

Impact of Climate Change on Rural Livelihood: A Case Study

by

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MASTER OF SCIENCE IN WATER RESOURCES DEVELOPMENT



Institute of Water and Flood Management
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

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A thesis submitted to the Institute of Water and Flood Management (IWFM) of
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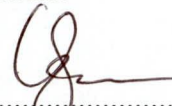
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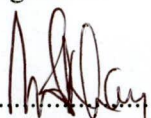
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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.



.....

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Dedicated to My

Beloved Parents, Brothers and Sisters

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ABSTRACT

This study has been conducted to figure out the changes in salient climatic parameters and their impacts on rural livelihood as well as to develop a sustainable livelihood framework. Two villages, namely Chander chak and Mauli at Kalia Upazilla under the coastal district Narail were chosen as the study area. Three livelihood groups; farmer, fisherman, wage laborer and also the woman as vulnerable group were selected for the study. The local climate change condition has been illustrated with observed data and the probable future scenario has been extracted from Regional Climate Model (RCM) prediction. This prediction was conveyed to the local people to express their observation according to their perception. People's information has been incorporated to the development of the livelihood framework which will provide them a sustainable livelihood against the climate change context.

In the study area, 73% of the rural people are farmers, 22% are farm laborers and 5% are fishermen whereas the woman are 50% of the total rural population. From the RCM prediction, it has been found that the temperature of the study area will rise 3-4°C and the monsoon rainfall will decrease by 12-15% of the annual rainfall whereas the total annual rainfall will increase by 17%. Following these circumstances, the probable impact on the rural livelihood was worked out. According to the findings, the farmers' overall access to natural capital is 75% which will come down to 54% in climate change context. The 76% access to the physical capital will be reduced to 63% due to damages caused by frequent disasters. Due to less productive land and insecure public property, the financial capital will be affected by 30% of the present condition. The farm laborers will be similarly affected as the farmers as they mostly are engaged in farm activities. Annual work days will be 40% less and their financial capital will reduce from 58% to 44%. The fishermen's fishing activity will reduce to 25% in a year and the fish diversity in the waterbody will be affected as 40% of fish will be lost from their habitats in future. As the fishermen are less in number in the village, their access to social capital will reduce from 65% to 45%. The woman have low access to natural capital which will go down by 30% due to climate change. Their income generating activities will be reduced and financial capital will come down from 50% to 40%. For all the livelihood groups, the increasing hot and dry weather will increase illness by 15% causing more diarrhea, cholera and vector borne diseases. Adaptive measures like effective use of agricultural lands and waterbodies, infrastructure rehabilitation, better health care, natural resource conservation, afforestation, etc. are necessary to protect the livelihood capitals and provide the people a sustainable livelihood in the coming days.

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LIST OF ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
CDMP	Comprehensive Disaster Management Program
CEGIS	Centre for Environmental and Geographic Information Services
DFID	Department for International Development
FGD	Focused Group Discussion
ICZMP	Integrated Coastal Zone Management Policy
IPCC	International Panel for Climate CHnage
IRD	Integrated Rural Development
IWM	Institute of Water Modelling
LGED	Local Government Engineering Department
PRA	Participatory Rural Appraisal
PRECIS	Providing Regional Climates for Impacts Studies
RCM	Regional Climate Model
RHD	Roads and Highways Department
SLA	Sustainable Livelihood Approach
SSWRD	Small Scaled Water Resources Development
VGf	Vulnerable Group Fund
WMG	Water Management Group

Chapter 1 Introduction

1.1 Background of the Study

From the very beginning of human civilization, we are polluting our environment around us by our invention and development activities. Since, man learned to set fire and started using it for different purposes; the environment started to become polluted. Now standing on a remarkable position of modern world, we see how we are practicing these activities individually, nationally and internationally. These anthropogenic activities around the world have caused important and influential phenomena in changing the climate from previous condition. The climate, which governs things like hydrology, ecology, biodiversity and the overall living condition of all species in this world, has been affected gradually since nineteenth century. Having a high density of population and located at estuary of some mighty rivers, Bangladesh is now being considered as one of the most vulnerable for the impacts of climate change as predicted by Inter-Governmental Panel for Climate Change, IPCC. Within 2100, the sea level in the coastal region of Bangladesh will rise up to 80 cm due to climate change (IPCC, 2007). If any effective, sustainable and integrated measures are not adopted soon, it may face unavoidable situations which will damage Bangladesh geographically, economically and socially. Among these, rural livelihood of the people of this region is in one of the most vulnerable situation which needs immediate attention.

Livelihood comprises the capabilities, assets including both material and social resources, and activities required for a means of living (DFID, 1999a). Livelihood of people varies from place to place and time to time. In the rural areas it depends on the environment, geographical condition, development activities as well as social, cultural and political contexts (Haque 2001). That's why rural livelihood of countries like Bangladesh is remarkably flexible and vulnerable to any changed in the surrounding environment. The climate change impact certainly affect the rural livelihood pattern in the coastal zone of Bangladesh. The coastal zone of Bangladesh has been formed with nineteen districts along its 700 km coastal belt. Among these, Narail district lies in the outer periphery of coastal zone and it has declared as the interior coastal area. like other coastal districts the people of Narail has to depend on the nature and environment for searching their livelihood in the cities and as well as in the villages. The rural livelihood here is controlled by frequent scenario of the coastal area such as tide, saline water, cyclones and river system. As these climatic parameters are seen to be changed over the years, the livelihood status of this locality is also shifting its quality and quantity as well.



1.2 Objectives

The objectives of the study are as follows:

- Determination of change of climatic parameters of the study area.
- Assessment of impacts on rural livelihood due to climate change.
- Establishment of a sustainable rural livelihood framework for the study area.

1.3 Rationale of the Study

As Bangladesh is one the developing countries of Asia, most of its people have to search for their livelihoods by their own means. The geographical position has made this job for its people more complicated as the tropical weather and deltaic land formation play an important role in the activities and lifestyle of people. The high growth rate in this region and ever changing landscape obstructed the people to concentrate in a sustainable livelihood for a long period. They are to face the devastation of the natural calamities frequently and the change in our climate is making this situation more critical. In addition to theses, rural people of this region are victims of human intervention adopted in different times which are not implemented following any integrated approach related to the people and the environment. The area focused in this study is situated in the brackish water zone of the South-West Region (SWR) of Bangladesh. The local people's livelihood is mainly formed with agriculture related activities with some other verities which are affected by the climate change realities. The sea level rise in the Bay of Bengal, frequent devastating cyclones, water logging due to increased upland flow due to excess glacier melting are disturbing the rural livelihood framework. The extent of impact of climate change on the rural livelihood is different in place to place as the livelihoods are defined by the variable landscape and environment. This study will search for this degree of flexibility and a sustainable livelihood strategy for the coming days.

1.4 Limitations

This study comprises mathematical modelling outputs as well as socio-economical features related to rural livelihood. Regional climate model used in this study covers 50km in each grid cell. So only one grid cell can be extracted to represent the study area. The knowledge sharing with the local people is always a challenging job for this sort of study. Sometimes, they are influenced by the power group of the society and gives wrong information if they are not approached properly. The women group usually is reluctant to share their knowledge free and frankly with the outsiders because of traditional practice. So, the field data collection may have some set back to extract the correct information.

1.5 Outline of the Thesis

The study was conducted with the help of a Regional Climate Model prediction focused on a coastal region of Bangladesh. As rural population of Bangladesh are highly dependable on nature for their livelihood and it is anticipated to be one of the affected countries due to climate change, the impact of climate change on their livelihood will be significant. In this study, these impacts have been revealed being informed by the rural people of the study area. The rural people also contributed in this study by their experience and knowledge to adopt the climate change condition so that minimum affect and disturbance on their daily life is ensured. With their information, a sustainable livelihood framework has been built to ensure their wellbeing and long lasting of the natural resources.

Chapter 2 Literature Review

2.1 Climate Change

Climate change is now being considered as the greatest challenge for the world. As the environment and the activities of all living creatures are governed by climates in place to place, our surrounding environment and living styles are affected by this much discussed climate change scenario. The IPCC has been working on this issue since its birth accumulating scientist and researchers from all over the world. They are analyzing this situation based on different green house gas emission scenario named as A1, B2 etc. and predicting the circumstances for 2050, 2080 and so on. IPCC's projection considering the present condition is; without further action to reduce greenhouse gas emissions, the global average surface temperature is likely to rise by a further 1.8-4.0°C this century, and by up to 6.4°C in the worst case scenario. Even the lower end of this range would take the temperature increase since pre-industrial times above 2°C - the threshold beyond which irreversible and possibly catastrophic changes become far more likely (4th Assessment Report, 2007). Human activities that contribute to climate change include in particular the burning of fossil fuels, agriculture and land-use changes like deforestation. These cause emissions of carbon dioxide (CO₂), the main gas responsible for climate change, as well as of other 'greenhouse' gases. To bring climate change to a halt, global greenhouse gas emissions must be reduced significantly.

In South Asia, the 4th IPCC Report predicts that monsoon rainfall will increase, resulting in higher flows during the monsoon season in the rivers, which flow into Bangladesh from India, Nepal, Bhutan and China. These flows are likely to further increase in the medium term due to the melting of the Himalayan glaciers. The IPCC also forecasts that global warming will result in sea level rises of between 0.18 and 0.79 meters, which could increase coastal flooding and saline intrusion into aquifers and rivers across a wide belt in the south of the country, although most of the area is protected by polders. Rainfall is predicted to become both higher and more erratic, and the frequency and intensity of droughts are likely to increase, especially in the drier northern and western parts of the country.

Deursen and Kwadjik (1994) developed a GIS based model to determine the impact of climate change on the water balance in the Ganges-Brahmaputra-Meghna basin. The model algorithm were implemented in GIS using generic functions and a set of modules for hydrologic and geomorphologic modeling. The model was set using every variables that are involved in the

water cycle and then validated with observed data for both dry and wet season. Then the mean monthly inputs related to water cycle such as precipitation, temperature, evaporation etc. were provided in the model for present and different scenarios due to climate change in future.

Nasrin (2009) conduct an analysis on the trends of climatic variables in Bangladesh due to climate change and its impact on the irrigation water demand. In this study a detailed statistical analysis has been carried out with the available historical data comprising the temperature, wind speed, sunshine hour, humidity, rainfall and evaporation. The climate is changing gradually through the changes of those climatic parameters and the combined effect is increasing the water demand for agricultural sector. The very essential water is getting scarce and farmers cant irrigate the fields timely which hampers the production significantly. As agriculture is the back bone of our economy, the climate change is affecting our economy through the changes in the agriculture sector.

IWM-CEGIS (2007) analyzed the sea-level rise condition due to climate change by simulating hydrodynamic and storm surge models as well as conducting focus group discussion in the coastal region of Bangladesh. The impacts of sea level rise on the coastal livelihoods are determined by establishing relationship between hazard due to inundation, flooding, salinity and cyclones. The spatial and temporal distribution of inundation, salinity intrusion and storm surge flooding due to sea level rise in the coastal region are determined by mathematical modeling. All the impacts are determined from affected land or population in base year of 2005 and scenario years of 2020, 2050 and 2080 which has predicted by IPCC for climate change affects.

Islam (2002) has analyzed the observed temperature data of 34 stations of Bangladesh which shows the overall increase of temperature in monsoon and winter. Especially in winter, the temperature has increased in last sixty years more than the summer season. This temperature increase has increased the crop water requirement and also has affected the yield of rabi crops like wheat, potatot and other temperate crops.

World Bank (2009) calculated the global cost of US\$75-100 billion per year for climate change adaptation by comparing the future world with climate change and without climate change. They consider the both 'wet' and 'dry' conditions adaptation where the adaptation cost for 'wet' condition is higher. The rich countries can bare the adaptation costs but the poor countries need to be funded. It is high in the East Asia and Pacific region, little less in the Latin

America, Caribbean and in the Sub-Saharan Africa. The important thing is, economic growth is a very effective tool for reducing the climate change adaptation costs in the poor countries.

In the first ten years of twenty first century, it has faced three major flood events and four devastating cyclones. The damage extents in different sectors and fields due to the floods and cyclones from 2000 – 2008 has been given below under Table-2.1 to Table-2.7 (ref. CDMP)

Table-2.1 Flood-2004 (Damages Information Summary)

Items	Counts
No. of Affected District	39
No. of Affected Upazilla	265
No. of Affected Union	2492
Affected Area in Sq. Km	34583
No. Affected Family	7468128
No. Affected Population	36337944
Crops Damaged in Acre (fully)	1605958
Crops Damaged in Acre (partialy)	1038176
Human Causality	747
No. of Bridge Culvert Damages	5478
No. Sheltered Operated	103
Sheltered	12581
Loss of Cattle Head	1451
Loss of Poultry	254488

Table-2.2 Flood-2007 (Damage Information Summary)

Items	Counts
Affected District	39
Affected Upazila	254
Affected Union,	1,965
Affected Pourashava	67
Families affected at present	22,64,933
Affected People	1,05,72,145
Households (Full)	62,956
Households (Partial)	8,81,922
Crops (Full)	7,55,047 Acres
Crops (Partial)	7,62,653 Acres
Roads (Full)	2,869 km.
Roads (Partial)	22,970 km.
Educational Institutes (full)	510
Educational Institutes (partial)	7040
Embankment (Full)	87 km.
Embankment (Partial)	731 km.
Bridge/Culvert (Full):	72
Bridge/Culvert (Partial)	1692

Table -2.3 Flood-2008 (Damage Information Summary)

Srl	Items	Counts
01.	No. of Affected District	22
02.	No. of Affected Upazila	86
03.	Total Affected Area	3,394.13
04.	No. of Affected Pourashava	06
05.	No. of Affected Union	481
06.	No. of Affected Family	225009
07.	No. of Affected People	974461
08.	Fully Damage Crops (acre)	21628
09.	Partially Damaged Crops (acre)	326717
10.	Fully Damaged Houses	11448
11.	Partially Damaged Houses	75453
12.	No. of Death People	07
13.	Fully Damaged Roads (KM)	58
14.	Partially Damaged Roads (KM)	1912.1
15.	No. of Educational Institute Damaged Fully	49
16.	No. of Educational Institute Damaged Partially	405
17.	Damaged Embankment Fully (KM)	8.55
18.	Damaged Embankment Partially (KM)	99.35
19.	No. of Damaged Culverts/Bridges	97
20.	No. of Sheltered People	15638

Table-2.4 Super Cyclone SIDR (Date of Occurrence: 16 October, 2007)

Damages Sector	Quantity
No. of Affected District	30
No. of Most Affected District	12
No. of Affected Upazila	200
No. of Affected Union/Pourashava	1,950
No. of Affected Family	20,64,026
No. Affected People's	89,23,259
Fully damaged crops	7,42,826 acr.
Partially damaged crops	17,30,116 acr
No. of fully damaged household	5,63,877
No. of partially damaged household	9,55,065
No. death people	3,406
No. of Injured People	55,282
No. missing people	871
No. of Livestock death	17,78,507
No. of fully damaged educational institutions	4,231
No. of partially damaged educational institutions	12,723
Fully damaged roads	1,714 km
Partially damaged roads	6,361 km
No. of damaged bridges/culverts,	1,687
Embankment	1,875 km
No. of damaged trees	40,65,316

Table-2.5 Tropical Storm: Aila (Date of Occurrence: 25/05/2009)

Sl. No.	District	No. Affected Upazilla	Total No. of Affected People	No. of Injured	Total No. Death
01.	Barisal	10	292105	121	11
02.	Bhola	07	584970	201	18
03.	Pirojpur	07	248470		01
04.	Patuakhali	07	615785	610	08
05.	Khulna	06	546630	543	57
06.	Bagerhat	05	497036		4
07.	Satkhira	07	563783	5357	59
08.	Chittagong	03	13630	10	01
09.	Laximpur	04	17071	06	07
10.	Noakhali	03	1163071	255	24
11.	Barguna	05	284079		-
Total	11 district	64	4826630	7103	190

Table-2.6 Tropical Storm: BIJLI (Date of Occurrence: 17 April, 2009)

Srl	Items	Counts
01.	No. Affected District	15 (wrost affected 3), Chittagong, Cox's Bazar, Bhola, Noakhali
02.	No. Affected Upazilla	24 (Chittagong-9, Cox's Bazar-6, Noakhali-5, Bhola-4)
03.	No. Affected Union	76 (Chittagong-32, Cox's Bazar-40, Bhola-04)
04.	No. affected Family	6600 (Chittagong-2915, Cox's Bazar-3685)
05.	No. affected People	92558 (Chittagong-14408, Cox's Bazar-78150)
06.	Damaged Crops Full (Acre)	320 (Bhola)
07.	Damaged Crops partially (Acre)	4815 (Chittagong-885, Cox's Bazar-3716, Bhola-214)
08.	Damaged Households Full	1460 (Chittagong-448, Cox's Bazar-826, Bhola-186)
09.	Damaged Households Partially	5991 (Chittagong-2117, Cox's Bazar-3874)
10.	No of Death	5 (Chittagong-1, Cox's Bazar-3, Noakhali-1)
11.	No of Injured	16 (Chittagong-12, Cox's Bazar-4)
12.	No. livestock death	607 (Cox's Bazar)
13.	Affected Educational Institute Full	17 (Cox's Bazar-2, Bhola-15)
14.	Affected Educational Institute Partial	89 (Chittagong-22, Cox's Bazar-67)
15.	Damaged Embankment (km)	7 (Cox's Bazar)
16.	People in shelter	373624 (Chittagong-115500, Cox's Bazar-116000, Noakhali-47625, Laxmipur-15000, Bagerhat-3000, Pirojpur-7000, Bhola-45899, Borguna-10000, Patukhali-13600)

Table-2.7 Tropical Storm: Rashmi (Date of Occurrence: 26 October, 2008)

Srl	Items	Counts
01.	No. Affected District	17
02.	No. of Affected Upzilla	27
03.	No. of Affected Union	94
04.	No. of Death	7
05.	No. of Missing	4
06.	No. of Affected Family	92701
07.	No. of Affected People	321831
08.	Crops Damaged Fully	775 acres
09.	Crops Damaged Partially	18022 acres
10.	Households damaged totally	4360
11.	Households damaged partially	12404
12.	Affected Shrimp Farm	100 acres
13.	Partially affected road	212 km
14.	Partially affected embankment	28 km
15.	Partially affected institutions/infrastructure	107

2.2 Climate Model

Islam (2009) describes the generation of the Regional Climate Models (RCM) from Global Climate Models or General Circulation Model (GCM). GCMs are some sort of computer based models which are also called Global Climate Model considering its output. It is a computer based simulation that use mathematical formulae to calculate the chemical and physical processes such as winds, heat transfer, radiation, relative humidity, surface hydrology etc. It divides the earth as three dimensional grids, comprising height or pressure, latitude and longitude as dimensions. It works with Special Report of Emission Scenario (SRES) and predicts the climate calculating the future emissions. Regional Climate Model (RCM) is another model which comes from GCM. It takes the coarse resolution information from GCM and develop temporally and spatially fine scaled information considering the chemical/ physical processes and emission scenario same as GCM. Te resolutions are finer (50km) than the GCM (250km) will be converted into more fine (25 km) in future.

2.3 Study Area

ICZMP (2005) extensively gathered information related to Narail district. It is a part of project activities under Integrated Coastal Zone Management Plan (ICZMP). The aim of this project is to create an environment favorable to the sustainable livelihood development and linking the coastal zone with the national development processes. It reflects of the existing situation of Narail district such as its geographic condition, environment, population, agriculture, industries, social and economic status, infrastructures, weakness, opportunities etc. Development activities for Narail district will be guided by these information to indicated the lacking and scope of development programs

2.4 Participatory Rural Appraisal (PRA)

Allan and Curtis (2002) practiced the Participatory Rural Appraisal (PRA) which is now being used extensively in almost everywhere to involve the local people into their own development works. Its aim is to foster community participation to share the reflections about the social and physical environment with the development workers. At Billabong village in Heartland, Australia people were passed through PRA tolls and also with some Semi Structured Interviews (SSI). They wanted to gather information from them about their living status, the recent changes in lifestyles, pressure, potentials and their interest to be involved in the addressing land and water management. The total works were done in two stages; first the people were oriented to the researchers and then they were asked with PRA and SSI to achieve the objectives and goals.

2.5 Sustainable Livelihood

Generally we think about livelihood simply as an occupation of people. In the development activities livelihoods are meant for the deprived and poor people of the society. When we are discussing the livelihoods of poor people, it means more than only occupation. It covers the different corners of the working environment for poor, their potentialities, their setbacks and ultimate conditions coming out from their activities. According to DFID's definition, "Livelihoods comprises the capabilities, assets (including both material and social resources) and activities required for a means of living." The poor people are always in vulnerable condition because of their inconsistent and inappropriate livelihood. As they can't find any firm and favorable employment for their lives and needs, any adverse situation affects them so much and victimize them by loosing assets and activities they had. That's why the Sustainability of livelihoods has been discussed in the development policies. Developments partners and researchers are searching for approaches which can provide a sustainable livelihood which can

cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future without undermining the natural resources.

The Sustainable Livelihood Approach (SLA) has been oriented by Department of International Development (DFID) and it has been kept open for all around the world for comments for modification. The livelihood approach is a way of thinking about the objectives, scopes and priorities for development by putting the people at the center of development. SLA has six objectives set by DFID to increase the sustainability of poor people's livelihoods through promoting:

- Improved access to high quality education, information, technologies and training and better nutrition and health
- A more supportive and cohesive social environment;
- More secure access to, and better management of, natural resources;
- Better access to basic and facilitating infrastructure;
- More secure access to financial resources; and
- A policy and institutional environment that supports multiple livelihood strategies and promotes equitable access to competitive markets for all.

The livelihood approach puts people at the center of development. This focus on people is equally important at higher levels as it is at the micro or community level. This approach starts with an analysis of people's livelihood and how these have been changing over time by fully involving people and respecting their views. It focuses on the impact of different policy and institutional arrangement upon people and the dimensions of poverty as they define because poverty reduction will be achieved only if these external helping agencies work with the people by fitting their current livelihood strategies, social environment and ability to adapt. It tries to promote the agenda of poor by ensuring political participation of poor people and support people to achieve their own livelihood goals.

The framework is based on the available livelihood assets which are called Livelihood Capitals and the success of this approach depends upon the proper illustration and utilization of the livelihood capitals. Then the vulnerability context and institutional influence is oriented. These two have both way relationship with livelihoods and finally effects the livelihood outcomes significantly. So proper addressing of these two elements is important for the sustainability of the strategy. Figure 2.1 shows the schematic diagram of Sustainable Livelihoods Framework.

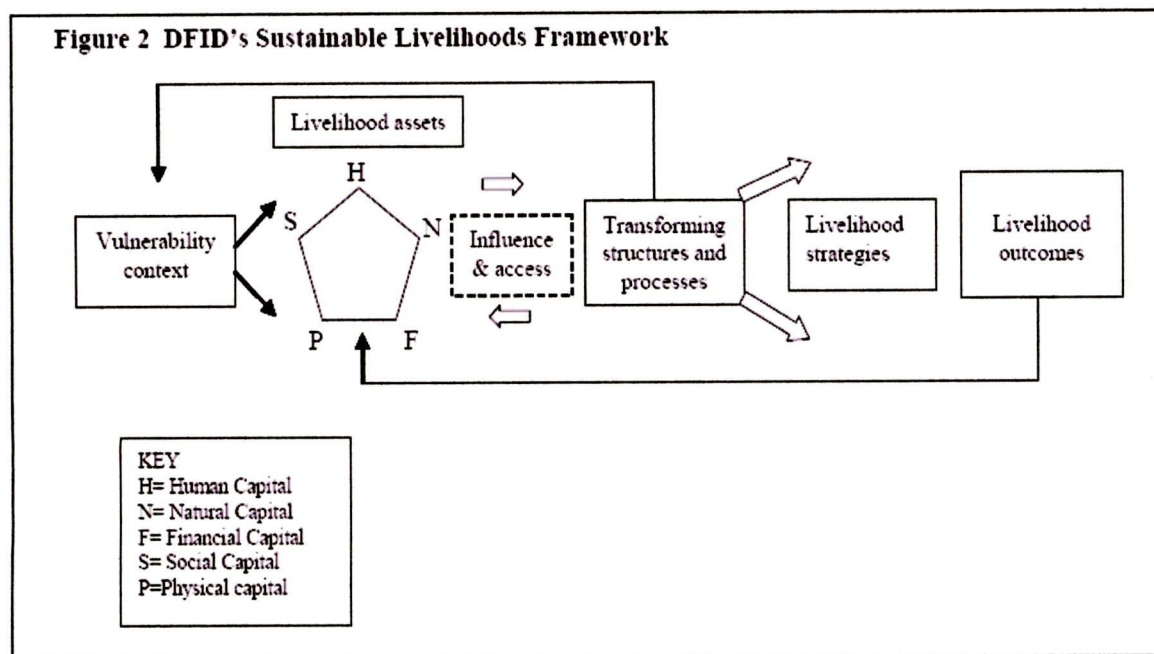


Figure 2.1 Sustainable Livelihood Framework with its components.

SLA can be helpful to the other ongoing approaches practiced by development workers. Livelihood approach and Sector wide approach are broadly complementary and each can gain from the strength of others. sector wide approach can be characterised as one in which sector strategy is formulated and costed, matched to available finance through an iterative process, converted to a work-plan, and formalised in agreements between the implementing agency and the sources of finance. Livelihoods analysis lays a heavy emphasis on understanding the structures and processes that condition people's access to assets and their choice of livelihood strategies. Where the major constraint is poor performance by government agencies at a sectoral level, then sector wide support programs will be highly appropriate. This is especially the case for government-dominated areas such as health and education. Sector programs themselves will be enriched if they build on the information gathered in livelihoods analysis.

Integrated Rural Development (IRD) is a similar approach to SLA. It holds the key principles as the specific resources of any area; natural, social and human resources to achieve sustainable development. It tried to increase the local people's capabilities and helped to enable to combine the local initiatives and external helps to ensure a diverse economy. The sustainable livelihoods approach endeavors to build upon the strengths of IRD (especially the recognition of the need for broad-based support in rural areas) without falling into the traps that caused IRD's downfall. In particular, the livelihoods approach does not aim to establish integrated programs

in rural areas. While recognising the importance to rural poverty reduction of a wide range of factors it will target just a few core areas (with the help of thorough analysis of existing livelihoods and a bottom-up planning process) so that activities remain manageable.

Carney (1999) discussed the approaches needed for sustainable livelihood in the rural poor people. As the most of the poor people live in the rural area, donors have spent their majority of the budget for the rural development. But this approach was never successful to achieve the goal. Initially the focus was on the agricultural development, then it diversified in social services and infrastructure development as well as the agriculture. Gradually the relationship between natural resources and rural development got focused and the new livelihood approaches are formed from this point of view. So these approaches are built upon the past experiences but still they need to be proved effective in the practical field. Now-a-days the food security is the top most concern in all over the world. So it has to be ensured so that people can have access to food. The natural resources, upon which the rural people depend, should remain undisturbed by any intervention so that people can get sustainable livelihood assets for their next generation. Moreover the approach should be non-sectoral and suitable for any location in the world having any group of livelihoods.

Scoone (2005) explains the relationship between poverty and environment as the poor people's livelihood is mostly dependent on nature. The sustainable livelihood has been explained as it will be able to cope with and recover from adverse situation, shocks and stresses. It will enhance its capabilities and assets without undermining the natural resources base and create more working days for the poor people and poverty reduction process will be accelerated. The people will be able to keep them above poverty line and improve their condition day by day. For this, different livelihood strategies may be adopted according to the circumstances. It may be set by intensification (more concentrated agricultural activity) or extensification (more wide agricultural activity) or by diversification and migration also. The roll of institutes and organizations has been described as some regularized practices set by the rules of society having a persistent use. They will act as cementing material between the stakeholders to access the capitals and exercise their power. The operational implication for adopting sustainable livelihood approach such as the field investigations methodology, suitable intervention options selection and planning approaches are discussed with examples.

