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Adaptation strategies of GO and NGOs combating climate change impacts: a study on perception of communities in the coastal areas

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ACRONYMS AND ABBREVIATIONS

BCN	Basic Coast Need
BBS	Bangladesh Bureau of Statistics
CBO	Community Based Organization
CDMP	Comprehensive Disaster Management Program
FGD	Focus Group Discussion
GO	Government Organization
HFL	Highest Flood Level
IPCC	Intergovernmental Panel on Climate Change
LGED	Local Government Engineering Department
NAPA	National Adaptation Programme of Action
NGO	Non-Government Organization
PPT	Parts per Thousand
PSF	Pond Sand Filter
UNDP	United Nations Development Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
WAPDA	Water and Power development Authority (Recent WDB)
WDB	Water Development Board

ABSTRACT

The unique geographic location, high population density, high levels of poverty, and overwhelming dependence on nature make Bangladesh one of the countries, most vulnerable to climate change. Various adaptation strategies and policy actions (e.g. National Adaptation Programmes of Action), structural and non-structural adaptation measures have already been suggested to reduce the impact of climate change. This research aims to study the socio-economic vulnerability of the population to be affected by climate change impacts, adaptation measures practiced by the GO and NGOs in the coastal areas of Bangladesh in response to climate change and the perception of the community regarding the adaptation measures practiced by the different government and non-government agencies. Considering the spatial distribution, rural urban setting and highest vulnerability to climate change, four *upazillas*-Burhanuddin *upazilla* from Bhola district, Barguna Sadar *upazilla*, from Barguna district, Shyamnagar from Satkhiradistrict and Sharonkhola from Bagerhat district were selected as study area. Various scholarly literatures on climate change adaptation, vulnerability analysis, study on physical vulnerability, assessment of adaptation strategies etc. have been studied to design the study methodology. Data is collected from both primary and secondary sources. For primary data collection semi-structured questionnaire was used. Along with that participatory data collection tools like focused group discussion (FGD),venn diagram analysis etc. was also employed. In the data analysis process, information and data collected from field survey have been analyzed. Major findings of analysis are as following. People in the study areas are suffering from high level of poverty (52% to 75%). Income inequality in the study area is low. Due to poverty people depend on GOs and NGOs for adaptation measures. Currently practiced adaptation measures include water supply and purification programs by NGOs, road and embankment construction by GOs, emergency health care, plantation, training programs, solar panel installation. However agricultural and health related adaptation measures are less practiced in the study areas. In order to study people's perception regarding adaptation measures 'Respondent's Frequency ' analysis was performed on issues like their preference for different types of GO and NGO sector adaptation measures, perceived benefit from various projects, their level of satisfaction etc. It is found that 45.5% of total respondents are not satisfied with adaptation measures in the study areas.

Thus from the analysis of adaptation measures and people's perception regarding those measure it is evident that a lot is to be done yet for adaptation against climate change. This study also provides some recommendation towards improved adaptation programs for the study areas.

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

The unique geographic location, dominance of floodplains, and low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature make Bangladesh is one of the countries, most vulnerable to climate change. The coastal zone covers 47,000 km^2 areas, which is about 32 percent of total landmass of the country. Twenty eight percent of the total population lives in the coastal zone. Several studies indicate that the coastal zone vulnerability would be acute due to climate change (MoEF, 2005). Four key types of primary physical effects would be evident in the coastal areas of Bangladesh these will include saline water intrusion; drainage congestion; extreme events of cyclone; and changes in coastal morphology (MoEF. 2005). A one meter rise in sea level will inundate about 17.5% of the landmass mostly in the central and western coast (Hossain, 2008). In addition to these primary impacts at local levels, there will be impact at national social, economic and demographic sectors as a large share of the national population resides in the coastal areas.

Various adaptation strategies and policy actions (e.g. National Adaptation Programmes of Action), various structural and non-structural adaptation measures have already been suggested to reduce the impact of climate change. Adaptation is adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It is important in the climate change issue in two ways—one relating to the assessment of impacts and vulnerabilities, the other to the development and evaluation of response options (Adger et al, 2003). In order to safeguard the coastal areas and the whole country against such a disaster, it is imperative to know the disaster, its impending dangers beforehand and effective adaptation measures in response to climate change impact.

It is important to note that the most vulnerable communities of Bangladesh affected by climate change impacts are the poor. Government has undertaken a list of 15 priority projects to address climate change impacts. Among those, four specific projects are designed for coastal areas, the most vulnerable areas of Bangladesh. Activities have been undertaken by common people, non-governmental and government sectors. NGOs and private research organizations have also taken national activities on pilot basis to test different adaptation measures. Climate Change Action Plan is built on six pillars: i) food security, social protection and health; ii) comprehensive disaster management; iii) infrastructure; iv) research and knowledge management; v) mitigation and low carbon development and vi) capacity building and institutional strengthening (MoEF, 2009). With this background, this study discusses the vulnerability of population of coastal regions in selected *upazillas* due to climate change impacts. The study also identifies the existing adaptation measures practiced by different agencies. It is very important to know how the local community is responding to these measures. Thus this research aims to have a comprehensive understanding of the local peoples' view.

1.2 Objectives of the Study

This research has the following objectives:

- To study the socio-economic vulnerability of the population to be affected by climate change impacts.
- To study the adaptation measures practiced by the GO and NGOs in the coastal areas of Bangladesh in response to climate change.
- To study the perception of the community regarding the adaptation measures practiced by the different government and non-government agencies.

1.3 Study Area Selection

To select the study areas following factors are considered. :

- Higher degree of risk due to climate change related hazard (sea level rise, salinity intrusion, tidal surge etc.)
- Availability of adaptation program or project to combat climate change both by GO and NGO.

