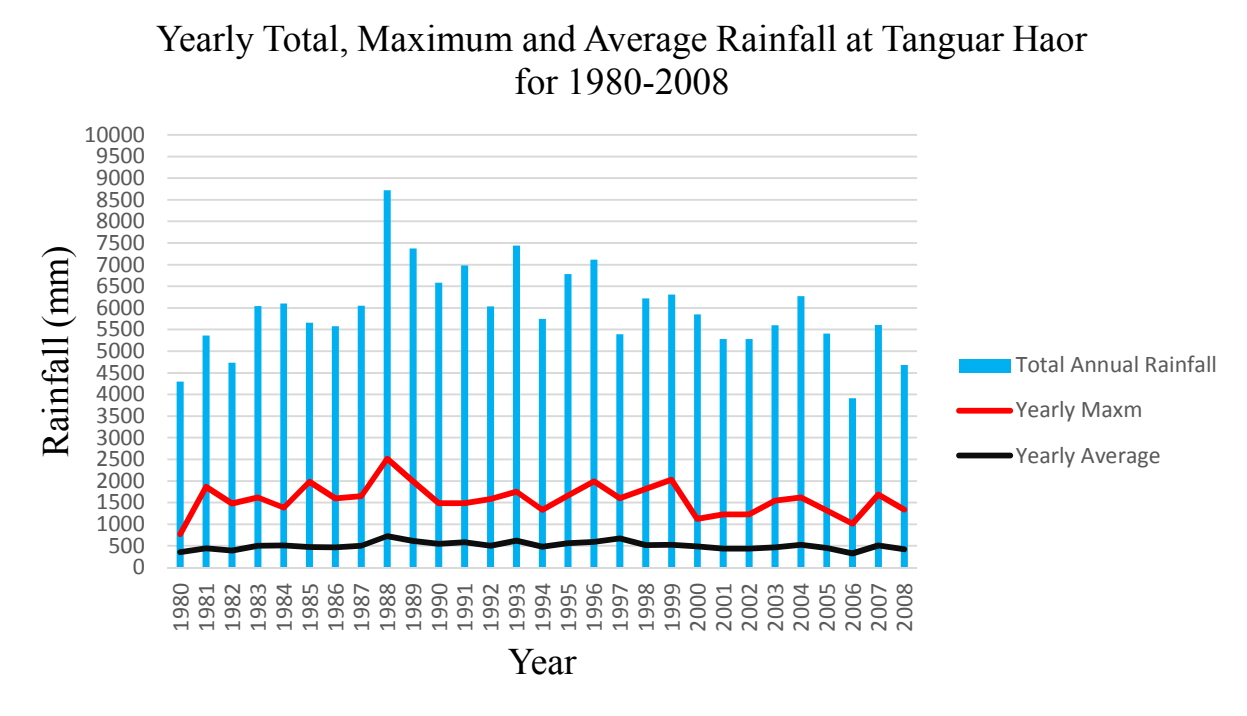

Figure 3.1: Annual total, maximum and average Rainfall at Tanguar Haor

Source: Data collected from IUCN, 2014

Using the trend line equation, this study found that over the period of 28 years (1980-2008) in annual total, average and maximum rainfall has decreased by 582 mm, 25 mm and 228 mm respectively.

