Climatic Risks Assessment at Community Level in Agriculture

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ABSTRACT

Climate change may be referred as the most concerning issue not only in national but also global perspective. Bangladesh has already been recognized as the most vulnerable country due to the climate change. Climate change becomes the most important issue to the environmental specialists, geographers, politicians, policy makers and the other stakeholders. The principal sector which directly offset with the livelihoods of the inhabitants of Bangladesh is agriculture. From various study, it is projected that agricultural sector will be remarkably affected due to climate change impacts. It is also mentioned in National Adaptation Program of Action (NAPA).

In this backdrop, this study explores the climatic risks at community level in agriculture. Mainly using the participatory approach, the activities were done to achieve the goal. Prioritizing the local people's concept and integrating with the other relevant secondary data, it was found that farmers of the study area (located in North West Region of Bangladesh) already suffering from some remarkable climatic risks- like severe drought, temperature rise, heavy fog during the winter etc. The findings also reflect in the national level assessment for this region. Later, the study ends with the narrating the probable solutions for this risks according to the farmers with a critical cross-matching with the understanding of climate change experts.

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1.1 Introduction

In Bengali there is a phrase to denote Bangladesh that is "Sujola Sufola Sossya Shymaola"[1]. The geographic location, seasonal diversity and other environmental components have made this country resourceful and which also play a vital role on the livelihood of its inhabitants. The inhabitants are still dependent basically on the ecological resources and its services. These services and supports are possible due to the existence of favorable physical and climatic process of the country. In recent times, familiar natures of these processes seem to appear in a different form. These changes often addressed as climate change.

Climate change may be referred as the most concerning issue not only in national but also global perspective. Bangladesh has already been recognized as the most vulnerable country due to the climate change *(declared at Copenhagen)*. Climate change becomes one of the most important issues to the environmental specialists, geographers, politicians, policy makers and the other stakeholders.

It has been already declared that this country is going to experience noticeable adverse effects of climate change. The future situation will increase vulnerability in various key sectors of this country. These sector includes food security, agriculture, health, infrastructure, industry, disasters (adopted form NAPA, 2005)[2]

Agriculture, as a sector, may be denoted as the most concerning sector in this country. This sector plays a significant role in the Bangladesh economy as well socially and culturally. Agriculture accounts for about 20% of the country's Gross Domestic Product[3]. This study explores the in detail documentation of the climatic risks at community level in agriculture emphasizing the perception of the farmers; the people make sure that rest can have food for their existence.

[1] Sujola means availability of water, sufola means our land is fertile, shossya syamola means it looks green due to huge amount of crop production.
[2] National Adaptation Programme for Action, 2005
[3] Published in the report of I-Phase of the Agricultural Sector Programme Support implemented by Government of Bangladesh and Denmark.

1.2 Rationale

It has already been stated, the essential ecological services and supports are possible due to the existence of favourable physical and climatic process of the country. The land of this country is very fertile. The climatic conditions are favourable since many years; providing great seasonal variations. The season changes here maintaining a harmonic process and distinctive intervals. But, if this favourable climate is no more available, there is going to be devastation in the total agricultural sector. So, a study focusing on the climatic risks in agriculture is a worthy one.

Agriculture is the dominant economic activity in Bangladesh and regarded as the lifeline of the Bangladesh economy. Its role is vital in enhancing productivity, profitability and employment in the rural areas for improving the wellbeing of the poor. As the largest private enterprise, agriculture (crops, livestock, fisheries and forestry) contributes about 21% of the GDP, sustains the livelihood of about 52% of the labour force, and remains a major supplier of raw materials for agro-based industries[4]. Agriculture plays an important role in the overall economic development of Bangladesh. Agriculture is also a social sector concerned with issues like food and nutritional security, income generation and poverty reduction. Besides, it is the biggest source of market for a variety of consumer goods, including consumer durables particularly in the rural area.[5] Agriculture is one of the threatened sectors due to climate change. Hence, conducting study about the climatic risks assessment in agriculture is critical to ensuring dealing with the upcoming climate change challenges.

Agriculture is always susceptible to unfavourable weather events and climatic conditions. Despite technological advances such as improved crop varieties and irrigation systems,

[4] National Agricultural Policy Draft 5
[5] See note 4

weather and climate are still key factors in agricultural productivity. Often the linkages between these key factors and production losses are obvious, but sometimes the linkages are less direct. The impacts of local level climate change on agricultural food production are global concerns, and they are very important for Bangladesh as well as in the study area.

According to the NAPA Bangladesh will face the critical challenges and scarcity of rainfall due to change in spatio-temporal pattern in north-western region. It also predicted that Bangladesh will experience flooding in wet season and scarcity of fresh water due to less rain and higher evapo-transpiration in the dry season. The prediction argues that the change will impact by the means of crop failure in north western region. Therefore, assessing these climatic risks in agriculture is crucial to formulate the ways of challenging the upcoming difficulties in north western region.

Addressing climate change induced risks and disasters would be challenging, because of the presence of scale issues in temporal dimension in the event. Therefore, both fine and course scale assessment is necessary. Place to place, community to community maximally varies on the processes upon which their livelihood is structured. There is plenty of studies regarding the climate change vulnerabilities available while dominant are the study have course resolution (national level, regional level). To understand the scenario of the very local level, community level assessment is beyond substitution.

Risk assessment is the inseparable task in ways of finding the probable ways for adaptation or enhancing the existing adaptation. Risk assessment can be referred as the basement of the decisions functioning in adaptation issue.

Despite having national, international efforts in disaster risk reduction in Bangladesh, disasters and their consequences have been increasing. The development projects are most often failed to reduce the disaster risk. For instance, the implementation of UN sponsored Krug Mission proposal of complete flood protection was inappropriate, that was even later admitted by implementing agency the BWDB and acknowledged in the FAP 12. Most of the mitigation programs are designed and implemented by ignoring the very physical processes and traditional pattern of human interactions in a floodplain ecology/ecosystem. Moreover, Adaptations are not isolated from other decisions, but occur in the context of demographic, cultural and economic change as well as transformations in information technologies, global governance, social conventions and the globalising flows of capital and*(to a lesser extent)* labour (see O'Brien and Leichenk o, 2000). It can therefore be difficult to separate climate change adaptation decisions or actions from actions triggered by other social or economic events. Adaptations can also arise as a result of other non-climate-related social or economic changes: a householder deciding to move from an area at increasing risk of flooding to an area at lower risk, for example, may not be primarily motivated by climate change, but rather by other demographic or economic factors. Clearly, attributing adaptations to climate change is not a simple process. Considering the previous exemplar failures and the complexity of climate change, as an issue, a study prioritizes the perception of the local people will be worthy one.

1.3 Aim and Specific Objectives

Reflecting upon the background, this study aimed as assessing the climatic risks at community level in agriculture. For the successful accomplishment of the aim the following objectives have been selected:

- ✓ Understanding the agricultural process in detail of the study area

- ✓ Documenting the cultivated crops and their rotation of the study area
- ✓ Finding out the climatic risks in agriculture

The objectives include also the following supplementary objective, which will help the other components of this project.

- ✓ Documenting the probable solutions from the peasants

1.4 Scope of the Study

Climate change has been a very large arena, even only studies regarding the vulnerability assessment have considered. It was addressed in the national adaptation plan that climate change has potential adverse impacts on various key sectors of Bangladesh, which includes- water, coastal zone, agriculture, infrastructure, forestry and health. This study focused on the agricultural sector.

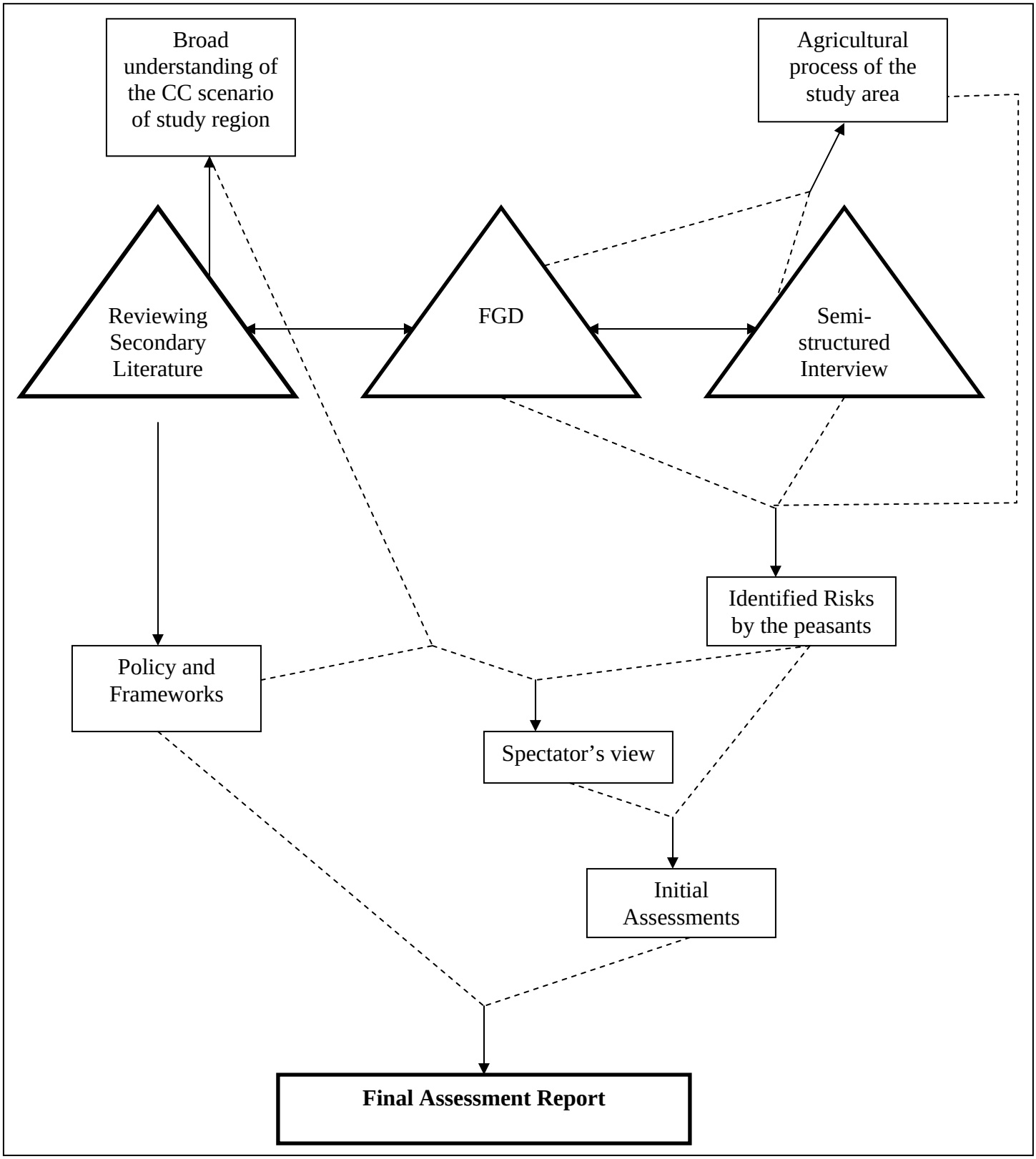
Agriculture sector encompasses crops, fisheries, livestock, and forestry sub-sectors.[6] So it is important to narrate that what agriculture includes in this study? Mainly crops have been taken as the focusing component but as supplementary components fisheries and livestock has come.