Based on spatial distribution, rural urban setting and highest vulnerability to climate change, four *unions* Gangapur from Bhola (Burhanuddin upazilla), Badarkhali from Barguna (Barguna Sadar upazilla), Gabura from Satkhira (Shyamnagar upazilla) and Southkhali/Dakhinkhali Bagerhat (Sharonkhola upazilla) districts were selected as study area (Table 1.1, Figure 1.2). To get the scenario of both rural and urban area, three *unions* from rural area and one *union* from urban area has been selected.

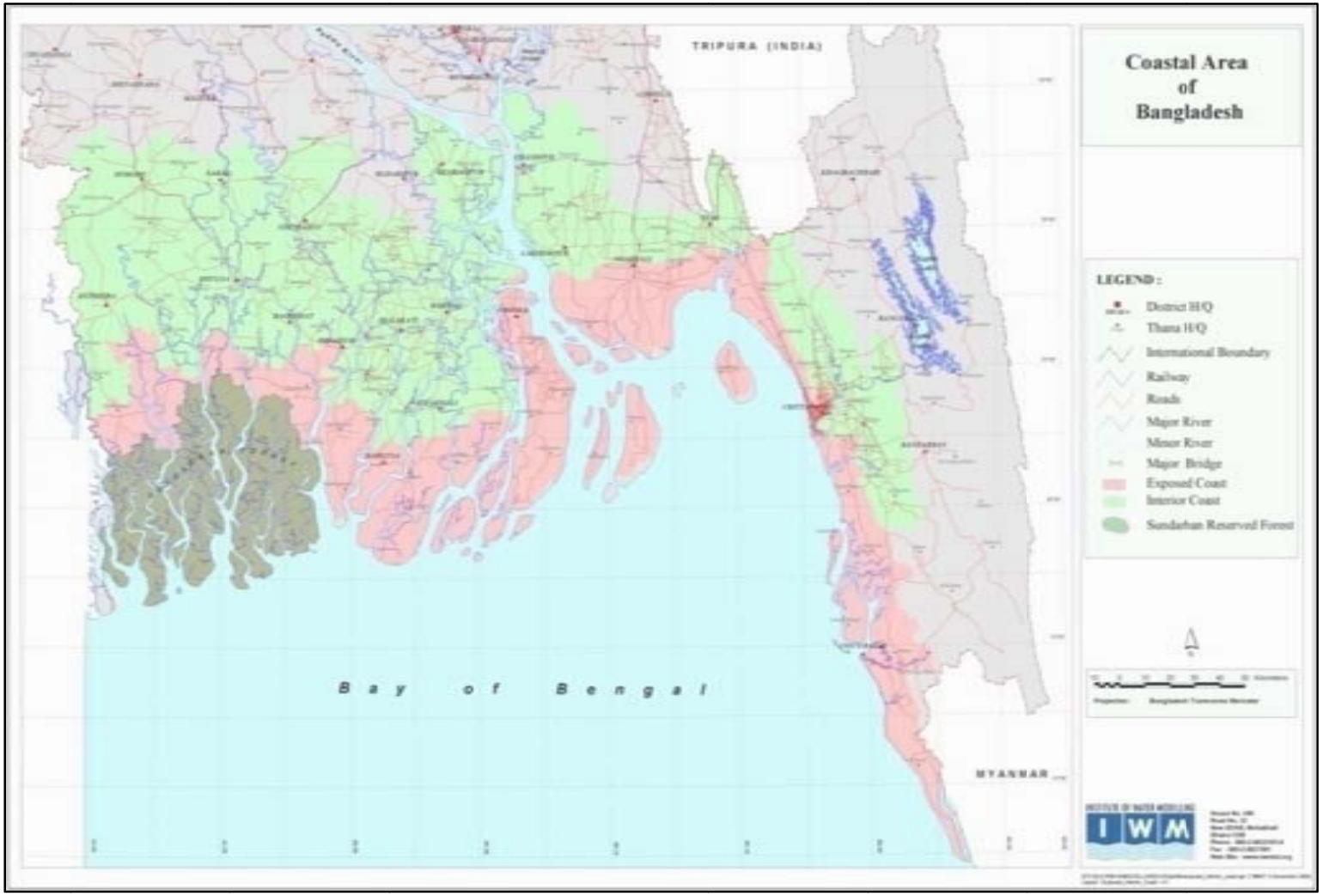

Figure 1.1: Coastal Areas of Bangladesh *Source: Institute of Water Modeling (2004)*