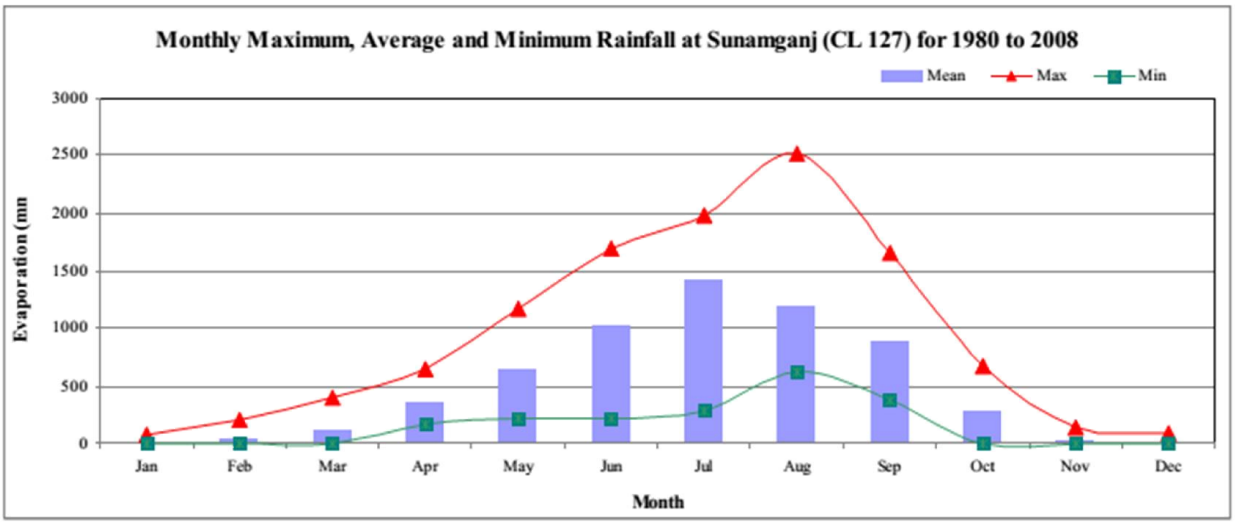

Figure 3.2: Comparison of monthly maximum, average and minimum rainfall at Tanguar Haor

*Source***:** IUCN, 2014

3.2 Temperature

Temperature is an important climatic parameter. It affects evaporation from open water and evapotranspiration from vegetated surface. In the following Fig 3.3 and Fig 3.4 show the annual and monthly maximum and minimum temperature respectively at Tanguar Haor. In winter often this area experiences the lowest temperature recorded in Bangladesh.

Using the trend line equation, this study found changes over the period of 29 years (1981-2010), annual maximum and minimum temperature has increased by 1.4°c and 1.45°c respectively.