Davis et al (2007) describes that the sustainable livelihood approach provides a framework for thinking and communicating about factors that impact on the livelihoods of individuals and

families of the poor people of the society. In this approach, the definition of a livelihood is broader than a job or business or other means through which people gain financial income or any other valuable products. It focuses on health and well-being outcomes and associated environmental factors such as natural resources as well as financial incomes. But, some community development analysts have mentioned the approach as technocratic and driven by agendas external to communities. This approach should be applied flexibly rather than a fixed format as the livelihood scenario varies place to place.

DFID (1999) explains the in-depth meanings of livelihoods, the objectives of different approaches relating to livelihoods and the objectives and methodology of Sustainable Livelihoods Approach (SLA). SLA and the other approaches like Poverty Elimination, Right Based Approach etc. have been discussed together with their different aspects. SLA is a continuous process initiated by DFID which is being analyzed by the experts and researchers all over the world in different contexts and it is updated accordingly by DFID itself. It starts with the various dimensions of livelihoods of the poor people who are the main targets of the development workers. The livelihoods of the poor people have been classified and their strength-weakness and sensitiveness to the environment has been discussed. The pentagon formed by five assets of livelihoods is the key object which is used to determine or assess the impacts on the rural people's lives and their future due to any changes in the environment or in the nature.

Ahmed (2009) conducted a study to illustrate how the principles underlying the Sustainable Livelihood Approach (SLA) are applied to support the development of Carp-SIS farming in rural Bangladesh. He explored the livelihood scenario of the fish farmers of a village and analyzed the available resources within the locality. The very beginning of the fish farming such as fry collection, pond management, feeding, treatment, production and marketing was learnt by Participatory Rural Appraisal (PRA), Focus Group Discussion (FGD) etc. The extent of livelihood assets was extracted with the help of people's participation. The vulnerability context and shocks in their activities was marked and the effect and the solution was figured out by discussing with themselves. Probable institutional intervention to solve the problems was also discussed. The present livelihood outcomes are impressive, but with adopting appropriate strategy for all the farmers more benefit can be achieved from this sector and development of the people can be made long lasting.

Dirwai (2008) stated the livelihood scenario of a village in Zimbabwe. As livelihood of the people varies place to place following the environment, here in Zimbabwe the livelihood

strategy is quite different. Agriculture is the major practice here too, but the poor people here are engaged in different activities. They collect timber from the forest and manufacture doors. But it was not enough for their daily lives. So, they were migrating to the city gradually. But, after Government developed the power sector and provide rural electricity, the scenario changed. Now, people can work more in shifts, with latest effective equipments and earn more to have a stable life. The migration rate suddenly dropped and the young unemployed groups become busy. This scenario can be developed more if government comes forward with initiatives like funding, training, marketing etc.

Sadik (2009) studied on the Sundarbans, the largest mangrove forest and a vast source of livelihood for the local people. Three groups, Bawali, Moual and Jele was taken into research work to assess their status against climate change impact on the Sundarabans. The resilience strength of these groups against climate change were assessed by observing the livelihood capitals by different livelihood indicators. Pre collected information regarding indicators were checked with field data collection through PRA and finally selected indicators were taken which are mostly active in the study area. Finally, livelihood resilience model is developed in view of three dimensions, Productivity, Sustainability and Risks.

Chapter 3 Study Area

3.1 Location of the Study Area

Bangladesh is one of the third world countries of Asia located at the north of Indian Ocean and having the Bay of Bengal in its coast line. It's a big deltaic plane land formed by three mighty rivers namely the Ganges, the Brahmaputra and the Meghna whereas all three rivers are being passed through Bangladesh to estuary at the Bay of Bengal. Our study area, Narail district is situated on the South-West region of Bangladesh being one of the nineteen coastal districts located around the 700 km shoreline. The criteria selected to indicate the coastal region are the tidal flow in the rivers, the saline water coming from the bay with the tide and cyclone prone weather. Narail, having all these three features is declared as interior coastal district as its in the periphery of the coastal belt. Figure-3.1 shows the location of Narail district inside the coastal region of Bangladesh:

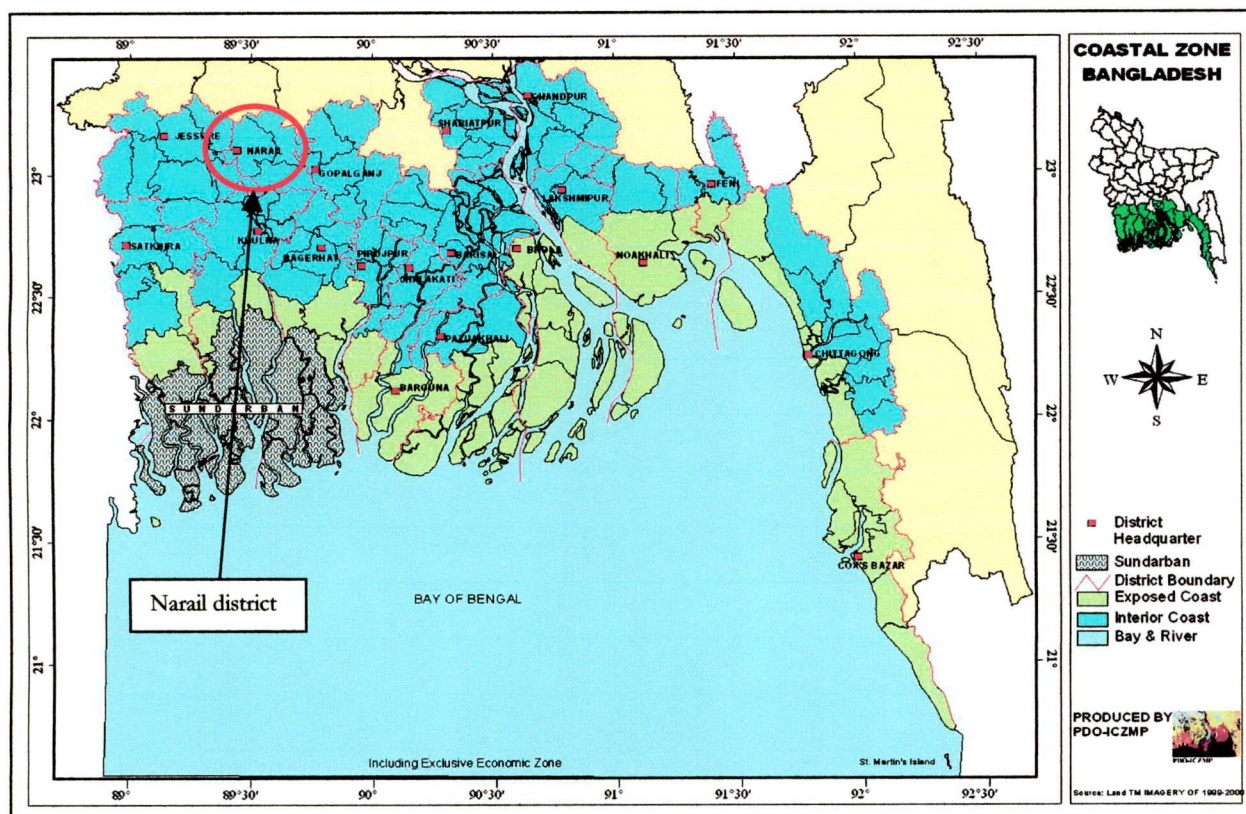


Figure-3.1 Map showing Narail district situated at the coast line of Bangladesh

3.2 Description of Study Area

Narail is one of the districts in the South-West region of Bangladesh. It is surrounded by Magura and Faridpur at north, Gopalganj at east, Khulna and Bagerhat at south and Jessore at west side. Its area is 99000 ha (990 sq. km.) of which 59563 ha is cultivable land. It has a population of around 7 lakh and the population density is 702 per sq. km (BBS, 2003). As it is a part of Ganges delta the surface soil is furnished by the sediment carried by the distributaries of the Ganges i.e. Gorai and Mathabhanga. It is divided into two layers; one layer upto 12 meter having clay, silt and dry sand. Down this part, it has a mixture of fine and coarse sand layer. The soil type varies from sand, clay to clay-loam overall in Narail district. Gorai River, Chitra and Nabaganga rivers passed through its plane land. Narail Sadar, Kalia and Lohagara are the three Upazillas of Narail and our study area is situated at Kalia Upazilla; at right bank of Nabaganga. Figure-3.2 shows the geographical location and other features.

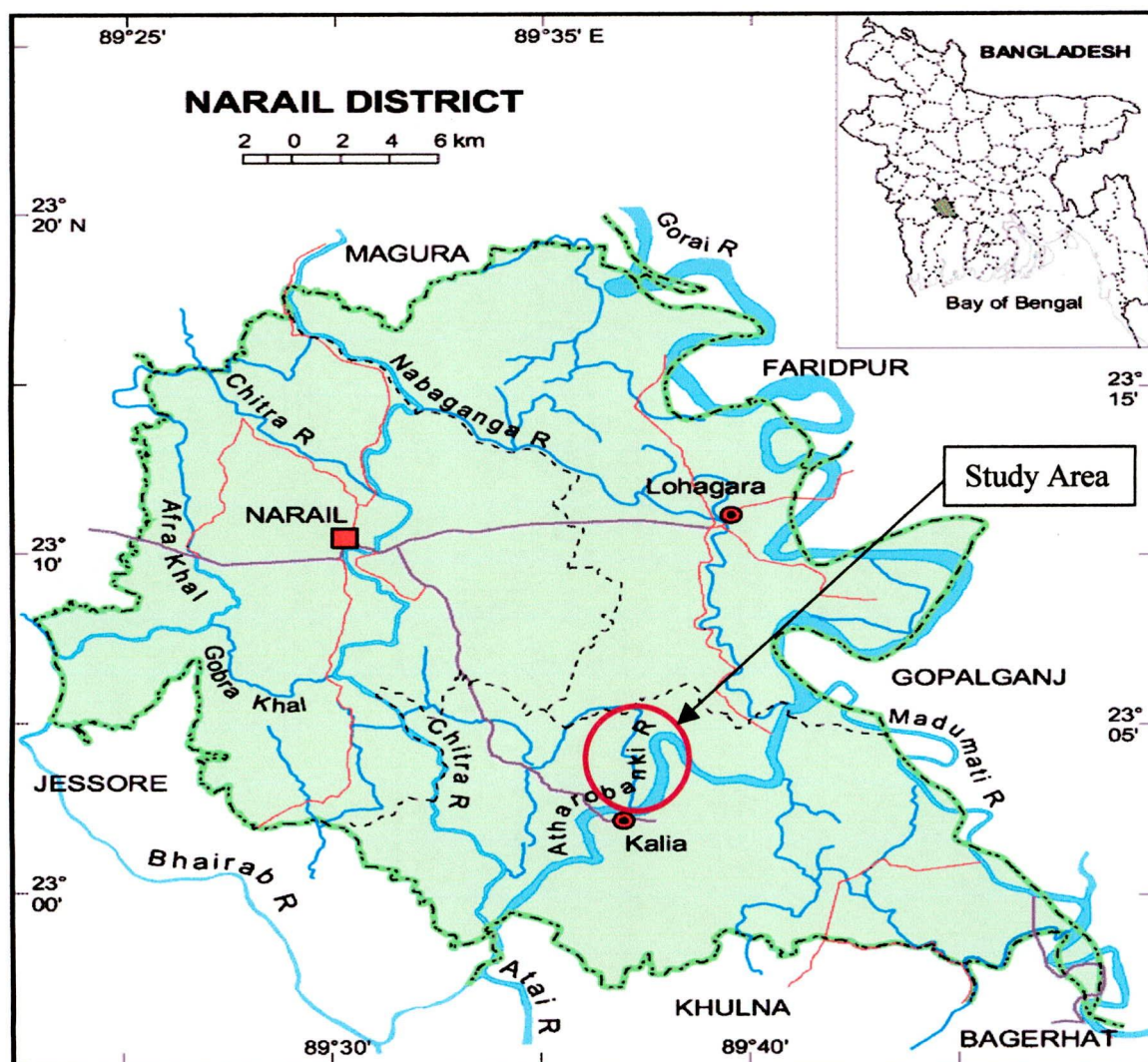


Figure-3.2 Map Showing the Study Area on Narail District

Average land level of Narail varies from 6 mPWD to 2 mPWD (Figure-3.3) and it has rivers and low lying areas which passes the rainfall runoff and the flow from the Ganges to Khulna and Bagerhat district. The climate is influenced by tropical seasonal climate having average annual rainfall of 1750 mm. Most of the rainfall occurs in the monsoon starting from July-September. The average temperature fluctuates from 11.5° c to 36° c which happens in the summer starting from April-Jun. Specific Humidity is found in a range of 67% - 88% in this district. The major rivers of Narail are Gorai, Modhumoti, Chitra, Nabaganga etc. and many low areas like beels. All the rivers are affected by tides coming from the downstream and the saline water intrudes through these rivers. Some of the rivers are meandering and changes the planform in course of times. So, river bank erosion is always a problem for the dwellers of these area. Besides, the river courses are ever changing with the change of river bed and river bank. The reduced flow in the Gorai and huge sediment carried by Gorai is changing the river beds which affects the river flows.

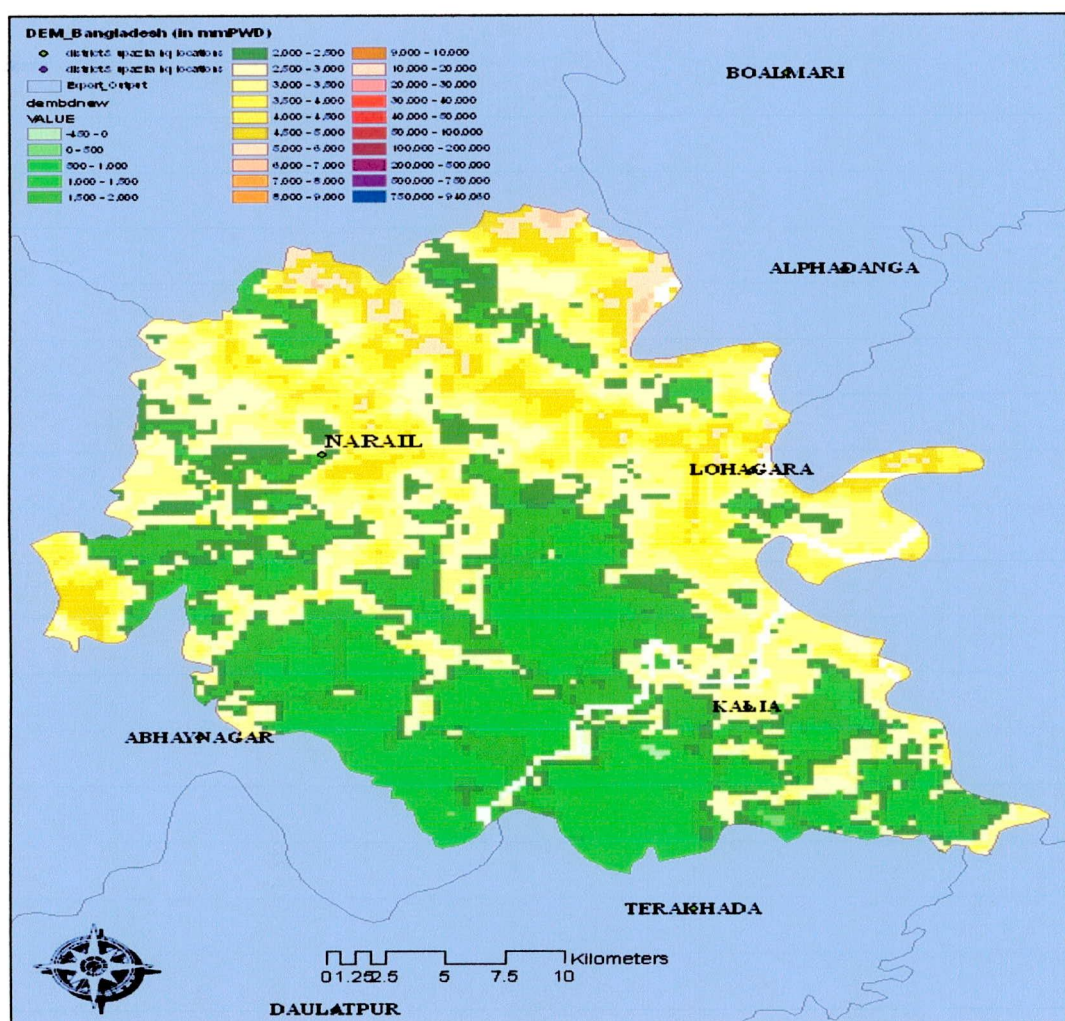


Figure-3.3 Map showing the land level (in mmPWD) of Narail district.

The agricultural practice of the study area is more or less similar to the rest of Bangladesh. A typical cropping pattern of Narail district is shown below in Table-3.1

Table-3.1 Narail district Agricultural Practices

Land category	Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High land	Mustard												
	Wheat												
	Musuri												
	Kalai												
	Jute												
	T.Aman												
Medium high Land	Boro												
	B.Aus												
	T.Aman												
	Rabi crops (Mustard)												
	B.Aman												
	Jute												
Medium low Land	Boro												
	B.Aman												
	B.aus												

In high land, the villagers grow vegetables around their houses all the year round. In Rabi season, they grow kalai, tisi, mustard, wheat, musur, dhania etc. In Kharif-I, they grow jute and in Kharif-II they grow broadcast Aman of different varieties like Ranjit, Sarna, 11 etc. In high land they grow all these crops with irrigation, except kalai which is grown without irrigation in few cases. In medium high land three or four types of crop combination are found. In most of cases the villagers grow Boro (28, 29, Hira, etc) in the Rabi season, and grow mixed Transplanted aman (GS, 28, 41, etc) and Transplanted Aus (Ratul, Burolokkhi, Hasa, Gamvir, etc) in the Kharif-I season. Broadcast Aus is harvested in September- October while Broadcast Aman is harvested in January. The villagers grow wheat in Rabi season, Jute in Kharif-I season and Transplanted Aman in Kharif-II. In medium low land, the villagers mainly grow Boro in Rabi season and Broadcast aman (Monowar, Jabra etc) & Broadcast Aus in Kharif-II season. The varieties of boro they grow are Ratna, 28, 29, Kajollata, etc. In few cases, the villagers grow jute in kharif-I season.

3.3 Infrastructures of Narail

3.3.1 Communication

Total 95 km length road network has been completed so far under Roads and Highways Department (RHD) at Narail. It includes 12 km of Regional Highway and length of Upazilla connecting roads is 83 km. Besides these, Local Government Engineering Department (LGED) has built total 345 km inside Narail. Very recently the SM Sultan Bridge over the Chitra river has been constructed. It has eased the communication between Narail Sadar and Lohagara Upazilla. A bridge over Nabaganga river connecting Kalia Upazilla is under planning stage initiated by LGED which will integrate the Narail district for its socio-economic activities. Another bridge on Modhumoti river at Kalna Upazilla of Gopalganj will develop Narail's communication system with Dhaka. The communication system in the rural areas is very poor. Transportation by navigation through the natural channels is widely used.

3.3.2 Industrial and Economic Infrastructure

Industrial sector of Narail has developed with the small and medium industries. Among them Textile mills, Biscuit factories, Pen factories, Saw mills, Ice factories, Lethe machine and welding, Rice and Wheel grinding mills, Press is remarkable. There are some brick fields scattered around adjacent and far locations of Narail city. Some village peoples are involved with Bamboo products, mat weaving, wood works and some works as goldsmith, potter and stitching etc as part of cottage industries.

Narail district has Branch offices of almost all Banks working throughout the country. The transaction through the banks are increasing day by day. Besides these banks, several Non-Government organizations are working here for financing the peoples specially women for development activities. They are Brac, Asha, Karitas, Proshika, Jagoroni, Bachte Shekha etc. which covers about 30% household under micro credit programs. There are many Market places locally called Hat/ Bazar for marketing of the local produced goods and materials. These covers averagely 66 skm per market inside Narail which is better than the overall coastal region market coverage.

3.3.3 Agricultural Infrastructure

Around 30% of the total cultivated lands have become under irrigation coverage at Narail. It is similar to the coastal region but less than the average irrigated land of the total country (50%). The irrigation using ground water is increasing day by day as the surface water is getting scarce. Irrigated land would be more if the electricity supply can be extended more in the villages (17% household has electricity supply). 70% of rural household uses chemical fertilizers. Few can use the power tiller for land preparing activities. 66% of the households have facilities for storage of their products.

3.4 People and Livelihoods of Narail

Total population of Narail is 6.94 lakhs of which 3.50 is men and 3.44 is women. 90% of the total population lives in the rural areas. Number of total household is 1.4 lakhs having average size of household is 5.0. On an average 720 people live in one square kilometer which is below than the coastal population density. 39% of the population is under 14 years old and 7% is above 60 years old. From the age concern the average dependable people's number is 85% of the total population.

In the rural area of Narail, 73.6% people is engaged in agricultural activities. Among them 51.0% is small farmer, 20.8% is medium and 1.9% are large farmers. As the population is increasing day by day and the cultivable land is reducing, gradually many people are getting involved in farm laborer which is 22% of the total household. Moreover, the unemployment condition and increasing natural disasters in the district driving the people from village to the city of Narail for livelihood. The number of these people is increasing who are mainly engaged in daily laborer in the urban area mainly in the housing industries. 4% of the population are fishermen who are doing this job from their fore fathers and they are mainly of Hindu religion. Considering the total economic condition of the Narail district, 41% of population lives under poverty line and 14% of them are very poor.

Chapter 4 Approach and Methodology

4.1 Study Approach

The study was operated by incorporating observed hydro-meteorological data and predicted climatic data with the field information related to climate change collected from the study area. The information gathered from the observed and predicted data were delivered to the local people and the people's perception and view about the field situation was noted with the help of different PRA tools. Combining all these, a sustainable livelihood framework was established which includes the knowledge gathered from desk as well as field information provided by the local people according to their perception. The study approach has been shown in a flow diagram in Figure-4.1 below:

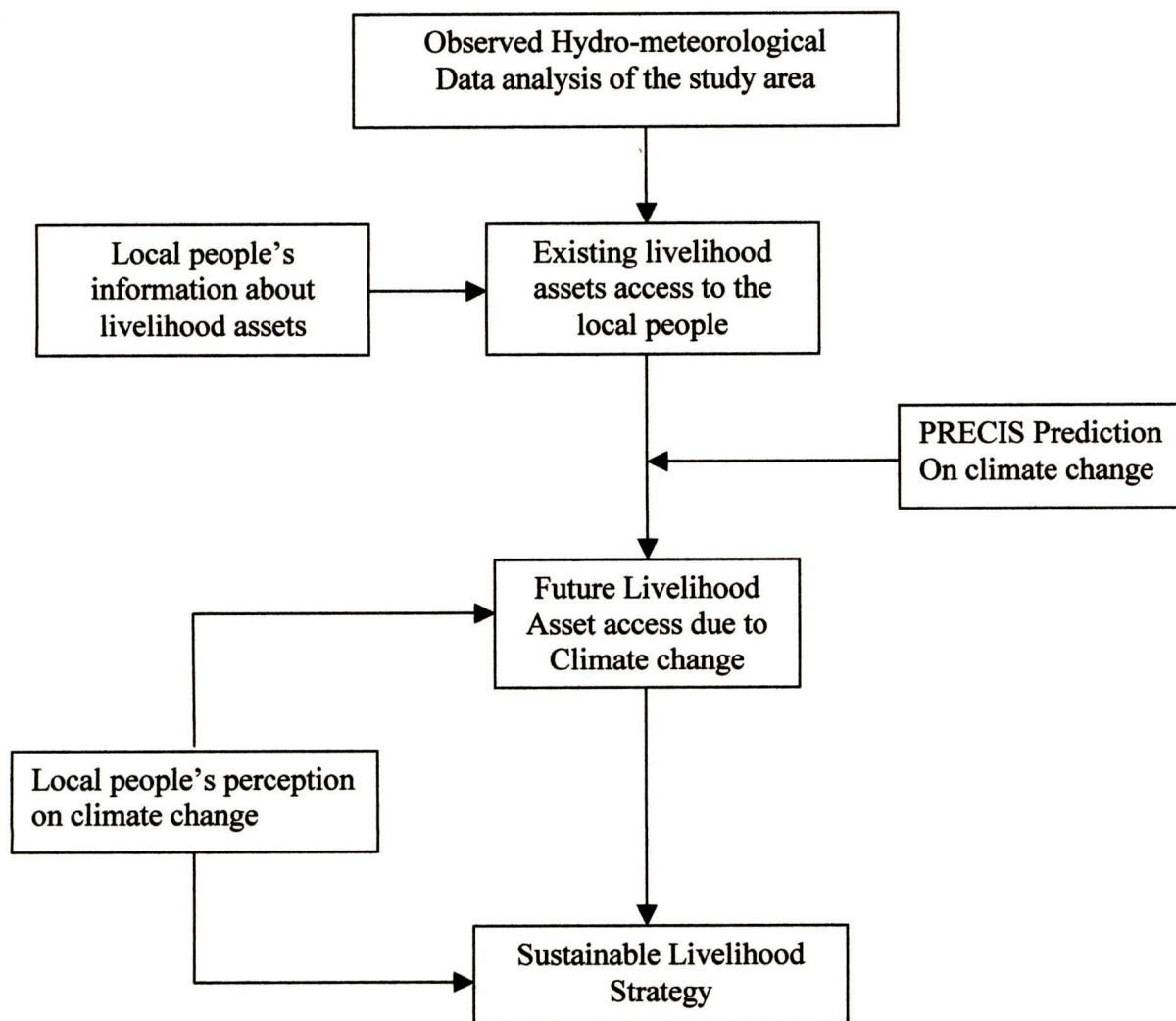


Figure-4.1 Flow Diagram of the Study Approach

4.2 Methodology

4.2.1 Secondary Data Collection

The hydro-meteorological data were collected from BWDB, BMD and IWFM database. It includes historical temperature, rainfall, ground water level and salinity data of the available station around the study area in the South-West region of Bangladesh. Temperature and rainfall data of three neighboring stations of Narail district as there is no such measuring station at Narail. The trend analysis of temperature and rainfall data series of these stations were done to visualize the rate of changes in the study area. Figure-4.2 shows the three stations at Jessore, Khulna and Madaripur around Narail district.

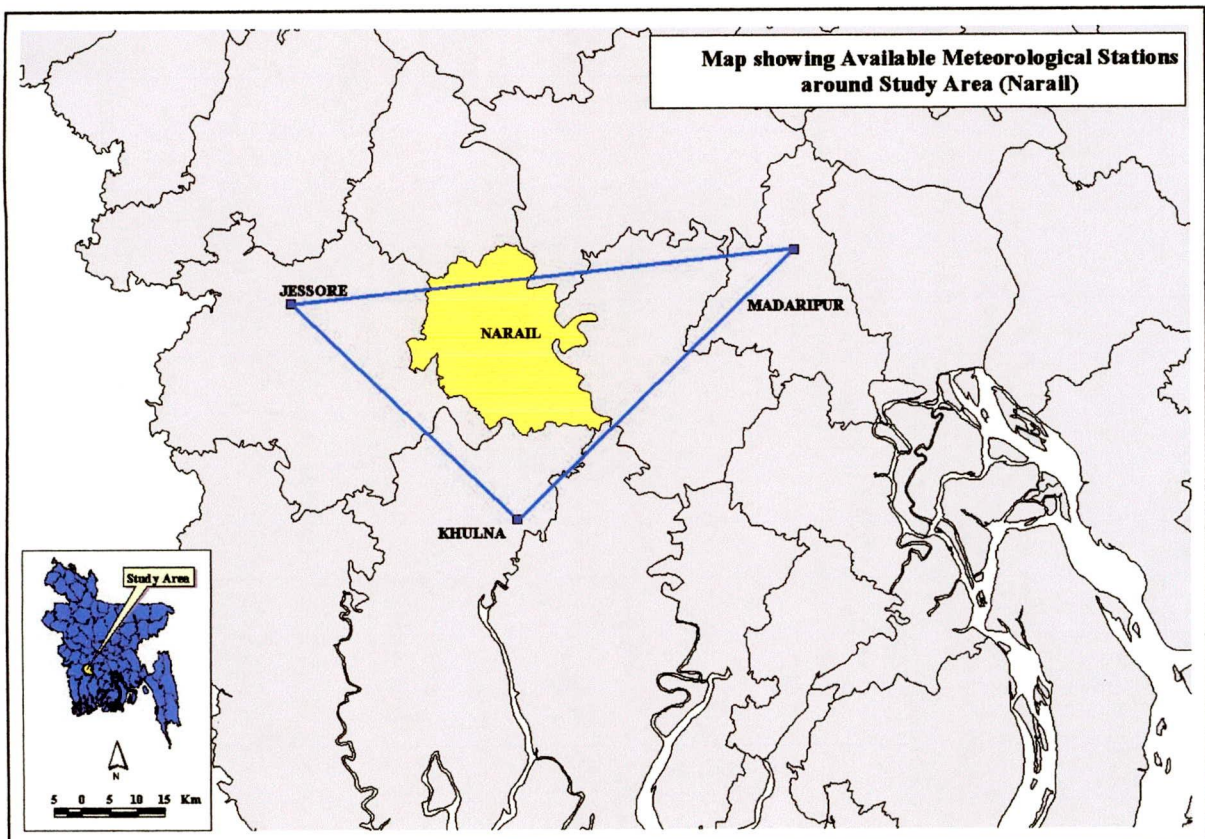


Figure-4.2 Map showing Hydro-Meteorological station around Narail District.