There are risks in agriculture resulting from various responsible factors, like- climatic, economic and even political. This study has emphasized the climatic risks though relevant risks induced by other factors also have come into the final discussion.

The database created and evaluated by this study contains a fine resolution (community level/ in some cases household level). So, the analysis and assessments remains prioritizing the community level assessment; not representing the broad scenario of the region.

[6] See note 4

1.5 The conceptual framework of the study



1.6 Organisation of the Report

Chapter 1 focuses on the primary issues of the study including the aim and objectives of the study.
Chapter 2 includes a narrative of the study area from both local and regional perspective. Data and data sources including all methods and techniques used in this study have been elaborately narrated in **Chapter 3**.

The main consideration of **Chapter 4** is to discuss the community response and their perception on the subject matter of the study.

Chapter 5 accumulates the analysis and findings of study incorporating the field data with data extracted form the secondary sources. This chapter also includes concluding remarks.

1.7 Conclusion

Considering the significance of agriculture as a sector and climate change as an issue of present Bangladesh, it can be firmly state that this study will be a guideline to fulfill the other component of the current project and function like a well exemplar to the local level climatic risk assessment in agricultural sector.

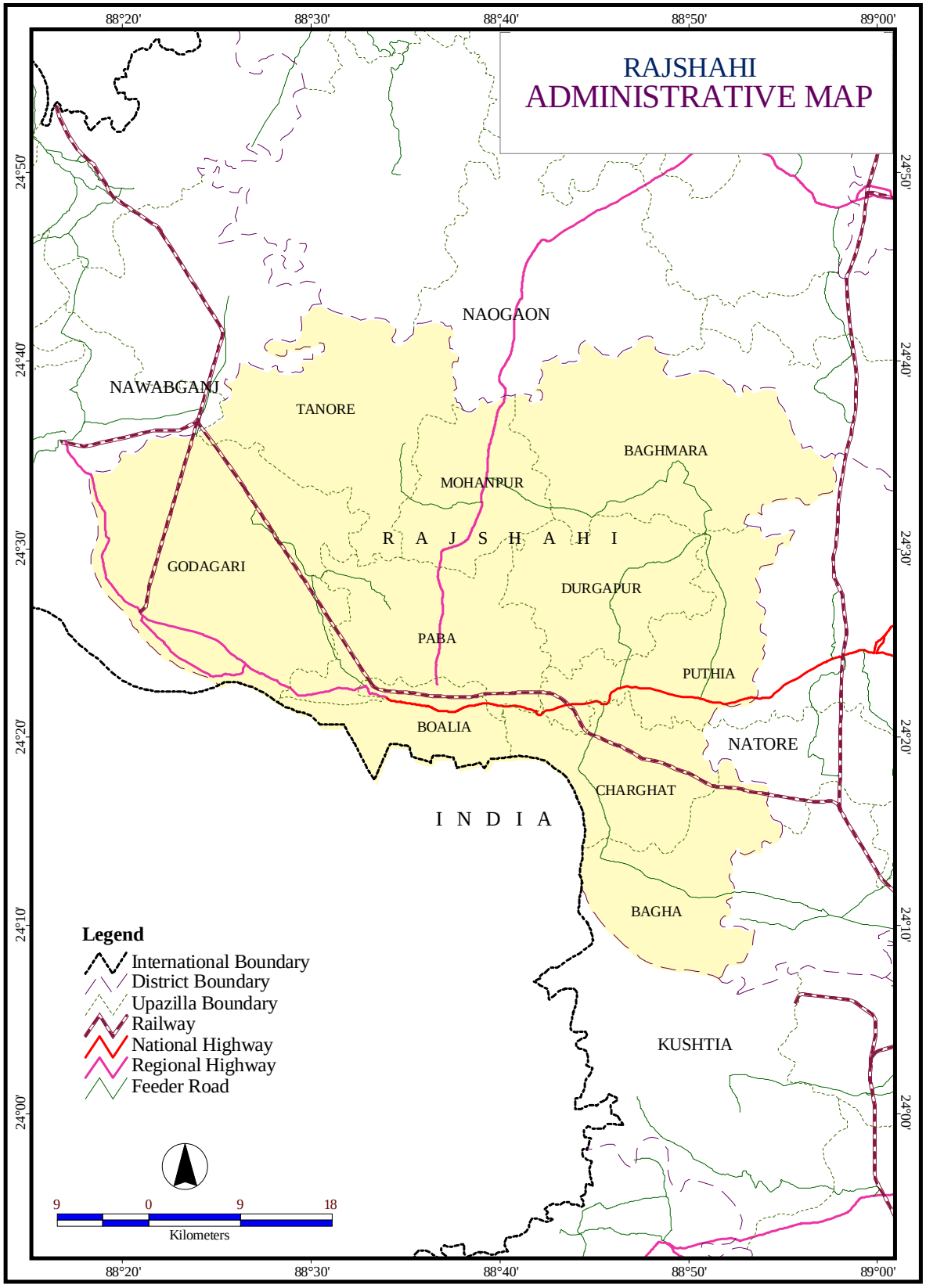
2.1 Introduction

As the chapter titled study area and region, there is an explanation. This study aims to assess the climatic risks at community level in agriculture. As this study is dealing with the issue of climate change, the understanding of the broad regional perspective also contain remarkable importance. This chapter narrate the study are from the both regional and local perspective. When the term study region is mentioned it encompasses basically the Rajshahi district, in the case of temperature and rainfall data analysis it includes the adjacent three more districts. The phrase study area is confined to the two villages Adariapara and Tengramari of Haragram and Haripur unions of Paba Upazilla under Rajshahi districts.

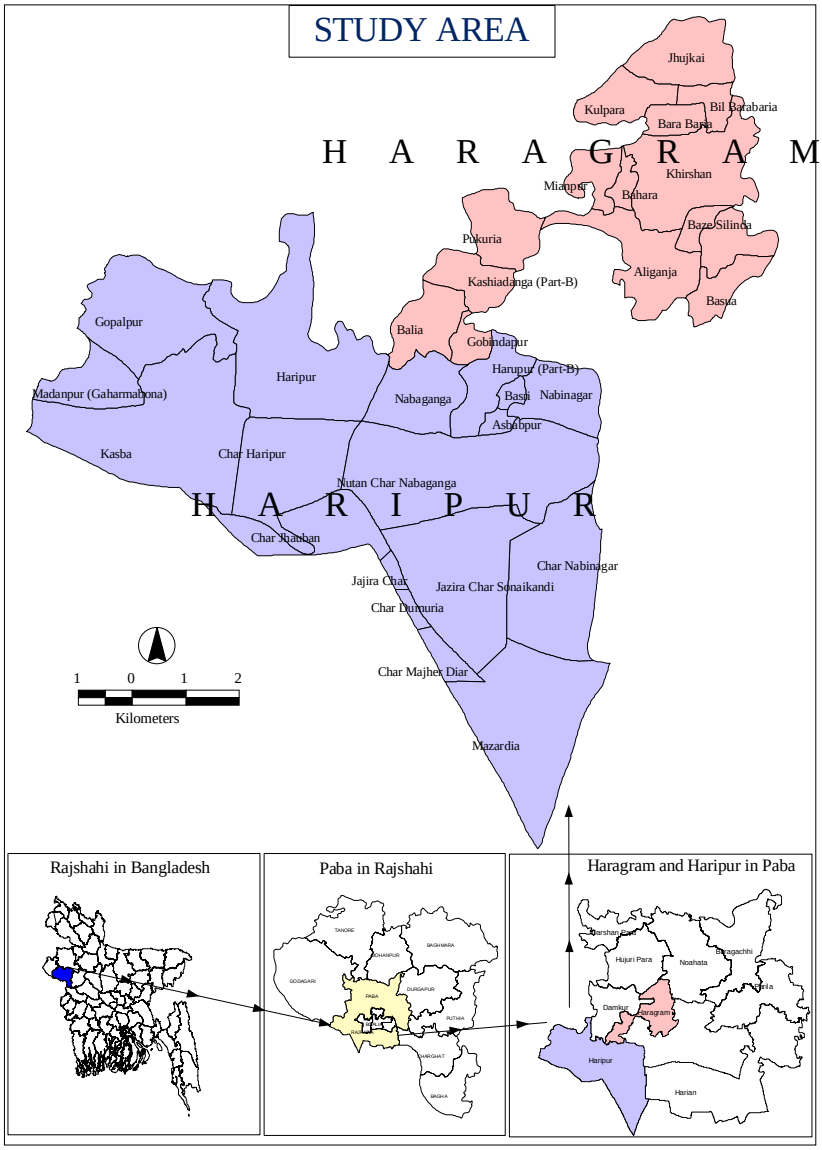
2.2 Location and Extent

Rajshahi District (rajshahi division) with an area of 2407.01 sq km, is bounded by Naogaon district on the north, West Bengal of India, Kushtia district and the Ganges on the south, Natore district on the east and Nawabganj district on the west. The region consists of Barind Tract, Diara and Char lands. Main rivers are Padma (Ganges), Mahananda, Baral and Barnai. Main occupations are Agriculture 38.73%, agricultural labourer 23.64%, wage labourer 3.50%, commerce 12.44%, service 8.81%, transport 2.36% and others 10.52%.