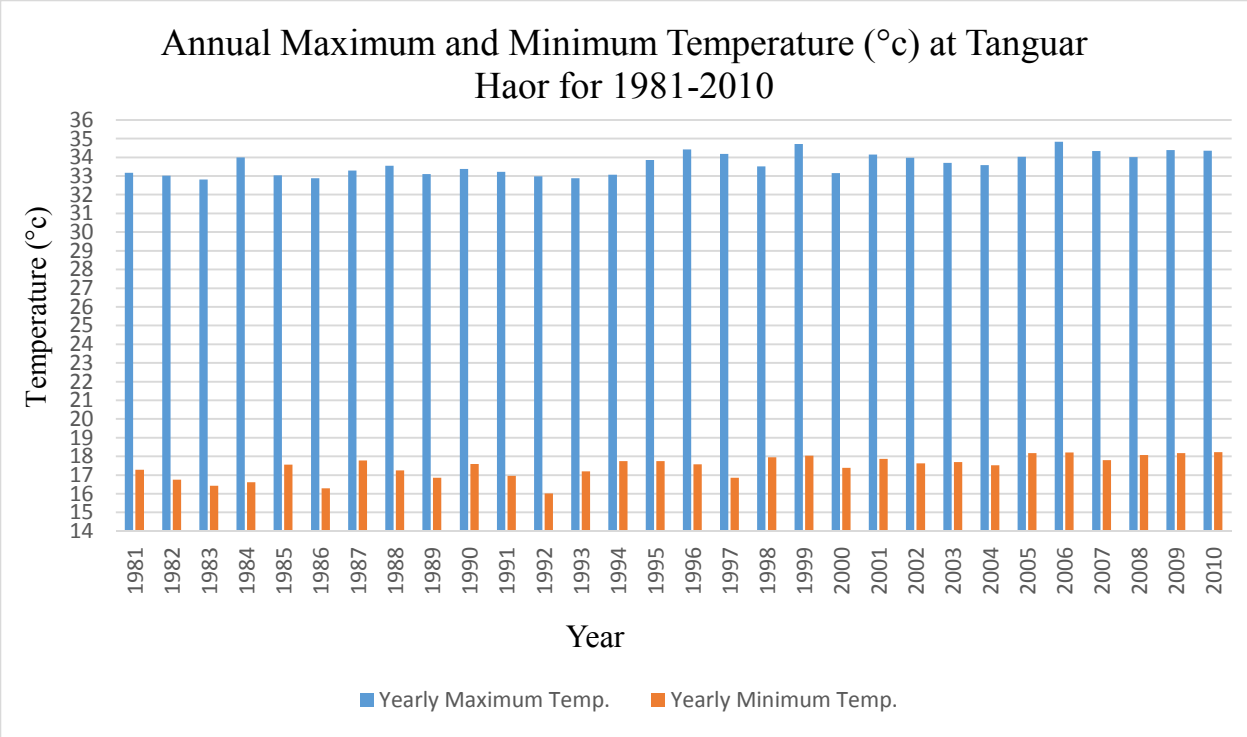

Fig 3.3: Annual maximum and minimum temperature at Tanguar *Haor*

Source: Data collected from IUCN, 2014

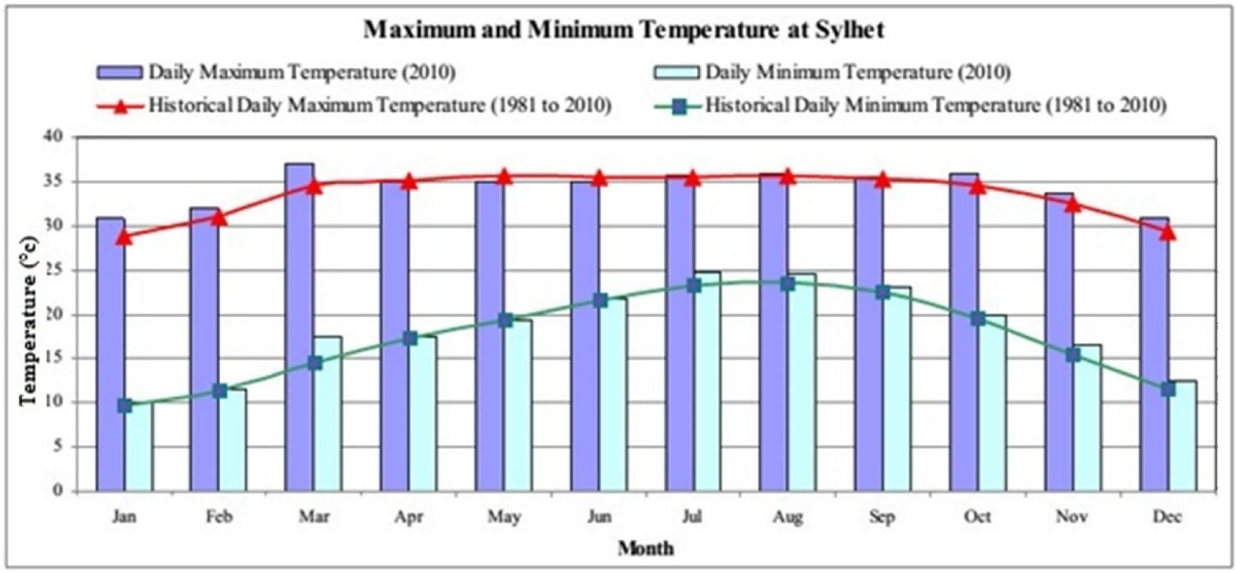

Fig 3.4: Comparison of monthly maximum and minimum temperature at Tanguar *Haor*

*Source***:** IUCN, 2014

3.3 Evaporation

Evaporation is one of the main parameters in the hydrologic balance of the haor. The delicate balance between rainfall and evaporation maintains the hydrology system in either a wet condition or a dry condition. Monthly distributions of evaporation for Tanguar Haor is shown in the following Figure 3.5.

