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Climate Change and Farming Vulnerability in the Coast of Bangladesh

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Abstract
The present research is highly related with a public interview to capture the data directly from the field related to the random data sampling based information. The farmers within the study region were earnestly affected by various types of hazards like, river bank erosion, salinity effects, effects of tidal flood, overweening rainfall, monsoonal cyclone, water logging as well, which are directly colligated to climate change. Agriculture is the main source of economy of the country, which is jeopardized by almost all the hazards. In the study area most of the farmers (46.36%) were having below 0.2 hectors of land and only 4.54% farmers had above 0.3 hectors. The major field crop of the study area was rice (Boro/Aman). Generically farmers were not acquainted to cultivate Aus in this area. During Aus growing season the salinity intensity became higher and they had less opportunity to use the land for Aus cultivation. Majority of the farmers (72.73%) used rain water for agricultural purpose instead of river water. As a consequence, around 37% farmers were migrating from affected areas to non affected areas and among the displaced farmer 21% were permanent and 16% were seasonal. In rainy season, more than 25% households were confronting water logging, tidal flood problems due to low plinth height of the houses. The farmers had been suffering from various communicable and non communicable diseases like arsenicosis, chronic obstructive pulmonary diseases, malaria, dengue, cholera, encephalitis, malnutrition and prevalence rate of the climate change associated diseases was 5.09. The present study revealed that climate change induced hazards severely leading to crisis of freshwater, decreasing in rice and other essential crop production. Finally, the study found that environmental migration, food deficiency and health problems that increasing vulnerability and reducing the sustainable capacity of the farmers to climate change adaptation. The livelihood of majority of the farmers was very dull and farmers community in the study area, a poorest among the poor.
Keywords: Climate Change, Agriculture, Migration, Food Deficiency, Health, Sustainable Capacity.

1. Introduction

Climate is the characteristic condition of the atmosphere near the earth's surface at a certain place on the earth. It is considered as one of the most serious threats to the World's Environment with its potential negative aspects on human health, food security, agriculture, fisheries, biodiversity, water, economic activities and other natural resources. Climate induced changes such as extreme cyclone, devastating tidal surges, severe floods, treacherous river erosion, excessive rainfall, overwhelming salinity intrusion etc are occurring more frequently and in an unpredictable manner around the world including Bangladesh. Low economic strength, inadequate infrastructure, low level of social development, lack of institutional capacity, and a higher dependency on the natural resource base make the country more vulnerable to climate stimuli including both variability as well as extreme events. Whoever and wherever we are, the climate dictates the way we live. The cities we build, the clothes we wear, the kind of homes we live in, the food we eat, even how we behave, all are linked to the weather patterns the climate creates locally. However, those patterns are changing rapidly and we are all to blame. Scientists and researchers are now claiming that this type of event is occurred due to the global climate change and thus, climate change is making things worse. The large portion of agro-based population represents the major component of the hard core poverty of Bangladesh. The agro-based community of the rural Bangladesh is very much susceptible to environment related vulnerability, as poverty is directly related to vulnerability (Chan and Parker, 1996; Fankhauser and Tol, 1997; Rayner and Malone, 1998). It is apparent that, all societies are fundamentally adaptive and there are many situations in the past where societies have adapted to changes in climate and environmental stressors and to similar risks.

Increasing climate uncertainties are an additional threat in disaster prone environmental and one of the major risk factor for risk averseness. Intensity and variability of climatic hazards are expected to steadily increase in the near future due impacts of climate change (Ahmed *et al.,* 1998). The impacts of climate change

on agricultural food production are global concerns, and they are very important for Bangladesh. Agriculture is the single and largest sector of Bangladesh economy, accounting for about 35% the GDP and about 63% of the labour force. Agriculture in Bangladesh is already under pressure both from huge and increasing demands for food, and from problems of agricultural land and water resources depletion. The prospect of global climate change makes the issue particularly urgent. The main goal of this research is to assess the increasing consciousness by which the people of this locality can survive against different types of disaster successfully. Consequently, Assasuni upazila of Satkhira district has been selected as the climate-related disaster prone area in which Protapnagar union is the main of them.