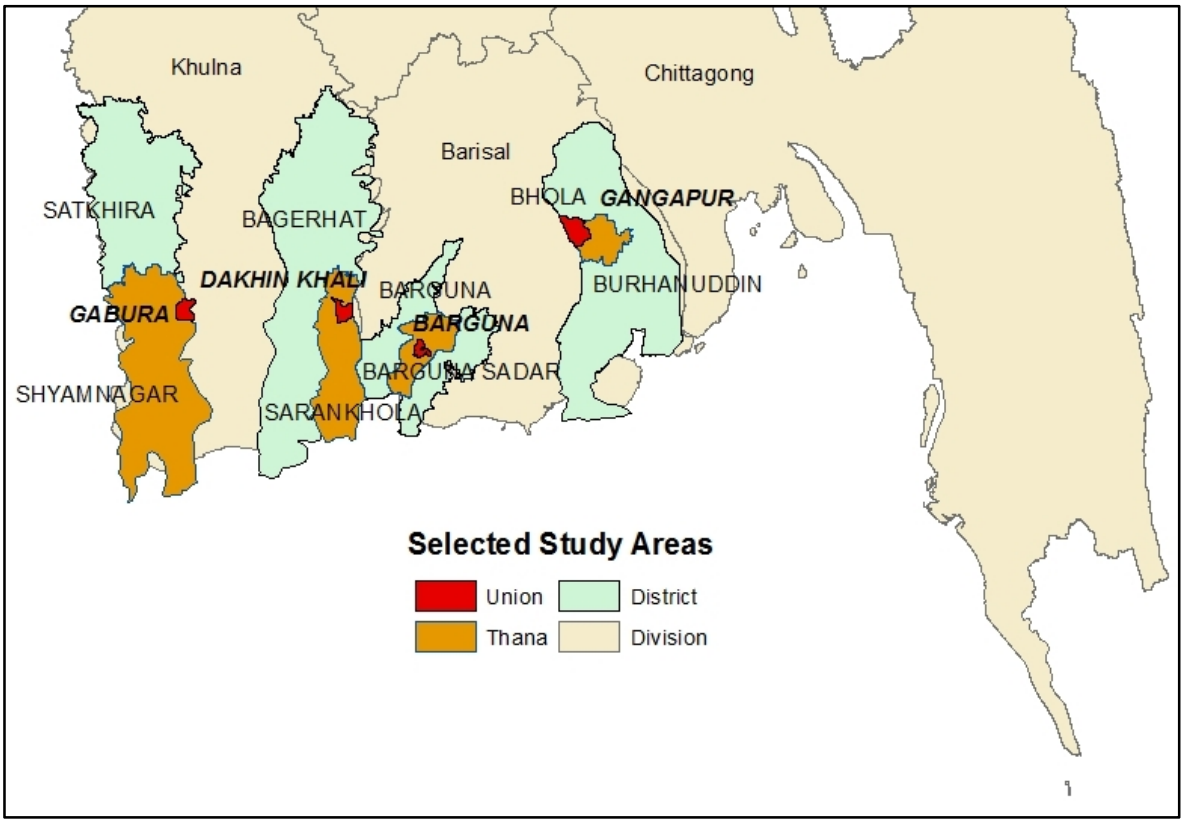

Figure1.2: Selected Study Areas (Zilla, Upazilla and Union)

Table 1.1: Selected study areas

Zilla	Upazilla	Union	Status
Shatkhira	Shymnagar	Gabura	Rural
Bagerhat	Sarankhola	Dakhin Khali (South Khali)	Rural
Barguna	BargunaSadar	Badar Khali	Urban
Bhola	Burhanuddin	Gangapur	Rural

CHAPTER 2
LITERATURE REVIEW

2.1 Definitions

Vulnerability to climate change

Generally, Vulnerability to climate change is the outcome and function of a mixture of environmental, social, economic structures, cultural, institutional and other related social aspects of the phenomenon. Vulnerability According to the fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) is "The degree, to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (Parry et al, 2007).

Adaptation to climate change

Adaptability refers to the degree to which adjustments are possible in practices, processes or structures of systems to projected or actual changes of climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in conditions.

2.2 Conceptual frame work for measuring vulnerability

There are several demographic, social and economic factors to measure vulnerability (Cox et al, 2006). Vulnerability to climate change can be seen as biophysical risk or it can be seen social resilience to hazards (Cutter, 1996). This study focuses to study the social (Socio-economic) vulnerabilities in the coastal areas of Bangladesh; but biophysical vulnerability is also significant as it is the basis of study area selection. Biophysical vulnerability can be identified by mapping bio-physical risk of an area (Cutter, 1996). These maps can show the distribution of hazards and occurrence, impact, severity of particular hazards etc (Cutter, 1996).

The essential features of a model of social vulnerability to climate change are firstly that it focuses on social aspects of the phenomenon. Ultimately, under-standing of present climate variability on society will reduce the impacts of climate change on individuals and society. According to Kelly and Adger (2000), vulnerability occurs from interaction between stress caused by natural disasters resulted from various impacts of climate change. According to Cutter (1996), vulnerability as tempered social response approach looks at social construction of vulnerability, where it occurs due to failure to response in case of a natural hazard. This vulnerability is rooted in the historical, cultural, social and economic process of the society. Now vulnerability can be measured by economic indicators like poverty, income, inequality etc. There can other proxies used for vulnerability too. Those include access to sanitation, literacy rate, political rights, government effectiveness, female literacy rate, life expectancy at

birth etc. (Brooks et al, 2006). So adaptation strategies will be successful if they also focus on issues of health, education, governance etc.

Socio-economic vulnerability can be divided into two aspects: individual vulnerability and collective vulnerability. Individual vulnerability can be analyzed through access to resources, diversity of income and resource dependency of income. Collective or social vulnerability can be defined at national, regional or community level. At community level social vulnerability is determined by relative distribution of income, diversity of economic assets, more over institutional arrangement of the community (Adger, 1998).

2.2.1 Measurement of Individual (Household) Vulnerability

Access to resources is difficult to measure. It is similar to the concept of entitlements to resources (Sen, 1981; Fine, 1997; Leach et al., 1997; cited by Adger, 1998). Both are difficult to measure because of their temporal and seasonal dimensions and because they involve transactions and exchanges between different members of households (Adger, 1998). But some aspect of access is correlated with poverty. So under some condition poverty can be a good measure of access to resources and income can be a proxy for poverty. In this study poverty is used as an important indicator of individual vulnerability to climate change. Because poverty can be directly related to marginalization and lack of access to resources which are critical when faced with the risk of hazards and the resultant stress on livelihoods. Income is taken as an economic indicator of poverty, recognizing that this is an external measure of poverty but one which correlates with other aspects of poverty relevant for vulnerability, such as health indicators (Glewwe and van der Gaag, 1990; as cited in Adger , 1998). Thus individual vulnerability can be measured by various poverty indices and examining natural resource dependency of household income. We use the poverty severity measures (P0, P1 and P2) which are developed by Foster *et al* (1984) (as cited in Adger, 1998) and used for quantitative research of income poverty widely.