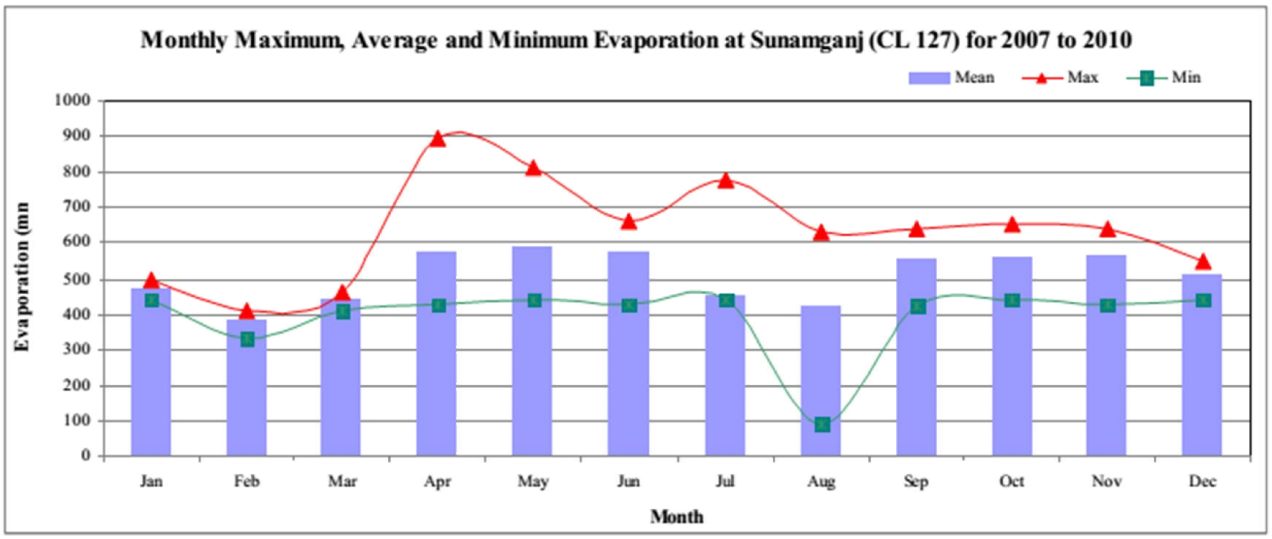

Figure 3.5: Comparison of Monthly Evaporation and Rainfall at Sunamganj

*Source***:** IUCN, 2014.

3.4 Water level and flow

Waters in the Tanguar haor consist mainly of water from the rivers systems located south of the Taguar *Haor*. Water is also received from streams flowing from the Hills in India at the North. Although rich in nutrients, waters are generally clear, especially in the dry season. During the wet seasons, water levels within the haor area gradually rise as water flows from the rivers into the haor. In dry season, water level recedes as reversal of flow takes place with the falling stage in rivers as well as evaporation exceeds rainfall. Hydrograph and monthly mean water level of Surma River for 1981-2010 are given in Fig 3.6 and Fig 3.7 respectively.