Paba Upazila (Rajshahi district) with an area of 161.85 sq km, is bounded by Mohanpur and Tanore upazilas on the north, West Bengal of India and Charghat upazila on the south, Puthia and Durgapur (Rajshahi) upazilas on the east, Godagari upazila on the west. Rajpara, Boalia, Shah Mokdum and Matihar thanas of Rajshahi City Corporation are surrounded by this upazila. About 98% area of this upazila consists of Ganges alluvial soil and 2% Barind land. Main rivers are Ganges, Shiba and Barnai; depressions 5, most noted of which is Karnahar Beel.



Map-2.1: Map of the Study Region



Map-2.2: Map of the Study Area

Paba thana, now an upazila, was established in 1949. It consists of seven union parishads, 108 mouzas and 261 villages. The study area for this intervention is confined on the two villages named Adariapara and Tengramari of the Haragram and Haripur union parisad of the Paba upazilla.

2.3 Conclusion

This chapter has provided the very basic ideas about the study area and regions. This will guide the ongoing chapters and the discussions

3.1 Introduction

Methodology is one of the important parts in any study. Methodology is entirely responsible for the systematic arrangement and proceeding of the study. The systematic surveying, the plan of study and the problems and prospects are the main subject matter of discussion in the methodology. The significance of the study rests upon the smooth expression and interpretation of the events (Dixon and Leach, 1978). This chapter will sequentially discuss about the sources of data and its processing methods.

3.2 Data Sources

A. Primary Data Source

3.2.1 Field survey

Primary data is collected through questionnaire survey, in-depth interview and FGD during the field study. During the survey different participatory tools were used. The tools were used in different sessions with selected representative groups of people and communities. In these participatory sessions community people drew different graphics and did group discussions. The specific data has been obtained from the field survey include

- Seasonal calendar of crop and hazard map
- Timeline and trends of event
- Farmer's perception in detail
- Relevant photographs

B. Secondary Data Source

3.2.2 Bangladesh Meteorological Department (one of the most important source of secondary data)

Mainly the study is conducted by using the BMD data. In selecting the stations, the length of available periods of records, data consistency, regional hydro-climatic characteristics

and agricultural practices is taken into consideration.

3.2.3 Other Sources

The other sources are various books, journal articles, policy papers, frameworks and adaptation strategy etc. the noticeable ones are described-

National Adaptation Programme of Action (NAPA)

The National Adaptation Programme of Action (NAPA) of Bangladesh draws upon the understanding gathered through discussion with relevant stakeholders in 4 sub-national workshops and one national workshop, prior research, background papers prepared for this report as well as research carried out for these background reports, and expert judgments.

National Agricultural Policy (Draft 5)

Agricuture sector encompasses crops, fisheries, livestock, and forestry sub-sectors. Separate policies on livestock, fisheries and forestry have been formulated by the respective ministries. In this perspective, Ministry of Agriculture has drafted this policy document in order to undertake and guide development activities in the crops sub-sector. As expected, policies aimed at crop production in the areas of reaserch, extension, seeds, fertilisers, minor irrigation, marketing, gender and HRD have prominence in this document. Since crop sector plays a major role in Bangladesh agriculture and gets the utmost importance in various agriculture related programmes of the government, this policy document for the development of crop sector is, therefore, entitled as the National Agriculture Policy.

Bangladesh country almanac (BCA)

Bangladesh Agricultural Research institute, Bangladesh Meteorological Center has provided a unique and valuable datasets named Bangladesh Country Almanac (BCA), 2005 in CD format. This report takes helps from the BCA GIS database.

3.3 Methodology

3.3.1 Literature Review

Climate change is an alteration of long standing weather patterns-as opposed to daily fluctuations-above and beyond natural climate variability observed over comparable time periods; climate changes are changes in the composition of the global atmosphere that can be attributed directly or indirectly to human activity (Falconer, 2004).

Although globally averaged surface temperature increase and sea level rise are the most certain of the IPCC projections, other effects can be also projected with some confidence. It is argued that the global climate change has the adverse effect on the regional level as well as on the local level. The effect on the local level can be accelerated by various anthropogenic events. The adverse effect can hit at the regional and local level creating the evidence of extreme temperature, drought, flood, extreme cold, and anomaly in the climatic variables.

Variables of climate change

The most dominant climatic drivers for water availability are precipitation, temperature, and evaporative demand (Meehl et al., 2007) and Uncertainties in climate change impacts on water resources are mainly due to the uncertainty in precipitation inputs and less due to the uncertainties in greenhouse gas emissions (Doll et al., 2003;Arnell, 2004b), in climate sensitivities.

A warmer climate with its increased climatic variability will increase the risk of both drought and flood (Wetherald and Manabe, 2002) as the realization of risk comes from the various factors of climate. The perfect example can be the drought, long-lasting precipitation, sudden flood, or heavy cold. Among the examples flood depends on precipitation intensity, volume, timing, antecedent conditions of rivers, and their drainage basins (e.g., presence of snow and ice, soil character, wetness, urbanization, and existence of dikes, dams, or reservoirs). Human encroachment into flood plains and lack of flood response plans increase the damage potential.

Vulnerable area of Bangladesh

South Asia is the most vulnerable region of the world to climate change impacts (McCarthy et al., 2001) and the international community also recognizes that Bangladesh ranks high in the list of most vulnerable countries on earth. Bangladesh's high

vulnerability to climate change is due to a number of hydro-geological and socio-economic factors that include the deltaic topography, geographic location, and extreme climatic variability that is governed by monsoon and which results in actual water distribution over space and time. The major problem lies in its high population density and poverty incidence and majority of population being dependent of crop agriculture which is highly influenced by climate variability change. (Haque, 1990).

Drought area covers almost one third of Bangladesh, particularly the north-western part. Evaporation rate in most of these areas is high for more than 7 months than the participation rate. Extraction of ground water for irrigation purpose is not adequately recharged. Consequently the aquifer level of ground water is going down steadily. (Nasreen*et.al,* 2004) Though Bangladesh has very negligible contribution to green house gas emission but her vulnerability to climate change considered to have massive and disastrous consequences. IPCC impact assessments identify Bangladesh as one of the most susceptible countries of the world. These impacts range from an overall increase in sea level, atmospheric temperature, and rainfall to more intense natural disasters in the form of floods, cyclones, storm surges, drought and others consequential impacts.

It is concrete from the IPCC report and Ecosystem assessment that Ecosystem function and species composition are likely to respond mainly to precipitation change and warming in temperate systems. Rainfall change and variability is very likely to affect vegetation in tropical area and savanna system (IPCC, 2007, WG II) ecosystems are expected to tolerate some level of future climate change and While earlier IPCC reports described several ecosystems to be resilient to warming up to 1°C (Fischlin, 2007), recent studies provide a more differentiated view of ecosystem sensitivity (Wetherald et al., 2002) that includes understanding of the role of climatic variability an extremes. Changing amounts and variability of rainfall may also strongly control temperate vegetation responses to future climate change (Novick et al., 2004; Zha et al., 2005).

Sectors will be affected

From the above discussion it is clear that Bangladesh is critically linked with the above climatic phenomena and the key sector of the economy of Bangladesh is agriculture; it is influenced by seasonal characteristics and different variables of climate such as temperature, rainfall, humidity, day-length etc. Several reports of DoE especially Climate Change Cell (CCC 2009) and National Adaptation Programme of Action (NAPA)

indicated that climate is changing and becoming more unpredictable every year and more frequently than ever before. Flood and water logging in the central region, flash-flood in the northeast region, drought in the northwest and southwest region, and salinity intrusion and coastal inundation in the coastal regional would be a more acute problem in future. All of these will have an extra bearing on the agriculture sector. But the agriculture sector has multiple linkages with nearly all major sectors in Bangladesh economy. The performance of agricultural sector has an overwhelming impact on major macroeconomic objectives like employment generation, poverty alleviation, human resources development, and above all food security. This sector generates 63.2% of total employment, of which crop sectors share is nearly 55%. About 84% of the total population live in rural areas and directly or indirectly engaged in wide range of agricultural activities. (BBS, 2000a, 2000b) but unfortunately the real condition is there is decreasing trend in its share in GDP and despite this, it is still of paramount importance, because it still supports a large number of people and most other sectors or activities depend on it.