2. Methodology:

2.1 An Overview of the Study Area

Protapnagar is one of the most vulnerable unions of Assasuni upazila (Map 2.1). It is situated on the western part of Assassuni upazila and this union is bounded by river and the Kholpetua River on the west, Anulia union lay on the north, to the east is the Kobadak River and to the south is Paddho Pukur union. The extent of the union spreads within the latitude of N- $21^0$36′ and N- $22^0$54′ and the longitude of E- $88^0$54′ and E- $89^0$20′. The total area of this union is about 16.70 sq. km and the population density is about 1500 per sq. km. Protapnagar union comprises of 13 Mouzas and 18 villages and these Mouzas belong to nine new wards of three old wards.

2.2 Data Collection Method

2.2.1 Primary Data Collection

The data has been collected through personal interview. A set of questionnaire has been developed which covers the information necessary for the study. The method is also called ‘structured interview’. After developing the questionnaire, interview has been conducted in the study area. The household survey has been completed in four intervals.

2.2.2 Field Investigation

Field investigations were conducted through the sequential completion of the following:

2.2.2.1 Respondent Group Selection:

Participants have been selected for the study from different age of farmers livelihood representatives of present nine wards of Protapnagar union and as secondary stakeholder there have been participated the members of the disaster management committee and Govt. officials as vulnerability assessment activities.

2.2.2.2 Population and Sample of the Study:

With the help of Upazila Agricultural Officer (UAO), his field staff and local leader, an updated list of farmers was collected. In old ward of Protapnagar union, 110 farmers were selected. After the union selection with population determination, respondents were then selected at the rate of 10 percent following simple random method. But due to absence of some selected farmers during the data collecting the researcher made a reserve list of the farmers. Thus, the sample size of the study was 110. The distribution of the selected farmers along with reserve list in the selected union is shown in Table 2.2.2.2.

2.2.2.3 Questionnaire Design and Pre-testing and Finalization:

An interview schedule was prepared for collection of data from the respondents keeping the objectives of the study in mind. The questions and statements contained in the schedule were simple, direct and easily understandable by the farmers. Simple and direct questions, different scales, closed and open form statements were included in the interview schedule to obtain necessary information. Appropriate scales were also developed to operation the selected characteristics of the farmers.

The draft interview schedule was prepared in English and was pre-tested with 15 farmers. This pre-testing facilitated the researcher to examine the suitability of different questions and statements in general. On the basis of pretest result, corrections, modifications and adjustment were done in the interview schedule.

2.2.3 Farm Size

The farm size of a respondent was measured in hectares using the following formula:

$Fs = A1 + A2 + A3 + A4 + ½(A5 + A6) – A7 + A8$

Where,

Fs = Farm size
A1 = Homestead area
A2 = Vegetable land besides homestead
A3 = Own land under own cultivation
A4 = Fallow land
A5 = Own land given to other on borga
A6 = Land taken as borga from others
A7 = Own land given to others as lease
A8 = Land taken as lease from others

The data were first recorded in term of local unit i.e. ‘bigha’ and then converted to hectare.

2.2.4 Environmental Hazards in Coastal Areas

A-four point rating scale ranging from "frequently" to " not at all" was developed to measured the extent of environmental hazards in draught prone areas of the farmers. However, use of four point scales identical to one was found in many studies employed to ascertain the "extent of environmental hazards in draught prone areas" of the respondents.

2.2.4.1 Scoring Techniques

The range of environmental hazards score of the respondents could vary from 0 to 21, where, 0 indicated no environmental hazards and 21 indicated full environmental hazards. However, besides having calculated the "extent of environmental hazards" score for each of 110 respondents, an effort was also made to compare the relative hazards (Table 2.2.4.1). An Environmental Hazards Index (EHI) was developed to fulfill this objective using the following formula:

$$EHI= N1\times3+N2\times2+N3\times1+N4\times0$$

Where,

EHI= Environmental Hazards Index

N1=Number of farmers affected by the environmental hazards frequently

N2= Number of farmers affected by the environmental hazards occasionally

N3= Number of farmers affected by the environmental hazards rarely

N4= Number of farmers not at all affected by the environmental hazards

The EHI for each of the environmental hazards ranged from 0 to 330.