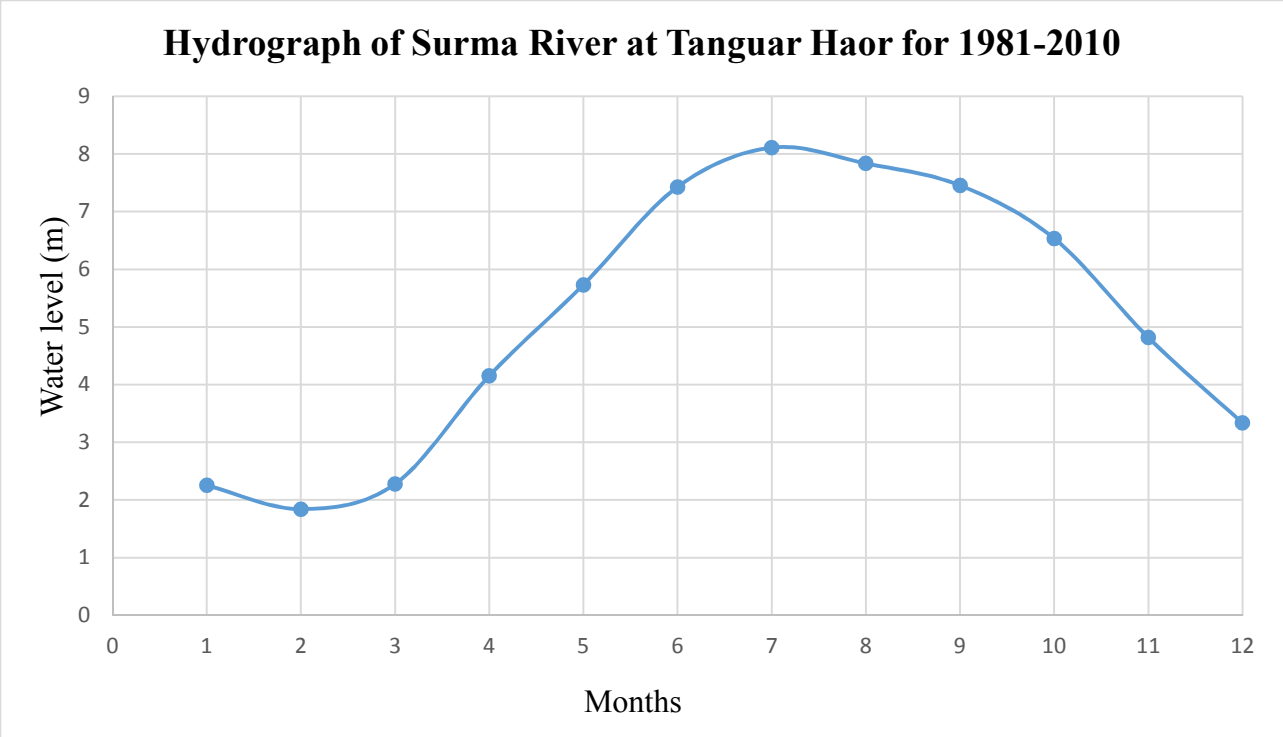

Figure 3.6: Hydrograph of Surma River at Sunamganj

Source: Data collected from IUCN, 2014.

The pattern and quality of water flowing through the wetlands have been altered substantially due to changing flow pattern in feeder Rivers such as Surma River as well as various water management and infrastructure development schemes in haor areas. Consequently, the volume of water flowing through natural areas has decreased. The pattern (timing and distribution) of the water that does flow through the natural areas might have also been altered. However there are neither any water level measurement gauges or inflow-outflow observation or measurement system for the Tanguar haor. It is observed that July-September period represents high flow season and November-April period low flow season. The river is flashy in nature.

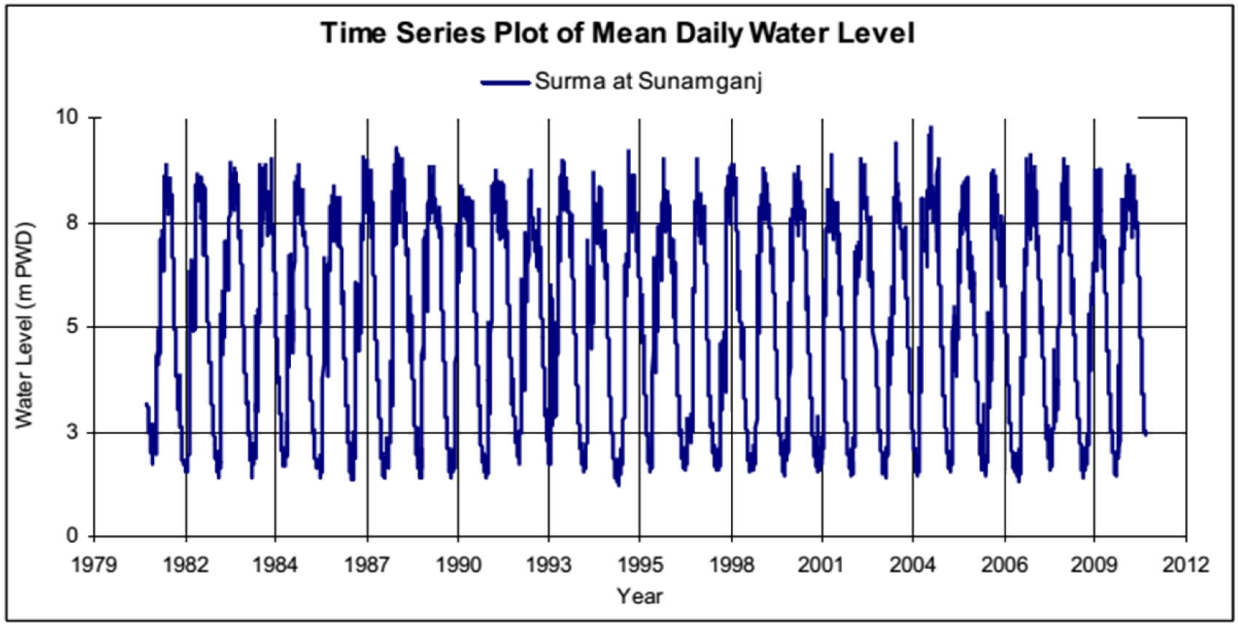

Figure 3.7: Time series plot of mean daily water level of Surma River at Tanguar Haor

Source: IUCN, 2014

3.5 Questionnaire survey findings

People's perception level about various climatic problems

Measuring people's perception level is inevitable for the study about climate change variability and to cope with the climatic disruption. It must be necessary to gain a clear conception about the various climatic events. There were various climatic changes that affect the overall livelihood pattern of the selected communities. This is very much crucial for the selected communities to recognize the adverse climatic impacts. The perception levels on different climatic events are shown in table 3.1.