Ground water and availability of water

In Bangladesh, the largest demand for both surface and groundwater is to support irrigation in the dry months. The largest impact of global warming will be felt in the water resources of Bangladesh. Many projections suggest greater variability in future monsoon patterns, with severe impacts upon agriculture and other related sectors due to either excess flow or severely low flows and draughts in other years. Increased vulnerability to these threats and erratic climate conditions dictates that Bangladesh will experience more extreme climatic conditions. Following sections provide the concerns that Bangladesh might face due to global warming. The review has been heavily borrowed from study "Strategy for adaptation: coping with climate change and climate variability in Bangladesh" conducted by IUCN Bangladesh Country Office. Changes in climate may affect irrigation requirements for all the three cropping seasons: Rabi, Kharif-I, Kharif-II. Increase in temperature will scale up irrigation demands by 200 Mm3 for March alone (Country Environmental Analysis, 2004).

Lower precipitation mostly during the dry season in combination with higher evaporation will lead to increased withdrawal of surface water. Low flow conditions of the rivers will be subsequently accentuated. Bangladesh will also be at risk from droughts from the effect

of climate change induced moisture stress and resulting drought impacts. It is found that, under a moderate climate change scenario, Aus production would decline by 27% while wheat production would be reduced to 61%. Under a severe climate change scenario (with 60% moisture stress), yield of *Boro* might reduce by 55 to 62%. Moisture stress might force farmers to reduce the area for Boro cultivation (Country Environmental Analysis, 2004).

A 10% increase in monsoon precipitation due to climate change in Bangladesh could increase runoff depths by 18 to 20%, resulting in a sevenfold increase in the probability of an extremely wet year. Since climate models predict an increase in monsoon precipitation by 11 and 20%, it follows that surface runoff is likely to increase in the order of 20 to 45 %, respectively. IUCN (2003) reported that, by the year 2030, an additional 14.3% of the country will become extremely vulnerable to floods, while the already flood-vulnerable areas will face higher levels of flooding (Country Environmental Analysis, 2004).

Agricultural crop production

Various studies indicate that a rise of 1° to 2° C in combination with lower solar radiation causes sterility in rice spike lets. High temperature was found to reduce yields of HYVs of Aus, Aman and Boro rice in all study locations and in all seasons. The effect was particularly evident at a rise of temperature by 4°C. Climate changes, especially in temperature, humidity and radiation, have great effects on the incidence of insect pests, diseases and microorganisms. A change of 1°C changes the virulence of some races of rust infecting wheat (NAPA 2005).

Of the three varieties of rice grown in Bangladesh, the Aus rice (grown during the summer, monsoon period under rain-fed conditions) seems to be the most vulnerable. The other model, Canadian Climate Change Model (CCCM) predicted a significant fall in food grain production. It should be noted, however, that this scenario was based on projecting existing cropping patterns into the future which is not necessarily what will happen.

It was noticed that temperature increase of 4°C would have severe impact on food-grain production, especially for wheat production. On the other hand, carbon-dioxide fertilization would facilitate food-grain production. A rise in temperature would cause significant decrease in production, some 28 % and 68 % for rice and wheat, respectively. Moreover, doubling of atmospheric concentration of CO_2 in combination with a similar

rise in temperature would result into an overall 20 % rise in rice production and 31 % decline in wheat production. It was found that Boro rice would enjoy good harvest under severe climate change scenario with doubling of atmospheric concentration of CO2 (Karim et al., 1999).

Food security

Bangladeshi scientists estimated that approximately 40 percent of crop yield will be reduced by 2050 due to climate change variability. A rise in temperature is likely to reduce yields of the HYV rice varieties and may cause diseases in wheat. There will be no wheat production in Bangladesh if the temperature increases by 2°C. Crop production is also restrained by excessive water or the lack of it. Various models have been used to predict the crop production. All models predict a reduction, especially, wheat. On the other hand in the carbon di-oxide fertilization will increase the Boro paddy production, but at the same time moisture stress will affect this increase. Overall the crop production is likely to decrease endangering food security (IPCC, 2007, WG II, Chapter 3). But the prediction of IPCC requires extensive investigation to know the trend of change at regional and local level.

Soil moisture content

The increase in yield of Boro (dry season rice crop generally grown under irrigated conditions and includes high yielding varieties) and other crops might be constrained by moisture stress. A 60 % moisture stress on top of other effects might cause as high as 32 % decline in Boro yield, instead of having an overall 20 % net increase. It is feared that moisture stress would be more intense during the dry season, which might force the Bangladeshi farmers to reduce the area for Boro cultivation. Shortfall in food grain production would severely threaten food security of the poverty-ridden country (Ahmad et al., 1999).

Impact on socio economic condition

The NAPA (2005) and the Initial National Communication revealed the fact that a weak economy and widespread poverty in Bangladesh have contributed to low adaptive capacity to withstand the adverse impacts of climate change. This scenario is further aggravated due to the high dependence of a majority of the population on climate-sensitive sectors, such as agriculture, forestry and fisheries, coupled with poor infrastructure facilities, weak

institutional mechanisms and lack of financial resources.

3.3.2 Focus Group Discussion (FGD)

The objective is set as assessing the climatic risk assessment at community level in agriculture. If the key word or phrases is highlighted; then it may be written as follows-

Climatic Risk Assessment at **Community Level** in **Agriculture**

So there are agricultural issue, climate as an issue and as the resolution of data will be of community level, which will make a dimension here.

The agricultural system got some broad key stages-

- Preparing the land before seeding
- Planting at the land
- Post planting caring
- Harvesting the crops
- Post harvesting issues

And the irrigation issue.

The discussions of FGD have continued surrounding the stages noted above. The checklist developed for the FGD is given on the annex.

3.3.3 Semi-structured Questionnaire Survey

The questionnaire format was semi-structured and open ended. The purpose was documenting the existing risks and problems in agriculture in a very detail and with fine resolution (house hold level). The survey made sure that no small information regarding risks and vulnerability haven been missed out. The format of the questionnaire is given in the annex.

3.4 Secondary analysis of BMD temperature and rainfall data

Addressing climate change induced disasters would be very challenging, because of the presence of scale issues in temporal dimension in the event. What duration of change can be mentioned as climate change and the changes occurs in how big areas are another issue. If we go through the formal definition of climate- climate defined as an average weather condition of an area characterized by its own internal dynamics and by changes in external factors that affect climate (Trewartha and Horn, 1980). The considerable period of time denotes at least 35-40 years. Here besides the study area

(Rajshahi District), three more adjacent districts have been taken (considering scale issue) into consideration while temperature and rainfall data of 26[1] years (considering temporal issue) have been analyzed. This analysis has introduced us to the broad climate change scenario of the region on the basis of temperature and rainfall.

The summarized results mined from the analysis are given below:

Trend of temperature

Observed data indicates that the annual average temperature is increasing in the monsoon season. Annual average maximum and minimum temperatures show an increasing trend annually at the relatively high rate of 0.192°C and 0.044°C respectively in Rajshahi.

Summer temperature is increasing day by day and the summer maximum and minimum temperature is increasing in Rajshahi at the rate of 0.078°C and 0.132° respectively.

On the other hand average winter time (December, January) maximum and minimum temperatures show respectively a decreasing and an increasing and trend annually at the rate of increase of 0.234°C and decreases of 0.333°C at Rajshahi station.

Trend of rainfall

Though the rainfall data in Rajshahi shows that the trend is static up to 2006, but there is a severe change observed locally after 2006. The farmers claimed that they did not see rainfall at the beginning of the rainy season since last 3/4 years. It is observed that the monsoon rainfall is increasing all the stations at a very low gradient and average rainfall is decreasing day by day.

3.5 Conclusion

This chapter have discussed the all data sources and methods adopted in this study. This will make the later discussions comprehensive. This also provides the understanding of the climate change scenario at local level on the basis of temperature and rainfall data.

[1] We had to take 26 years of the data instead of 35 years; some of the stations are newly established and data in a comprehensive mode is normally unavailable.

4.1 Introduction

This chapter can be considered the heart of this study as it encompasses the all information collected from the field. This chapter narrates in detail agricultural process and crop rotation of the study area, the climatic risks and other problems in their agriculture and the probable solutions according the farmer's view.

4.2 Agricultural processes and crop rotation

Mainly, three kinds of paddy is cultivated here- Aus, Amon and Boro. The preparation for the cultivation of Aus paddy starts from the first week of 'Chaitra'. The plants are being planted in first week of jaistha. The paddy is harvested within the first week of 'Shrabon'.

The Amon cultivation process normally starts within the first week of 'Ashar' through peparing the land. The plants are being planted in the last week of 'Ashar'. The harvesting process starts within the second week of 'Agrahayan'.

First or second week of 'Poush' is considered the suitable time for the start of Boro cultivation. The plants are being planted within the first and second week of 'Magh'. The hervasting starts within the first week of 'Jaishtha'.

The lands are not being engaged with the three times of paddy cultivation has been used fort the cultivation of different kinds of vegetables (e.g. potato, tomato, colliflower, cabbage, pumpkin, bringal, radish, patal, jhingah, corn etc.).

The land is being prepared within the last week of 'Kartik' for the cultivation of potato. The seedling process starts within the first week of Agrahayan. The harvesting process is being conducted in the mid-falgun. Pumpkin and corn also been cultivated within the same timeframe; having difference of 7/8 days.

Some crops are cultivated for once in a year (e.g. Bringal, Jhingah, Raddish etc.). Brinjals are normally cultivated for a long time basis- 8/12 months. This crop has varieties kind of species. Hybrid species of them normally cultivated after 'Chaitra' month.

During the rainy season, farmers normally give priority to cultivate paddy. As paddy consumes more water for irrigation, rainy season is considered very suitable for paddy cultivation.

4.3 Risks and problems in agriculture and the causes according to farmers

We stated already that farmers normally try to cultivate the paddy (Aman) during rainy season. This season normally got sufficient rainfall to cultivate paddy. This is harmonic seasonal process of the nature here. So farmers mainly depend on nature for the irrigation process. Since last 10-12 years, the rainfall pattern shows some unpredictable behavior (as the farmers mentioned). Sometimes the rain comes earlier and some times it comes a little late. But since last 3 years the situation becomes very critical. They did not get any rainfall during rainy season. So water becomes the prior and severe problem. The farmers are affected as it was a great support in their livelihood.