The ground water levels at Narail district starting from 1980 to 2007 were collected. The variation in the ground water table was also statistically analysed to see its trends whether any significant ground water recharge or depletion is happening. Enough salinity data of Narail was not available, so the salinity condition was visualized by creating Digital Elevation Model with numbers of BWDB salinity stations of two time period; 1999 and 2009. Figure-4.3 shows the salinity measuring stations in South-West region of Bangladesh.

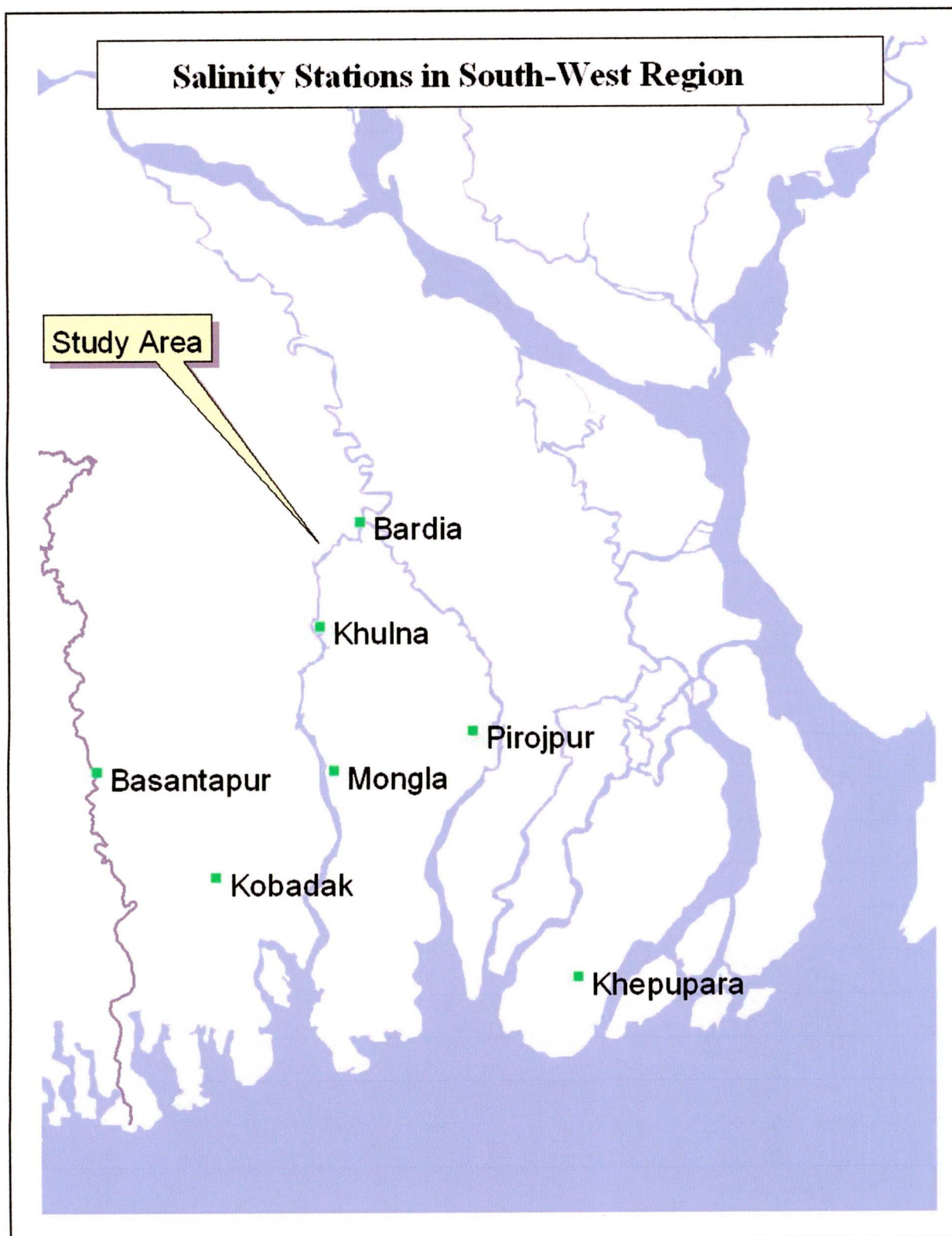


Figure-4.3 Map Showing Salinity Stations in South-West Region

4.2.2 Primary Data Collection

4.2.2.1 Regional Climate Model (RCM) Prediction

Primary data was collected both in desk and on field level for this study. A Regional Climate Model, PRECIS has been simulated in IWFM laboratory from which the primary climate prediction data were collected. The simulation results for those three stations, Jessore, Khulna and Madaripur was extracted and analysed for the understanding of future probable climatic condition in the study area. These results were conveyed to the rural people of the study area to make their comments and view regarding how these are happening in their locality.

4.2.2.2 Field Information

Field information was collected from the local people by conducting several field visits. At first, one focus group discussion (FGD) was made for the each livelihood groups to make an inventory of the local livelihood assets under different capitals. Once the inventory was made, some semi-structured questions were asked to them based upon five livelihood capitals. The availability of the livelihood assets and local people's affordability and access to those assets were noted to draw the livelihood pentagon for the base condition. A resource map of the study area was developed with the help of local people for this purpose.

Another set of FGD was conducted to discuss the predictions from RCM with the local people and their ideas and observation were noted. Their observation were gathered using several participatory tools such as seasonal calendar, mobility map, venn diagram, trend line, transect walk, daily routine diagram, etc. The rural people provides information related to ongoing changes in the study area climate and also the probable future conditions of the livelihood assets. Each participatory tool was used on the basis of their applicability and usefulness to sketch the assets conditions for present and future time. They also provided information regarding the reasons of impacts on assets and suitable adaptive measures for them to overcome the climate change condition.

Finally, a sustainable livelihood framework has been built for the study area following the sustainable livelihood approach (SLA) referred by DFID. While having this framework, the local people's recommendations were taken into account as this will suit for them most and the ultimate goal of SLA can be achieved by offering a sustainable livelihood strategy from study area point of view.

Chapter 5 Data Collection and Analysis

5.1 Secondary Data

The climate change has affected Bangladesh from many different aspects. Almost every regions of Bangladesh got affected directly or indirectly. Some hydrological, meteorological as well as environmental data has been collected and analyzed to assess the impact of this scenario. The ground water level data of the study area has been collected at Kalia Upazilla under Narail district . The salinity data of the South part of this region was collected to identify the water level changes over past years. The Khulna, Jessore and Madaripur; three stations meteorological data is taken which are adjacent to Narail. The data analysis of these is described below;

5.1.1 Ground Water Level of Study Area

The ground water level data of the study area has been collected from IWFM database. Starting from 1980 upto 2007, the yearly minimum ground water levels hydrograph shows average gradual declining condition. The increasing hot weather has decreased the soil moisture which reduces the ground water recharging during monsoon period. Ground water level has dropped more than 2 meter in last 25 years at Kalia Upazilla under Narail district as shown in Figure-5.1

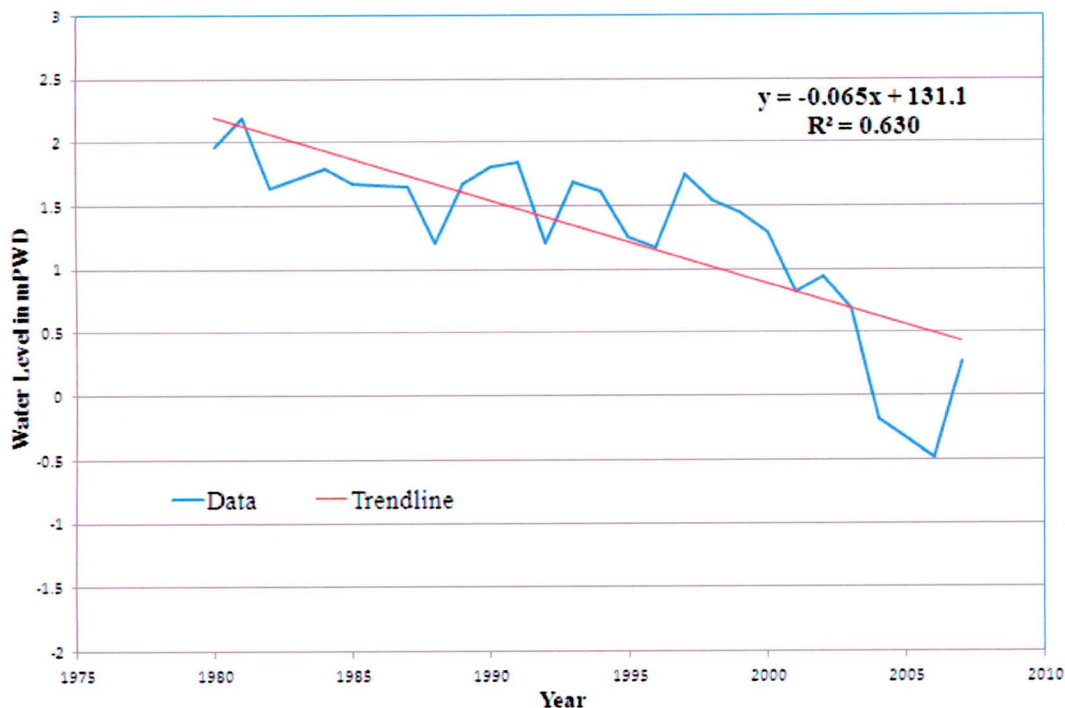


Figure-5.1 Yearly Minimum Ground Water Level of Kalia Upazilla

5.1.2 Salinity Condition of South West Region

An analysis has been done based on salinity data of ten years range from 1999 to 2009. Within this time no major change in the SW regional environment was found except the impact of Gorai River Restoration Project. This project has augmented the flow through the Gorai river which has decreased the salinity of the entire region to some extent. Despite this intervention, the total salinity condition of the region has declined which is reflected from the analysis. From literature review, it is learnt that salinity concentration slope of SW region is from north-east to south-west direction. The Fig-5.2 of salinity map of 1999 shows the previous situation. The unit of salinity concentration measured is in parts per million (ppt).

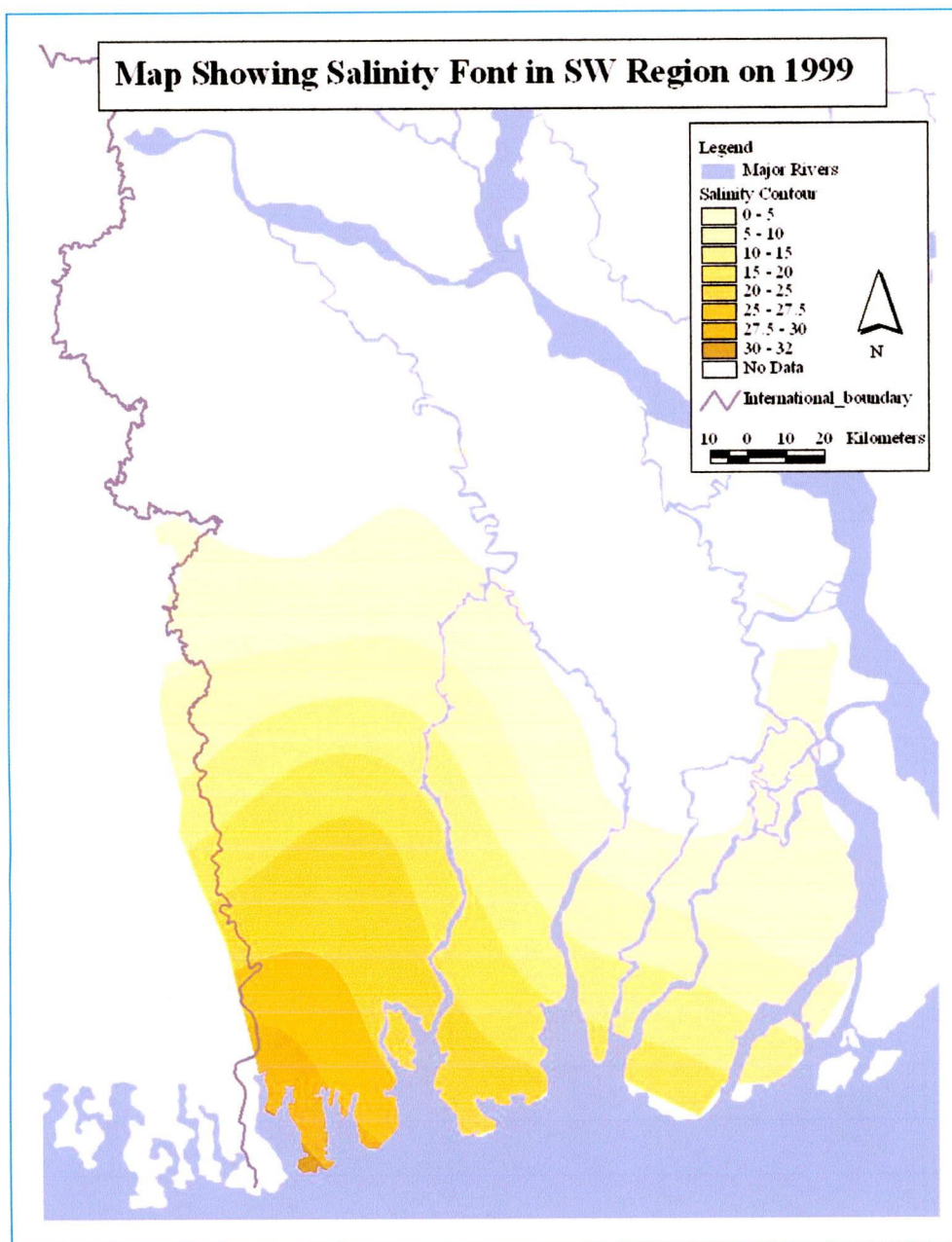


Figure-5.2 Map showing the salinity of South-West region on 1999

The area adjacent to the right bank of the Ganges-Padma-Meghna system has zero salinity because of the huge fresh water flow. Saline zone starts from the north-west side and gradually increased towards south-west direction. In this circumstances, the salinity map for 2009 was generated to observe the changes in the condition over the ten years period. The most salinity is found in the Satkhira Reserved Forest, part of the Sundarban. Fig-5.3 shows the salinity distribution on 2009. The unit of salinity concentration measured is in parts per million (ppt).

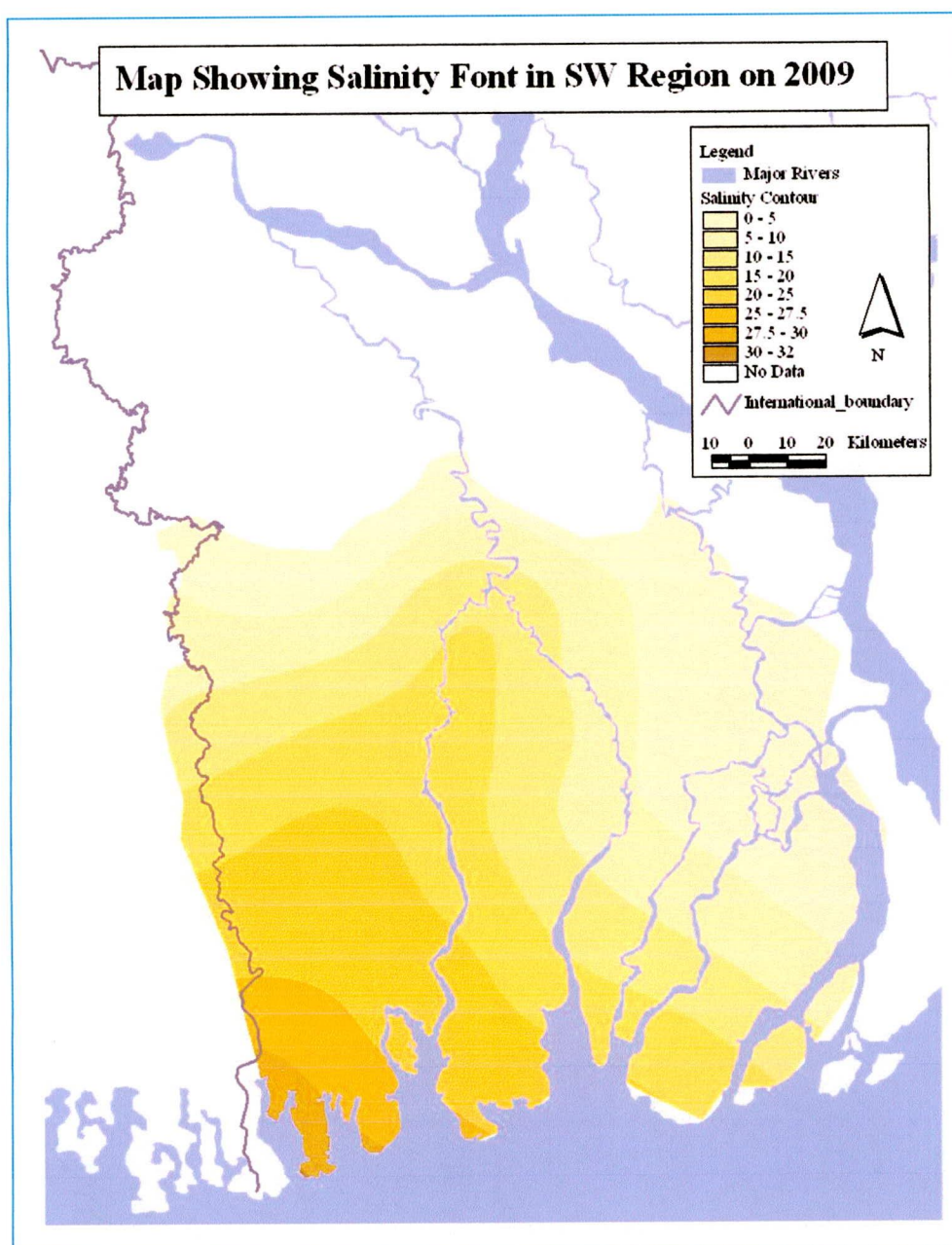


Figure-5.3 Map showing the salinity of South-West region on 2009

The scenario in the SW region has changed quite remarkably over the last ten years. The salinity gradient remains in the same direction, but its concentration has increased. The south-west portion remained same but the salinity front has advanced towards further north-east direction affecting new location which was salinity free earlier. Moreover the concentration of salinity has increased in the saline zone in the middle part of the region.

It is to be mentioned that, two measurements have been taken after the Gorai River Restoration Project was started which augmented the Gorai fresh water flow. Though previously reducing fresh water flow through the Gorai River increased after 1998, the salinity concentration has increased in the South-west region. The probable reason for this situation is the sea level rise on the Bay of Bengal due to the climate change. Sea level rise is gradually causing the permanent inundation in the coastal edges as well as the salinity increase in the entire South-West region.

5.1.3 Meteorological Data around Study Area

Narail district has no hydro-meteorological stations, so three neighboring stations of Narail such as Jessore, Khulna and Madaripur has been taken for analysis. These three station are selected because they surrounded Narail district from almost every side. So, the data found from this stations should represent Narail. Khulna and Jessore stations have data from 1948 to 2002 whereas Madaripur station has data from 1978. The average temperature at summer season (March-April-May) have been taken for analysis. The monsoon rainfall of wet season (june-July-August-September) has been analysed. The collected meteorological data of these stations are plotted and simple statistical analysis was done to find the trend. Following figures (from Figure-5.4 to Figure-5.9) show the time series data and their trend along with correlation with respect to time.

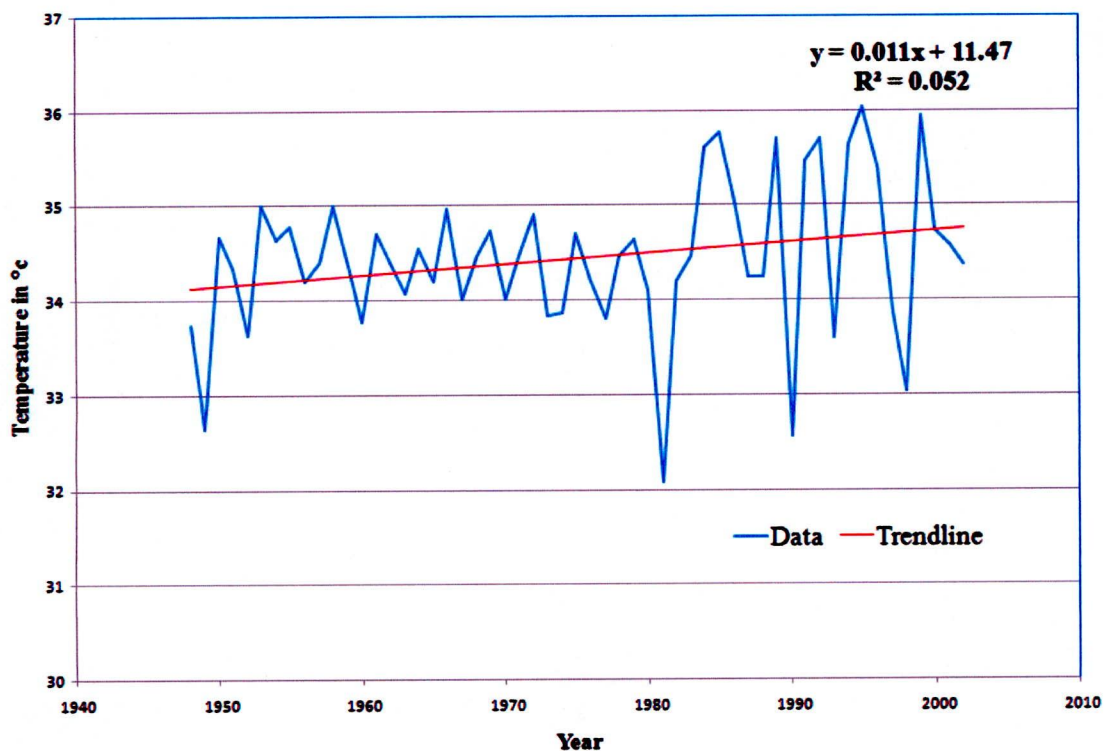


Figure-5.4 Observed Summer Temperature of Jessore

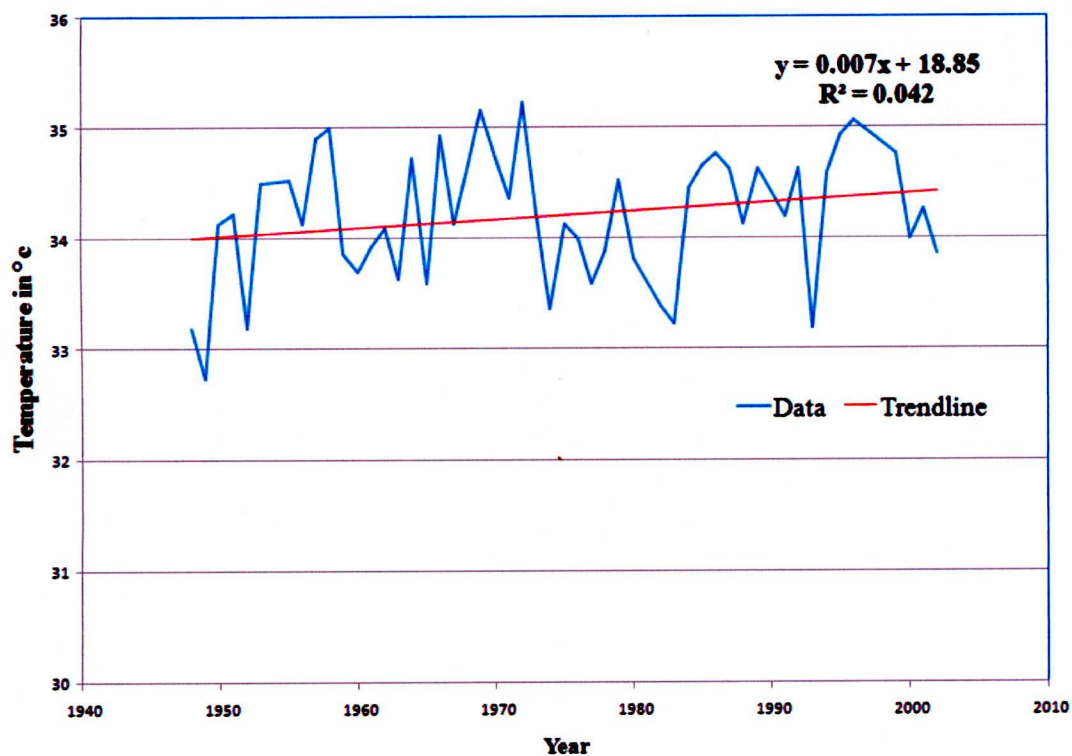


Figure-5.5 Observed Summer Temperature of Khulna

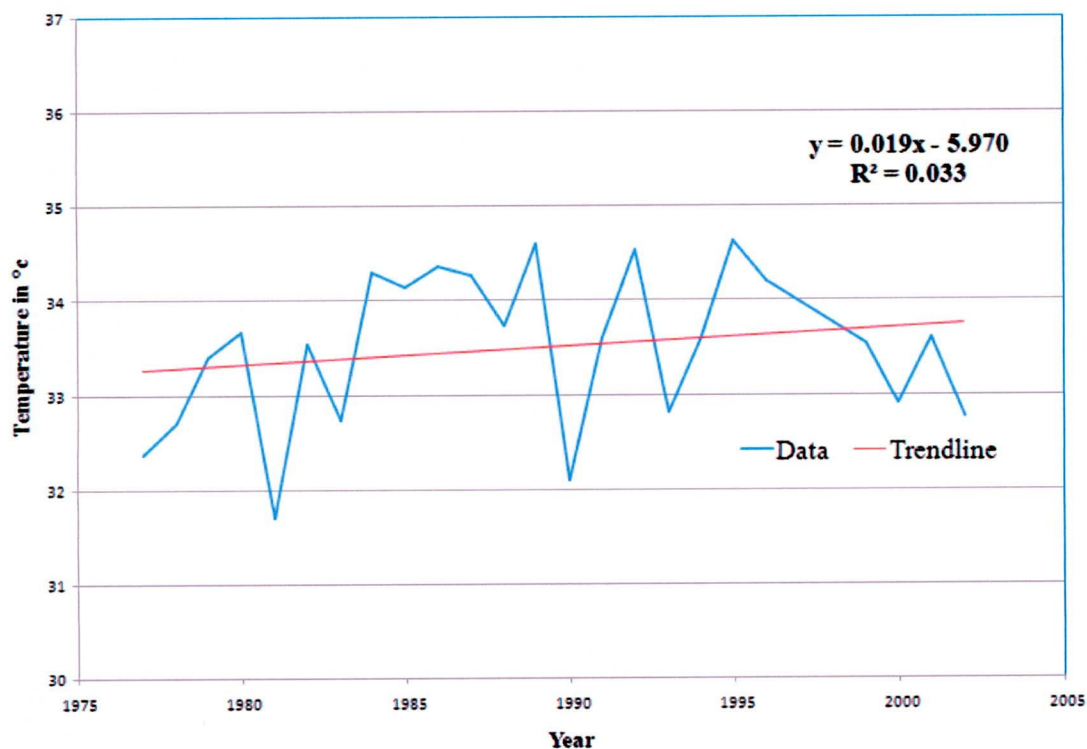


Figure-5.6 Observed Summer Temperature of Madaripur

All the three stations shows averagely increasing summer temperature. The temperature rise trend in Khulna and Jessore is comparatively higher than the other station. As Khulna and Jessore have more industries and factories, the rise in temperature is higher than Madaripur. The temperature fluctuations are also more in these two stations than Madaripur.