3. Results and Discussions

3.1 Summary of the Findings

The research was undertaken with the objectives: (i) to identify farmers perception about climate and climatic hazards, (ii) to describe selected personal, economic and social characteristics of the farmers livelihood, (iii) to explore climate change impact on socio-economic characteristics of the farmer's livelihood. The selected characteristics were age, family size, annual income, educational status, earners dependents, farm size, cropping pattern/system, food sufficiency, natural resource accessibility, environmental displacement, housing characteristic, water supply and sanitation, health and diseases, knowledge about climate, environmental hazard faced by farmer, and impact of climatic change on livelihood. Protapnagar union of Assasuni upazila under Satkhira district was the locale of the study. The sample of 110 farmers was drawn from a population of 734. Data were collected from November, 2008 to January, 2009 using a pre-tested interview schedule. The major findings of the study are summarized below:

3.2 Socio-economic Characteristics of the Farmers

3.2.1 Age

Age of the respondents ranged from 18 to 75 years with an average of 39.40 years. The analysis of the age structure of the study area showed that 31-40 years age groups are manly engaged in income activities (34.55%) in average of total population. The groups are 21-30 years of age (21.82%), above 60 years (4.54%) and below 20 years (7.27%). Below 20 years age group may be regarded as occasional working age group. The decrease of percentage distribution for above 60 years age group due to less working capacity and but also show interest in the profession.

3.2.2 Family Size

In case of sample, the medium size family (1-3 members) accounts for about 51.82%, respectively. As the highest in respect of total sample unions followed by small, large and larger families, the percentages in respect of sample were 8.18, 30, and 10, respectively. From the distribution it is evident that 51.82% for medium size family (highest) and 10% for larger size family (lowest) in the study area. The small size families are positively associated with low income, nuclear family and lower capital investment. Medium and large families are due to the more birth rate. It is also associated with the high sex ratios, higher income, extended family and capital investment in different ways and multi income sources.

3.2.3 Annual Income

The highest portion (60.91%) of the respondents have low annual income (upto BDT 50 thousand) compared to 13.64% had high income (above BDT 100 thousand) and 25.45 % under medium annual income (BDT 50-100 thousand) level. The average income of the peoples of the study area (<200 US Dollar) is lower than the average per capita income of the country i.e. 470 US Dollar (BBS, 2004).

3.2.4 Educational Status

Majorities of the members were class I-V group (54.57%). The second largest education group (41.82%) occurred in illiterate group and only sign but literate. Their tendency is to earn more money. For this reason they are deprived from school in the early age.

3.2.5 Earners Dependents

Earners dependents in the study sample 110 (20.23%) out of 734 population were earning members. In the view of the samples in the earning consideration 20.23% and 79.77% were earner and dependent members, respectively and the earner and dependent ratio was 1:3.94 in average out of 180 populations.

3.2.6 Farm Size

The farm size of the respondents ranged from 0.028 to more than 3.23 hectares. The highest portion (46.36%) of the farmers had marginal farm as compared to 34.55% small farm, 14.55% medium farm and 4.54% had large farm. Large farm size may be less vulnerable rather than small farm

3.2.7 Cropping Pattern/System

In the study area single cropped production farmers were 34.55% and the double cropped production farmers were 66% and triple cropped were 5.45%. The major field crop of the study area is rice (aman/boro). Generally farmers did not cultivated Aus in this area. During Aus growing season the salinity intensity becomes higher and they have less opportunity to use the land for Aus cultivation. Other crops like sesame, groundnut, potato, mustard, vegetables (especially winter vegetables) are also grown in limited field.

3.2.8 Food Sufficiency

It is proved that about 11.83% of the people in the study area have food sufficiency for the whole year. On the other hand 30% of farmer has food sufficiency for the less than one month. The findings indicate that that majority (59.18%) of the farmers had food sufficiency for the less than six months. Food insecurity of farmers had a significant and positive relationship with their livelihood vulnerability.

3.2.9 Natural Resource Accessibility

In the study area 65.91% poor and marginal farmer has access to natural resources for additional income and they are facing various problems to access natural resources. The majority (62.5%) of the respondent are facing problem during accessing natural resources due to ill planned shrimp culture in canals followed by 26.39% for environmental hazards and 11.11% for lack of adequate money. So, more accessibility of poor and marginal farmers to natural resource has reduced their livelihood vulnerability.