Some farmers take initiatives to overcome this problem through using shallow machine for irrigation. But that solution sustained very short duration. Now days they are not also getting water by a shallow machine.

Another problem they address is the water management system of the Padma River. Padma act as a vast natural source of water, as well as, irrigation. But a barrage named 'Farakka' was built by Indian side at upstream. This barrage severely affects the natural flow of water. The farmers think that this crisis of water in the Padma for Farakka barrage and unavailability of water through shallow machine is somehow linked. The barrage also directly harms their irrigation system and the availability of fish.

Moreover, the farmers claimed that huge volume of water discharged through Farakka barrage when there is abundance of water everywhere (both in upstream and downstream). This unexpected discharge results in severe flood. In addition, some farmers cultivate in the low lands as water has been unavailable. Most of the time, the discharge of Farakka happens, when it is time to reap their crops. The farmers state that the frequency of this event is continuing since the barrage has been built.

The other problems in their agriculture they denoted as the unavailability of the good seed, fertilizer and insecticides. Normally, farmers try to produce seed on their own; otherwise they have to buy it. They said that most of the time they have to buy this from some private enterprise providing low quality seeds. This results in decrease in production and 'chita' in paddy. The same problem is found in the case of seed of the various vegetables.

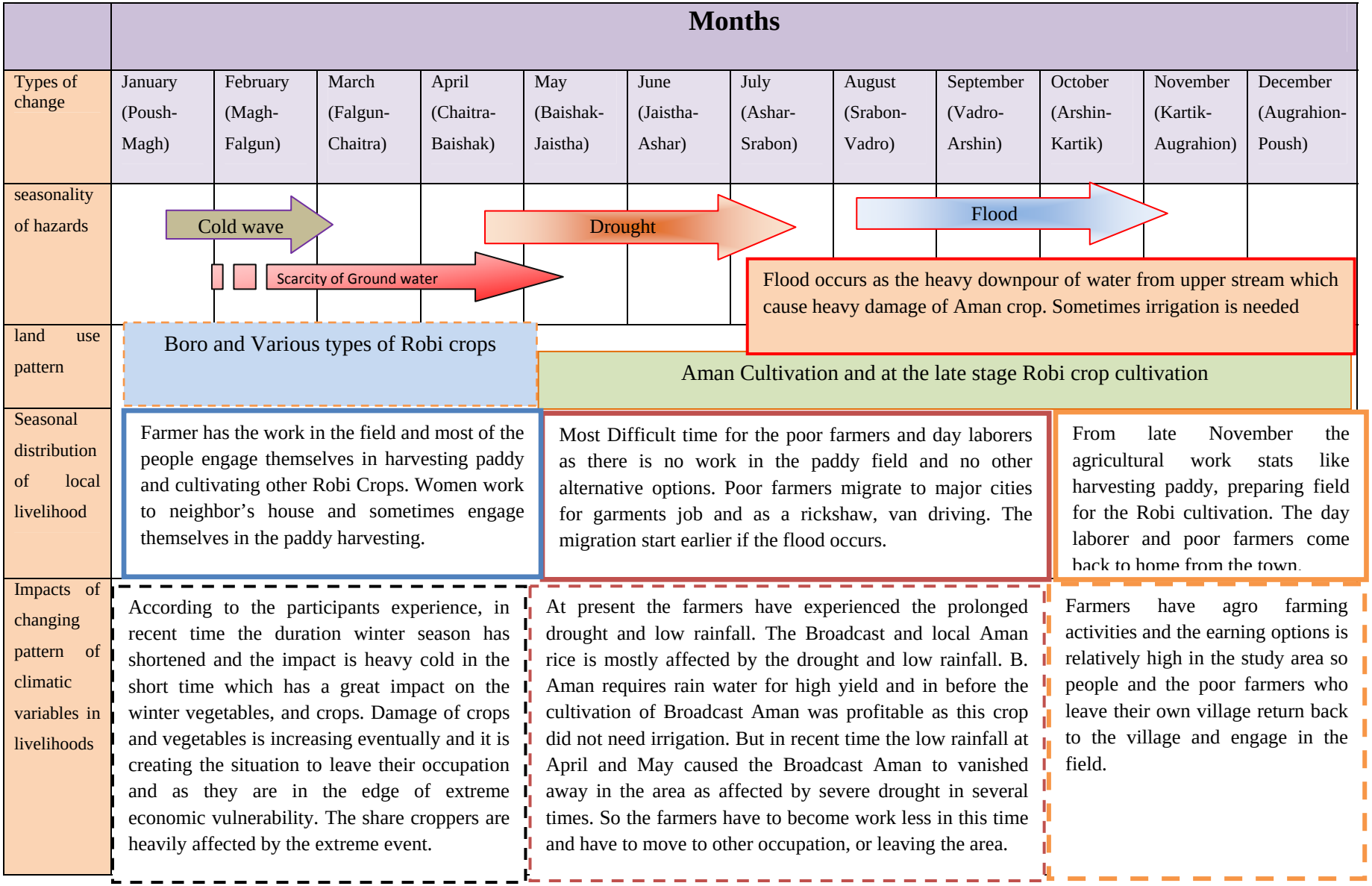
The price of fertilizer is increasing day by day. The farmers are disheartened as they listen through media that government is giving huge subsidies in the agricultural sector. They said that they did not find any implication of this announcement in reality; at least in their lives. In addition, they narrated one more thing in this regard. Their practice of having livestock, especially cow, is decreased in an alarming rate. By generation, this kind of livestock support played a vital role in their agricultural. This support helped them to plough their land, provide fertilizer (bio) and help to promote their livelihood mechanism by providing milk, meat etc. various local phenomenon like not having enough field to cattle them are responsible for this decrease.

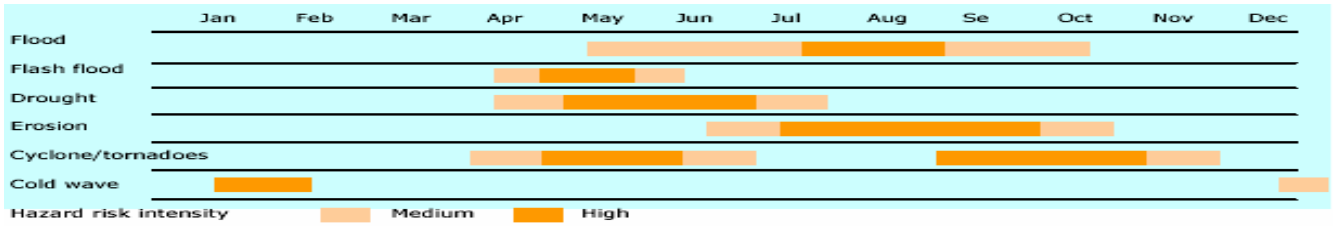
Fig-4.1: During FGD

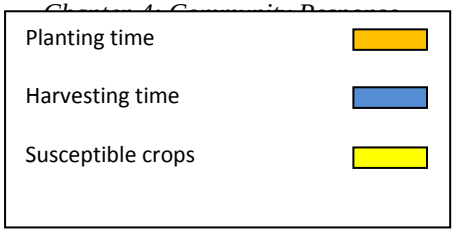
Fig-4.2: uncertain early blooming

Fig-4.3: Severe drought (the land during the rainy season)

Figure: Integration of Hazard, livelihood map and crop calendar







Types of Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Characteristics
B. Aman									Most Susceptible due to fluctuation of rain fall heavy of low or flood.				Under low-lying condition. Deep water rice
T.Aman						Most Susceptible due to fluctuation of rain fall							Area liable of 0.5 m depth of flood. Sensitive to day length
B.Aus			Susceptible as late monsoon shower										Under pre monsoon. Mature on pre monsoon showers, insensitive to day length
T.Aus			Lowering the ground water table due to Huge irrigation of water and scarcity of water										Irrigated condition, insensitive to day length
Boro	In before this rice and vegetables were planted during the early flooding or due to rise of river level. But now the crop some time damages due to heavy cold condition.												Planted under irrigaton during dry season, toalarent of cold temperature, insensitive to day length
Kharif			All kind of crops and vegetables are susceptible due to heavy rain or flood.										Monsoon rain and high temperature, characterized by wet season.
Kharif 1		Most susceptible is Aus crop especially the summer vegetables and pulps, jute and broadcast Aman.											Rainfall is high and temperature is high
Kharif 2							Most susceptible is Transplanted Aman crop especially the summer vegetables and pulps, jute.						Heavy rainfall and flood
Robi	Most susceptible crop is wheat, potato, pulps and oil seed due to rain or heavy cold and fog.												Low or minimum rainfall and high evaporation rate

4.4 Probable solutions according to them

The farmers have taken initiatives locally from both personal and group basis to address the above stated problems and risks. For irrigation purposes they manage some shallow machine but the thing is now days it seems to be very difficult with the shallow pump. Hence, they suggested a deep machine to supply the water for irrigation. At least that could be a mini deep machine. It will cost more than one lakh (1,00,000) taka. With a mini deep machine one bigha land can be cultivated. The deep one is expensive. That will cost at least 10-12 lakh tk. but that can provide complete irrigation to 10-12 bigha land.

They also suggest how the problem can be addressed at regional level by a proper river management of Padma. They mentioned about Padma barrage project (it was not been finished as planned). Farmers addressed that if would be possible to hold the water from upstream into the downstream, that will help vastly to address the water scarcity of the whole region. As an example they mentioned about the project have taken at Pabna. The water form the river has been used to fulfill the canals and being used to fish cultivation and the small water bodies also been fulfilled to supply the necessary water at the whole season. The farmers of that region can cultivate three times in a year without having difficulties of water. They can cultivate fish in the big canals and the small water bodies remains as the irrigation source during the dry season. For the irrigation purpose they have provide only one hundred taka per year.