Various poverty indices include Cost of basic need method (CBN), Head count ratio (HCR), poverty gap, poverty severity etc. These measures will be used to examine individual socio-economic vulnerability in the study areas. Along with that analysis of natural resource dependency for income sources of household shall help to determine vulnerability to climate change impact. It is found in a recent study that floodplain residents living below poverty line depend more on natural resources for livelihood, and their livelihood is more at risk due to environmental stresses (Brouwer et al, 2006). Therefore in this study relationship between poverty and natural resource dependent livelihood for households will be analyzed by various statistical methods.

Lorenz curve and Gini coefficient

Lorenz curve, L(x), is a graphical representation of the cumulative proportion function. In Lorenz curve cumulative percent of population sets up along the horizontal axis and cumulative percent of population along the vertical axis.

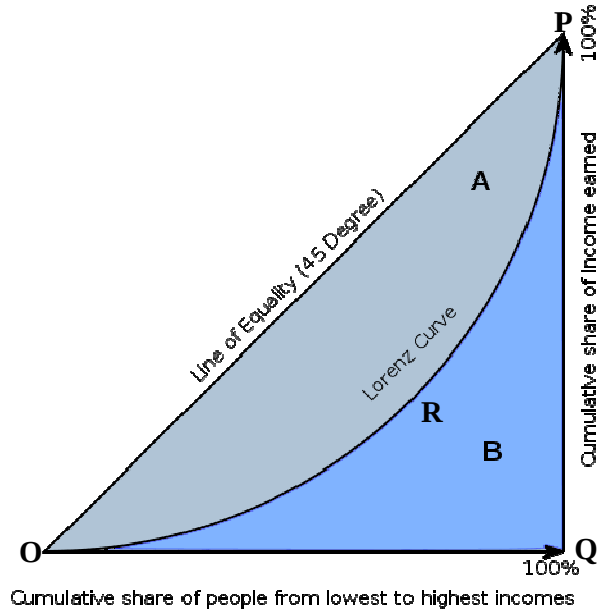

Figure 2.1: Lorenz Curve and Gini Index

In case of perfect equality in income distribution, the distribution function is L(x) = x; which is shown by line OP in figure A. Lorenz curve ORP (in figure A) shows the real income distribution. The relative disparity of income distribution is the area between L(x) = x (line OP) and Lorenz curve ORP. The ratio of this area to the total area of the triangle under L(x) = x (OP) is called Gini coefficient. So, Gini coefficient is

G= Area of ORP/ Area of OPQ

By using calculus we can calculate Gini coefficient easily. Following simplified equation is used to calculate the Gini coefficient:

$$\text{Gini coefficient} = 1 - 2\int_0^1 L(x)dx. \qquad (1)$$

Here, L(x) is the Lorenz function; which is developed from surveyed income data. For example, the cumulative proportion of income has been calculated from sample household income data.

Value of Gini coefficient is varies between 0 to 1, where 0 represents absolute equality (equal distribution of income) and 1 represents absolute inequality. When Gini coefficient is interpreted as the percent of inequality within a given population; it is called the Gini index.(Catalano et al, 2009)

Head Count Ratio

The Head Count Ratio is the proportion of the population that is counted as poor and generally denoted by P_0.Formally, it is expressed by the following equation:

$$P_0 = \frac{N_p}{N}$$

Where, *Np* = the number of poor people and *N* = total size of population (or sample)

For example, in a survey the number of poor people is 170 and sample size is 300; then P_0=170/300 = 0.5666= 56.66%. Same thing is also expressed by the following equation:

$$P_0 = \frac{1}{N}\sum_{i=1}^{N} I(y_i < z),$$

Where, y_i= Income of the poor people

Z= Poverty line

Here, *I(.)* is an indicator function that is 1 if its arguments is true otherwise 0 . (World Bank Institute, 2005)

Head count ratio is very easy to understand but it is insensitive to the degree of poverty and the distribution of income among the poor.

Poverty Gap Index

Poverty Gap (PG) measures the difference between income of the poor and the poverty line. Poverty Gap index is the average poverty gap (average short fall from the poverty line) in the population as a proportion of the poverty line; where only the poor people are considered (non-poor hold zero poverty gap). Generally Poverty gap is denoted by P_1 and computation formula is:

$$P_1 = \frac{1}{N}\sum_{i=1}^{N} \frac{G_i}{z}.$$

Where,

$$G_i = (z - y_i).I(y_i < z).$$

Here, *z*= poverty line, y_i = income of poor household, *N* = total number of population and *I(.)* is an indicator function that is 1 if its arguments is true otherwise 0

Generally, Poverty gap index is expressed in percentage. Poverty gap measures the intensity or depth of poverty i.e. it measures how much the poor beyond from the poverty line or how

poor the poor are. But, Poverty gap index is insensitive to distribution of income among the poor i.e. income inequality (World Bank Institute, 2005).

Squared poverty gapIndex (Poverty severity)

Squared poverty gap Index or Poverty severity is a measure of poverty which accounts inequality among the poor. Poverty severity is the weighted sum of poverty gaps (as a proportion of the poverty line).Here the weights are the proportional to poverty gaps; for example a poverty gap of 10% of the poverty line gives a weight of 10%. Generally Poverty severityis denoted by P_2 and computation formula is:

$$P_2 = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{G_i}{z}\right)^2$$

Where,

$$G_i = (z - y_i).I(y_i < z).$$

Here, z = poverty line, y_i = income of poor household, N = total number of population and $I(.)$ is an indicator function that is 1 if its arguments is true otherwise 0.

Squared poverty gap can measure poverty severity i.e. accounts inequality among the poor and it is an advantage of Squared Poverty Gap Index over the Poverty gap Index. (World Bank Institute, 2005).