3.2.10 Environmental Displacement

In the study area 57.27% of the farmers have displaced to another area, for either permanent or seasonally. About 62% of the respondents have cited the absence of job in the village as the principal reason for displacement to the areas, where 54% for seasonally and 8% for permanent. On the other hand about 37% of the respondents have displaced for lack of land for habitat due to environmental hazards, where about 16% for seasonally and 21% for permanent.

3.2.11 Housing Characteristic

Most of the dwellers in my study area have kacha house (90%) and small percentage of the dwellers use semi-pacca and pacca house (5%). About 25 % households of my study area use golpata as for roofing material. 30% households use thatch (rice straw) as roofing purpose. Majority plinth heights of the house were medium (75%) categories and were prime consideration for housing to protect against water logging and flood. On the other hand low plinth height of the house (25%) was at risk in various hazards. In the study area 40% of farmers had fencing around their house as an environmental protector.

3.2.12 Water Supply and Sanitation

Majority (90.91%) of the villagers used tub-well water for drinking. On the other hand the respondents who (9.09%) used pond water for drinking water were at risk by water born diseases. Majority of the villagers reserved their drinking water in earthen pot. Other findings indicate that majority farmers (72.73%) used rain water for agriculture purpose. The respondents were not used river water for agriculture due to saline intensity. In the study are 81.82% of the population used sanitary latrine and 18.18% having no sanitary latrine (open hollow, close pit, katcha). Findings indicate that majority of respondents (81.82%) used sanitary latrine. On the other hand some of the respondents (18.18%) do not have sanitary latrine. After defecation, majority wash their hand with soil. 37.29% (41) people in my study area facing various climate change related diseases. People are suffering from malaria (11.83%), dengue (4.55%), cholera (6.36%), encephalitis (3%) and malnutrition (3.64%). The prevalence rate of the climatic diseases is 5.09.

3.2.13 Knowledge about Climate

The majority (65.45%) of the respondent had low knowledge while 28.18 percent had no knowledge about climate and only 6.37% have medium knowledge and zero percentage had high about climate (Figure 3.2.13).

3.2.14 Environmental Hazard Faced by Farmer

In the study area, 88.78% of the farmers faced river bank erosion is to a considerable extent rather than others environmental hazards. Salinity is another hazards which also faced by the 65% farmers (Table 3.2.14). Climatic Hazards are caused by one or a combination of heavy rainfall, hail, thunder & lightning, strong winds – tornadoes, snow & ice, droughts, salinity and wildfires (Figure 3.2.14). So these types of hazards are called climatic hazards.

3.2.15 Climate Change Hazards and Vulnerability

Environmental hazards like salinity have serious negative impacts on 45.54% for agriculture, 10% for house,

28.19% for health, 10% for forest and 7.27% for water and sanitation. River bank erosion also have serious impacts on 32.72% for agriculture, 53.64% for house, 9.09% for health, 1.19% for forest and 2.27% for water and sanitation (Map 3.2.15).

4. Conclusion

Findings of the present study and the logical interpretation of other relevant facts, promoted the researchers to draw the following conclusion:

Livelihoods and economic activities in coastal region of Bangladesh are closely tied to the natural resource base, and are hence, highly sensitive to changes in the climate. Agriculture will be threatened by a combination sea level rise, increased flooding, salinity effects and strong winds associated with intense tropical cyclones.

Freshwater availability for domestic and agricultural uses is further impacted by climate change. The rapid expansion of shrimp farm in the saline zone has caused growing concern as to its adverse effect on the coastal environment and damage to the traditional agricultural systems. Due to the declination of agriculture production, particularly in the saline zone of Protapnagar Union, rural people have to change their means of livelihood.

Human population growth, declination in agricultural production and a prevailing disease epidemic have typically been seen as the primary causative factors of insecurity within farmers' livelihood.

The loss of agricultural productivity due to environmental degradation and the non-adoption of technological inputs have resulted in a decrease in the food supply—while demand continues to grow.