Another probable solution they suggest that bringing a change in their cropping pattern. According to that plan, they will give emphasize on the cultivation of various vegetables instead of paddy. Normally, paddy consumes more irrigation than the other vegetables. Even vegetable cultivation is cost effective also. Paddy cultivation needs ten times more expense rather than the vegetables.

They assessed that they have to restore the practice of raising the livestock (specifically cow). This practice will help them in more than one ways by providing milk, fertilizer for the land, providing meat etc.

When the issue was raised of getting help form the agricultural personnel, they seemed to be frustrated. They know that there must be a block supervisor to advise them in various issues of agriculture. Many of the farmers claimed that they did not even see him/her in reality. The farmers looked really upset with them.

4.5 Farmer's Perception about climate change

To explore farmers' perceptions dry spell, heavy cold and foggy condition thresholds were identified for various stages of the crop, as illustrated in Table-5. In the high Barind areas, the threshold dry spell lengths, meaning the number of consecutive days without rain, varies considerably with respect to stages of growth. On average, a dry spell of five to seven days is considered mild drought at seedling and flowering stages, but in the vegetative state, it is seven to eight days. At flowering stage, the community considers a rainless period of more than 15 days to be a severe drought that can reduce crop yield.

Table: Local perception about climate change

Stage	Length (Days)Upper limit for Dry spells and lower limit is for the Cold and fogy condition	Drought, severe cold Perception
Seedling stage: most of the farmers said that the Dry spell condition persists during seedling stage and it ranges from 7 to 15 days. And in winter season the foggy condition persist for 3to 4 days	5-7	Mid
	2-3	
	7-15	Moderate
	3-4	
	>15	Severe
	>4	
Vegetation: when the seed grows and the duration of dry or cold condition is relatively low. Even sometimes rain and foggy condition damage the crops.	5-7	Mid
	2-3	
	7-15	Moderate
	3-4	
	>15	Severe
	>4	
Flowering: during the flowering time the long duration of dry spell condition persist, especially in summer season.	5-7	Mid
	2-3	
	7-15	Moderate
	3-4	
	>15	Severe
	>4	

4.6 Changing pattern of Climatic Variables

The respondents pointed that the erratic behavior of weather sometimes first time in their memory such as fogs in places where these were never seen of during summer time, drought, floods including flash flood, and cyclone as major problems they are facing in this parts of the area. Problems related to early and untimely floods, localized inundation. Local farmers understand climate change in different way and it is the change of local climate and its behavior. According to the local farmers opinion the Broadcast Aman has disappeared due to uncertainty of rainfall and low production. They think that the drought condition is now prolonged ever before and temperature is increasing day by day.

People in the study area perceive that today's climate is different from the past – the seasonal cycle and rainfall pattern have changed, droughts have become more frequent, pest and disease incidences have increased and the average temperature has increased in the summer while winter has shortened. Local people also feel that their production of Boro and Aus rice, winter vegetables and fruit including several varieties of mangoes have been affected by increased variations in rainfall, dry spells, temperature and drought occurrences.

4.7 Conclusion

Drought is adversely affecting rice crop in different seasons of the study area, which accounts huge loss. Droughts in March-April prevent land preparation and plowing activities from being conducted on time, delaying planting of crops during monsoon season. Inadequate rains in July–August delay transplantation of Aman in highland areas, while droughts in September and October reducing yields of both broadcast and transplanted Aman and delay sowing of pulses and potatoes in the region. Boro and other crops grown in the dry season (summer) are also periodically affected by drought. But it is said that the region has been playing a vital role to ensuring food security and socio-economic condition of the region by the way of agricultural activities. But the change of agricultural practice will affect the poor farmers if the change of the climatic variability continues. From this chapter we also know that the farmers, often ignored as layman, actually are very concerned about their risks and problems in the agriculture.

5.1 Introduction

This chapter summarizes the data found at field. It also provides a critical review of the findings. Finally it incorporates the final findings with the National Agricultural Policy and National Adaptation Program of Action (NAPA). Later it ends this documentation with some concluding remarks.

5.2 Summary of Findings

5.2.1 Trend of temperature

The overall temperature trend indicates an increasing trend in Rajshahi. The summarized statistics are:

BMD Station: Rajshahi	**Increasing Rate**
Annual Average Maximum Temperature	**0.192°C**
Annual Average Minimum Temperature	**0.044°C**
Average Maximum Temperature at Summer	**0.078°C**
Average Minimum Temperature at Summer	**0.132°C**
Average Maximum Temperature at Winter	***0.234℃ (decreasing)***
Average Minimum Temperature at Winter	**0.333°C**

Source: compiled from the BMD temperature data

5.2.2 Trend of rainfall

Though the rainfall data in Rajshahi shows that the trend is static up to 2006, but there is a severe change observed locally after 2006. The farmers claimed that they did not see rainfall at the beginning of the rainy season since last 3/4 years. It is observed that the monsoon rainfall is increasing all the stations at a very low gradient and average rainfall is decreasing day by day.

5.2.3 Risks and problems they face in Agriculture

The most prominent risk they mentioned is the scarcity of water. Particularly results from the erratic nature of rainfall. The erratic nature of rainfall includes-

- Having rainless rainy season
- Unexpected rainfall later time
- Arriving rainfall suddenly at a earlier time

The scarcity of water also functioned in different ways. This includes-

- down warding the ground water level
- having water scarcity in the Padma River
- having water abundance, resulting floods, in an unexpected time

Specific Climatic Risks

- ***the increasing trend of temperature in a relatively high rate rather than the adjacent areas***
- ***the erratic nature of rainfall occurrence***
- ***heavy fog in the winter season***

Another problem the farmers mentioned at the winter time is heavy fog resulting damage in total production of some specific winter crops.

In addition the farmers mentioned about another problems like within the seeds and fertilizer, which include-

- increasing trend of the price of seed
- not getting the quality seed
- alarming increasing trend of the price of fertilizer
- lack of bio-fertilizer

From the above stated risks and problems, if the specific risks are extracted emphasizing the climate (climatic risks) are given in the above text box.

5.2.4 Probable solutions according to the farmers

In summary, the suggestions are provided by the farmer's are-

- establishing deep machine to combat with the water scarcity
- if the previous one is beyond cost, then at least, establishing mini-deep machine.
- harvesting rain water for drought time
- bringing a change in their cropping pattern
- proper river management of Padma river by the Government
- re-storing the practice of raising the livestock (specifically cow).

5.3 Critical review of the findings

Considering the present situation form both global and local level, particularly while the Bangladesh is taken in consideration, climate change became an issue that just can not be ignored anymore. The complex nature of climate change claims more and more careful assessments of the impact of climate change. As the focusing sector of the present study is agriculture. The intensity of impacts on agriculture sector due to climate change can be shown as:

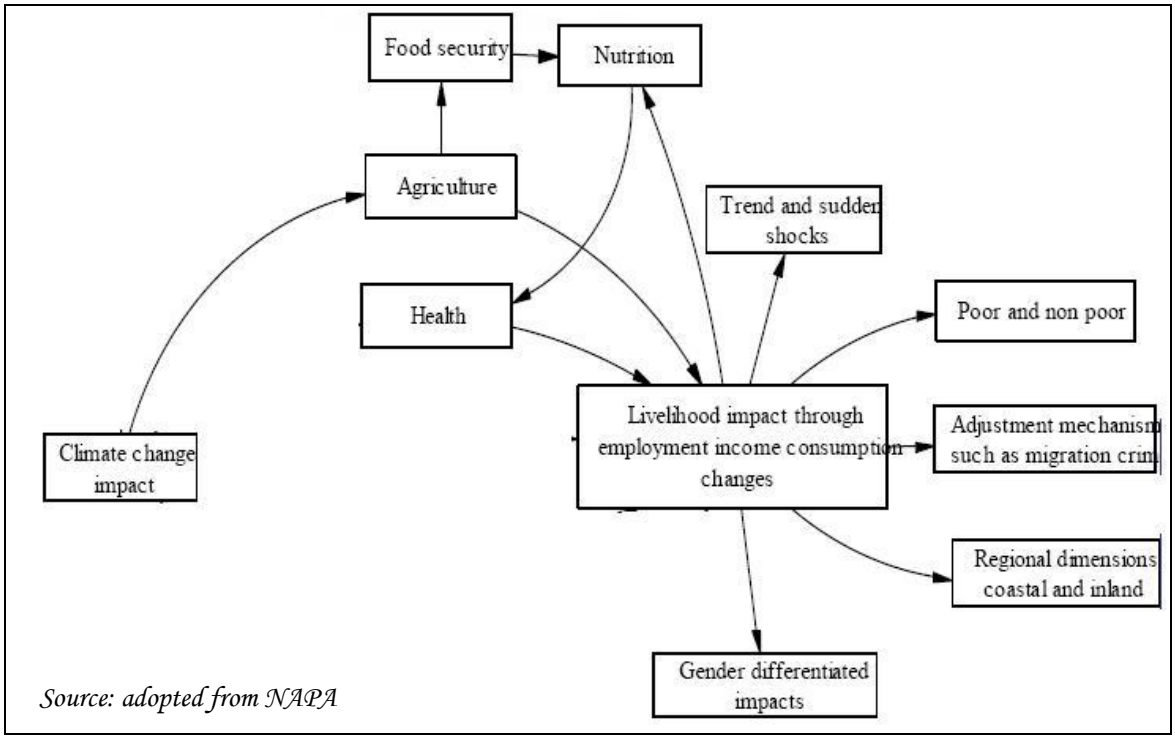


Fig: 5.1- The intensity of impacts on agriculture sector due to climate change

Though the aim of the study was confined at assessing the climatic risks in agriculture, but during the assessment all sort of problem and risks were documented carefully. Because the other relevant risks and problems are contains a deep inter-linkage with the climatic ones. For instance, if there exist the natural flow and water availability at Padma River, the farmer would have remained from the water scarcity if there were less rainfall. This statement was stated by the farmers.