2.2.2 Measurement of Collective Social Vulnerability

Collective social vulnerability can be determined by relative distribution of income, access to and diversity of economic resources and performance of formal and informal institutional coping mechanisms. Collective vulnerability includes level of infrastructure, institutional capacity, inequality within the population. Inequality can directly affect vulnerability by reducing adaptive capacity of the households. Indirectly inequality and poverty together can constrain coping strategies. Inequality can be with various indicators. Important issue here is to determine the causes of inequality to understand the nature of collective vulnerability. One commonly used measure of inequality is Gini index.

2.3 Conceptual framework for evaluating adaptation strategies

Mainstreaming of climate risk into sustainable development strategies includes building adaptive capacity to climate change and management of climate risks. This requires in depth understanding of climate change issues. Adaptation actions actually take place at community and individual level. Adaptation measures should be based on existing coping mechanisms and it will also require sharing of information between communities. This knowledge should be integrated in the comprehensive disaster management framework for Bangladesh. To

promote links between disaster risk reduction and climate change adaptation, the government is raising awareness in both communities about the links between disaster risk reduction and adaptation to climate change and the need to integrate both in development plans, strengthening national institutions working in climate change. Adaptation Programs of Action (NAPAs) provide a process for Least Developed Countries to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change. Adaptation Measures as Prioritized in Bangladesh NAPA are as follows:

Intervention measures

• Promoting adaptation to coastal crop agriculture to combat salinity intrusion through maize production under Wet Bed No-tillage Method and *Sorjan.*

•Promoting adaptation to coastal fisheries through culture of salt tolerant fish especially in coastal areas of Bangladesh.

• Reduction of climate change hazards through coastal afforestation with community focus.

• Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise.

• Exploring options for insurance and other emergency preparedness measures to cope with enhanced climatic disasters (e. g. flood, cyclones and drought).

• Climate change and adaptation information dissemination to vulnerable community to raise awareness.

• Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.

• Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change (NAPA, 2005 as cited in DoE, 2007).

Various adaptation measures proposed by IPCC in its fourth assessment report are as following. It will be useful to compare these measures with currently practiced techniques in the selected study area.

Table 2.1: Adaptation measures proposed by IPCC

Sector	**Adaptation measures proposed by IPCC**
Water	1. Expanded rainwater harvesting 2. Water storage and conservation techniques 3. Water re-use; 4. Desalination 5. Water-use and irrigation efficiency
	1. Adjustment of planting dates and crop variety; crop relocation.

Sector	**Adaptation measures proposed by IPCC**
Agriculture	2. Improved land management, e.g. erosion control and soil protection through tree planting.
Human health	1. Heat-health action plans; 2. Emergency medical services. 3. Improved climate-sensitive disease surveillance and control. 4. Safe water and improved sanitation
Tourism	1. Diversification of tourism attractions and revenues. 2. Shifting ski slopes to higher altitudes and glaciers; 3. Artificial snow-making
Transport	1. Realignment/relocation; 2. Design standards and planning for roads, rail and other infrastructure to cope with warming and drainage
Energy	1. Strengthening of overhead transmission and distribution infrastructure; 3. Underground cabling for utilities; 4. Energy efficiency; 5. Use of renewable sources; 6. Reduced dependence on single sources of energy

(Adger et al., 2007)

CHAPTER 3
METHODOLOGY

Adaptation to climate change is adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It is important in the climate change issue in two ways-one relating to the assessment of impacts and vulnerabilities, the other to the development and evaluation of response options. Thus three objectives have been identified for this study. To obtain these objectives four most vulnerable unions are selected primarily considering physical vulnerability to climate change.

Literature review

Various scholarly literatures on climate change adaptation, socio-economic vulnerability analysis, study on physical vulnerability, assessment of adaptation strategies etc. have been studied to design the study methodology and define the variables for data collection.

Study Area selection

To select the study area various maps and data regarding coastal regions of Bangladesh, cyclone risk area and high risk area, sea level rise impact, salinity intrusion line, average tidal range and tidal limit have collected. Through extensive reviewing and analysis of the data, prospective study areas for this study have been selected considering the scope and limitations of this study. Based on secondary data sources prospective study areas were selected (Table 3.1).

Table 3.1: Most Climate Vulnerable Unions in Coastal Area of Bangladesh

Sl. No.	Name Of District	Name of Upazilla	Name of Union
1	Satkhira	Shamnagor	1) Padma Pukur 2) Koikhali 3) Gabura 4) Ramnagor
		Tala	1) Kholilnagor 2) Krista 3) Islamkathi 4) Nagorghata 5) Tutulia
2	Khulna	Dacop	1) Sutterkhali 2) Kamerkhata 3) Lawdop
3	Bagherhat	Mongla	1) Chapti 2) Sundarbone 3) Mitakhali 4) Chilla
		Morolgonj	1) Giodhara 2) Joipokkahati
		Sarankhola	1)Southkhali/Dakhinkhal 2)Royenda
4	Patuakhali	Golachipa	1) Supastia 2) Baropasdia 3) Rangabali 4) Kazol 5)

Sl. No.	Name Of District	Name of Upazilla	Name of Union
			Chormontor 6) Pampotti
		Kalapara	1) Latachapli 2) Lalua 3) Dhulashshor 4) Shaprabanga
		Mirjagonj	1) Mirjagonj 2) Kakrabunia 3) Mojidbaria 4) Dewri 5) Subidkhali
		Bawfal	1) Boga 2) Dulia 3) Kalishuri 4) Nurienpura
5	Bhola	Monpura	1) Hazirhat 2) Ramnawz 3) Shakushia
		Charseshion	1) Chortakrimuldi 2) Dhalchor 3) Chormarika 4) Kolmi 5) Nurabad 6) Chormadraz 7) Osmangonj
		Doluatkhan	1) Chorpata 2) Medua 3) Modonpur 4) Bhabanipur 5) Hazipur 6) Syedpur
		Borhanuddin	1) Boromanika 2) Pokshia 3) Hasannagor 4) Gangapur 5) Shachra
		Tozumuddin	1) Chadpur 2) Sonapur 3) Tombupur 4) Chachra
		Lalmohon	1) Lordhardin 2) Dhaligournagor 3) Chorbhuta 4) Bodorpur
		BholaSador	1) Purboelisha 2) Kachia 3) Donia 4) Shibpur
6	Barguna	BargunaSadar	1) Badarkhali 2) M. Baliatali 3)Dhalua