The present study reveals that climate change induced hazards severely leading to crisis of freshwater, decreasing in rice and other essential crop production. Finally, the study found that environmental migration, food deficiency and health problems that increasing vulnerability and reducing the sustainable capacity of the farmers to adapt to the climate change.

5. Recommendations

Based on findings and conclusion of the study, vulnerability assessment modeling (Diagram 5) and the following recommendations are presented below:

A. Massive and relevant training programme should be conducted for farmers to upgrade their awareness and understandings of the knowledge about climate change and its effect on agriculture and how to cope with new climatic condition for agricultural situation. The various GOs and NGOs should be involved in the conduction of training programme.

B. Steps should be taken that farmers can easily get necessary production inputs (i.e. saline tolerance crops or varieties, irrigation facilities etc.) and in less cost.

C. Raise homesteads with land fillings so that houses remain above the water level during high tides.

D. Setting deep tube wells, re-excavation of khal, streams and strengthening of polder and tree plantation both side of the polder.

E. House - Afforestation around homesteads may be increased. Clustered villages are to be raised. Houses are to be built with strong tins.

F. Arrangement for appropriate treatment is to be done and number of physicians is increased and the price of medicines be lowered.

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Table 2.2.2.2: Distribution of the sampled farmers in Protapnagar union

Old Ward	Total number of farmers	Number of sample drawn	Number of reserve farmers
Ward no. 1	390	39	10
Ward no. 2	360	36	10
Ward no. 3	350	35	10

In the above table, different wards are mentioned with total number of farmers, sample drawn and reserve farmers' quantity. Three Wards were taken from the Protapnagar union as the study areas.

Table 2.2.4.1: The method of assigning scores to the four alternatives in each statement was as follows:

Extent of environmental hazards	Scored assigned
Frequently	3
Occasionally	2
Rarely	1
Not at all	0

The method of assigning scores is represented in the above table. Extend of environmental hazards with their nature and scoring were used and reflected into the research extensively.

Table 3.2.14: Environmental hazards faced by the farmers

Problems	Farmers (N = 110)				Environmental hazards index (EHI)	Percent of hazards scores faced by farmers	Rank order
	High	Medium	Low	Not at all			
River bank erosion	82	19	9	0	293	88.78	1
Salinity	65	18	8	19	231	70.00	2
Cyclone	45	17	9	39	178	53.93	3
Tidal flood	30	18	9	53	135	40.90	4
Rainfall Flood	26	15	8	61	116	35.15	5
Water logging	23	18	9	60	114	34.54	6
Hail storm	20	18	9	63	105	31.81	7

Data presented in the table indicate that, 88.78% of the farmers of the study area faced river bank erosion to a

considerable extent rather than others environmental hazards. Findings indicate that the highest environmental hazard index (293) was found in case of river bank erosion. The next index was found in case of salinity followed by cyclone, Tidal flood, rainfall flood, water logging and hail storm.

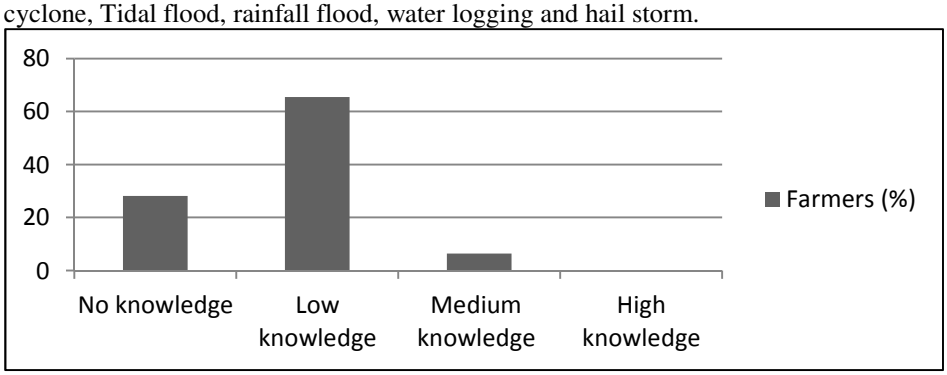


Figure 3.2.13: The distribution of the respondents according to their climate knowledge.