So, this study actually draws the complete scenario of the existing risks and problems in agriculture of the study area at community level. But, the climatic risks have identified separately as aimed.

Radiation of sun is not the only determinant of atmospheric warmth. There are other factors contributing in this process; like- effects of clouds/water vapour, wind systems, pressure gradient, location of the place within the broader region, land use and vegetation cover, oceanic convection, bio-physical processes, biological and bio-geo-chemical processes, effects of urban heat islands and various other human processes. So, we need to careful in making conclusive statements about the change

It is pertinent to mentioned that the local behaviour of rainfall occurrence is strongly connected with regional and continental scale climatic processes and influenced by the physical landscape of the region. Three dimensional model of Bangladesh including its adjacent areas clearly indicates that Bay of Bengal and Indian Ocean in the south and major uplands in remaining three areas have strong influence on the rainfall occurrence. The Himalayan mountain range builds 7 to 8 km high wall in the immediate Northern parts of Bangladesh, which influence the thermodynamic properties of monsoon clouds and result in bounce back parts of monsoon winds causing downward gliding of clouds. As a result, condensation of water vapour happens and resulted in the occurrence of rainfall in the region. Thus the rainfall occurs over about 1.72 million sq km of Ganges-Brammaputra- Meghna (GBM) catchments (12 time larger than the area of bangladesh) channelled through Bangladesh.

Therefore, understanding rainfall pattern may not be complete unless system scale experiments are carried out. In other words, assessments of rainfall variable solely based on rainfall data of weather stations located in Bangladesh will not provide sufficient insights to understand the dynamics and inherent properties.

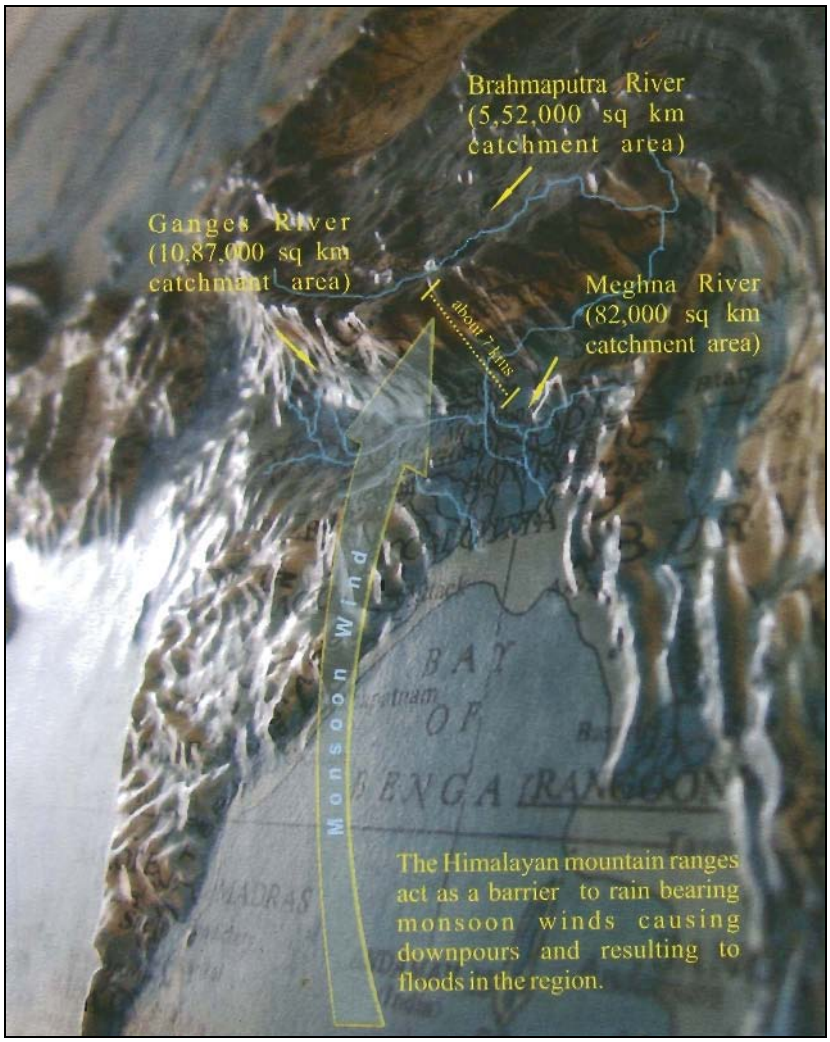


Fig: physical model (not to the scale) of Asian sub-continent

The issue of the river management of Padma and the ground water level decreasing (farmers also gave priorities to these issues) is the another issues of prioritizing. The unilateral and disproportionate diversion of the Ganges since that time has caused a dangerous reduction in the amount of sediment and water flow of the Ganges in Bangladesh. Now Bangladesh's delta receives less sediment and inadequate water flow for navigation and irrigation during the summer months.

The summer of 1993 was characterized by almost completely dry riverbeds across the country as reported by all major newspapers in Bangladesh. Groundwater also dropped below the level of existing pumping capacity. Such conditions lead to significant decreases in food production and curtailment of industrial activities.

Though this Farakka Barrage Project of India is a direct violation of the International Water Convention (Helsinki Rule signed in 1996), over the last two decades, Bangladesh

has tried unsuccessfully to come to agreement with India and the other co-riparian nations on an acceptable plan for water allocation rights. If the initiatives of the combating the water scarcity and unexpected flood are taken for the whole region so Bangladesh, there is no way of ignoring this Farakka issue.

5.4 Incorporating the National Agricultural Policy

National Agricultural policy has identified the climate change and other relevant environmental vulnerabilities (e.g. flood, drought, storm, salinity, pest and diseases, river erosion etc.) as a prior threat to agriculture in the section **2.4 (Threats)**.

And even in the specific objectives at the **3.2 section, the 4th objectives** is determined as *'establishing a self-reliant and sustainable agriculture adaptive to **climate change** and responsive to farmer's needs'*

In the **section 4.3 (Research Focus and Areas)** at 3rd point it is clearly stated that The Government will support research on emerging issues e.g., biotechnology, hybrid, climate change, disaster and stress including flood, drought, cyclone, salinity, upland/hill, deep water crop management, organic farming.

> The National Agricultural Policy includes the climate change issue with priority. As the policy review provides the findings that government of Bangladesh is already aware about climate change and other hazard and disasters induced by it in Agricultural sector. Hence, the activities regarding this issue like the present study will be very appreciated by the government as the policy says.

In the natural management portion of the policy at **section 4.6.2** it is stated that '*Research thrust will be placed on weather and crop forecasting, **climate change** and disaster management'*. The policy also narrates the partnership issue at the **5.6 section.** In the 3rd point it is stated that *'The Government through Department of Agricultural Extension (DAE) and allied agencies will maintain liaison with the NGOs and other development partners at local level for cooperation and coordination'.*

For the agro-ecologically disadvantaged regions, there is special attention has been given in the policy. At the section 5.10 it was stated that *'The Government will pursue programme for hilly area, **drought-prone area, Barind tract,** char land**, monga-prone area**, haor-baor and coastal belt with appropriate technological support'.*

5.5 Incorporating the National Adaptations Programs for Action (NAPA)

The finding on temperature rise also reflects on the NAPA. At the **section 3.1.1 (Observed changes)** it is stated that Observed data indicates that the temperature is generally increasing in the monsoon season (June, July and August). Average monsoon time maximum and minimum temperatures show an increasing trend annually at the rate of 0.05°C and 0.03°C, respectively. (Rahman Alam: 2003). Regional variations have been observed around the average trend (SMRC, 2003).

NAPA already assessed the broad level assessment of climate change impact on Bangladesh (region basis). The north western region is already mentioned as one of the suffered area of climate change.

Climate and Related Elements	Critical Vulnerable Areas	Most Impacted Sectors
Temperature rise and drought	• North-west	• Agriculture (crop, livestock, fisheries) • Water • Energy • Health

Source: NAPA team

The goal of the study (assessing climatic risks in Agriculture) and specific findings (temperature rise and drought) also reflects the understanding and assessment of national level.

The production of crop in Bangladesh is constrained by too much water during the wet season and too little during the dry season. Presently total irrigated area is 4.4 million ha which is more than 50 % of the potentially irrigable area of 7.12 million ha cultivated area. This area is being irrigated through surface and ground water resource. Irrigation coverage through Shallow tubewells (STWs) during the dry period has grown very fast following a policy of privatization and deregulation.

As a result, the groundwater table in Bangladesh is declining at a rapid rate causing STWs non-operating in many parts of the country during dry period. Lack of surface water during the dry season limits the function of Low Lift Pumps. A simulation study conducted under the climate change country study assessed the vulnerability of food grain production due to climate change in Bangladesh. Two general circulation models were used for development of climate scenarios. The experiments considered impact on three high yielding rice varieties and a high yielding wheat variety. Sensitivity to changes in temperature, moisture regime and carbon dioxide fertilization was analyzed against the

baseline climate condition.

The GFDL model predicted about 17 % decline in overall rice production and as high as 61 percent decline in wheat production compared to the baseline situation. The highest impact would be on wheat followed by rice (aus variety). This translates to a reduction of 4.5 million tons of rice at the present level (2002) of production. Of the three varieties of rice grown in Bangladesh, the aus rice (grown during the summer, monsoon period under rain-fed conditions) seems to be the most vulnerable. The other model, Canadian Climate Change Model (CCCM) predicted a significant fall in foodgrain production. It should be noted, however, that this scenario was based on projecting existing cropping patterns into the future- which is not necessarily what will happen, as there are signs of significant changes in cropping patterns already occurring.