Source: Bangladesh Center for Advanced Studies (2010)

Based on secondary source data, firstly four vulnerable most *upazillas* each of Bhola (Burhanuddin), Barguna (Barguna Sadar), Satkhira (Shyamnagar) and Bagerhat (Sharonkhola) districts and finally four *unions* each of these *upazilas* have been selected as the areas for the study (mentioned earlier in Table 1.1).During final selection form the short list of *unions*; where maximum climate change impacts are present, spatial distribution has been considered. To get the scenario of both rural and urban area, three *unions* from rural area and one *union* from urban area has been selected. After that data of indicators of vulnerability to climate change and adaptation strategies etc. were collected for the study areas.

Secondary Data Collection

Secondary data is collected from Bangladesh bureau of statistics (BBS), SPARSSO, Meteorological Department of Bangladesh, Institute of water modeling (IWM) etc. Secondary data includes Community series for study areas, satellite image of study areas, rainfall readings of the coastal area; various maps related to cyclone, salinity intrusion are also collected.

Primary Data Collection

Pilot survey

Based on the extensive literature review a draft questionnaire has been prepared to conduct the pilot survey. Three prospective *unions* and one *pourashava* were primarily selected as the prospective study areas. Those are - Bara Manika (Burhanuddin, Bhola), Barguna Pourashava (Barguna Sadar, Barguna), and Royenda (Sharonkhola, Bagerhat). During this selection procedure maximum populous union and vulnerability due to geographical location was considered. Finally, after considering the findings of pilot survey Badarkhali union (Barguna Sadar, Barguna), Dakhin Khali/Southkhali (Sharonkhola, Bagerhat), Gangapur (Buhanuddin, Bhola) and Gabura (Shyamnagar, Shatkhira) are selected as study area. Selection was performed considering more vulnerable geographical location and past disaster experience. After necessary modification the draft questionnaire was finalized.

Field survey

After preparation of final questionnaire, field survey has been conducted by the project team. Field survey included questionnaire survey, focused group discussion, key informant interview (KII), application of participatory rural appraisal method etc. Sample Questionnaire survey was performed oversample size of 400 household in all four study areas altogether. According to population census 2011, there are 22,937 households in the four selected unions. Of this 400 households are surveyed where sample size was determined assuming 95% confidence level and 5% margin of error. From each union 100 households were surveyed.

Data entry, Data processing and Map preparation

After data collection, data entry and data processing operation took place. For data entry and processing SPSS software has been used. Along with that map preparation using ArcGIS software has been conducted.

Data analysis

In the data analysis process, information and data collected from field survey have been analyzed, so that the three objectives of this study can be achieved. To analyze data SPSS-13 and MS- Excel 2010 etc. software have been used for quantitative and qualitative data respectively. To analyze socio-economic vulnerability for the study areas income and poverty

measures were applied. AT the same time education, medical care, infrastructure etc. were also analyzed. After wards surveyed data on adaptation practices were analyzed and compared with IPCC proposed adaptation techniques. Finally people's perceptions regarding adaptation measures were got using frequency analysis.

Final report preparation

At the final stage of the study a final report has been prepared. This report is based on the data collection and data analysis process to attain objectives.

CHAPTER 4
STUDY AREA PROFILE

The socio-economic condition of a community is interlinked with the vulnerability. Poor socio-economic condition reduces individual's capability to alleviate risks, diminishes access to adaptation measures from extreme natural events. In order to assess and study the socio-economic vulnerability to climate change, it is necessary to know the socio-economic scenario of the selected study areas. In this chapter, the socio-economic aspects of the study areas with physical/infrastructural conditions are discussed.

Geographical location

Geographically the four selected unions are vulnerable to natural hazards as those areas are located just beside Bay of Bengal. Climate change scenario makes the situation more critical. The geographical location of the study areas is given bellow:

Table 4.1: Geographical location of the study areas

Name of the Union	Latitude and Longitude
Southkhali Union, Sarankhola Upazila, Bagerhat	22°12'N to 22°18'N and 89°47E to 89°55'E
Gabura union, Shamnagar Upazila, Satkhira	22°12'N to 22°17'N and 89°14'E to 89°20'E
Badarkhali union, Barguna Sadar, Barguna	22°9'N to 22°13'N and 90°1'E to 90° 7E
Gangapur union, Burhanuddin Upazila, Bhola	22°36'N to 22°27N and 90°35E to 90°42'E

4.1 Socio-economic Profile

4.1.1 Demographic Information

The four unions have a total population of 99,020 with 48,668 (49.15%) male and 50,352 (50.85%) female. Total number of household of four unions is 22,937 with an average household size 4.31. The detail population and demographic data of each union is given in the following Table 4.2.