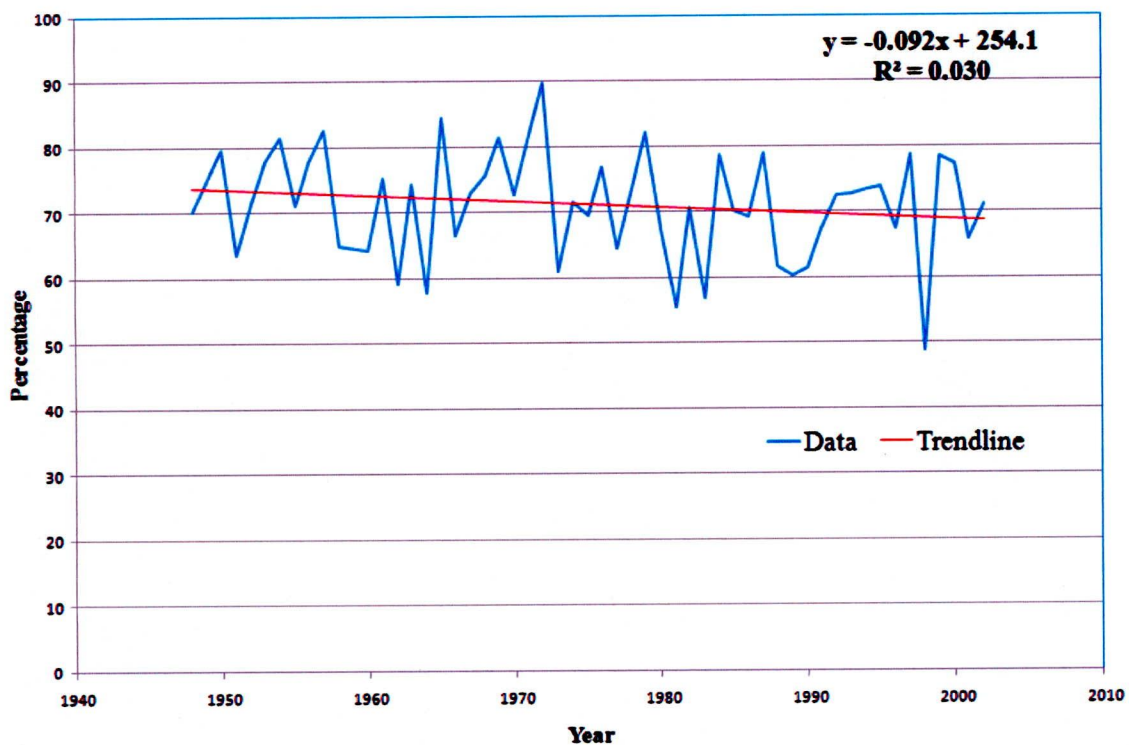


Figure-5.7 Observed Monsoon Rainfall as % of Annual Rainfall of Jessore

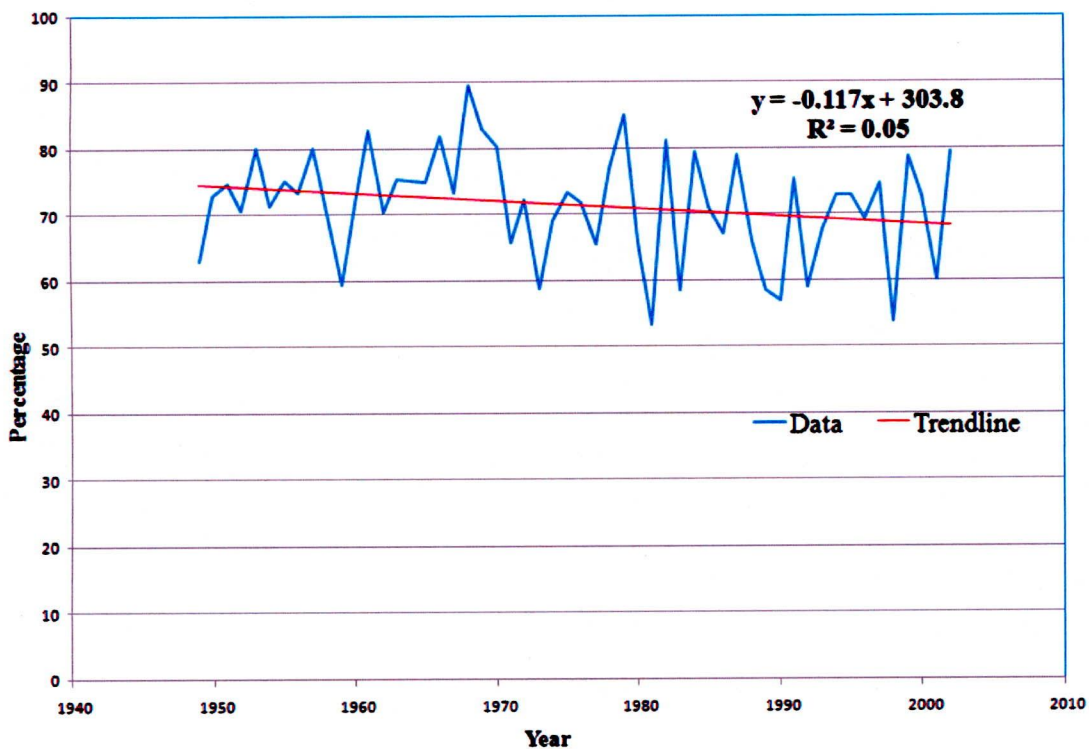


Figure-5.8 Observed Monsoon Rainfall as % of Annual Rainfall of Khulna

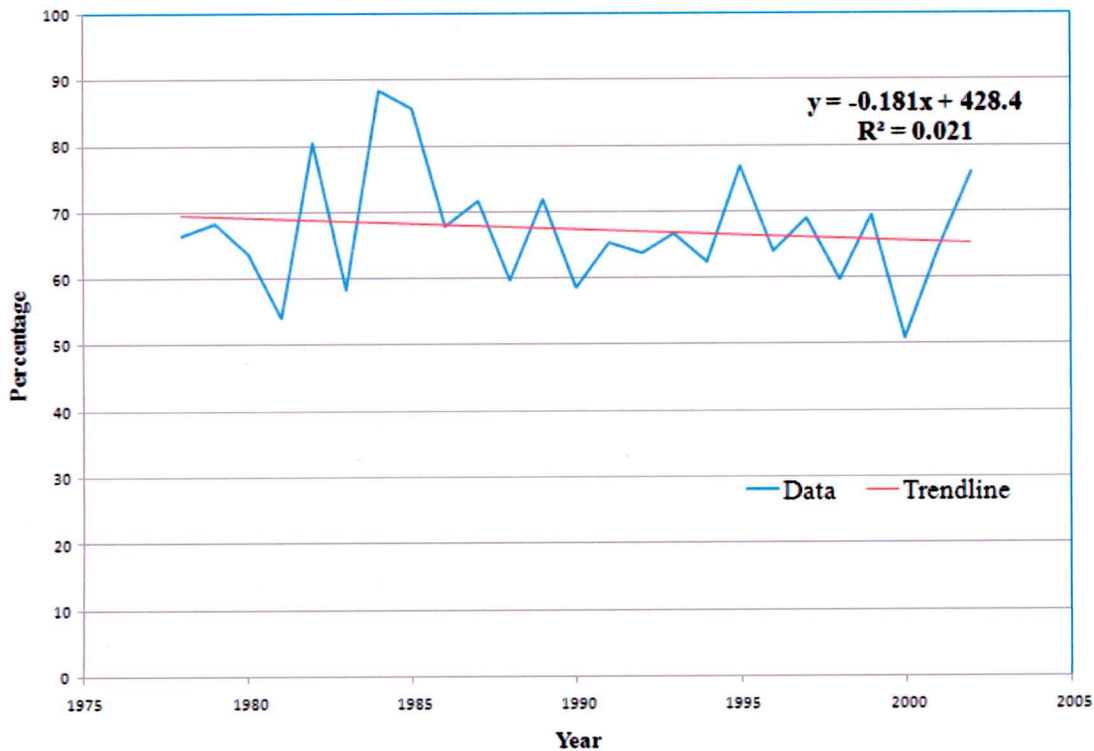


Figure-5.9 Observed Monsoon Rainfall as % of Annual Rainfall of Madaripur

The rainfall data of the three stations shows similar characteristics as the monsoon rainfall is gradually decreasing. It indicates the wet season is shifting from its original occurrence of tropical climate. The rainfall has become erratic and not occurring substantially when it is expected. The typical heating and cooling process of ocean and land mass responsible for tropical monsoon in the region has been disturbed by the excessive warming of the weather. As a result, the moist monsoon wind from Bay of Bengal to the land and dry winter wind from land to the bay is interrupted and the rainfall pattern is changing. For this reason, sudden rainfall and delayed rainfall scenario has been experienced in this region.

5.2 Field Data Collection

To assess the impact on the rural livelihood three livelihood groups and another vulnerable group has been selected. The farmers, fishers and the daily laborer have been taken under study and women group has been chosen as vulnerable group. From a preliminary field visit the rural people's livelihood asset was identified and noted. It started with a resource map of the study area and then focus group discussions with different groups about climate change and its impacts. The details of the activities are discussed below:

5.2.1 Resource Mapping

A reconnaissance survey was made to assess the existing resources in the study area. Resource map shows the existing natural and infrastructural assets which local people can avail them for their livelihoods. After it has been prepared, it is refreshed and developed with other sources such as maps and satellite images. Figure-5.10 and Figure-5.11 shows the preparation of the resource map for the Mauli and Chander Chak villages at Narail.

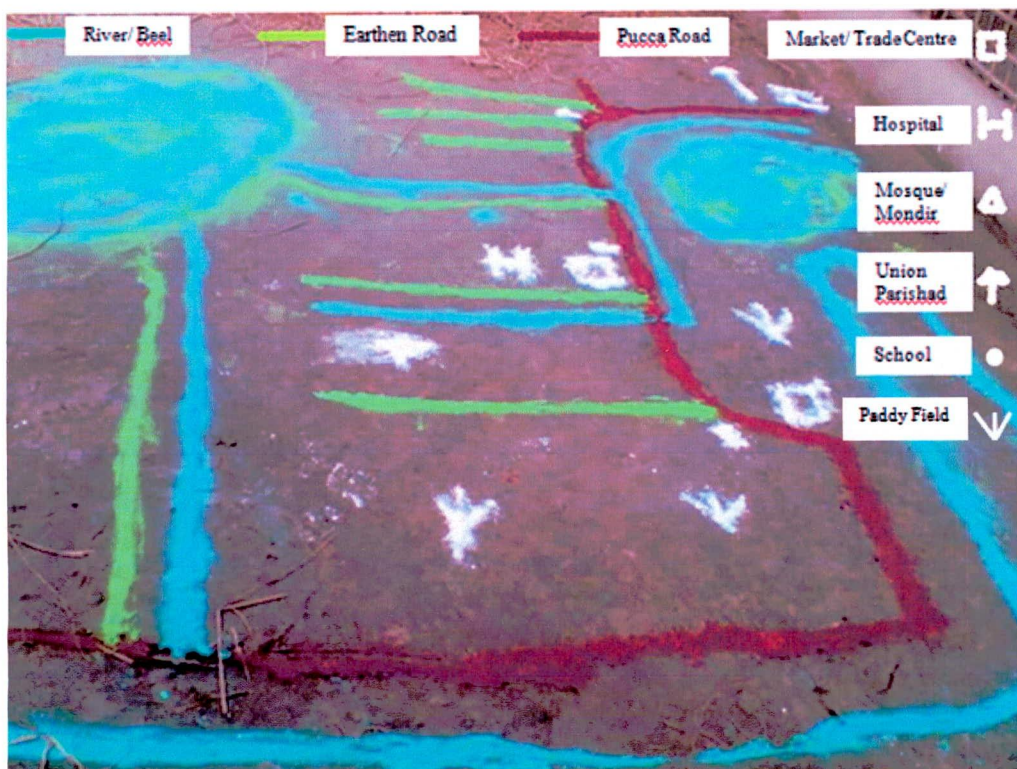


Figure-5.10 Resource Map drawn by the local people

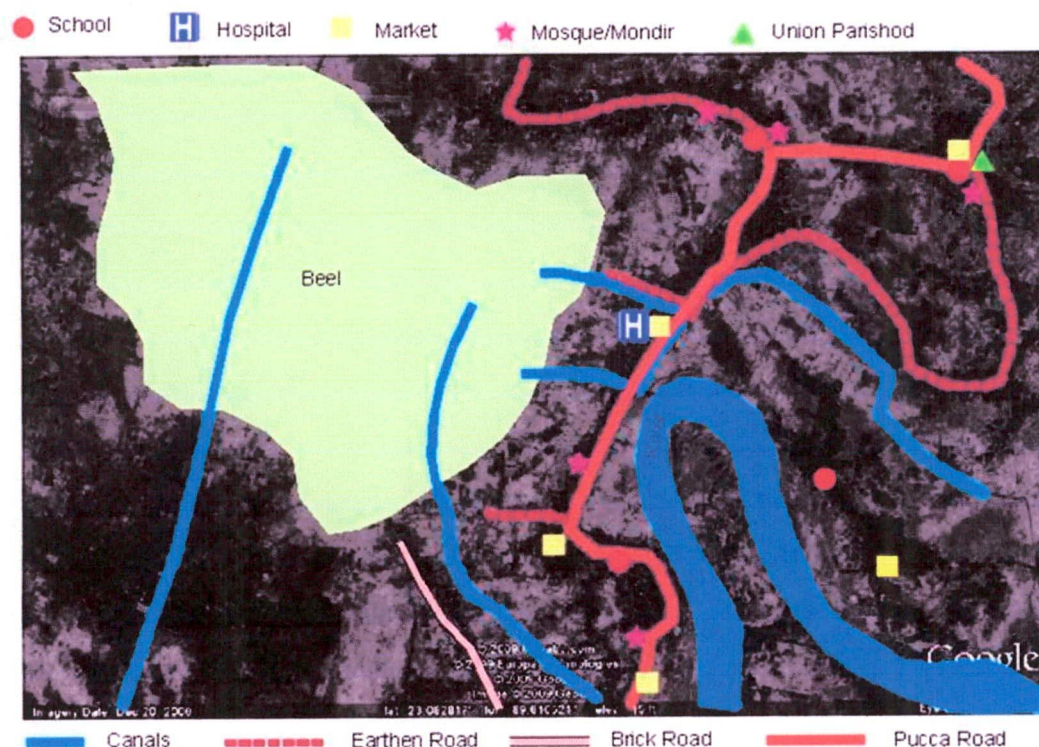


Figure-5.11 Developed Resource Map of Study Area with Satellite Image

5.2.2 Focus Group Discussion

Several FGD was made in the study area for this perspective. The target of this activity was to get the details of their livelihood activities and available assets. From FGD, the livelihood assets in the study area are recorded and listed in Table-5.1 to Table-5.4. The livelihood asset was prioritized by the local people according to their needs with the help of matrix ranking tool. Figure-5.12 shows matrix ranking by the laborers during a FGD in the study area.

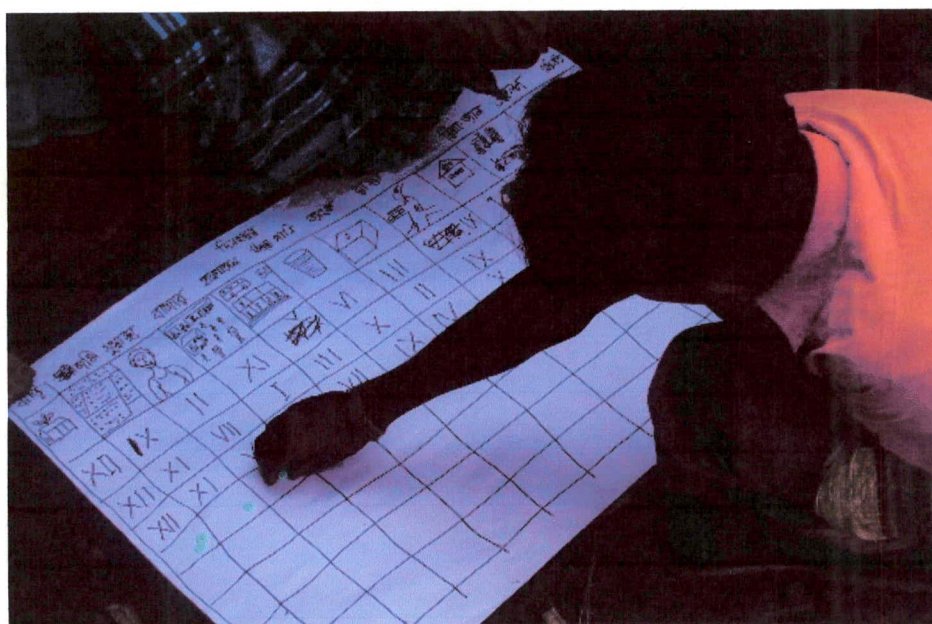


Figure-5.12 Matrix Ranking by the Laborer in Chander Chak

Table-5.1 Capital wise Livelihood Asset Distribution of Farmers Group

Capitals	Assets	Remarks
Natural	Crop, Ground Water, Land, Rainfall, Surface Water	Land is financial asset
Human	Education, Health, Skill	
Social	Cooperatives, Institutions	
Physical	Communications, Disaster Warning, Drainage, Electricity, Equipment, Irrigation, Road	
Financial	Credit, Savings, House Plot	

Table-5.2 Capital wise Livelihood Asset Distribution of Fisherman Group

Capitals	Assets	Remarks
Natural	Beel, Fish, Land, Rainfall	Works in field at offseason
Human	Education, Health, Skill	
Social	Cooperatives, Institute	
Physical	Communications, Disaster Warning, Electricity, Fishing Gear, Road,	
Financial	Credit, House Plot, Savings	

Table-5.3 Capital wise Livelihood Asset Distribution of Laborer Group

Capitals	Assets	Remarks
Natural	Beel, Land	Works in daily hire basis
Human	Education, Health	
Social	Cooperatives, Institute	
Physical	Communications, Disaster Warning, Electricity, Industry, Road, Transport, Work	
Financial	Credit, House Plot, Savings	

Table-5.4 Capital wise Livelihood Asset Distribution of Woman Group

Capitals	Assets	Remarks
Natural	Beel, Land	Works in field at harvesting
Human	Education, Health, Skill	
Social	Cooperatives, Institute	
Physical	Communications, Disaster Warning, Market, Water Point	
Financial	Credit, Savings	

In the FGD, a checklist formed by semi structured questions about the asset availability to the people was discussed and their replies were noted. Five options were placed for each question which represents their access to assets from very good access to very low access such as shown below:

Farmers:	How do you use the cultivable land?	Access status
	1. Cultivate your own land	Very good
	2. Share land to other people to cultivate	Good
	3. Cultivate other people's shared land	Moderate
	4. Work in the cultivable land	Low
	5. Do not work in the field	Very low
Fishers:	What is the condition of Beel Chachuri?	Access status
	1. Always can fish in the Beel	Very good
	2. Except few months they can fish	Good
	3. Only can fish in monsoon	Moderate
	4. Only few months they can fish	Low
	5. No water to fish at all	Very low
Labour:	What is your health condition?	Access status
	1. Very good health	Very good
	2. Good health	Good
	3. Moderate health	Moderate
	4. Bad health	Low
	5. Very bad health	Very low
Women:	Do you have any income generating activity?	Access status
	1. Own a cottage industry	Very good
	2. Work in a cottage industry	Good
	3. Sale handmade products	Moderate
	4. Only make garments for family	Low
	5. Do not make anything	Very low

Another set of FGD were conducted with the livelihood groups for discussing the RCM predicted climate in the study area and the local people's comments and observation about it.

Local people express their views and comments from their experiences with the help of different PRA (Participatory Rural Appraisal) tools such as trend line, mobility map, venn diagram, seasonal calendar, transect walk, daily routine, etc. The details of those activities are given below:

Trend Line:

Trend line was used for the farmers and fishermen to know the general tendency of the production of land and waterbody. The farmers were asked about the crop production per unit land in past, present and future condition of climate change and the trend line was drawn in paper. They also drew the trend line of irrigation cost ratio to the total production cost and irrigation frequency of Boro crop in winter. They explain the reasons of the trend as they understand and experienced in life. The fishermen drew the trend line of tentative number of different fishes they catch in past, present and future (from Figure-5.13 to 5.15)

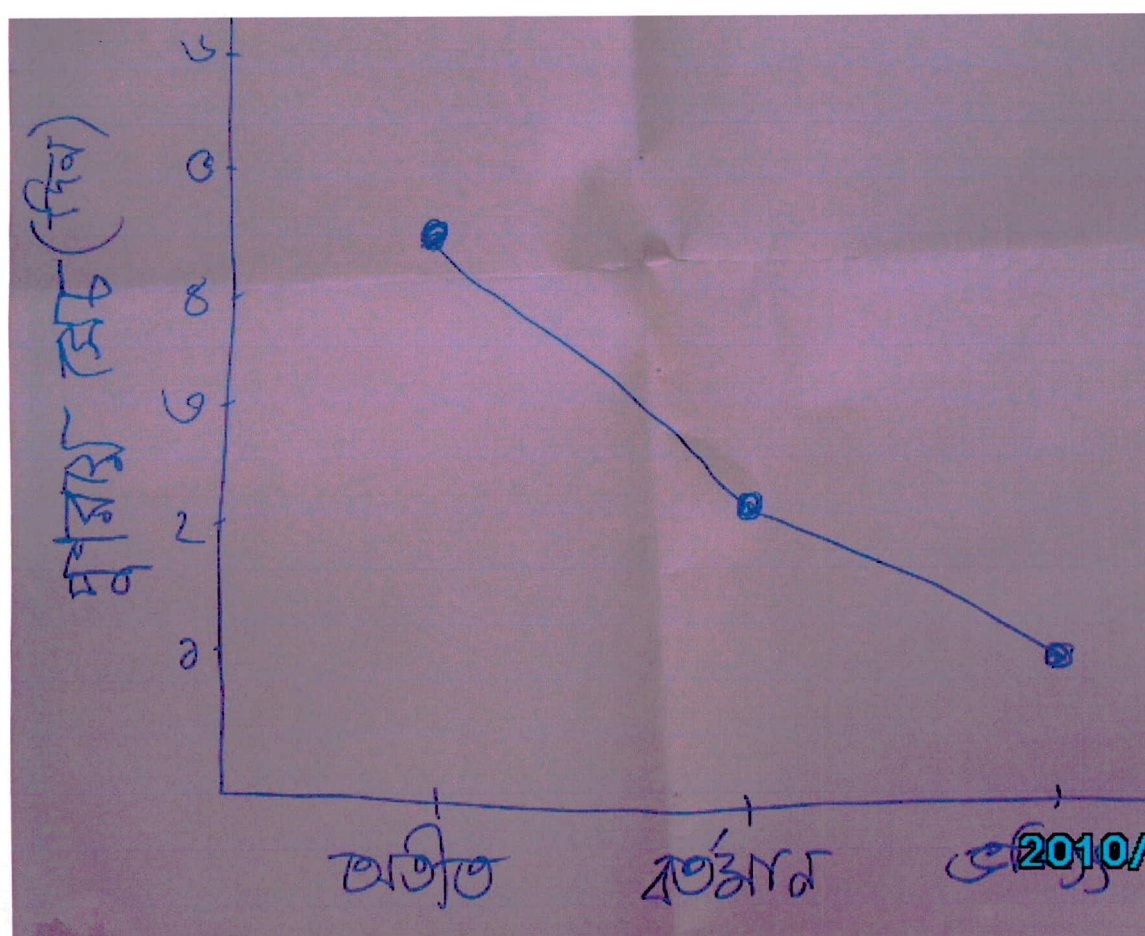


Figure-5.13 Trend line showing irrigation frequency in paddy field

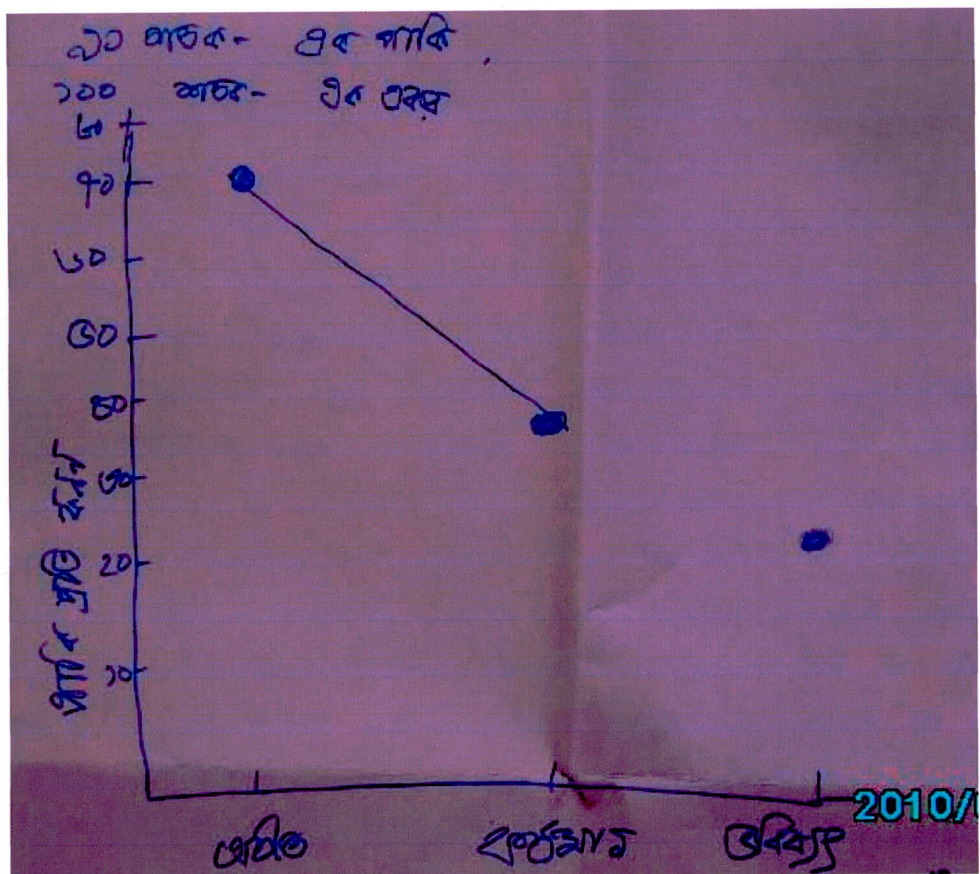


Figure-5.14 Trend line showing irrigation frequency in paddy field

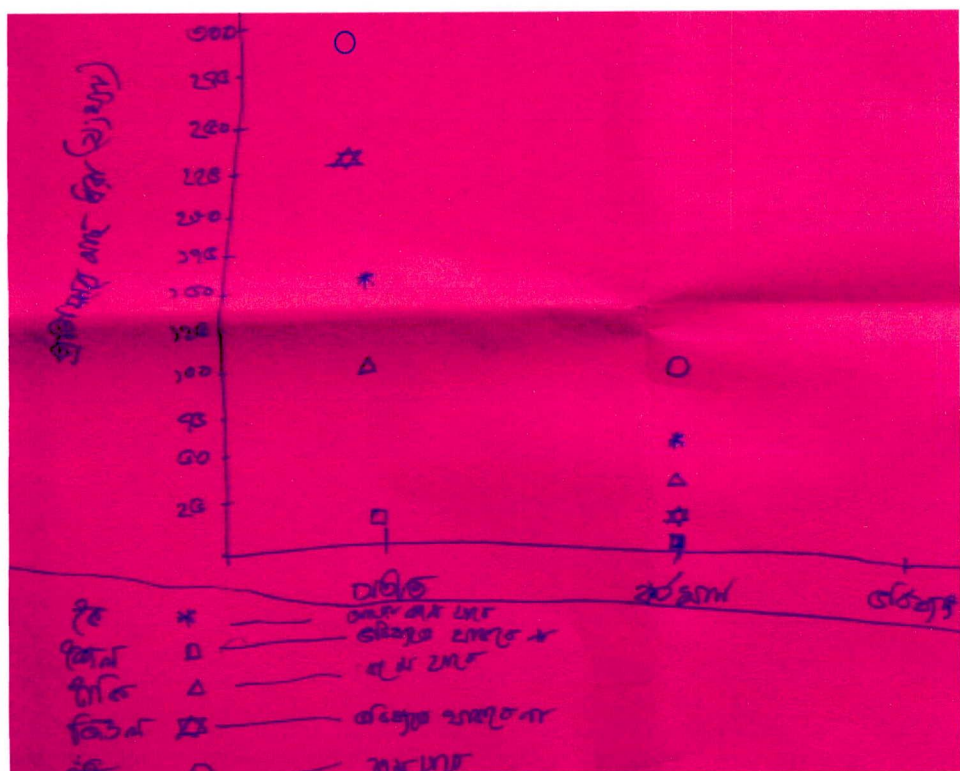


Figure-5.15 Trend line showing daily average captive fish in Beel Chachuri

Mobility Map:

Mobility map shows the internal and external movement of the local people for their livelihood activities. It shows their potentialities and extent of activities in and outside their locality. A mobility map of Chander Chalk village people were drawn with their information. Another mobility map was drawn having the affected mobility of the people due to damage due to flooding. The affected road link has been shown with red lines shown in Figure-5.16.