Table 3.1: Perception level of the respondents' on different climatic problems

Climatic Problem	Respondent (%) (N=95)	Frequency of occurrence/year	Perception level (%)	Ranking problems based on vulnerabilities (%)		
				High	Medium	Low
Flash Flood	100	1~2 times	80 (n=76)	71	29	0
Cyclone	100	1~2 times	40 (n=38)	67	23	0

Heavy Rainfall	100	3~5 times	87 (n=83)	100	0	0
River Erosion	100	Throughout the year	63 (n=60)	25	34	41
Drought	100	1~2 times	44 (n=43)	40	30	30
Potable Water Crisis	100	Throughout the year	15 (n=14)	0	45	55
Water Borne Disease	100	Throughout the year	05 (n=05)	50	25	25

Source: Field Survey, 2014

Notes: (%) Indicate percentage of respondent perception level, N= Total no. of people surveyed (95), n = No. of respondent perceive about different climatic problems

Perception about the flash floods

The climate impacts result not only from gradual changes in temperature and sea level rise, but also, in particular, from increased climate variability and extremes, including more intense floods, droughts, and storms. But it's a matter of fact that most of the people have no idea why the floods are happening more and more frequently in recent years. The perception level of flood as a phenomenon of climate change of the selected communities is 80%. Floods cause 43% respondents to migrate and 35% population to switch jobs. Due to flood, 77% of the respondents are affected by property loss, disease and shortage of drinking water.

Perception about the cyclone and tidal surge

The people of the Tanguar Haor are facing cyclone not as a very frequent problem of climate change and thus the perception level of this climatic event is 40%. Cyclone has devastating effect on the communities which also make their lives vulnerable.

Perception about the heavy rainfall

The frequency of heavy rainfall is 3~5 times over the study area and the perception level about heavy rainfall is 87% which is quite higher than other climatic events such as river erosion, cyclone, potable water crises etc. . Heavy rainfall forces 50% of the respondents to change their crop calendar, 18% of the respondents to switch the jobs, 12% of the respondents to face the problem of home damages and damage communication.

Perception about the river erosion

River erosion is a very common and a serious problem to the Tanguar *Haor* people The consequences of river erosion are migration, loosing cultivated land, job switching.. The perception level of river bank erosion related to the results of climate change is 63%.

Perception about the drought

Drought is not a very common problem in this area. But as they get one crop in November-February and the water dried out sometimes drought happens and the perception level is 44%.

Perception about the potable water crisis

The perception level about the crisis of potable water in this village community is about 15%. The people of these communities, use pond water as their daily needs and drinking purposes. It is found that 91% of the respondents use/ drink rain water to meet their demand. About 55% of the respondents use potash alum to purify their water.