Findings indicate that the major portions of farmers (65.45%) are low climatic knowledge categories. This means that the low climatic knowledge of the farmers, the more was the rate of their livelihood vulnerable to climate change.

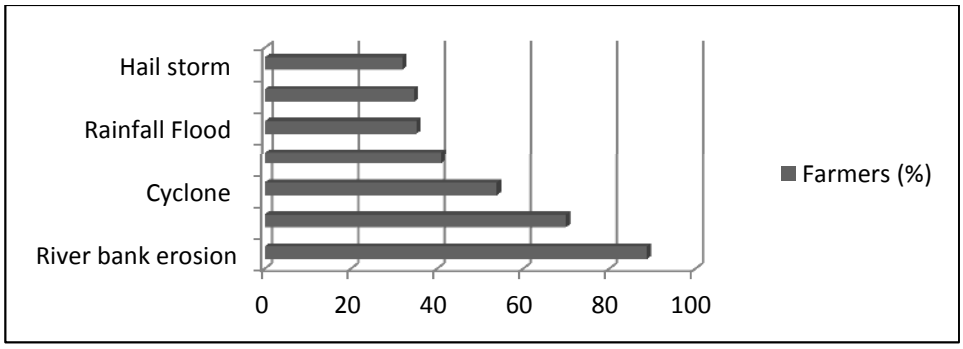


Figure 3.2.14: Environmental hazards faced by the farmers.

A graphical representation environmental hazard experienced by the farmers is presented in the above figure.

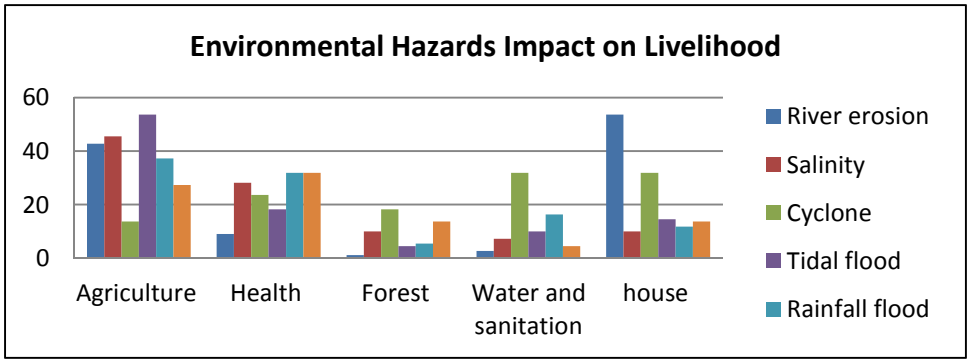


Figure 3.2.15: Climatic hazards impact on livelihood

The possible impacts of Climate change related hazards would mainly be increased coastal erosion leading to more coastal flooding, relocation of human settlements, increased salinity leading to crisis of freshwater, decrease in rice and other essential crop production, loss of biodiversity of the mangrove ecosystem, and destruction of aquaculture and fish habitat. Environmental hazards like salinity have serious negative impacts on 45.54% for agriculture, 10% for house, 28.19% for health, 10% for forest and 7.27% for water and sanitation. River bank erosion also have serious impacts on 32.72% for agriculture, 53.64% for house, 9.09% for health, 1.19% for forest and 2.27% for water and sanitation.