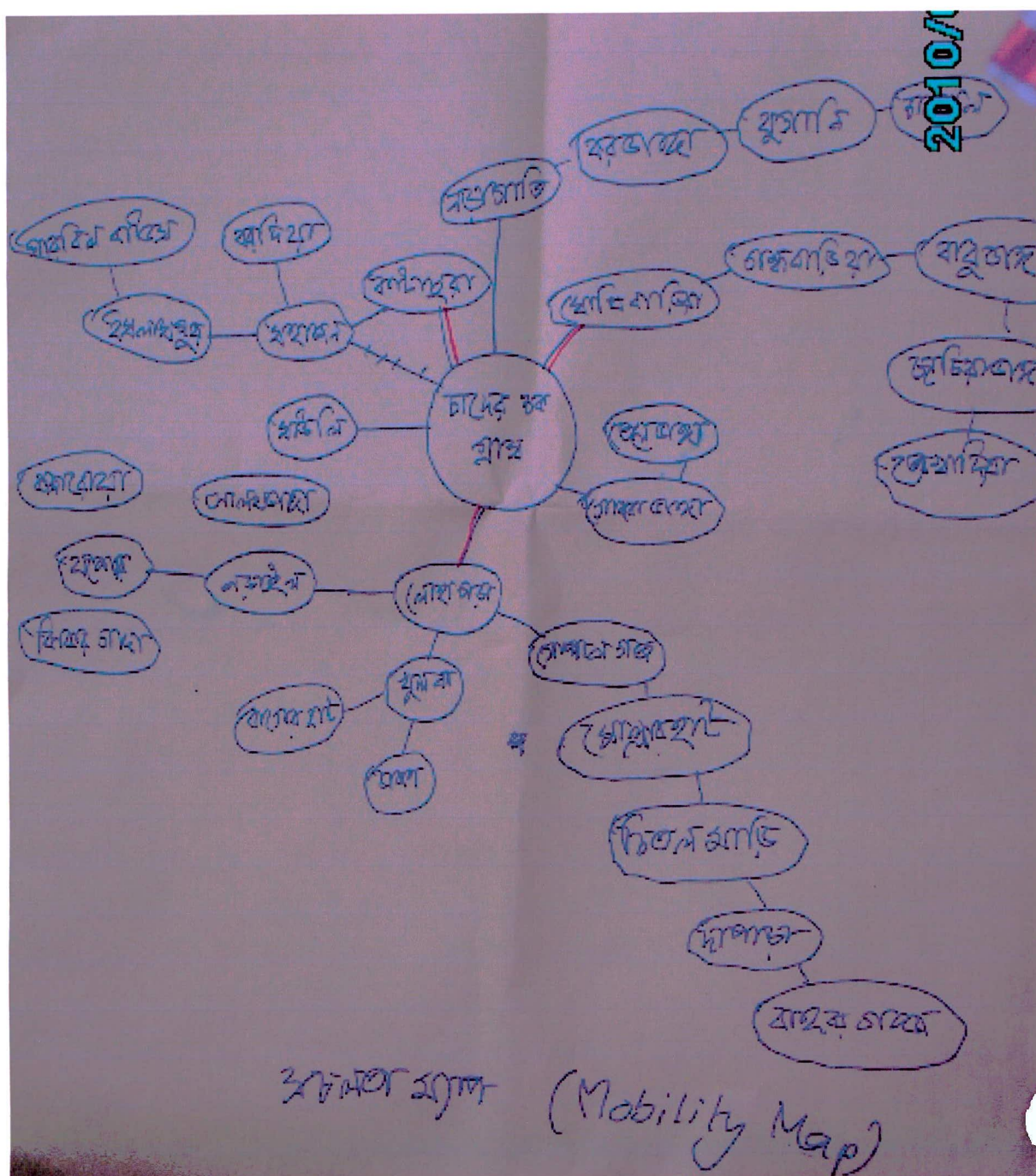


Figure-5.16 Mobility Map of Chander Chalk village

Venn Diagram:

A venn diagram shows the linkage and dependency of the rural people upon the different institutes and agencies. It's a simple pictorial view which shows the intimacy and gaps between people and institutions. For the study area, we have drawn two venn diagrams of the credit system, one for the recent time and other for the future time having climate change happened. This two diagrams shows the change in the credit system in the study area by the change of the venn sizes and their distances from the village shown in Figure-5.17 and 5.18

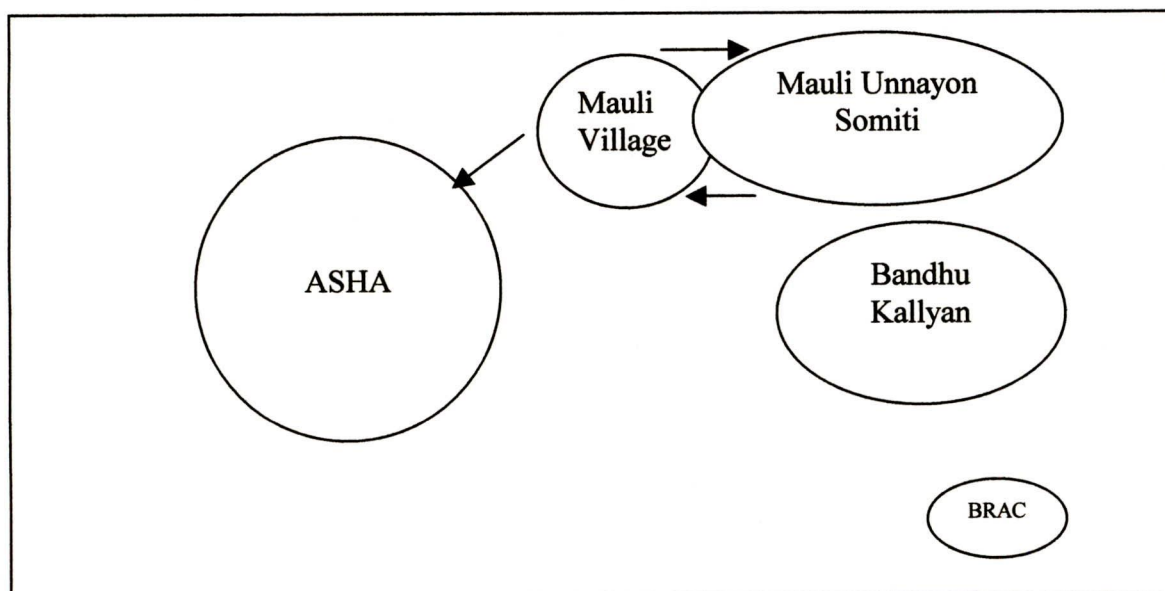


Figure-5.17 Credit system in Mauli village at present

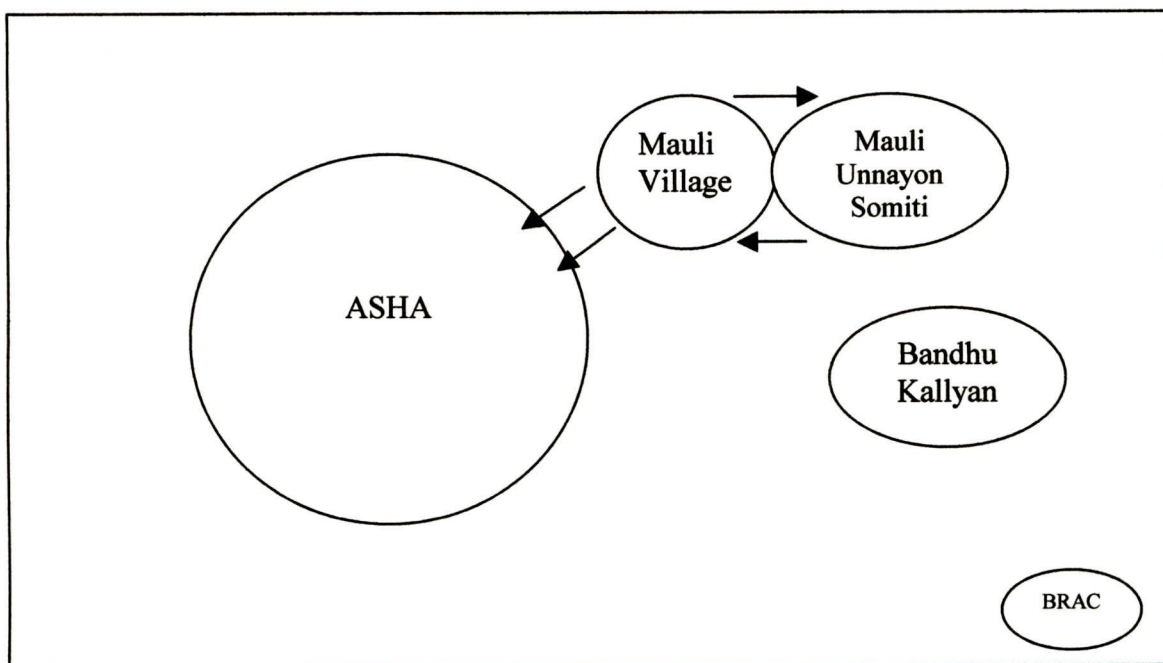


Figure-5.18 Credit system in Mauli village in future

Transect Walk:

It is a tool to draw the important features of a locality in a single direction across the village. It gives the damaged extent on the study area on different natural disasters and also gives idea about what to be done to overcome those situations (shown in Figure-5.19 to 5.22).

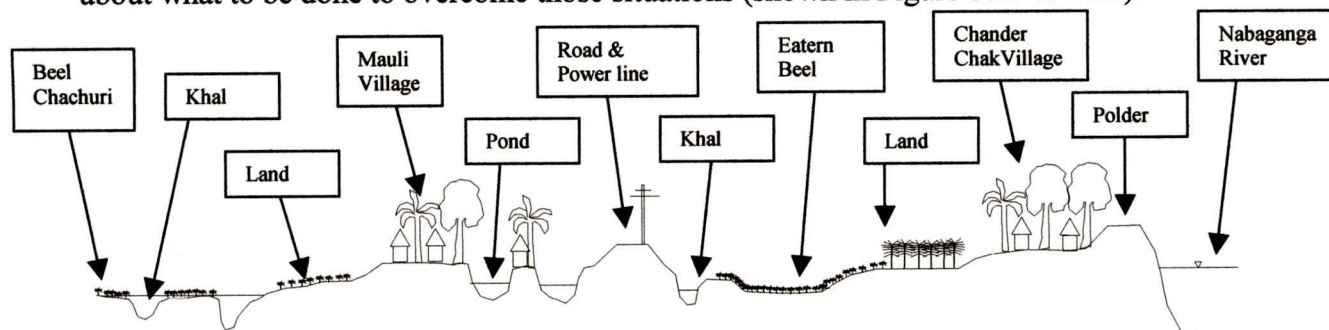


Figure-5.19 Transect Walk of the Study Area

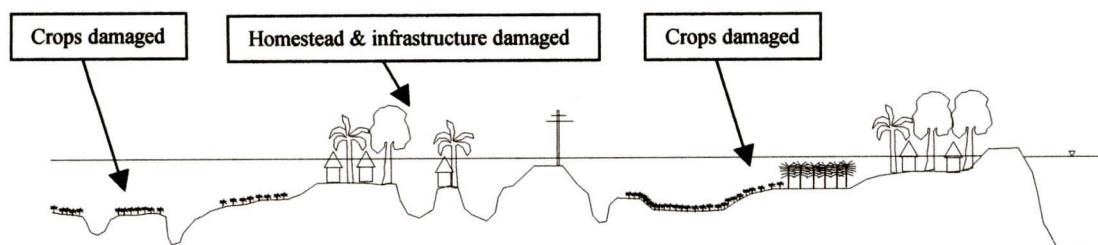


Figure-5.20 Transect walk during

flood in the study area

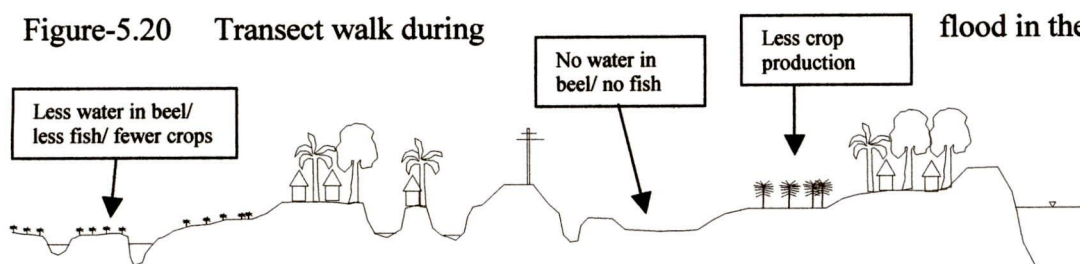


Figure-5.21 Transect walk during extended dry season in the study area

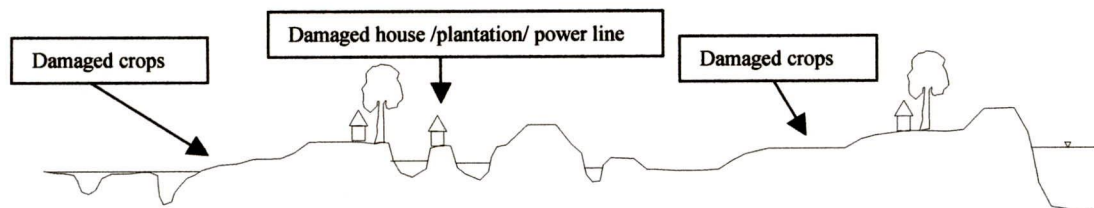


Figure-5.22 Transect walk of damages due to cyclone in the study area

Seasonal Calendar:

A seasonal calendar shows the different types of activities that people usually perform all the year round. It is done by dividing the year by individual months and indicating the activity ranges under the corresponding months. Three seasonal calendars have been made for the farmers, fishermen and the wage laborer that are shown below (from Table-5.5 to 5.10):

Table-5.5 Seasonal calendar of Farmers

Months	Baishakh	Jaistho	Ashar	Shrabon	Vadro	Ashin	Kartik	Agrohaon	Poush	Magh	Falgun	Chaitra
Activities	Iri Harvesting				Jute/ aush harvesting				Iri sowing			Iri Harvesting
		Jute/ Aush sowing			T Aman preparation & sowing			T Aman harvesting				
Irrigation with river water	Not useable		Useable								Not useable	

Table-5.6 Seasonal calendar of Farmers in Future

Months	Baishakh	Jaistho	Ashar	Shrabon	Vadro	Ashin	Kartik	Agrohaon	Poush	Magh	Falgun	Chaitra
Activities				Delay in Jute processing					Iri sowing			Less production of Iri due to lack of irrigation
	Jute/ Aush sowing				T Aman seed bed delay or barren land				T Aman harvesting			
Irrigation with river water	Not useable				Useable						Not useable	

Table-5.7 Seasonal calendar of Fisherman

Months	Baishakh	Jaistho	Ashar	Shrabon	Vadro	Ashin	Kartik	Agrohaon	Poush	Magh	Falgun	Chaitra
Activities	Work in paddy field	No Job										Work in paddy field
Diseases	Dihorhea/ Fever		Cold/ Pneomonea			Typhoed				Pox		

Table-5.8 Seasonal calendar of Fisherman in future

Months	Baishakh	Jaistho	Ashar	Shrabon	Vadro	Ashin	Kartik	Agrohaon	Poush	Magh	Falgun	Chaitra
Activities	Work in paddy field	No Job										Work in paddy field
Diseases	Dihorhea/ Fever extended		Cold/ Pneomonea			Typhoed				Pox		

Table-5.9 Seasonal calendar of Laborer

Months	Baishakh	Jaistho	Ashar	Shrabon	Vadro	Ashin	Kartik	Agrohaon	Poush	Magh	Falgun	Chaitra
Activities	Work in field	No Job		Work in field		Other job		Work in field		Other job		Work in field
Diseases	Dihorhea/ fever		Cold/ Pneomonea			Typhoed				Pox		

Table-5.10 Seasonal calendar of Laborer in future

Months	Baishakh	Jaistho	Ashar	Shrabon	Vadro	Ashin	Kartik	Agrohaon	Poush	Magh	Falgun	Chaitra
Activities	Work in field	No Job		Less work in field	Other job			Less work in field	Other job			Work in field
Diseases	Dihorhea/ fever extended			Cold/ Pneomonea		Typhoed				Pox		

Daily Routine:

Daily routine is used for a detail break up of peoples activities all the day. A daily routine was developed for the women group at Mauli village showing all the daily activities from dawn to dusk as shown in Figure-5.23.

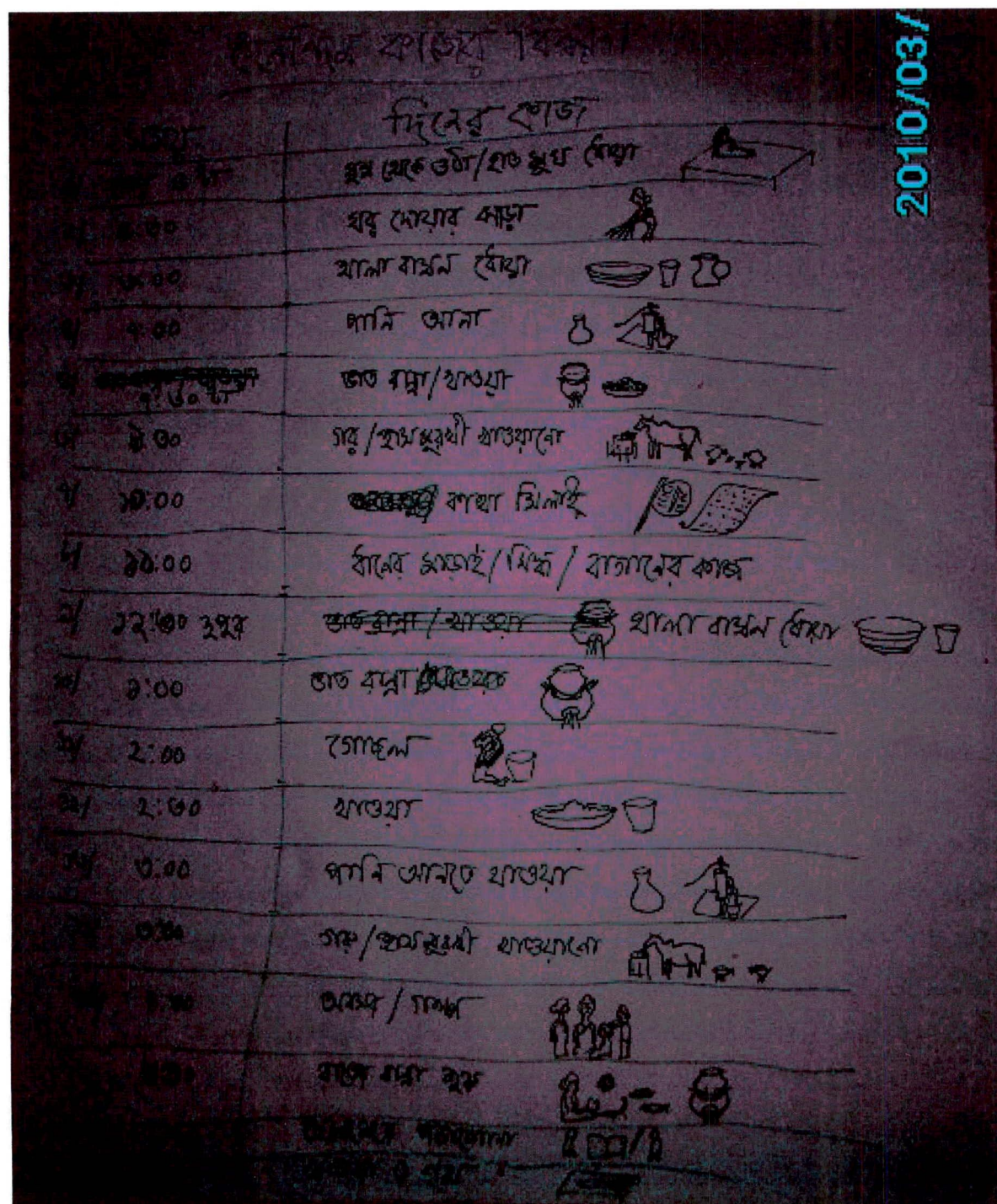


Figure-5.23 Daily Routine of Women in Mauli Village

Impact Diagram:

Impact diagram shows the inter relationship among the peoples livelihood activities with any particular object or phenomena. The climate change condition has been set in the centre and its impact has been drawn in this diagram with the help of local people's information. The diagram has been shown in Figure-5.24.

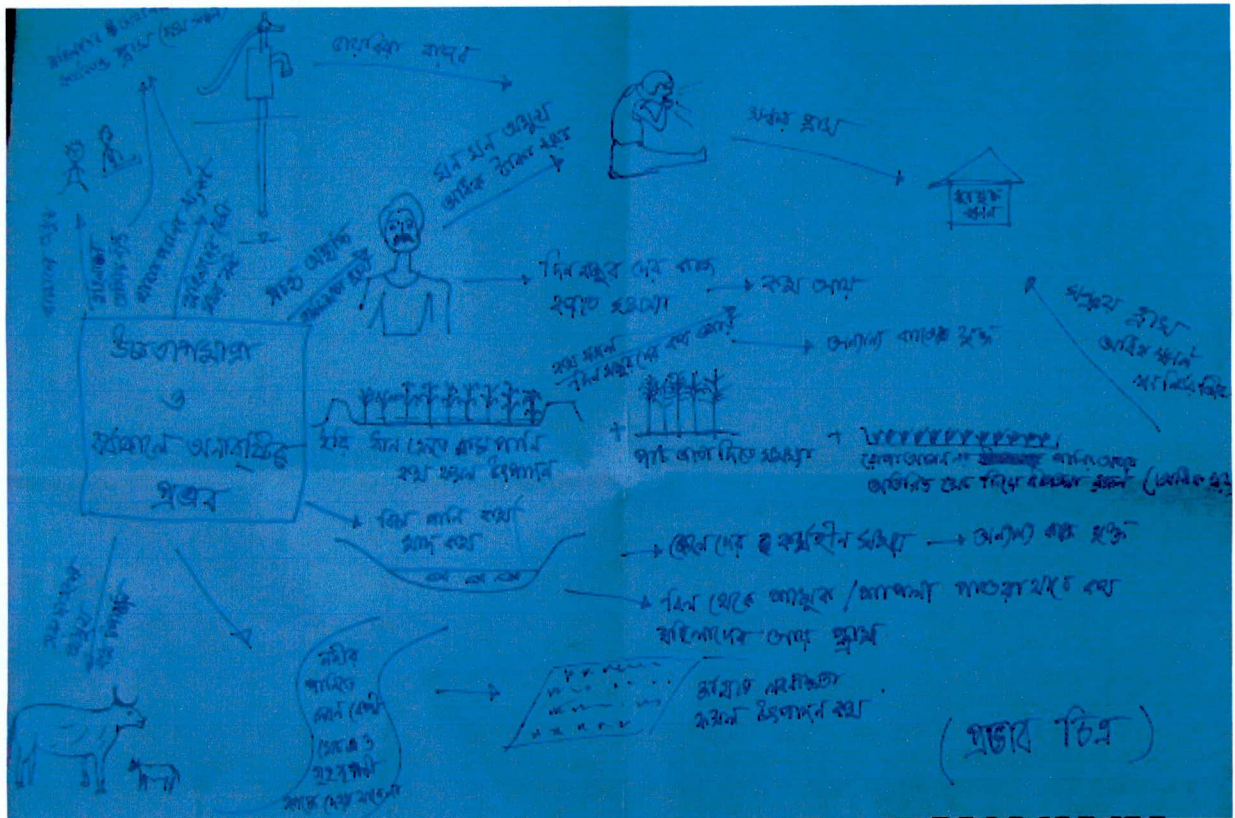


Figure-5.24 Impact Diagram of High Temperature and Less Monsoon Rainfall

Chapter 6 Prediction of Climate Change

6.1 Climate Model and Scenarios

PRECIS (Providing Regional Climates for Impacts Studies, pronounced pray-sea, i.e. as in French), has been developed at the Hadley Centre and is sponsored by the UK Department for Environment, Food and Rural Affairs (DEFRA), the UK Department for International Development (DFID) and the United Nations Development Programme (UNDP). PRECIS runs on a personal computer (PC) and comprises:

- An RCM that can be applied easily to any area of the globe to generate detailed climate change projections,
- A simple user interface to allow the user to set up and run the RCM, and
- A visualisation and data-processing package to allow display and manipulation of RCM output.

Usually the climate change is projected by applying the Global Climate Model (GCM) which analyzes the global changes within several hundreds of kilometers. But it does not capture the local details in environment comprising land and air. This is why Regional Climate Models have been developed and it can be applied in any location in globe. PRECIS is such type of flexible RCM which takes the geographical location, orbital positions in account and calculating the greenhouse gas emission amount according to Serial Report of Emission Scenario (SRES) of Inter-Continental Panel for Climate Change (IPCC), it delivers the impact on local weather and hydro-meteorological condition.

IPCC SRES has developed new emission scenarios, the so called "SRES scenarios". Emission scenarios are plausible representations of future emissions of substances that are radiatively active (i.e greenhouse gases) or which can affect constituents which are radiatively active (e.g. sulphur dioxide which forms sulphate aerosols). These are based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development and technological change) and their key relationships. The SRES scenario set comprises four scenario families: A1, A2, B1 and B2. The scenarios within each family follow the same picture of world development. The A1 family includes three groups reflecting a consistent variation of the storyline (A1T, A1FI and A1B). Hence, the SRES emissions scenarios consist of six distinct scenario groups, all of which are plausible and together capture the range of uncertainties associated with driving forces.

RCMs are full climate models and as such are physically based and represent most or all of the processes, interactions and feedbacks between the climate system components that are represented in GCMs. They take coarse resolution information from a GCM and then develop temporally and spatially fine-scale information consistent with this using their higher resolution representation of the climate system. In general they do not model oceans, as this would substantially increase the computing cost yet, in many cases, would make little difference to the projections over land that most impacts assessments require. The typical resolution of an RCM is about 50 km in the horizontal. It covers an area (domain) typically 5000 km x 5000 km, located over a particular region of interest. Figure-6.1(a) and (b) shows the regional climate model, PRECIS developed for the South-Asia region.