Table 4.2: Population and demographic data of the unions

Union	Total Household	Average household size	Total Population	Male	Female	Population density (Per sq.km)	Disability rate (In percentage)
Southkhali	6,179	4	24,980	12,240 (49%)	12,740 (51%)	998	2.5
Badarkhali	6,390	4.1	26,201	12,785 (48.8%)	13,416 (51.2%)	850	2.3
Gabura	6,762	4.6	31,115	15,398 (49.48)	15,717 (50.52)	1,137	1.7
Gangapur	3,606	4.6	16,724	8,245 (49.3%)	8,479 (50.7%)	376	2.7

(Source: BBS, 2011)

4.1.2 Income and Poverty

Per capita income of all four unions is lower than the national figure of USD 848 (Bangladesh Economic Review, 2012). About 99% people of the Southkhali/Dakhinkhali union live under the poverty line with an income less than USD 1.25 per person per day (1 USD = 79 BDT) (Table 4.3). This poverty rate for Badarkhali, Gabura and Gangapur union is about 90%, 85% and 93% respectively.

Using the Basic Cost Need (BCN), estimated by Bangladesh Bureau of Statistic as the poverty threshold USD 0.71 per person per day (BDT 50 per person per day or per capita per day calorie intake 2,122 kcal), about 74% people of the Southkhali/Dakhinkhali union live below the poverty line. Using this poverty line, percentage of people living below poverty line at Badarkhali, Gabura and Gangapur is 55%, 60% and 52% respectively.

Table 4.3: Income and poverty condition of the study unions

Union	Per capital income (In USD)	People living under food poverty line(BCN) (BDT 50/ USD 0.71 per person per day or per capita per day calorie intake 2,122 kcal)	People living under poverty line (USD 1.25 per person per day)	Gini-coefficient
Southkhali	185.87	74%	99%	0.242
Badarkhali	236.63	55%	90%	0.389
Gabura	286.07	60%	85%	0.417
Gangapur	241.4	52%	93%	0.287

(Source: Field survey, 2012-13)

Value of Gini co-efficient of Southkhali/Dakhinkhali and Gangapur has been estimated to 0.242 and 0.287 respectively, which is lower than the national figure of 0.458 (HIES report,

BBS, 2010).This represents a lower inequality in income distribution at Southkhali/ Dakhinkhali and Gangapur. Value of Gini co-efficient at Badarkhali is 0.389, which is higher than Southkhali and Gangapur. Value of Gini co-efficient at Gabura is highest among the four unions and it is 0.417; which is nearest to national figure 0.458 and represents a moderate inequality in income distribution.

Income distribution function for each union (Table 4.4) has been developed from the surveyed income data to find out the proportion of income distribution and Gini co-efficient. Here, L (0.9) = 0.8009. This means bottom 90% of the population receive 80.09% of total income generated at Southkhali/Dakhinkhali or inversely top 10% people receive 19.91% of total income; which represents a lower inequality in income distribution. Similarly, at Badarkhali and Gangapur bottom 90% of the population receive 73.86% and 76.31% of total generated income at corresponding unions respectively. But, at Gabura top 10% people receive 31.79% of total income of the union which represents a moderate inequality in income distribution.

Table 4.4: Income distribution functions of the four unions

Union	**Income distribution function** (Enforcing the condition L(0) = 0 via the intercept option)	**L (0.9)**
Southkhali	$L(x) = 0.2385x^3 + 0.3299x^2 + 0.4184x$	0.8009
Badarkhali	$L(x) = 0.2385x^3 + 0.3299x^2 + 0.4184x$	0.7368
Gabura	$L(x) = 3.4058x^4 - 5.051x^3 + 2.6864x^2 - 0.0451x$	0.6821
Gangapur	$L(x) = 3.4058x^4 - 5.051x^3 + 2.6864x^2 - 0.0451x$	0.7631

(Source: Calculated from surveyed income data, 2012-13)

In the study areas, we have found following types of income sources of the people:

Table 4.5: Distribution of Households by Main Occupation

Occupation Type	**Southkhali(%)**	**Gangapur (%)**	**Badarkhali (%)**	**Gabura (%)**
Farmer	5	12.25	12.25	1
Fishermen	31.5	37.75	30.75	23
Wood Collector/Honey collector	0.75	-	-	4.25
Share Cropping	-	10.75	12	
Shrimp culture	-	-	-	16.75
Poultry Rearing	-	0.25	-	-
Boatmanship	2	0.75	2	1.25
Service Holder	12	4	4	3.75
Wage Labour	15	13.5	25	22.75
Rickshaw/Van	3.75	5	-	1

Occupation Type	Southkhali(%)	Gangapur (%)	Badarkhali (%)	Gabura (%)
Puller/Carts Driver				
Small Trading	21.75	13	9	18.5
Begging	-	1	-	-
Paid Domestic Worker	-	0.25	2	1
Handicrafts	-	-	1	-
Remittance	3			4
Others	5.25	1.5	2	2.75

(Source: Field survey, 2012-13)

From the Table 4.5 it is clear a major portion of households (includes farmer, Share croppers, fisherman, poultry rearing honey and wood collector) directly depend on climate dependent income sources. Almost 50% of the small traders at all of four unions trade with fish which is caught by fishermen i.e. they indirectly depend on natural resources (FGD, 2013).These income sources are very sensitive to climate change. According to the people, before SIDR (15th November 2007 A.C.) the percentage of wood and honey collector at Gabura and Southkhali/Dakhinkhali were greater than current figure 4.25% and 0.75% respectively. It has reduced now as government banned resource extraction from the Sunderbans after cyclone **SIDR** and **AILA** (FGD, 2013).

4.1.3 Agriculture

Cyclone **SIDR** and **AILA** totally destroyed the agricultural production at all of four unions and agriculture was not possible to the next year of these cyclones due to water logging and increasing salinity. Now agricultural production is normal at three unions except Gabura. At Gabura, agriculture is not possible to till now due to water and soil salinity. Even the saline resist verities of crops cannot grow as the salinity level is very high. Only about 1% of the total population takes agriculture as a primary occupation (Table 4.6). Before **AILA**, they produced rice, wheat, Ravi-crops, vegetables etc. but, now it is only dream. After **AILA,** long termwater logging of salt water over 2 yearsis the main cause of this salinity at Gabura. Shrimp is the only agricultural product but, only capitalist land owners are the main beneficiary of it. Moreover Shrimp culture encourages the salt water intrusion which hampers the agricultural recovery. Shrimp culture also decreases the new job creation as it needs lower labor force than agriculture. People wish that 4-5 years will be needed to wash away the salinity, if another storm surges or salt water flood do not occur.