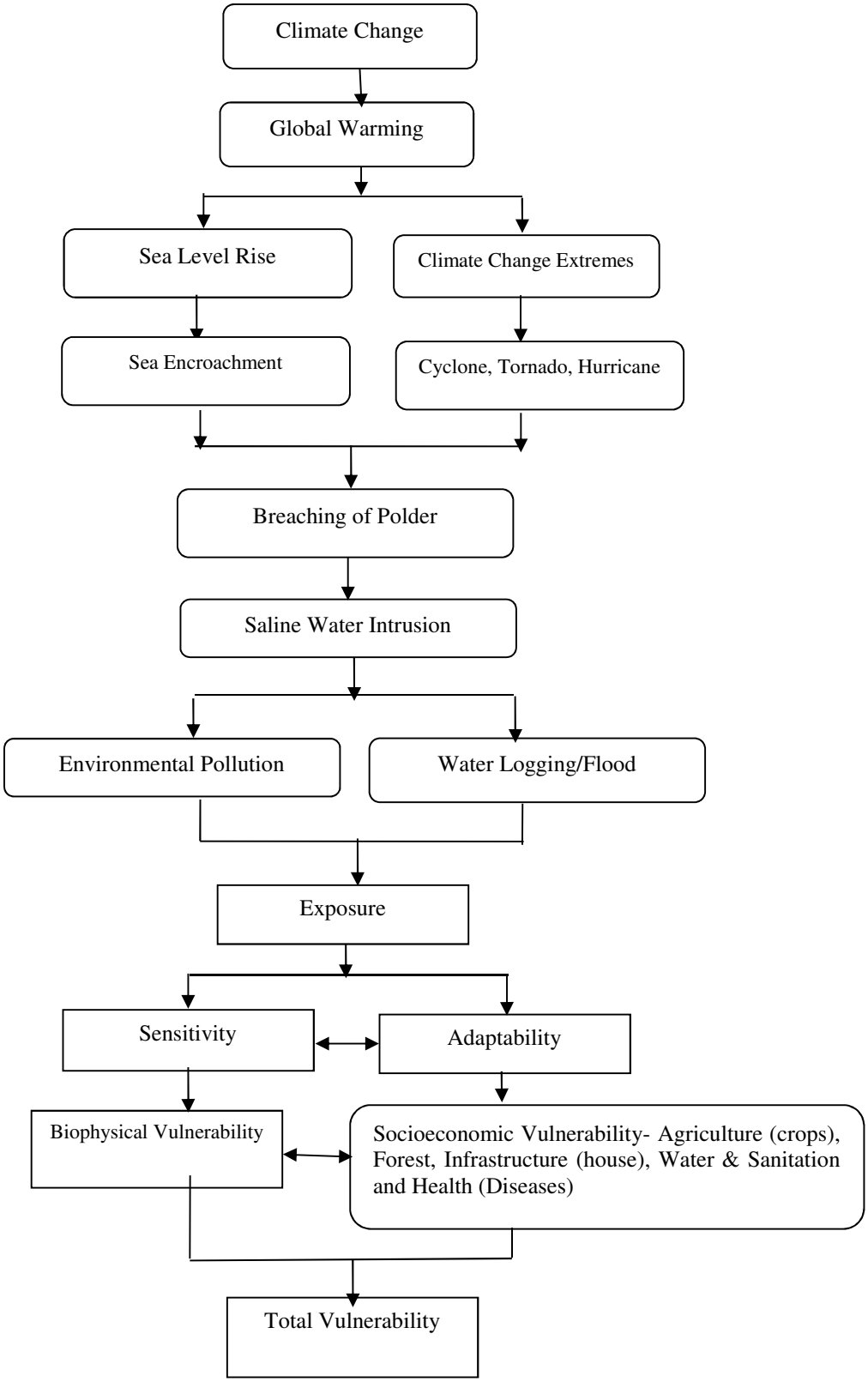
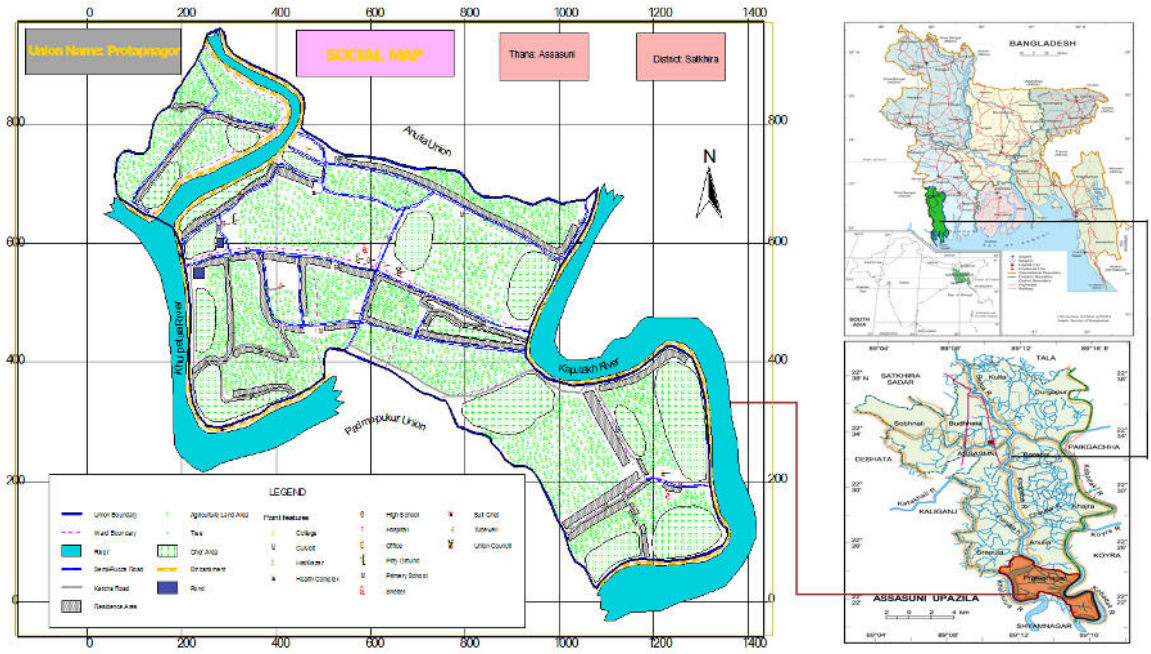
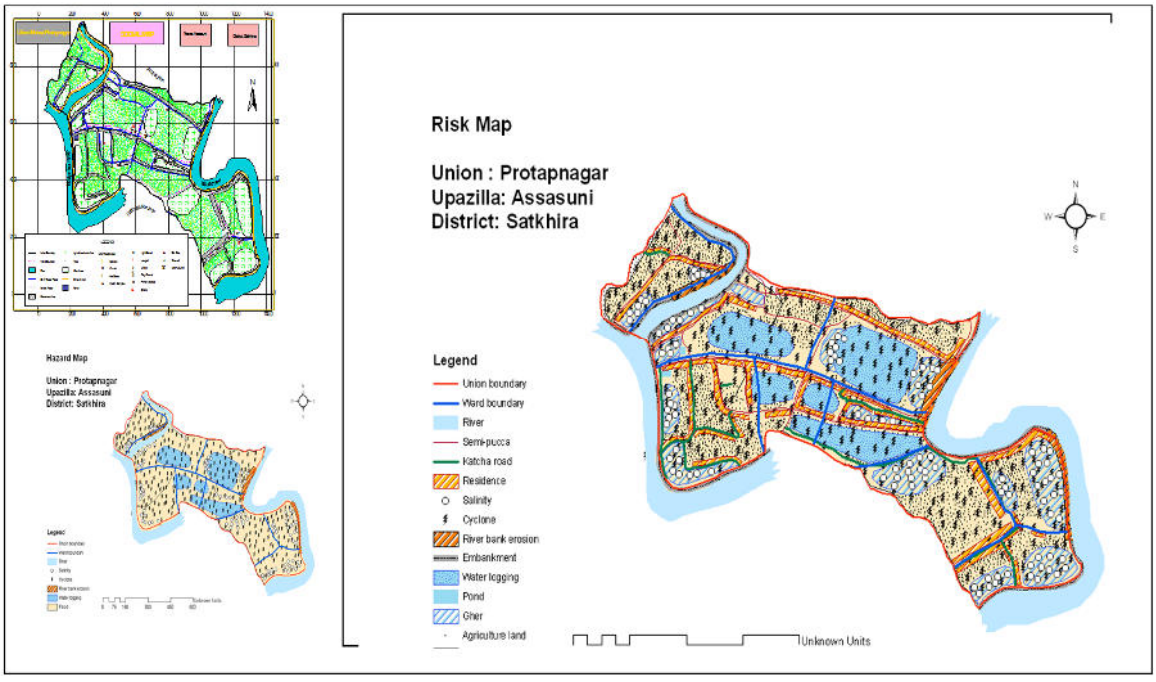


Diagram 5: Climate change impact model on livelihood



Map 2.1: Location of the study area



Map 3.2.15: Risk map of Protapnagar

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