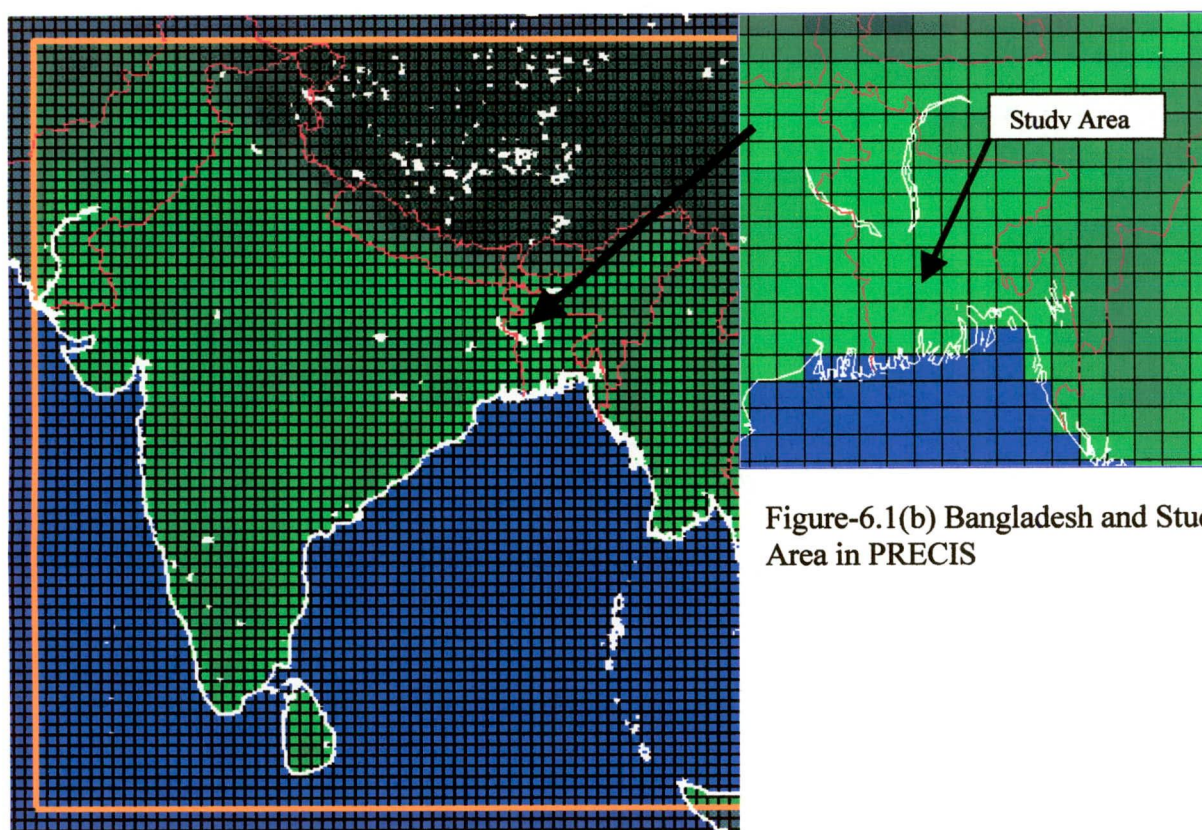


Figure-6.1(b) Bangladesh and Study Area in PRECIS

Figure-6.1(a) PRECIS model applied for South Asia Region

A PRECIS model has been developed and simulated for the South Asia region to facilitate this study with some model output regarding the predicted climatic condition in the study area (Narail). The results were extracted for the hydro-meteorological stations of Bangladesh. The simulation results for the three selected stations showing the predictions (from 1990 to 2090) of temperature & rainfall of above mentioned station are given below in Table-6.1 to Table-6.3:

Table-6.1(a) Jessore (Temperature)

Month	Station Mean	1990	2000	2010	2020	2030	2040	2050	2070	2080	2090
January	18.41	14.31	15.57	14.7	16.06	15.99	17.44	19.36	17.94	22.54	20.87
February	21.55	14.17	22.5	20.75	23.86	20.92	20.98	23.98	25.61	23.34	24.16
March	26.33	25.89	28.28	27	26.76	30.74	28.29	30.59	32.14	30.27	30.56
April	29.64	29.93	35.97	31.58	34.86	38.21	35.79	33.89	36.33	33.78	38.73
May	30.14	32.43	34.26	35.52	37.49	34.15	36.13	30.15	34.95	37.84	37.98
June	29.54	30.49	33.57	32.1	34.13	31.87	33.84	33.8	40.07	37.85	37.54
July	28.97	29.29	28.83	29.31	29.79	29.7	31.14	31.16	31.68	32.75	30.9
August	28.99	28.94	28.74	29.67	30.7	29.15	30.8	30.93	30.4	30.52	30.77
September	28.96	28.67	27.81	29.5	28.73	29.07	31.33	29.6	31.42	29.54	30.35
October	27.6	25.53	25.82	27.91	27.99	26.54	29.44	29.33	30.77	28.3	29.44
November	23.59	19.32	19.64	21.19	20.27	20.68	24.04	22.26	24.32	25.7	25.82
December	19.42	13.73	16.88	18.03	18.7	15.97	18.87	19.9	19.62	20.31	20.3

Table-6.1(b) Jessore (Rainfall)

Month	Station Mean	1990	2000	2010	2020	2030	2040	2050	2070	2080	2090
January	0.37	1.99	0.15	0.01	0.01	0.62	1.04	2.03	0.02	0.7	0.66
February	0.75	0.33	0.39	1.05	0.18	0.55	1.8	0.14	0.13	2.56	0.2
March	1.42	1.67	0.57	4.45	2.41	1.21	1.03	0.9	0.81	0.65	6.46
April	2.39	4.13	0.37	6.4	1.72	0.31	1.74	6.62	2.45	4.57	1.87
May	5.02	6.34	4.87	8.85	1.17	8.62	13.91	30.34	26.98	4.69	8.98
June	10.06	13.22	4.88	12.45	5.3	10.39	10.7	8	4.1	5.57	4.55
July	10.58	7.22	6.86	7.78	6.38	6.34	8.61	4.93	9.24	4.87	8.85
August	9.06	7.33	4.18	4.38	2.69	8.34	5.61	6.15	9.7	7.81	9.7
September	7.73	4.86	6.23	4.01	7.99	7.79	10.89	10.76	9.7	7.23	7.68
October	4.34	7.87	1.48	6.73	1.96	5.56	3.69	1.99	1.84	7.65	7.76
November	0.83	0.12	0.05	0.1	0.87	0.01	1.89	0.01	0.25	1.84	0.96
December	0.29	0.06	0.06	0.06	0.27	0.03	0.26	1.27	0.03	0.56	0

Table-6.2(a) Khulna (Temperature)

Month	Station Mean	1990	2000	2010	2020	2030	2040	2050	2070	2080	2090
January	19.38	14.51	15.85	14.92	16.37	16.53	17.94	19.79	18.2	22.98	21.11
February	22.5	14.47	22.4	21.16	24.13	21.23	21.47	24.01	25.77	23.63	24.55
March	26.93	25.98	28.38	27.25	27.23	30.16	28.53	30.63	31.99	30.47	30.36
April	29.47	29.81	35.14	31.56	34.21	37.65	35.38	33.92	36.24	33.79	37.98
May	29.99	32.05	33.97	35.36	36.72	33.88	36.04	30.46	34.74	38.09	37.77
June	29.48	30.77	33.92	32.18	34.55	31.42	34.04	34.19	39.67	37.86	37.07
July	28.88	28.7	28.6	29	29.34	29.14	30.88	30.59	31.47	32.03	30.58
August	29	28.58	28.28	29.17	30.01	28.79	30.32	30.55	30.08	30.02	30.46
September	29.04	28.21	27.48	28.83	28.29	28.82	30.95	29.3	31.12	29.26	30.04
October	27.93	25.46	25.74	27.69	28.06	26.22	29.1	28.79	30.42	28.23	29.18
November	24.58	19.34	19.59	21.23	20.27	20.61	24.01	22.25	24.11	25.84	25.91
December	20.56	14.04	17.07	18.42	19.08	15.96	19.11	19.89	19.5	20.46	20.58

Table-6.2(b) Khulna (Rainfall)

Month	Station Mean	1990	2000	2010	2020	2030	2040	2050	2070	2080	2090
January		1.85	0.33	0.01	0.01	0.68	0.97	1.3	0.04	1.34	0.54
February		0.73	0.34	1.24	0.29	2.01	1.84	0.21	0.22	1.72	0.23
March		1.81	0.45	2.97	2.12	1.44	0.92	0.84	0.79	0.61	6.8
April		3.57	0.38	6.35	1.86	0.24	2.18	5.98	2.27	4.06	0.73
May		4.02	3.37	7.31	0.98	6.96	9.18	29.81	23.65	3.21	6.63
June		10.58	4.34	14.77	3.9	8.56	10.48	7.68	6.13	6.19	5.52
July		7.57	8.57	8.15	7.63	7.82	8.57	5.1	9.61	4.55	11.37
August		7.07	6.14	5.27	2.84	9.34	5.94	6.87	11.76	9.4	10.62
September		4.72	7.34	5.47	8.02	8.66	9.17	9.73	10.38	7.55	7.62
October		7.97	1.49	5.9	1.73	5.49	3.6	1.83	1.66	6.87	7.28
November		0.1	0.08	0.04	1.17	0.01	0.71	0.02	0.15	1.62	0.36
December		0.05	0.04	0.06	0.22	0.03	0.34	1.63	0.01	0.48	0

Table-6.3(a) Madaripur (Temperature)

Month	Station Mean	1990	2000	2010	2020	2030	2040	2050	2070	2080	2090
January		14.79	15.69	14.87	16.46	16.36	17.91	19.76	18.2	22.69	21.15
February		14.64	21.76	20.82	23.67	21.14	21.12	23.99	25.63	23.56	24.55
March		25.41	27.73	26.8	26.78	29.36	27.88	30.41	31.12	30.01	29.79
April		29.1	33.76	30.43	32.73	36.44	33.86	32.59	34.63	32.72	36.48
May		30.73	33.27	33.96	35	33	34.49	29.91	33.63	36.24	36.75
June		30.09	32.86	31.65	33.49	31.16	33.16	33.3	38.34	36.74	36.12
July		28.48	28.23	28.78	28.9	29.09	30.42	30.29	31.05	31.69	30.3
August		28.34	28.09	28.97	29.72	28.58	30.18	30.27	29.9	29.77	30.29
September		28.09	27.28	28.68	28.17	28.63	30.84	29.04	30.83	29.04	29.83
October		25.42	25.78	27.57	28.05	26.26	28.86	28.74	30.29	27.96	29.2
November		19.45	19.91	21.35	20.09	21.03	23.92	22.71	24.04	25.89	26.63
December		14.04	17.5	18.28	18.88	16.23	19.24	20	19.68	20.83	20.95

Table-6.3(b) Madaripur (Rainfall)

Month	Station Mean	1990	2000	2010	2020	2030	2040	2050	2070	2080	2090
January	0.22	2.47	0.41	0	0.01	0.74	1.93	1.24	0.06	2.5	0.4
February	0.9	0.86	0.33	1.4	0.39	1.99	2.21	0.37	0.3	1.49	0.35
March	1.78	2.29	0.62	3.75	2.26	1.51	1.19	0.98	0.92	0.83	6.11
April	4.47	4.38	0.84	9.34	3.08	0.56	3.18	8.3	4.58	4.7	0.95
May	7.96	4.5	3.07	9.79	1.88	7.46	13.7	44.33	21.05	4.52	7.26
June	12.82	14.76	4.98	14.5	5.6	10.13	14.65	8.26	6.54	7.31	6.43
July	12.71	6.86	8.41	7.41	7.02	7.45	9.79	5.46	10.39	5.09	11.16
August	10.89	7.15	5.95	4.5	2.65	9.82	5.71	8.27	9.98	7.84	10.38
September	9.31	4.53	7.1	5.72	8.08	7.33	11.07	10.37	10.25	6.45	7.54
October	5.12	8.26	0.93	3.75	1.8	6.69	2.99	1.96	1.78	9.17	7.42
November	1.21	0.1	0.21	0.02	1.15	0.01	0.85	0	0.16	1.63	0.38
December	0.16	0.05	0.03	0.06	0.17	0.01	0.19	2.06	0.02	0.4	0.01

6.2 PRECIS Predictions

A statistical analysis has been done with the simulated temperature and rainfall data to find the future trend. The correlation and trend has been shown below in Figure-6.2 to Figure-6.13.

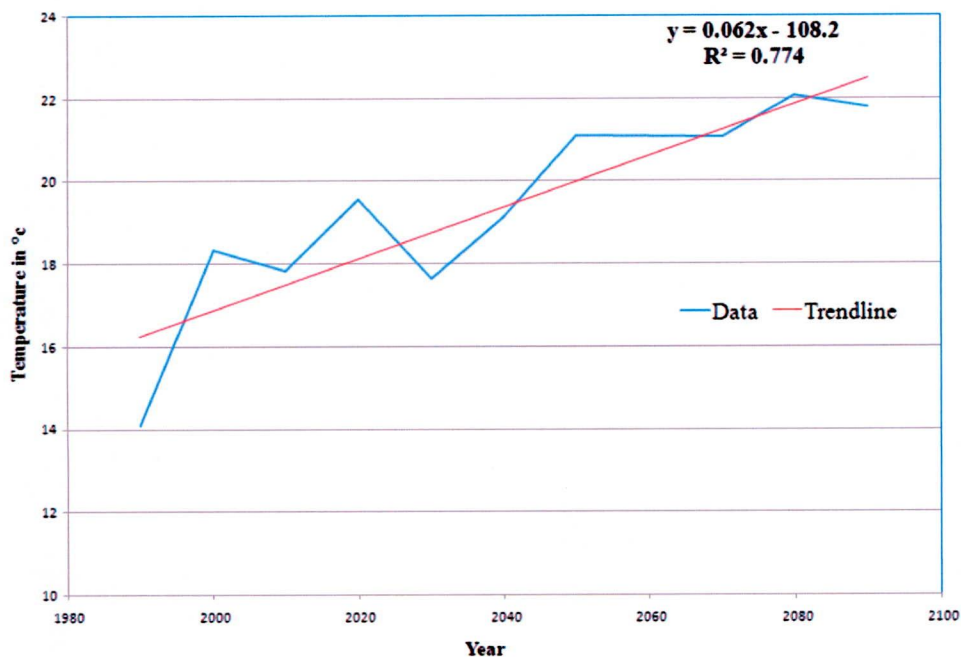


Figure-6.2 Predicted Average Winter Temperature of Jessore

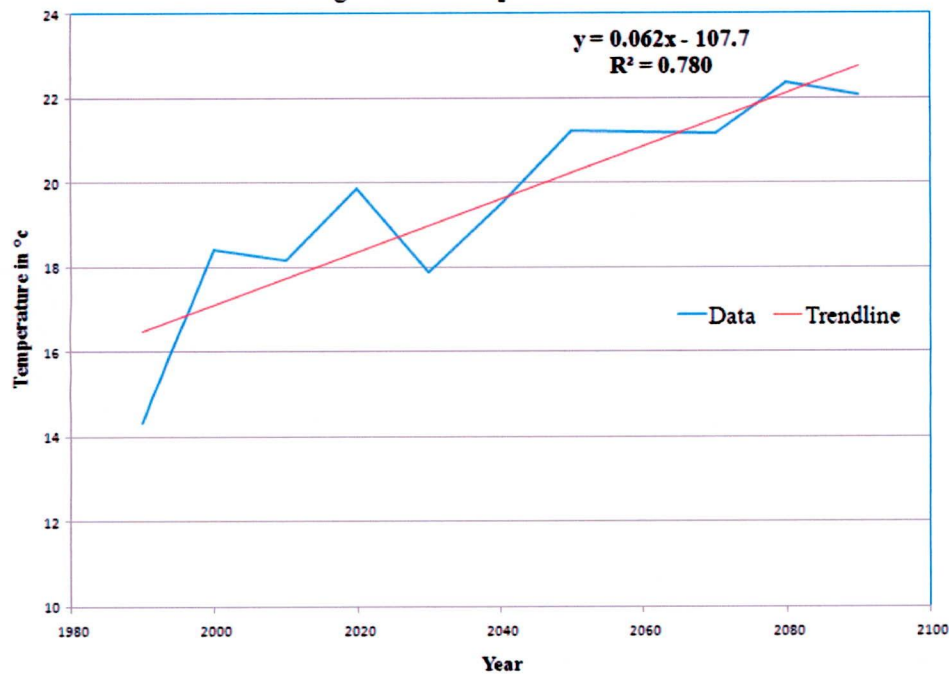


Figure-6.3 Predicted Average Winter Temperature of Khulna

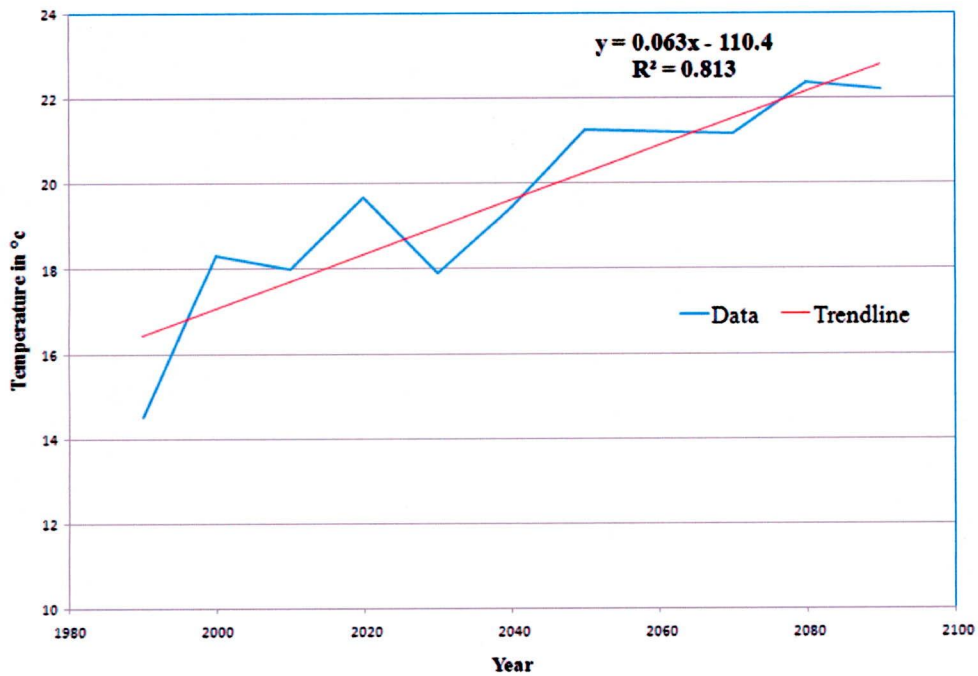


Figure-6.4 Predicted Average Winter Temperature of Madaripur

The temperature during winter season is found to be increasing very significantly in all three stations. Last sixty years in Bangladesh, the temperature in winter has also increased more than the summer (Islam 2002). The similar trend is found here in RCM prediction.

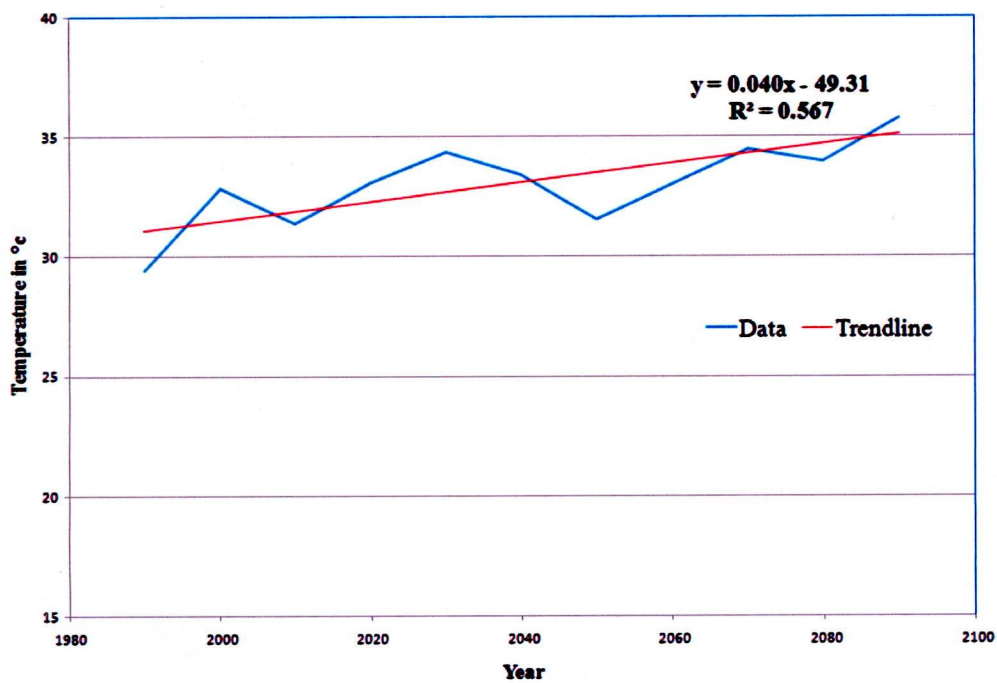


Figure-6.5 Predicted Average Summer Temperature of Jessore

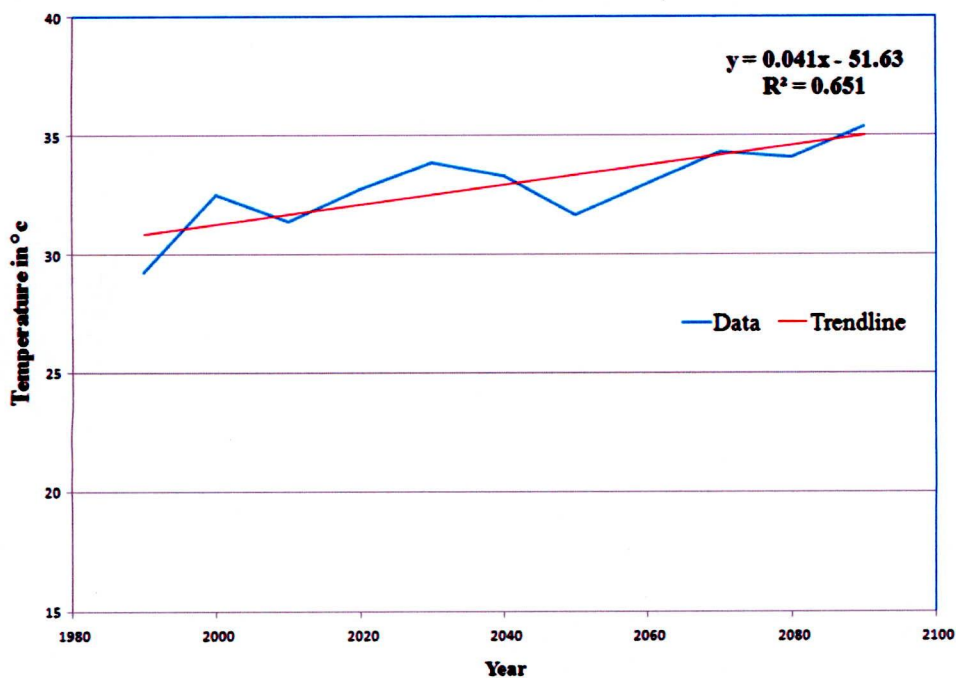


Figure-6.6 Predicted Average Summer Temperature of Khulna

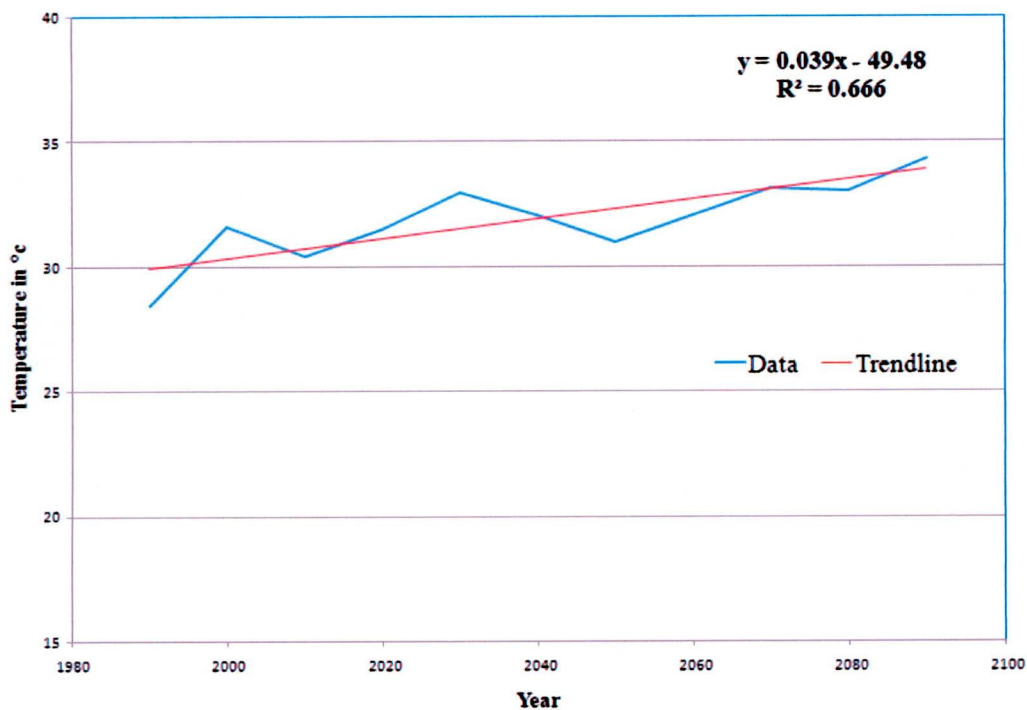


Figure-6.7 Predicted Average Summer Temperature of Madaripur

The temperature in summer (March-May) has a positive trend but not as high as the winter temperature. But, this is enough to hamper the crop production in the study area by increasing crop water requirement, lowering ground water table and creating unfavorable weather for the local people.