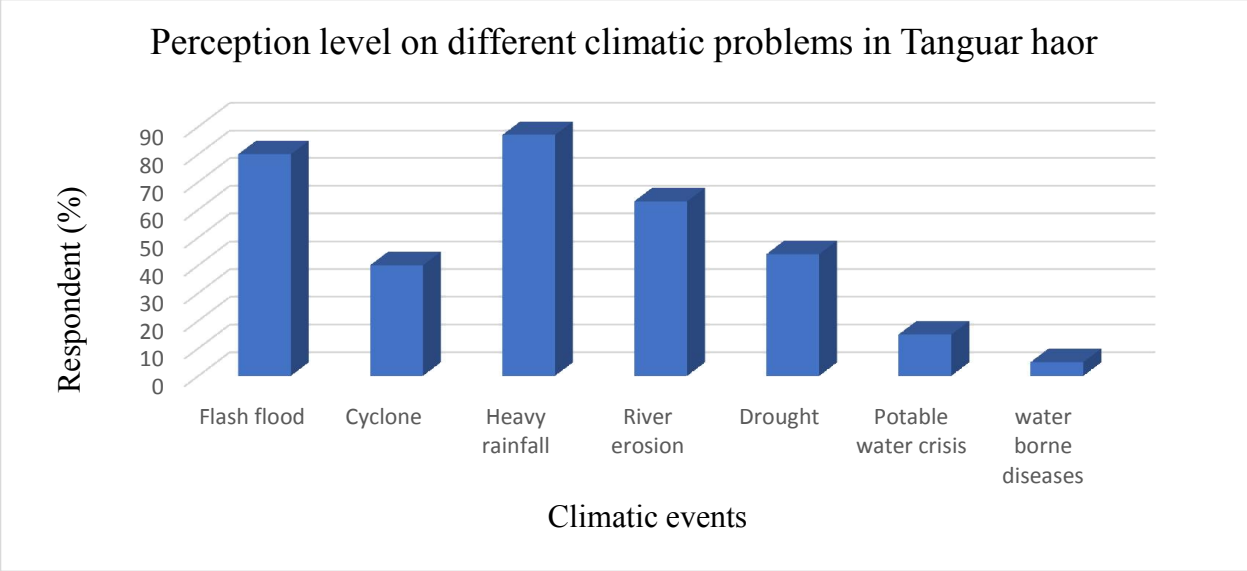

Figure 3.8: Perception level on different climatic problems in Tanguar *Haor*

Source: Field Survey, 2014

Adaptations strategies to climate change

Adaptation to climate change takes place in response to impacts experienced already, as well as in anticipation of expected impacts. In this sense, adaptation can be a spontaneous, autonomous process that takes place depending on existing capacity (so-called 'adaptive capacity') and it can also be planned (Schipper *et al.*, 2010). As scientific understanding of climate change has improved, many questions have been answered and many new ones have also emerged.

Uncertainty about the dynamics of climate change persists, although there is greater certainty about the overall phenomenon. At the same time, it has become clear that adaptation is about adjusting development trajectories not only to deal with climate change, but also to cope with fluctuations in the many other, non-climatic factors that influence human well-being. In the following table, we can find the adaptation strategy of Tanguar Haor communities.

Table 3.2: Coping adaptation strategies of Tanguar *Haor* communities

Vulnerability contexts	Adapting strategies of Tanguar Haor communities						
	Migration (%)	Rainwater harvesting (%)	Repair / reconstruct house (%)	Job switching (%)	Change in crop calendar (%)	Follow weather forecast (%)	Boil water + Alum (%)
Flash flood	43 (n=5)		77 (n=73)	35 (n=33)	45 (n=43)	90 (n=86)	
Cyclone	29 (n=28)		92 (n=88)			92 (n=88)	
Heavy rainfall			12 (n=10)	18 (n=17)	50 (n=48)		
River erosion	54 (n=52)		46 (n=44)	90 (n=86)			
Drought				57 (n=54)	64 (n=61)	85 (n=81)	
Potable water crisis		91 (n=86)					55 (n=53)
Water borne disease		73 (n=70)					37 (n=35)

Source: Field Survey, 2014

Every climatic event (e.g., Flash flood, heavy rainfall, river erosion, cyclone, drought) leaves its devastating scenario on every aspects of socio-economic life at Tanguar *Haor*. The devastating sectorial impacts of these climatic events demonstrated in the figure 3.9.