The apparent increase in yield of boro (dry season rice crop generally grown under irrigated conditions and includes high yielding varieties) and other crops might be constrained by moisture stress. A 60 % moisture stress on top of other effects might cause as high as 32 % decline in boro yield, instead of having an overall 20 % net increase. It is feared that moisture stress would be more intense during the dry season, which might force the Bangladeshi farmers to reduce the area for boro cultivation.

Various studies indicate that a rise of 1 to 2°C in combination with lower solar radiation causes sterility in rice spikelets. High temperature was found to reduce yields of HYVs of aus, aman and boro rice in all study locations and in all seasons. The effect was particularly evident at a rise of temperature by 4°C. Climate changes, especially in temperature, humidity and radiation, have great effects on the incidence of insect pests, diseases and micro organisms. A change of 1°C changes the virulence of some races of rust infecting wheat.

Shortfall in foodgrain production would severely threaten food security of the poverty-ridden country. Under a severe (4oC temperature rise) climate change scenario the potential shortfall in rice production could exceed 30 % from the trend, while that for wheat and potato could be as high as 50 % and 70 %, respectively (Karim, 1996). Under a moderate climate change scenario the crop loss due to salinity intrusion could be about 0.2

Mt (Habibullah et al., 1998). The loss of production due to such effects may be relatively higher compared to that under floods. However, the loss incurred in other sectors could be much higher in case of floods than the direct climatic changes.

The effect of low-flow on agricultural vulnerability is considered to be much less intense compared to other effects. The ultimate impacts of loss of food grain production would increase import of food which will require spending hard currency.

It was noticed that temperature increase of 4oC would have severe impact on food-grain production, especially for wheat production. On the other hand, carbon-dioxide fertilization would facilitate food-grain production. A rise in temperature would cause significant decrease in production, some 28 % and 68 % for rice and wheat, respectively. Moreover, doubling of atmospheric concentration of CO2 in combination with a similar rise in temperature would result into an overall 20 % rise in rice production and 31 % decline in wheat production. It was found that boro rice would enjoy good harvest under severe climate change scenario with doubling of atmospheric concentration of CO2 (Karim et al., 1999).

5.6 Concluding Remarks

The climatic risks addressed by the farmers and the other secondary assessment have provided similar anomalies for the study region and area. The solution drawn by farmers also praise worthy and feasible.

The assessed risks and related issues regarding the risks have broad domain of adverse effect than they normally appears. For instance, as the farmers mentioned that the practice of animal husbandry (specifically cow) has been reduced in an alarming rate. Cow, in the livelihood of rural people, has more significance than normally one see. The cow helps in agriculture (for ploughing the land). They provide milk, which is also related with nutrition intake of the family. The cow dung is used as fertilizer (bio) in the agricultural land. In practical, they are more suitable for the land. The cow increases its numbers by a year that is also an income generation activity. They also provide meat sometimes. So, each and every component of livelihood has its own complex interactions with the other

components. Without considering these sophisticated and complex arenas of interactions, a strategy for sustainable livelihoods seems to be impossible.

A livelihood also has its own domain of influences. Searching the ways and means of a sustainable livelihood is always praise-worthy. Particularly, for Bangladesh, agriculture must be prioritizing on the ways for a search of sustainable livelihood. If agriculture is affected then the income generation of the rural people will face a severe devastation. In addition their complex interaction with the ecosystem/environment will also be affected. That will also affect the health, education, social stability etc. A farmer having difficulties with the agriculture, normally, are not have willing to send their children to the school. It is natural fact of the rural life. So, this total issue of climate change impact on agriculture can influence the broad development process of this country through affecting the livelihood of the rural people.

For the selected fields in the two villages, the idea of mini-deep machine for the irrigation problem seems to be reasonable. In addition, the idea of bringing change in cropping pattern (paddy to vegetables) for the specific two fields of the target beneficiaries can be appreciated for these fields. The restoring of animal husbandry also can provide very positive stimulation in their agriculture and livelihood so on.

Refferences

Ahmed, A. U., Siddiqi, N. A., and Choudhuri, R.A. (1999). Vulnerability of Forest Ecosystems of Bangladesh to Climate Change, *In Vulnerability and Adaptation to Climate Change for Bangladesh,*

S. Huq, Z. Karim, M. Asaduzzaman and F. Mahtab (Eds.), Kluwer Academic Publishers, Dordrecht, The Netherlands.

BBS. (2000a). *Statistical Year Book of Bangladesh*. Bangladesh Bureau of Statistics, Dhaka.

BBS. (2000b). *Yearbook of Agricultural Statistics of Bangladesh*. Bangladesh Bureau of Statistics, Dhaka.

Country Environmental Analysis*: Bangladesh*. (2004). Asian Development Bank (3rd Draft)

Döll, P .Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen and I.A. Shiklomanov. (2007). *Freshwater resources and their management.*

Falconer A. and Foresman J., (2002) A system for survival: GIS and sustainable development.

Fischlin, A., G.F. Midgley, J.T. Price, R. Leemans, B. Gopal, C. Turley, M.D.A. Rounsevell, O.P. Dube, J. Tarazona, A.A. Velichko. (2007). *Ecosystems, their properties, goods, and services.*

GOB. (2008). Bangladesh Climate Change Strategy and Plan. Ministry of Environment and Forests Government of the People's Republic of Bangladesh

Habibullah, M., Ahmed, A.U. and Karim, Z., 1998. Assessment of Foodgrain Production Loss Due to Climate Induced Soil Salinity: A Case Study, in Vulnerability and Adaptation to Climate Change for Bangladesh, S. Huq, Z. Karim, M. Asaduzzaman and F. Mahtab (Eds.), Kluwer Academic Publishers, Dordrecht, The Netherlands, 1998. pp 51-66.

Haque, M. Z. and M.S. Islam. (1990). Low temperature damage in rice crops of Bangladesh. Paper No. 14. International Rice Conference, 27-31 August, Seoul, Korea, Papers, IRRI, Los Banos, Philippines (SB 206, AZ22, 1990).

IPCC. (2007). *Impacts, Adaptation and Vulnerability. Contribution of Working Group II* to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.

Karim, Z., Hussain, S.G. and Ahmed, M., 1996. "Assessing impacts of climate variations on food grain production in Bangladesh." Water, Air, and Soil Pollution 92:53-62.

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao. (2007). *Global Climate Projections.* In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

NAPA. (2005). *National Adaptation Programme of Action*, Ministry of Environment and Forest Government of the People's Republic of Bangladesh, Final Report November.

Nasreen, Mahbuba. (2004). *Disaster Research: Exploring Sociological Approach to Disaster in Bangladesh*, published in the e-journal of Sociology, www.bangladeshsociology.org. Volume 2, number 2, October.

National Enclycopedia of Bangladesh. 2006, (soft version), Asiatic Society of Bangladesh

Novick, K.A., P.C. Stoy, G.G. Katul, D.S. Ellsworth, M.B.S. Siqueira, J. Juang and R. Oren. (2004). *Carbon dioxide and water vapor exchange in a warm temperate grassland.*Oecologia, 138, 259-274.

O'Brien, K.L., Leichenko, R.M., 2000. Double exposure: assessing the impacts of climate change within the context of economic globalisation. Global Environmental Change 10, 221–232.

Rahman, A., and Alam, M, 2003. Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCs). Working Paper 2: Bangladesh Country Case Study. IIED, London, UK.

Raj, H., 1987, Theories and Practices in Social Research, *New Delhi: Surjeet Publications.*

SMRC, 2003. The Vulnerability Assessment of the SAARC Coastal Region due to Sea Level Rise: Bangladesh Case, SMRC-No.3, SMRC Publication, Dhaka, Bangladesh

Tawhid. I, (2010). Climate Change in Bangladesh: A closure look on temperature and rainfall. University Press Limited, funded by Oxfam International, Dhaka.

Wetherald, R.T. and Manabe, S. (2002). *'The mechanisms of summer dryness induced by greenhouse warming'*, Journal of Climate, V. 8, #12, pp 3096-3108.

McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (eds.). (2001). *Climate Change 2001:* Impacts, Adaptation, and Vulnerability, Published for the Intergovernmental Panel on Climate Change, Cambridge, Cambridge University Press, 1032 pp.

www.ambdhaka.um.dk/NR/rdonlyres/.../AppendixA30Jan2009.doc

Annex-A

1. **Checklist for FGD**

A. What are the crops they cultivate and the cultivation processes in detail.

B. The difficulties they face in their agricultural process.

C. Condition of the drought and flood

D. How they face the stated difficulties?

E. What they think about the causes of these difficulties?

F. What are their suggestions to overcome these difficulties?

Annex-B

2. **Questionnaire format for the Climatic Risk Assessment**

A. Household Profile:

a) Household Number: ……. b) Community/Para: …….

c) Name of the peasant: ……

d) Amount of cultivable land: ……. e) Land Status: …….

e) Monthly income: ……. f) Expenditure: …….

B. Agricultural process in detail: (How many times they crop, irrigation source, what are the crops they cultivate**)**

C. The difficulties they face in agriculture Crop Basis and what are the causes they think:

a) During preparing the land:

b) During Planting:

c) During irrigation:

d) During harvesting:

e) Post-harvesting processing:

f) Upcoming difficulties:

The surveyors have to carefully note either this difficulties are normal/regular or not

D. How the face the difficulties and Probable Solutions according to them: (The solutions according to the peasant's view should be noted specific difficulty wise. The difficulties are noted before this section will find the ways following them)

E. Their interaction with the ecosystem: (this will include the source of fuel, water source for themselves and the livestock, their economic activities besides agriculture, their recreation and festival and so on…….)