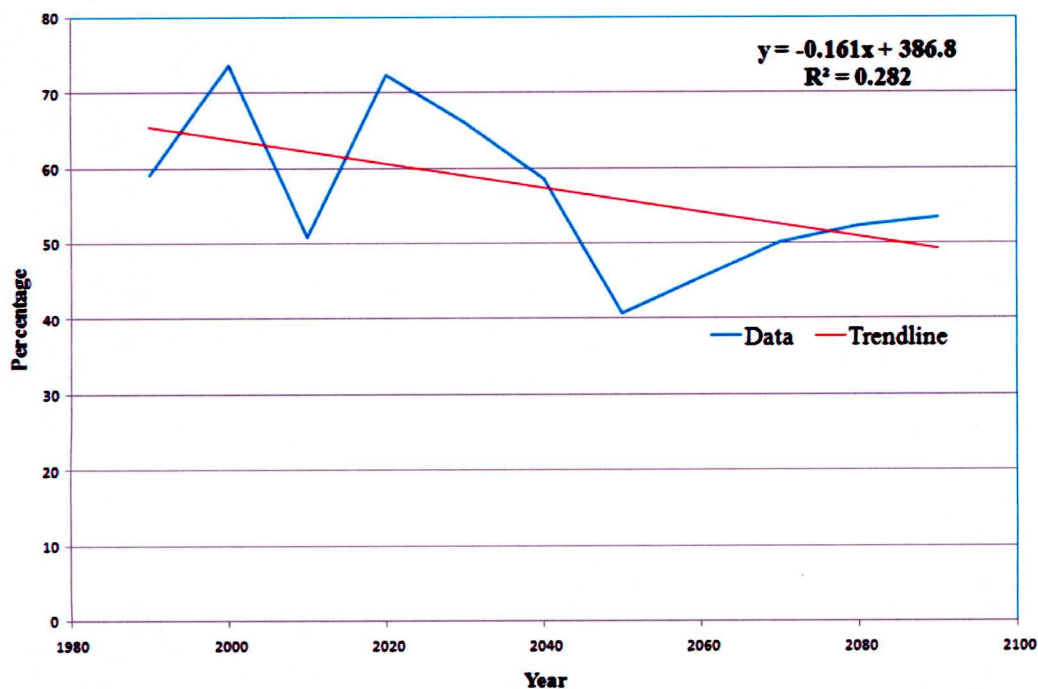


Figure-6.8 Predicted Monsoon Rainfall as Percentage of Annual Rainfall of Jessore

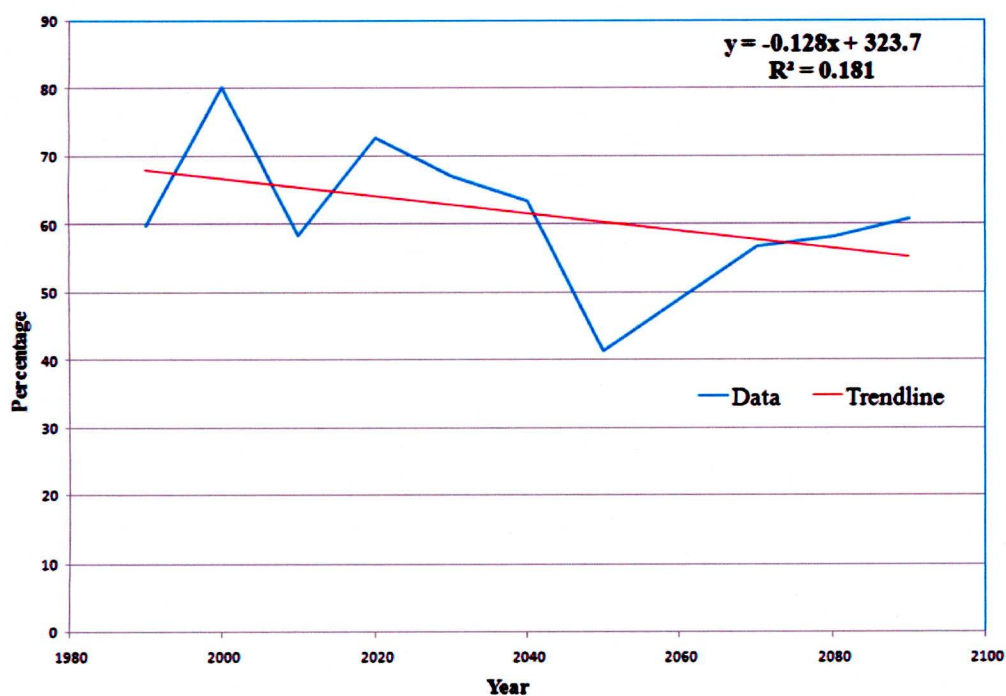


Figure-6.9 Predicted Monsoon Rainfall as Percentage of Annual Rainfall of Khulna

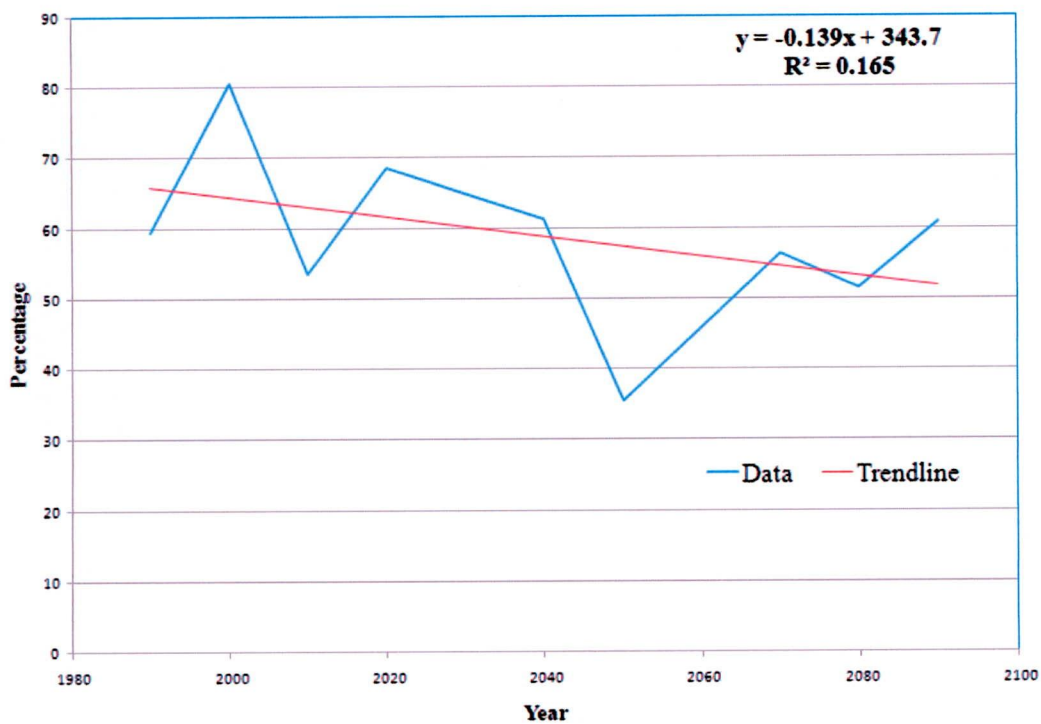


Figure-6.10 Predicted Monsoon Rainfall as Percentage of Annual Rainfall of Madaripur

The monsoon rainfall in the study area is found to be gradually declining with respect to time. The monsoon period (June-September) usually has the 80% of the total rainfall in Bangladesh. But, this is gradually declining to 70%-60% which would be affecting the rural people very badly in their livelihoods.

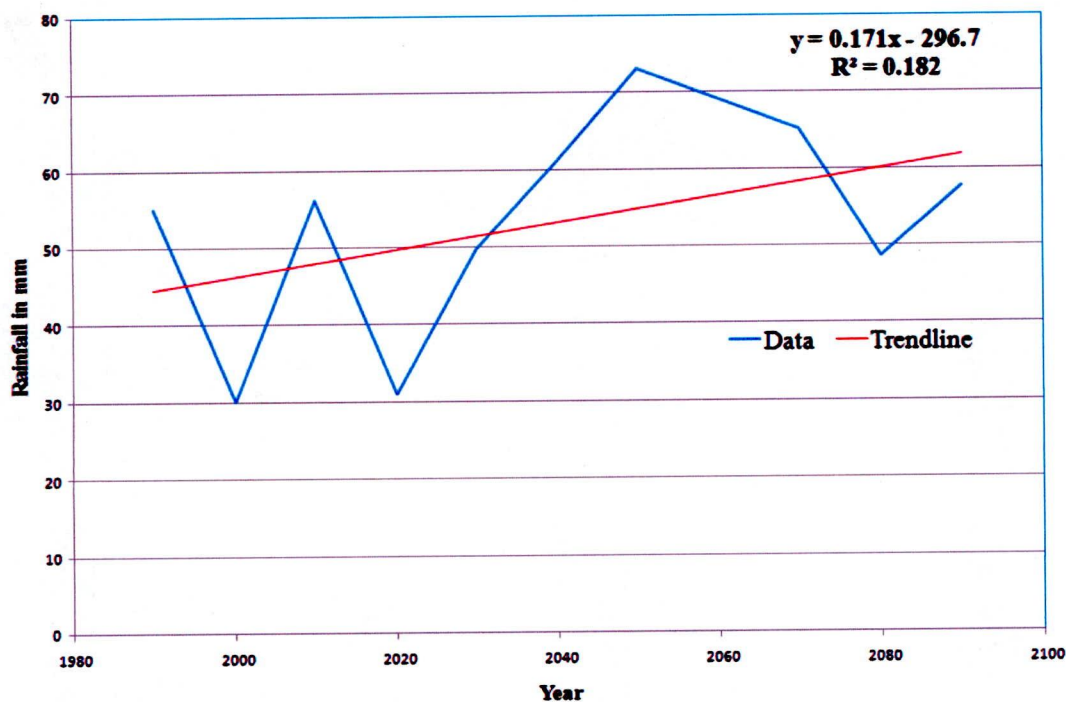


Figure-6.11 Predicted Annual Rainfall of Jessore

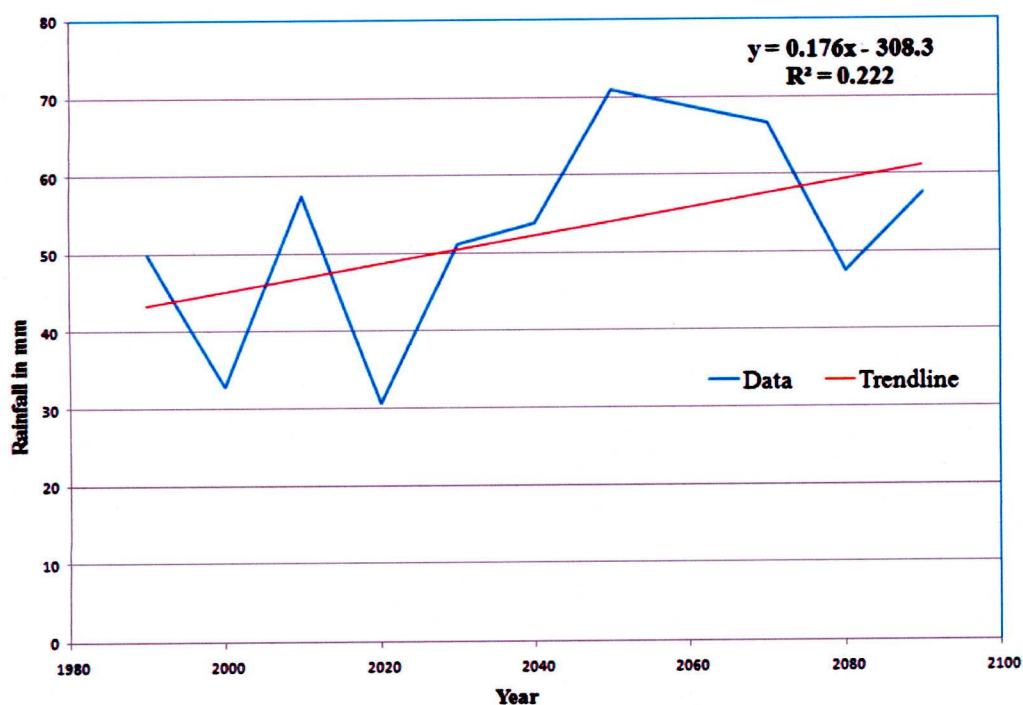


Figure-6.12 Predicted Annual Rainfall of Khulna

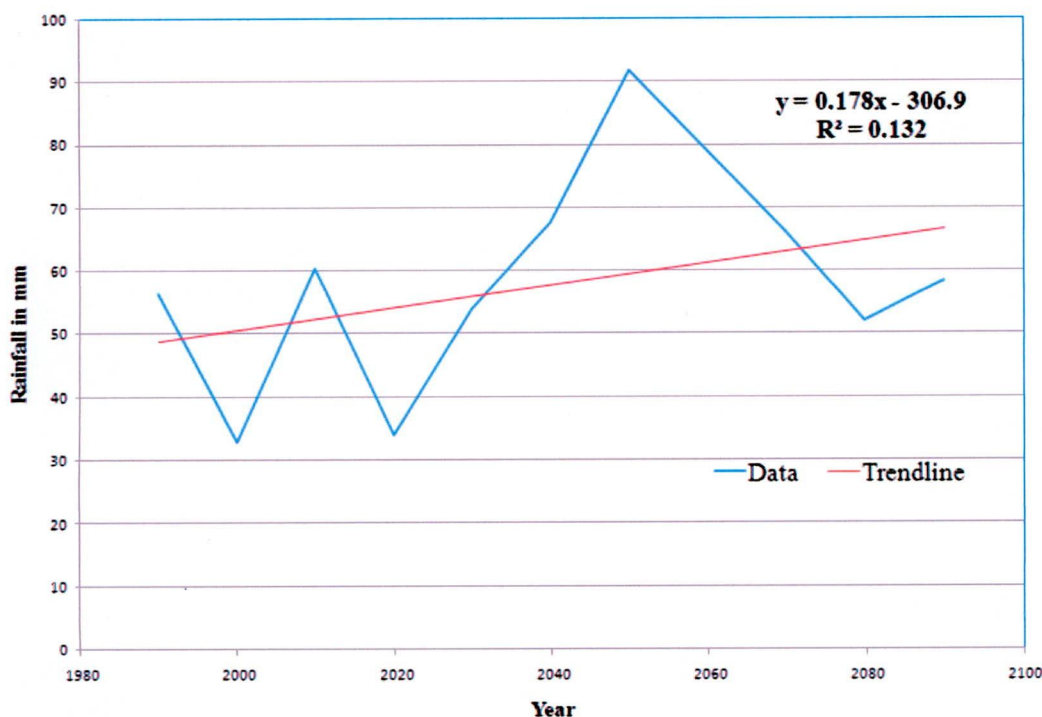


Figure-6.13 Predicted Annual Rainfall of Madaripur

The annual rainfall in all three stations is found to be increased whereas the monsoon rainfall is reducing. It means the erratic rainfall will occur in coming days. Wet season will be drier and dry seasons will be wet in future. After mid century, the total precipitation has gone down little bit as the fast economic and population growth was considered to be low after mid century in A1B scenario.

7 Result Analysis

7.1 Asset Accessibility by the Rural People

The local people provided information about their access to the livelihood assets by replying the semi structured questions in the first focus group discussion. Their answers were scaled within the range of very good access to very low access (very good access = 1 and very low access = 0). The findings of the focus group discussion are shown in Table-7.1 to Table-7.4:

Capitals	Farmer Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Crop	60	0.86	0.15
	G Water	69	0.92	0.18
	S Water	61	0.60	0.10
	Land	103	0.76	0.22
	Rain	62	0.60	0.10
	Total			0.75
Human	Education	51	0.90	0.22
	Health	113	0.80	0.43
	Skill	44	0.64	0.14
	Total			0.79
Social	Cooperatives	39	0.62	0.38
	Institutes	24	0.74	0.28
	Total			0.67
Physical	Communication	20	0.90	0.05
	Disaster Warning	35	0.82	0.07
	Irrigation-Drainage	60	0.68	0.11
	Electricity	43	0.78	0.09
	Equipment	91	0.84	0.20
	Road	87	0.60	0.13
	Market	52	0.84	0.11
	Total			0.76
Financial	Credit	12	0.60	0.05
	Savings	35	0.66	0.14
	House	113	0.76	0.54
	Total			0.73

Table-7.1 Asset Access of Farmer Group

Capitals	Fisherman Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Beel	90	0.72	0.21
	Fish	76	0.64	0.16
	Land	83	0.54	0.15
	Rain	60	0.66	0.13
	Total			0.64
Human	Education	30	0.70	0.16
	Health	63	0.60	0.28
	Skill	40	0.62	0.19
	Total			0.63
Social	Cooperatives	50	0.60	0.34
	Institutes	39	0.72	0.32
	Total			0.65
Physical	Communication	35	0.84	0.09
	Disaster Warning	38	0.90	0.11
	Electricity	64	0.84	0.17
	Fishing Gear	76	0.66	0.16
	Road	35	0.60	0.07
	Market	70	0.82	0.18
	Total			0.77
Financial	Credit	23	0.76	0.12
	Savings	37	0.32	0.08
	House	83	0.64	0.37
	Total			0.58

Table-7.2 Asset Access of Fisherman Group

Capitals	Laborer Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Land	66	0.34	0.22
	Beel	35	0.40	0.14
	Total			0.36
Human	Education	40	0.84	0.42
	Health	40	0.62	0.31
	Total			0.73
Social	Cooperatives	19	0.52	0.22
	Institutes	26	0.62	0.36
	Total			0.58
Physical	Market	16	0.80	0.05
	Communication	35	0.84	0.11
	Disaster Warning	38	0.82	0.12
	Electricity	45	0.74	0.13
	Industry	41	0.62	0.10
	Road	50	0.62	0.12
	Work	39	0.76	0.11
	Total			0.73
Financial	Credit	18	0.76	0.11
	Savings	40	0.32	0.11
	House	61	0.70	0.36
	Total			0.58

Table-7.3 Asset Access of Laborer Group

Capitals	Woman Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Land	20	0.26	0.08
	Beel	48	0.70	0.49
	Total			0.57
Human	Education	43	0.72	0.20
	Health	66	0.62	0.27
	Skill	44	0.40	0.12
	Total			0.58
Social	Cooperatives	20	0.20	0.07
	Institutes	35	0.60	0.38
	Total			0.45
Physical	Communication	25	0.90	0.17
	Disaster Warning	34	0.80	0.21
	Market	50	0.80	0.31
	Water pt	22	0.86	0.14
	Total			0.83
Financial	Credit	28	0.70	0.28
	Savings	42	0.36	0.22
	Total			0.50

Table-7.4 Asset Access of Woman Group

To view the capitals for each group in a frame to indicate the accessibility of the groups to the capitals, the livelihood pentagons of are drawn below in Figure-7.1:

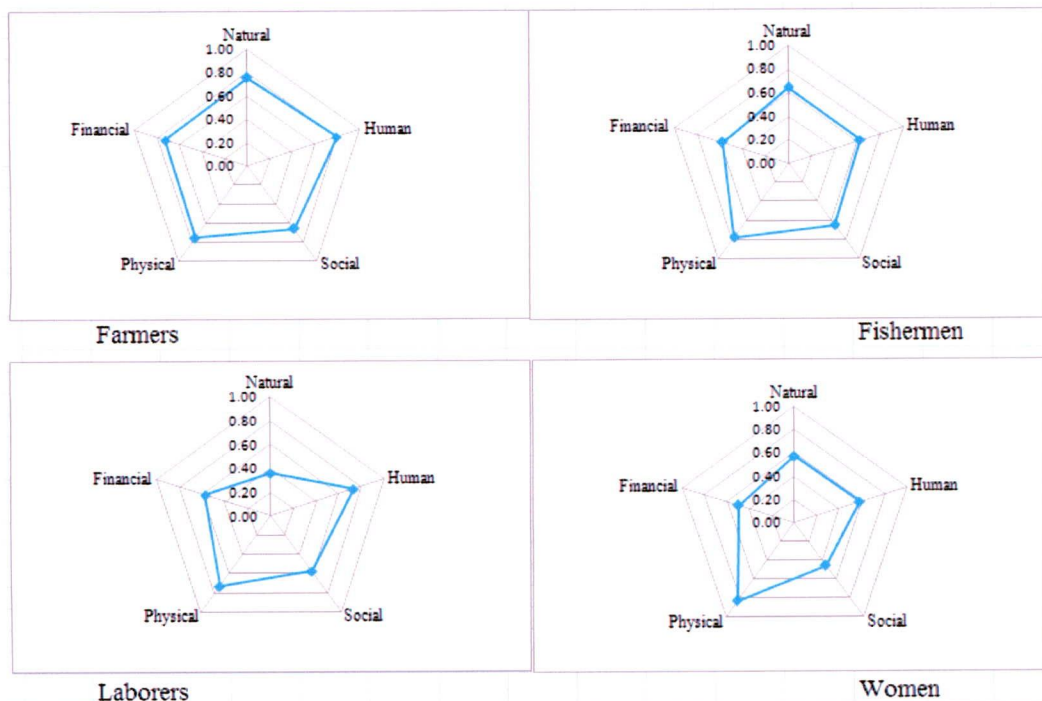


Figure-7.1 Livelihood Pentagon of Four Groups

7.2 Impacts of Climate Change on Livelihood Assets

The impacts of climate change scenario on the rural livelihoods have been assessed through the impacts on the assets or asset indicators. Those impacts were identified from discussion with the local people and previous studies also. A list of affected asset indicators due to climate change has been done for the study area in Narail and has been shown below in Table-7.5:

1. Land

The land is an important asset in rural Bangladesh. Almost every rural people directly or indirectly involved with agricultural activities. In the study area, the gradually changing climate is reducing the productivity. According to the farmer of Chander chak village, the productivity has reduced from 70 mounds to 40 mounds per unit land (Paki) for the Borro crop. They informed that if the climate change continues, it could be around 30 mounds per paki (90 decimile = 1 paki), 25% reduction in the assets access.

2. Beel

The study area is covers a large portion of beel chachuri which has link with another little beel in the eastern side. The beel chachuri is a vast resource of natural asset in the study area. The hot weather and delayed monsoon have affected these two water body and the fishing period has shrunk from 8 months to 6 months. Along with fishing, other productive materials like shapla and shamuk are getting scarce gradually which are a source of income of the rural women.

3. Health

Rural people usually has good health condition as they live in a fresh and pollution free environment. But, they suffers from diseases like diarrhea, cholera, fever, pox, etc. by the changes of seasons. If the hot weather continues in future, the diarrhea, cholera, fever will be extended than the usual time and vector borne diseases will increase.

4. Crop

They are struggling with Kharib-2 crop (T Aman). Delayed monsoon has affected the seed bed of T Aman. Even, some farmers left their land barren in these circumstances. If the

temperature increase and rain delayed continues more in future, they have to be satisfied with only 2 crops in a year. The crop intensity will reduced by 30 percent in future.

5. Fish

Fishing activity is a big event in our country. The fishermen of the study area use to fish in Beel chachuri. They showed in a trend line diagram that all sorts of fishes are becoming less in numbers. Koi, Taki, Puti, shoil Jiol, etc. are now available in the beel but Shoil and Jeol will be lost from the beel if the rainless monsoon and hot weather continues. More than 40% of fish diversity will be lost from the water body near Mauli and Chander chak village.

6. Work Volume

The wage laborers are very much dependent on the agricultural activities. As the farmers are struggling against climate change, the laborers are also victim. Now in kharib-2 season, they live in uncertainly whether they could manage work in the field or not. In future, they have to pass idle time as the T Aman crop is not cultivated. Almost 25 percent of work load will be reduced and they have to go outside for other works.

7. Crop Water Requirement

The crop water requirement of the study area has increased in any season. According to the farmers, they have to irrigate the field in every alternate days whereas they irrigated the land once in 4/5 days in past. If these situation continues, they have to irrigate the land on every day after sowing the Boro crop (shown in trendline diagram).

8. Surface Water

The surface water is a great source of irrigation water in the study area. But this water is gradually getting saline and unusable for irrigation and other household works. Now they can irrigate the land with water from Nabaganga river around 8 months in a year. According to the farmer, If the monsoon rain is delayed the salinity will exist in the river water for more couple of months (shown in seasonal calender).

9. Savings

The overall living expenses will increase as the rural people will face more diseases. The agricultural activity will be more expensive as the natural water will be scared and costly.

The income generating activity will be reduce as they have to be more busy with children and drinking water hunt. This will reduce their earning and savings.

10. Road and Communication

The road network of the study area is not so developed. They have only one pucca road passing through the Mauli and Chander chak village. All other roads are earthen and unusable in any disaster period. In the mobility map, the people showed the 75 percent road network will be disconnected if a medium level flood occurs in the study area.

The impact of all these assets has been incorporated to the livelihood pentagon and the revised pentagon was drawn as shown in Figure-7.2. The revised tables are given in Table-7.5 to 7.8.

Capitals	Farmer Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Crop	60	0.60	0.10
	G Water	69	0.60	0.12
	S Water	61	0.40	0.07
	Land	103	0.60	0.17
	Rain	62	0.50	0.09
	Total			0.55
Human	Education	51	0.90	0.22
	Health	113	0.60	0.33
	Skill	44	0.50	0.11
	Total			0.65
Social	Cooperatives	39	0.62	0.38
	Institutes	24	0.74	0.28
	Total			0.67
Physical	Comm	20	0.70	0.04
	Dis Warn	35	0.82	0.07
	Infrastr	60	0.68	0.11
	Electricity	43	0.60	0.07
	Equipment	91	0.84	0.20
	Road	87	0.20	0.04
	Market	52	0.84	0.11
	Total			0.64
Financial	Credit	12	0.60	0.05
	Savings	35	0.20	0.04
	House	113	0.60	0.42
	Total			0.51

Table-7.5 Revised Asset Access of Farmer Group

Capitals	Fisherman Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Beel	90	0.50	0.15
	Fish	76	0.40	0.10
	Land	83	0.40	0.11
	Rain	60	0.50	0.10
	Total			0.45
Human	Education	30	0.70	0.16
	Health	63	0.40	0.19
	Skill	40	0.40	0.12
	Total			0.47
Social	Cooperatives	50	0.40	0.22
	Institutes	39	0.72	0.32
	Total			0.54
Physical	Comm	35	0.60	0.07
	Dis Warn	38	0.90	0.11
	Electriccity	64	0.60	0.12
	Fish Gear	76	0.66	0.16
	Road	35	0.20	0.02
	Market	70	0.82	0.18
	Total			0.65
Financial	Credit	23	0.76	0.12
	Savings	37	0.20	0.05
	House	83	0.50	0.29
	Total			0.47

Table-7.6 Revised Asset Access of Fisherman Group

Capitals	Laborer Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Land	66	0.20	0.13
	Beel	35	0.20	0.07
	Total			0.20
Human	Education	40	0.84	0.42
	Health	40	0.40	0.20
	Total			0.62
Social	Cooperatives	19	0.52	0.22
	Institutes	26	0.62	0.36
	Total			0.58
Physical	Market	16	0.80	0.05
	Comm	35	0.70	0.09
	Dis Warn	38	0.82	0.12
	Electricity	45	0.60	0.10
	Industry	41	0.62	0.10
	Road	50	0.20	0.04
	Work	39	0.60	0.09
	Total			0.58
Financial	Credit	18	0.76	0.11
	Savings	40	0.11	0.07
	House	61	0.50	0.26
	Total			0.44

Table-7.7 Revised Asset Access of Laborer Group

Capitals	Woman Group Assets	Weightage from Matrix Ranking	Access_individual	Access_weighted
Natural	Land	20	0.20	0.06
	Beel	48	0.50	0.35
	Total			0.41
Human	Education	43	0.72	0.20
	Health	66	0.40	0.17
	Skill	44	0.20	0.06
	Total			0.43
Social	Cooperatives	20	0.20	0.07
	Institutes	35	0.60	0.38
	Total			0.45
Physical	Comm	25	0.70	0.13
	Dis Warn	34	0.80	0.21
	Market	50	0.70	0.27
	Water pt	22	0.60	0.10
	Total			0.71
Financial	Credit	28	0.70	0.28
	Savings	42	0.20	0.12
	Total			0.40

Table-7.8 Revised Asset Access of Woman Group

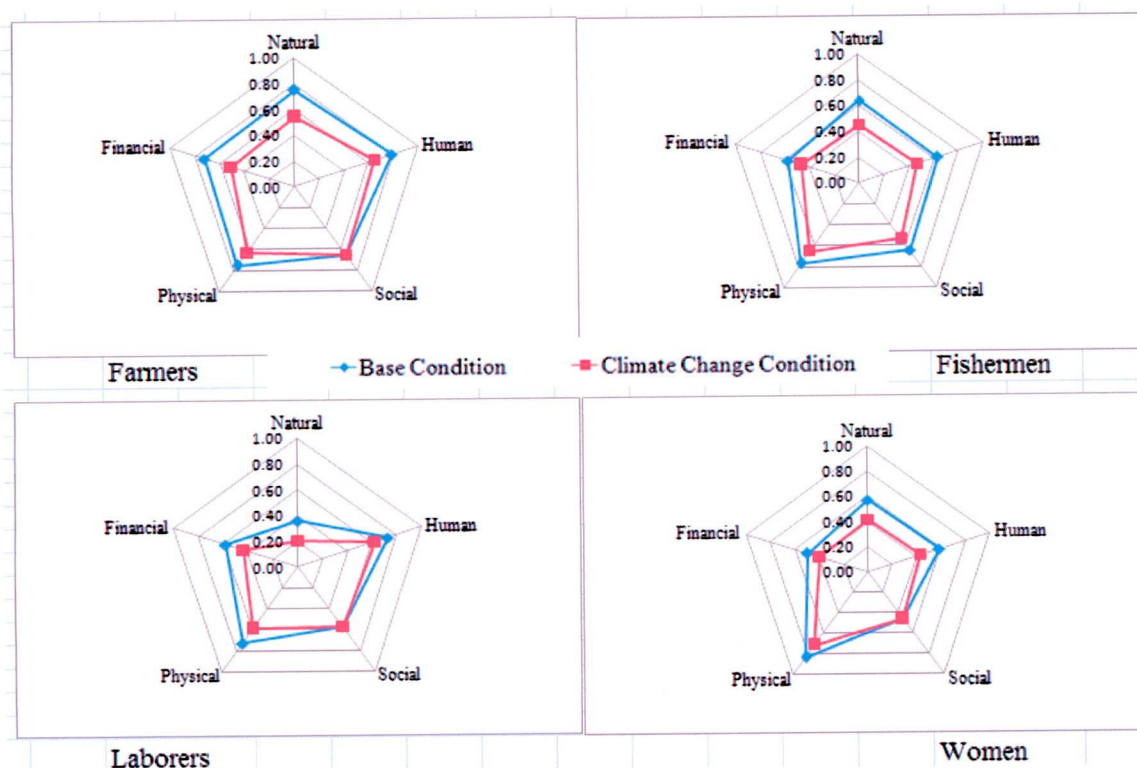


Figure-7.2 Revised Livelihood Pentagon due to Climate Change Impact

The above pentagons show a qualitative change due to probable climate change in the study area. As most of the livelihood capitals have link with other capitals, almost every one of them have been affected on this context. Such as, when the land or beel productivity is reduced which are the major natural capitals, people have to spent their savings and the financial capital becomes affected. Who has less or no savings, they have to migrate to other profession in the village or have to leave the village and the social capital is disturbed. This has made the rural lives more critical against any types of shocks or vulnerabilities and people always struggle to get rid of them. The following sections contain the details of each groups asset access and their vulnerability due to climate change in the study area:

7.2.1 Farmer Group

Around 75% of the people are farmers at Narail and they are dependent on natural and physical resources. Natural resources include crops, cultivable land, monsoon rainfall, ground water and surface water where land is the most important assets according to the matrix ranking. At present, farmers have overall access of 75% of the natural resources. The delayed monsoon would hamper the expected Jute production. They will need more irrigation for the seedbed of T Aman. This will increase the crop production cost by 50% and the farmer will have less

savings. Cyclones and storm surges always damage the standing crops and it would be more frequent due to climate change which could make them a crop less season. The salinity font will reduce the crop production and if the ground water becomes saline, it will be a huge blow for them. Due to these climate change effects, the access on land, crop, monsoon rain and surface water will reduce by 50%, 30%, 15% and 25% respectively which gives overall access of 55% of natural resources.