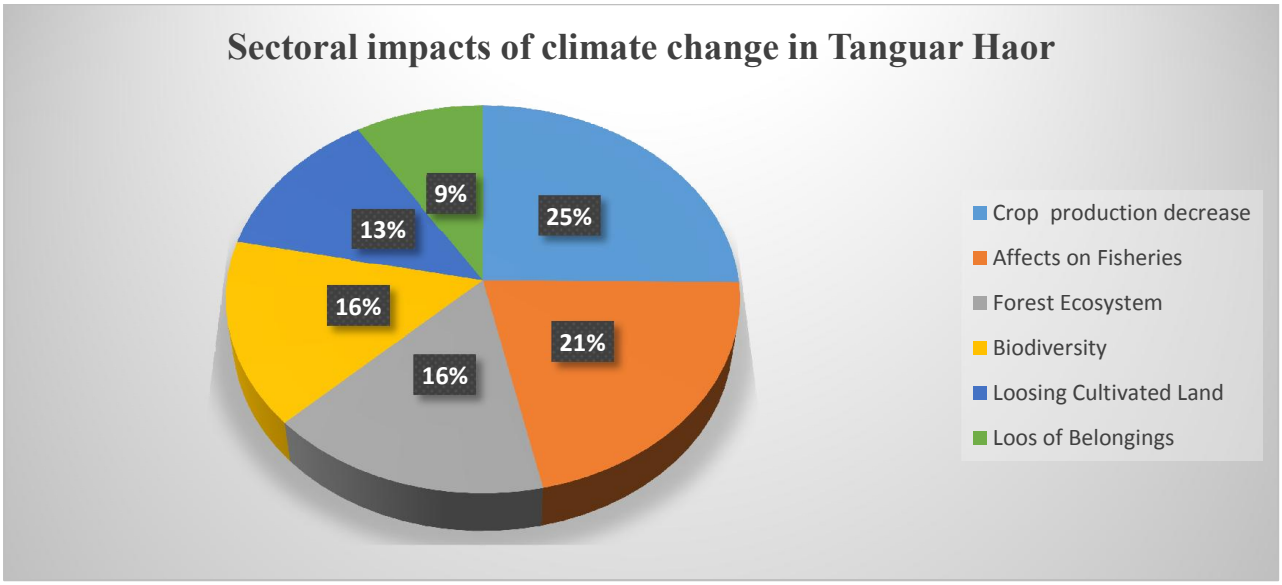

Figure 3.9: Climate change impacts at Tanguar Haor based on people's perception

Source: Field Survey, 2014

4.0 Conclusion

This study finds that changes over the period of 28 years (1980-2008), annual average rainfall has decreased by 25 mm which resulted in decreasing cropping yield. It creates more pressure on water resources and, as a result, ground water consumption is increasing in an unsustainable way. Consequently, ground water level is decreasing day by day. However, the impact of rainfall on agricultural production also varies how rainfall is distributed over the months.

It was also found that the average annual maximum and minimum temperature are increasing. The average annual maximum and minimum temperature are increasing around 1.45°C and 1.4°C respectively. It affects evaporation from open water and evapotranspiration from vegetated surface.

The research finds that the changing pattern of temperature in the Tanguar *Haor* (1.45°C) is significantly higher compared to the IPCC assessment over the world in last 100 years (1910-1940: 0.35°C, 1970-2007: 0.55°C) (IPCC, 2007:252). This creates considerable negative impacts on crop production as well as livelihoods of the local people. Therefore, location-wise and scientifically based sustainable adaption practices are essential to cope up with the changing climatic conditions. Otherwise, it would be very difficult to make communities more resilient towards adverse impacts of climate change and ensuring food security.

The rivers in the Tanguar *Haor* basin are flashy in nature and flash floods occur in the pre-monsoon months of April and May. In Surma river, it is observed that July-September represents high flow season and November-April period low flow season (see figure 3.6). During the monsoon season, water levels within the *Haor* area gradually rise as water flows from the rivers

into the *Haor* also increased. During dry season, water level recedes as reversal of flow takes place with the falling stage in rivers as well as evaporation exceeds rainfall.

From the field study, it is observed that the respondents' perception levels of different climate change induced events are as follows: flash flood (80%), heavy rainfall (87%), cyclone (40%), river erosion (63%), drought (44%), and potable water crises (15%). The adaptation strategies to cope up with these climatic events are migration, job switch, changes in crop calendar, rainwater harvesting, repair/reconstruction of houses, following weather forecast and purifying water to drink. The respondents' perception levels for sectorial negative impacts due to climate change in Tanguar Haor are as follows: decreasing crop production (25%), reduced fisheries (21%), loss of forest ecosystem (16%), loss of biodiversity (16%), loss of cultivable land (13%) and loss of personal belongings (9%).

In general, adaptations are mere reflections of 'needs of adjustments' felt by the impacted individual, household, and community. However, needs of adjustments are largely characterized by extent of adverse impacts. It is necessary to understand that most of the climate change induced problems are likely to be exhibited in the form of water-related problems. Since climate change will have severe adverse impacts on agriculture and livelihoods and well-being of the poor will most likely be at risk, a holistic policy approach should be considered.

As the haor allows single crop throughout a year, seasonal unemployment problem is very acute. People from outside consider it a natural beauty and many insider think it as a trap of nature (Hauqe & Kazal, 2004). The haor ecosystem is such that it withholds the flow of water into the plains right after the early monsoon months and allows the people in the lower regions to harvest their crops while people inside Tanguar often have a fifty-fifty chance of harvesting their own crops. Many a times, it goes under water with early flash flood.

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