The physical capital including communication, electricity, road network, equipment, drainage and irrigation system, market, etc. The road network in the study area is poor and very much vulnerable to disaster. Irrigation system is inadequate and the farmers lack from water in the dry seasons. The increased disaster like flood and cyclones will bring the physical asset access from 75% to 63%. The health condition, education and skill govern the human capital. The access on human capital will be reduced to 80% to 65% as the health hazards will increase by 25%. The declining condition of human and natural capital and property damages due to frequent disasters will affect the financial capital and its share will be reduced to 72% to 51%.

7.2.2 Fisherman Group

The fisherman of the study area are mainly Hindu and known as Rajbangshi. They are very few in numbers (around 5-7%) and usually fish in Beel Chachuri. In the study area, there are 15-20 households of fishermen out of average household size of 225. They mainly depends on natural resources which includes waterbody, fish diversity, monsoon rainfall and land also. Because of the hot and rainless weather, at present they have only 72% access on the waterbody and 64% on waterbody product like fish. The number of fish capture is going down and in future 40% of the fish will be lost. Overall stretched natural resource access will come down from 64% to 44% in climate change context in future. The physical resource access like road network will be 60% to 20% being damaged by floods. Health hazards will bring down the human capital access from 62% to 46%. The social resource will be affected because of comparatively few fisherman household (5% of total household). Less income from water body and deteriorating health condition will affect the financial capital access as it goes down 57% to 46%. The social capital will be changed (from 65% to 54%) as they are less in numbers and have poor cooperatives activity.

7.2.3 Laborer Group

20% people of the study area are farm laborers mainly do agricultural activities and little fishing activities also. The laborers are indirectly involved with natural resources like agricultural land, beel. So, they have low access on the natural capital around 36% which will be reduced to 20% due to climate change.. They use physical resources like road network, communication, work opportunity in the field, industry, etc. The road network is poor, so they can't be engaged in van pulling during the jobless season of monsoon due to the damaged roads. The overall access on physical capital will reduce from 73% to 58% as the road network, work volume, communication facility will be reduced due to climate change. Now they are workless for 3-4 months and in future it will increase to 5-6 months. Human capital will be reduced to 73% to 62% due to health problem during extended summer. At present they earn 100 taka daily in kharib-1 season and in kharib-2 and boro season they can earn upto 150 taka per day. The overall financial capital will be reduced to 58% to 44% as their daily income will reduce to 50% due to less work in the field if the kharib-1 crop is not cultivated or delayed in cultivation.

7.2.4 Woman Group

They are usually engaged in household works basically reproductive works inside the family. They are limited user of natural resources like land and beel which will be decline more in climate change context. Their natural capital access is 57% which will be reduced to 41%. The average poor health condition of household will shorten their earning activities which reduce the financial capital access from 50% to 40%. Their physical capital includes communication, drinking water facility, market.. The physical capital will be reduced from 82% to 70% due as the drinking water source will be scarce and they have to spend double time for water hunt in future. They are reluctant to do any cooperative activities so their social capital access is the least (45%) among four groups.

8 Sustainable Livelihood Approach

The access to the livelihood capitals is closely linked to the vulnerability of the poor people (Pari Baumann, 2002). So, to ensure sustainability of the poor people in rural areas, we have to focus on to increase their capability to reach the existing resource allocation within their environment. The natural resources and other infrastructures have to be availed by them for their continuous development and better well being. Moreover, their economic condition has to strengthen so that they can withstand any sort of shock or vulnerability context and get back to their work again. The Financial and Social capitals needs to be enriched which will ultimately develop other capitals and their availability to them. Moreover, the natural resources needs to be protected for the integrity of the ecology and environment as well as to ensure the peoples future livelihood. The following measures are prescribed for each livelihood group:

8.1 SLA for Farmer Group

Some direct measures should be taken for reducing the vulnerability context for the farmers. The salinity font can be reduced by Gorai-Modhumoti flow augmentation. Cultivable lands have to be protected from floods by rehabilitations of the embankments. It will protect their others assets also. Drainage and irrigation system has to be improved by excavating canals and repairing the structures. As there is no cyclone shelter in the area, it is urgent to construct so that they can escape the storm surges and cyclones.

There are several government agencies working in the study area. These agencies have to work in field level regularly and try to fulfill their problems. They need technical assistance to adapt the climate change context. Saline tolerant seed invention, high breed crops orientation, effective and low cost irrigation, education and health care campaign, etc. activities will help them to sustain in this context. The farmers should be provided more secure environment so that they can invest and get proper return. They should be provided logistic supports and environment which will keep them safe from artificial crisis and setbacks. The fertilizer supply should be adequate and in due time. The market price should be monitor and controlled by the authority. After any disaster, enough credit programs have to be offered to them so that they can starts working in the field quickly. The NGO's working in the area could make the people aware of the climate change condition and its possible impacts upon them. Table-8.1 shows the framework for sustainable livelihood for the farmer group.

Table-8.1 Sustainable Livelihood Framework for Farmer Group

Capital	Assets	Vulnerability	Direct Measure	Indirect Measures		Livelihood Strategy	Livelihood Outcomes
				Structures	Processes		
Natural	Land	Saline	Fresh water flow augmentation	BWDB, Soil Department	International Agreements Awareness building	Crop Rotation	Productive Land
Natural	Crop	Less production	Saline tolerant seeds	BADC, LGED	Creating more markets Offering incentives Awareness creating		
Natural	Surface Water	Saline	Fresh water flow augmentation	BWDB, Local Group	International Agreements Awareness building	Saline tolerant crop production	Food Security
Human	Education	Infrastructure damage	More schools and colleges, Trained Teachers	Facilities Dept., NGOs	Free education policy Offering jobs Awareness building		
Human	Health	More diseases	More hospitals, Doctors	DPHE, NGOs	More health campaigns Generating practices Awareness creating	Rainwater Harvesting	Better Health
Physical	Electricity	More interrupted	Spreading coverage area	REB	Limiting wastage of power Policy favorable to rural area		
Physical	Irrigation	Scarce water	Monsoon water storage	Agriculture Dept BWDB	Technology transfer to people Awareness building	Use of Credit, Insurance	More savings
Physical	Communication Road network	Disconnected by disaster	Rigid pavement construction	RHD, LGED	More funding in road construction & communication		
Financial	Property	Damaged by disaster	Cyclone Warning	BMD, NGOs	Setting insurance services Awareness creating	Drink Safe Water	Pleasant Life
Physical	Drinking water	Scarce	Deep tube well installation	DPHE, Local Group	National Water Policy Awareness building		

8.2 SLA for Fisherman Group

This group is dependent on Beel Chachuri for their livelihood and needs special attention. Beel Chachuri has to be protected for their existence. According to the fishermen, the internal canals should be excavated for allowing more water from Nabaganga river. This will keep the waterbody inundated more time in a year. They need more health care facility and education infrastructures. The fish variety needs to be increased by the Fisheries department. Special training for fishing with advanced equipment and technology would help them to income more. They can be advised in culture fisheries in groups which is practiced in the beel area by other people. An improved road network and communication system will help them for marketing fishes inside and outside village.

They usually fish in the beel as group but facing some problem with recent policy adopted by the government. People who have land inside the beel can only fish overthere whereas the fishermen used to fish all over the beel previously. It reduces their access on the beel for fishing. If the policy can be set as earlier time, they can take the beel "leased" from government and can fish more. Legislation increasing their access to the waterbody and proper implementation by the concerned agencies will protect their interest. People should be aware for not fishing in beel during breeding period and also for the beel conservation as a natural resource. Table-8.2 shows the framework for sustainable livelihood for the fisherman group.

Table-8.2 Sustainable Livelihood Framework for Fisherman Group

Capital	Assets	Vulnerability	Direct Measure	Indirect Measures		Livelihood Strategy	Livelihood Outcomes
				Structures	Processes		
Natural	Water body/ Beel	Drying up	Water body conservation, canal excavation	Fisheries Dept. NGOs	National Water body Policy Strengthening Agencies Awareness building	Modern Fishing	More Income
Natural	Fish	Losing variety	Fish sanctuary declaration	Fisheries Dept. LGED	National Fish Policy Restriction on fishing period Awareness building		
Natural	River	Saline	Fresh water flow augmentation	BWDB	International Agreements Awareness building	Group Fishing	Secured Income
Human	Education	Infrastructure damage	More schools and colleges, Trained Teachers	Facilities Dept., NGOs	Free education policy Offering jobs Awareness building		
Human	Health	More diseases	More hospitals, Doctors	DPHE, NGOs	More health campaigns Generating practices Awareness creating	Other work in fish breeding time	Better Health
Physical	Electricity	More interrupted	Spreading coverage area	REB	Limiting wastage of power Policy favorable to rural area		
Physical	Safety in fishing	Casualty in disaster	Modern equipment Warning System	Fisheries dept. BMD	Restriction on fishing time Awareness building	Use of Credit, Insurance	More savings
Physical	Communication Road network	Disconnected by disaster	Rigid pavement construction	RHD, LGED	More funding in road construction & communication		
Financial	Property	Damaged by disaster	Cyclone Warning	BMD, NGOs	Setting insurance services Awareness creating	Drink Safe Water	Pleasant Life
Physical	Drinking water	Scarce	Deep tube well installation	DPHE, Local Group	National Water Policy Awareness building		

8.3 SLA for Laborer Group

They have to do different types of work and it's an uncertain condition for them whether they will have any work or not in a particular day. So, to keep them active, more development activities have to be adopted in the study area. Road construction, embankment rehabilitation, food for work, etc. will create more opportunity of work for them. They need special health care treatment as they depend on the health status to remain fit to work. If they can be skilled up, they can be engaged in any particular work like house building industry, factory worker and other farm-non farm activities. The rickshaw-van puller will be benefited if the road network is developed. The credit program should be more accessible to them as they have limited or no asset to show against any loan. If the land and waterbody productivity is increased, they will have more income from those sectors. More support for them is needed to carry out their cooperatives activity so that they can invest combined in any productive sector. Other than agriculture activity, they can migrate to other job if industry and factories are installed in the study area. Government can help them by creating opportunity in abroad having international agreement. Table-8.3 shows the framework for sustainable livelihood for the laborer group.

Table-8.3 Sustainable Livelihood Framework for Laborer Group

Capital	Assets	Vulnerability	Direct Measure	Indirect Measures		Livelihood Strategy	Livelihood Outcomes
				Structures	Processes		
Natural	Water body/ Beel	Drying up	Water body conservation, canal excavation	Fisheries Dept. NGOs	National Water body Policy Strengthening Agencies Awareness building	Skilled Work	More Income
Natural	Land	Saline	Fresh water flow augmentation	BWDB, Soil Department	International Agreements Awareness building		
Physical	Work	Uncertainty	More work scope creating	BWDB, RHD, LGED	Food for Work Policy International Agreement	Group Work	Secured Income
Human	Education	Infrastructure damage	More schools and colleges, Trained Teachers	Facilities Dept., NGOs	Free education policy Offering jobs Awareness building		
Human	Health	More diseases	More hospitals, Doctors	DPHE, NGOs	More health campaigns Generating practices Awareness creating	Migration	Better Health
Physical	Electricity	More interrupted	Spreading coverage area	REB	Limiting wastage of power Policy favorable to rural area		
Physical	Communication Road network	Disconnected by disaster	Rigid pavement construction	RHD, LGED	More funding in road construction & communication	Use of Credit, Insurance	Secured Property
Financial	Property	Damaged by disaster	Cyclone Warning	BMD, NGOs	Setting insurance services Awareness creating	Drink Safe Water	Pleasant Life
Physical	Drinking water	Scarce	Deep tube well installation	DPHE, Local Group	National Water Policy Awareness building		

8.4 SLA for Woman Group

Woman needs to be raised up from their poor condition in the society. They should get more VGF cards than they are receiving now. They can be engaged in different income generating activities inside and outside home which will make them self dependent and confident. NGOs who are working in the study area can provide more credit for them with more flexibilities. Also they can engage the woman in cottage industries for producing handicrafts and selling them outside. They need more maternal care as there is no such facility in the study area. Education program has to be more accessible and attractive for the woman group. The drinking water facility has to be ensured for them in climate change context as they have to search for water always. They have to be aware about the benefits of co-operative activities as they are little reluctant to do it. In development activities, active participation of the woman group has to be ensured to get them properly benefited. The gender disparities have to be minimized in everywhere and their contribution needs to be acknowledgement to the society. They can be engaged in the maintenance works of roads and embankment inside the village.

Government can bring woman group by creating legislation considering woman rights in society. Public awareness is required for engaging woman in productive works rather than stuck inside household. Organisations working with rural women can be patronized for spreading their activities and programs. Table-8.4 shows the framework for sustainable livelihood for the woman group.

Table-8.4 Sustainable Livelihood Framework for Woman Group

Capital	Assets	Vulnerability	Direct Measure	Indirect Measures		Livelihood Strategy	Livelihood Outcomes
				Structures	Processes		
Natural	Water body/ Beel	Drying up	Water body conservation	Fisheries Dept. NGOs	National Water body Policy Strengthening Agencies Awareness building	Handicraft production	More Income
Natural	Land	Saline	Fresh water flow augmentation	BWDB, Soil Department	International Agreements Awareness building		
Physical	Cottage Industries	Damaged in disaster	Financial help	Local Govt. NGOs	Market creating Awareness building	Group Work	Social Status
Human	Education	Infrastructure damage	More schools and colleges, Trained Teachers	Facilities Dept., NGOs	Free education policy Offering jobs Awareness building		
Human	Health	More diseases	More hospitals, Doctors	DPHE, NGOs	More health campaigns Generating practices Awareness creating	Aware of Women Rights	Better Health
Physical	Electricity	More interrupted	Spreading coverage area	REB	Limiting wastage of power Policy favorable to rural area		
Physical	Communication Road network	Disconnected by disaster	Rigid pavement construction	RHD, LGED	More funding in road construction & communication	Use of Credit, Insurance	Gender balance
Social	Social Status	More deprived in society	VGF providing	Govt. NGOs	Encouraged to income Legislation for Women Rights Awareness building	Drink Safe Water	Pleasant Life
Physical	Drinking water	Scarce	Deep tube well installation	DPHE, Local Group	National Water Policy Awareness building		

9 Conclusion and Recommendations

9.1 Conclusions

In the study area, the farmers are mostly dependent on natural and physical resources. Natural resources include crops, cultivable land, monsoon rainfall, ground water and surface water where land is the most important assets according to the matrix ranking. At present, farmers have overall access of 75% of the natural resources. Due to climate change effect, the access on land, crop, monsoon rain and surface water will reduce by 50%, 30%, 15% and 25% respectively which gives overall access of 55% of natural resources. The physical capital including communication, electricity, road network, equipment, drainage and irrigation system, market, etc. The increased disaster like flood and cyclones will bring the physical asset access from 75% to 63%. The health condition, education and skill govern the human capital. The access on human capital will be reduced to 80% to 65% as the health hazards will increase by 25%. The declining condition of human and natural capital and property damages due to frequent disasters will affect the financial capital and its share will be reduced to 72% to 51%.

The fishermen mainly depends on natural resources which includes waterbody, fish diversity, monsoon rainfall and land also. Because of the hot and rainless weather, at present they have only 72% access on the waterbody and 64% on waterbody product like fish. Overall stretched natural resource access will come down from 64% to 44% in climate change context in future. The physical resource access like road network will be 60% to 20% being damaged by floods. Health hazards will bring down the human capital access from 62% to 46%. The social resource will be affected because of comparatively few fisherman household (5% of total household). Less income from water body and deteriorating health condition will affect the financial capital access as it goes down 57% to 46%.

The laborers are indirectly involved with natural resources like agricultural land, beel. So, they have low access on the natural capital around 36% which will be reduced to 20% due to climate change. They use physical resources like road network, communication, work opportunity in the field, industry, etc. The overall access on this capital will reduce from 73% to 58% as the road network, work volume, communication facility will be reduced due to climate change. Human capital will be reduced to 73% to 62% due to health problem. The overall financial capital will be reduced to 58% to 44% as their daily income will reduce to 50% due to less work in the field in climate change condition.

The women are limited user of natural resources like land and beel as they mainly do the household works. Their natural capital access is 57% which will be reduced to 41%. The average poor health condition of household will shorten their earning activities which reduces the financial capital access from 50% to 40%. Their physical capital includes communication, drinking water facility, market which will be reduced to 82% to 70% due to climate change.

9.2 Recommendation

Based on the study findings, some adaptive measures which fit the study area condition and the villager's recommendation have been set for sustainability of the rural people. Considering all groups together, the measures are recommended below:

- Chander Chak to Noragati and Katadura road should be well constructed
- More deep tube wells are needed for low cost irrigation.
- Soil tolerant crop seeds should be supplied to the farmers.
- Combined cultivation at a same time is required for getting more income from lands.
- The embankment on the left bank of Nabaganga should be strengthened
- The houses have to be elevated to keep them safe from flooding.
- At least one Cyclone shelter is need for the safety of human lives during cyclones.
- The water body (Beel Chachuri) conservation project should be taken.
- Existing canals should be excavated to allow more water into beel areas dry season.
- Fisheries development project is needed in Beel Chachuri.
- Fishermen have to be encouraged in culture fisheries.
- Better medical facilities have to be ensured for the villagers.
- The local laborers should be engaged in the development activities.
- The women have to be engaged in in-house income generating activities.
- Women should be offer more loan to buy livestock for an easier source of income.
- Planting more trees to keep the weather cool and favorable for more rainfall.

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Appendix-A
Semi-Structured Questions

Semi-Structured Questions showing all groups concerned

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

Q 01	How do you use the cultivable lands?	Access Status
1	Cultivate your own land	Very good
2	Other people share your lands	Good
3	Share other peoples lands	Moderate
4	Work as a labourer in lands	Low
5	Does not work in lands	Very low

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

Q 02	How is your health condition?	Access Status
1	Very good condition	Very good
2	Moderate condition	Good
3	Sometimes becomes sick	Moderate
4	Often becomes sick	Low
5	Very bad condition	Very low

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

Q 03	Do you have hospital in your village?	Access Status
1	There is a big hospital	Very good
2	There is a little hospital	Good
3	There is a Upazilla health centre	Moderate
4	There is only a Union health centre	Low
5	There is no hospitals, only local doctors	Very low

Livelihood groups Farmers

Q 04	How is the crop production in the lands?	Access Status
1	Three crops in a year, production very good	Very good
2	Two crops in a year	Good
3	Only one crop in a year	Moderate
4	Production is not satisfactory	Low
5	No crop at all	Very low

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|---------------------------------|---------------|
| Q 05 | Do your children go to school? | Access Status |
| 1 | All go to school | Very good |
| 2 | Only kids go, elders don't go | Good |
| 3 | Only boys go, girls don't go | Moderate |
| 4 | School is far, so they don't go | Low |
| 5 | No school in the area | Very low |

Livelihood groups Farmers

- | | | |
|------|---|---------------|
| Q 06 | Do you use deep tube well for irrigation? | Access Status |
| 1 | Use all the year round | Very good |
| 2 | Use but it is costly | Good |
| 3 | Cannot use in dry period | Moderate |
| 4 | Can use the water from tube well | Low |
| 5 | No water is available | Very low |

Livelihood groups Farmers/ Fisherman

- | | | |
|------|-----------------------------------|---------------|
| Q 07 | How is the rainfall in your area? | Access Status |
| 1 | Huge rainfall occurs | Very good |
| 2 | Enough rainfall occurs | Good |
| 3 | Less rainfall occurs | Moderate |
| 4 | Very low rainfall occurs | Low |
| 5 | No rainfall at all | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|--|---------------|
| Q 08 | Can you express your opinion in cooperative? | Access Status |
| 1 | Can say and work independently | Very good |
| 2 | Activity requires leaders approval | Good |
| 3 | Can express view but leader takes the decision | Moderate |
| 4 | Cannot say anything | Low |
| 5 | Activities are controlled by externals | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|------------------------------------|---------------|
| Q 09 | How are the roads in your village? | Access Status |
| 1 | Very good condition | Very good |
| 2 | Moderate condition | Good |
| 3 | Old road | Moderate |
| 4 | Brick road | Low |
| 5 | Only earthen road | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|-------------------------------------|---------------|
| Q 10 | How do you communicate with others? | Access Status |
| 1 | Own cell phone | Very good |
| 2 | Other people's cell phone | Good |
| 3 | Via postal service | Moderate |
| 4 | By messenger | Low |
| 5 | No communication at all | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|-------------------------------------|---------------|
| Q 11 | How do you receive cyclone warning? | Access Status |
| 1 | From television | Very good |
| 2 | From Radio transmission | Good |
| 3 | Via government service | Moderate |
| 4 | From people | Low |
| 5 | Does not receive warning | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer

- | | | |
|------|---|---------------|
| Q 12 | Do you have regular contact with government agencies? | Access Status |
| 1 | Always have contact | Very good |
| 2 | Sometimes you can contact to them | Good |
| 3 | They come when you call | Moderate |
| 4 | No contact at all | Low |
| 5 | You do not contact | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|--|---------------|
| Q 13 | Do you have training from government/non government. agencies? | Access Status |
| 1 | Always receives training | Very good |
| 2 | Sometimes they get trains | Good |
| 3 | You have to go to the city for training | Moderate |
| 4 | Only comes after disasters | Low |
| 5 | Nobody trains them | Very low |

Livelihood groups Farmers

- | | | |
|------|-------------------------------|---------------|
| Q 14 | How is the irrigation system? | Access Status |
| 1 | Very good | Very good |
| 2 | Moderate condition | Good |
| 3 | Group system | Moderate |
| 4 | Privately owned | Low |
| 5 | Very bad system | Very low |

Livelihood groups Farmers

- | | | |
|------|-----------------------------|---------------|
| Q 15 | How is the drainage system? | Access Status |
| 1 | Very good | Very good |
| 2 | Moderate condition | Good |
| 3 | Not good | Moderate |
| 4 | Very bad | Low |
| 5 | No system at all | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|----------------------------------|---------------|
| Q 16 | How is the electricity system? | Access Status |
| 1 | Very good | Very good |
| 2 | Some has and other people shares | Good |
| 3 | Some has but other don't have | Moderate |
| 4 | Very bad | Low |
| 5 | No system at all | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|--|---------------|
| Q 17 | Do you avail credit system? | Access Status |
| 1 | Always get loan from Government/ NGOs | Very good |
| 2 | Sometimes get loan from Government/ NGOs | Good |
| 3 | Only get loan after disaster | Moderate |
| 4 | Do not take loan | Low |
| 5 | No Credit service available | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer/ Woman

- | | | |
|------|-----------------------|---------------|
| Q 18 | Do you have savings? | Access Status |
| 1 | Save in cooperatives | Very good |
| 2 | Save in NGOs or banks | Good |
| 3 | Save privately | Moderate |
| 4 | Doesn't save | Low |
| 5 | Cannot save | Very low |

Livelihood groups Farmers/ Fisherman/ Laborer

Q 19	Do you have any relatives in abroad?	Access Status
1	All	Very good
2	Most of them	Good
3	Only one	Moderate
4	Nobody lives	Low
5	Don't want to go abroad	Very low

Livelihood groups Farmers

Q 20	How do you cultivate the lands?	Access Status
1	Group wise	Very good
2	Singly with modern equipment	Good
3	Traditional method	Moderate
4	Engaged other people	Low
5	Doesn't cultivate	Very low

Livelihood groups Fisherman

Q 21	What is the condition of the Beel Chachuri?	Access Status
1	Very well, always watered	Very good
2	Most of the time is watered	Good
3	Few months becomes dry	Moderate
4	Few months becomes watered	Low
5	Very bad, little watered	Very low

Livelihood groups Fisherman

Q 22	What is the condition of the fishes in Beel?	Access Status
1	Very well, huge fishes are available	Very good
2	Moderately fish available	Good
3	Less fish	Moderate
4	Fish variety losing gradually	Low
5	Very few fish	Very low

Livelihood groups Fisherman

Q 23	How do you fish in Beel?	Access Status
1	With modern equipment	Very good
2	Old boat and a new net are used in fishing	Good
3	All equipment are old	Moderate
4	No boat, use only net for fishing	Low
5	Use other techniques	Very low

Livelihood groups Laborer

- | | | |
|------|---|---------------|
| Q 24 | What is the transportation system | Access Status |
| 1 | Very well, bus –truck-ships are available | Very good |
| 2 | Only ships are available | Good |
| 3 | Only country boat | Moderate |
| 4 | Only local van | Low |
| 5 | No transport system at all | Very low |

Livelihood groups Laborer

- | | | |
|------|---|---------------|
| Q 25 | How are the work volume in the village? | Access Status |
| 1 | Always work available | Very good |
| 2 | Moderate works available | Good |
| 3 | Only in winter work available | Moderate |
| 4 | Most of the time no work | Low |
| 5 | No work at all | Very low |

Livelihood groups Laborer

- | | | |
|------|--|---------------|
| Q 26 | Is there any industry or factory here? | Access Status |
| 1 | Many industries and factories | Very good |
| 2 | Moderate industries and factories | Good |
| 3 | Several industries | Moderate |
| 4 | Few industries | Low |
| 5 | No industries at all | Very low |

Livelihood groups Laborer

- | | | |
|------|------------------------------|---------------|
| Q 27 | Do you work in the Beel? | Access Status |
| 1 | Always work for fishing | Very good |
| 2 | Sometimes fish in the beel | Good |
| 3 | Join other to fish | Moderate |
| 4 | Help other to later | Low |
| 5 | No work whole the year round | Very low |

Livelihood groups Woman

- | | | |
|------|---------------------------------------|---------------|
| Q 28 | Do you get maternal service and care? | Access Status |
| 1 | Very well established system | Very good |
| 2 | God system | Good |
| 3 | Moderate system | Moderate |
| 4 | Not good system | Low |
| 5 | No services at all | Very low |

Livelihood groups Woman

Q 29	Where do you get water from?	Access Status
1	Own tube well	Very good
2	Other tube well	Good
3	Carry from far place	Moderate
4	Use pond water	Low
5	Use river water	Very low

Livelihood groups Woman

Q 30	Are you talking training about income generating activities?	Access Status
1	Control a cottage industries	Very good
2	Work in a cottage industry	Good
3	Sells handicrafts	Moderate
4	Only develops as per household need	Low
5	Can't work	Very low