Proportion of farmers and sharecroppers at Southkhali/Dakhinkhali and Gabura are comparatively lower than Badarkhali and Gangapur (Table 4.5). Boro, aman and ravi crops (includes pulse, oil seeds and various vegetables) are main agricultural products of the unions. Poor condition of roads and transportation network also adversely affect the agriculture in all of four unions. Farmers are unable to sell their agro products in the large markets of the corresponding districts and compel to sell it at rural markets at a lower price causing financial loss and wastage of products.

4.1.4 Educational facilities and literacy

Statistics of educational institutions at study areas is given in the following Table:

Table 4.6: Profile of educational institutions at study areas

Types of educational institutions	Southkhali	Badarkhali	Gabura	Gangapur
Primary schools (Government)	7	6	7	8
Primary schools and community school (Non-government)	12	23	3	-
High school	-	-	-	-
Madrasa	3	1	3	1

(Source: LGED, 2011)

Remarkably, there is no high school at the study areas. Statistics of literacy at study areas is given in Table 4.6. Literacy rate at Southkhali/Dakhinkhali and Badarkhali (Table 4.7) is about 52.5% and 55.9% respectively (aged 7 years and above), which is higher than the national figure 51.8%. Literacy rate at Gabura (35.9%) and Gangapur (45%) is lower than national rate. Female literacy rate at Southkhali/Dakhinkhali and Gangapur is higher than that of male; this will be helpful to expedite the socio-economic development of the community i.e. women empowerment.

Table 4.7: Recent literacy rate at study areas

Union	Literacy rate	Male	Female
Southkhali	52.5%	50.2%	54%
Badarkhali	55.9%	58.6%	53.4%
Gabura	35.9%	38.8%	33.2%
Gangapur	45%	42.3%	47.8%

(Source: BBS, 2011)

4.1.5 Social institutions

In the study areas, there are good numbers of social institutions and people have good interaction with them. Through FGD it is found that people of all four unions have best interaction with the NGOs, Chowkidar and ward members. Generally, in case of any problem they notify ward members through Chowkidar. People also have a good interaction and co-operation with NGOs to improve their socio-economic conditions i.e. people of

Southkhali/Dakhinkhali and Gabura have best interaction with NGOs. They have also interaction with agriculture officer, health worker, and family planning worker but it is not very strong. They have least interaction with legislative and executive bodies of the government. (FGD, 2013)

4.2 Infrastructural profile

4.2.1 Habitation

Three unions out of four (except Badarkhali) are at rural area and most of the households live in kutcha houses. Most of the households at Badarkhali union also live in kutcha houses as Badarkhali union locates at the periphery of the Barguna Sadar upazila town. Following types of structure are found at study areas.

Table 4.8: Structure types at study areas

Types of structure	Southkhali	Badarkhali	Gabura	Gangapur
Pucca	1.3%	0.6%	2.1%	1.2%
Semi-pucca	1.8%	3%	1.7%	3.3%
Kutcha	96.5%	94.6%	93.1%	95.0%
Jhupri(Thatched)	0.4%	1.8%	3.1%	0.6%

(Source: BBS, 2011)

Maximum households, about 98.7%, 99.4%, 97.9% and 98.9% houses (includes kutcha, semi-pucca and jhupri) at Southkhali, Badarkhali, Gabura and Gangapur respectively cannot resist disasters (particularly cyclone, storm surges and flood). Pucca houses mainly include schools, union council, forest office and several NGOs offices.

Most of the households at the study areas have their own house. Tenancy status of households is given bellow.

Table 4.9: Households by housing tenancy status

Types of structure	Southkhali	Badarkhali	Gabura	Gangapur
Owned	98.00%	98.2%	97.6%	98.7%
Rented	0.8%	1%	0.1%	0.3%
Rent free	1.1%	0 .8%	2.3%	1.1%

(Source: BBS, 2011)

4.2.2 Health facilities

People of Southkhali/Dakhinkhali and Gabura have better access to medical services than Badarkhali and Gangapur (Table 4.10). Current condition of health care services at the study areas is given bellow.

Table 4.10: Health care services at the study areas

Union	No of medical centers/community clinics	Percentage of households have access in medical services	Average distant of Medical centers/community clinics (Kilometer)
Southkhali	4	94%	2.35
Badarkhali	4	30%	2.37
Gabura	4	78%	1.56
Gangapur	4	69%	5.36

(Source: Field Survey, 2013)

Facilities of the medical centers are not improved and there is lack of medicine and trained health worker. Health workers and family planning workers do not perform their job properly. People all of four unions cannot go to district or upazila town getting better treatment because of poor condition of roads and transportation system i.e. women with delivery case suffer much. (FGD, 2013).

4.2.3 Water supply

At Southkhali/Dakhinkhali and Gabura, there is scarcity of pure drinking water due to ground water salinity. After cyclone **SIDR** and **AILA** situation become more critical. At Badarkhali and Gangapur, there is no scarcity of pure drinking water and most of the households drink tube-well water. Sources of drinking water in the study areas are given bellow in (Table 4.11).

Table 4.11: Sources of drinking water at the study areas

Source	Southkhali	Badarkhali	Gabura	Gangapur
Tap	6.4%	-	0.1%	-
Tube-Well	11.2%	98.6%	51.7%	100%
Others (Harvested rain water, pond water filtrated (PSF), purified water provided by NGOs)	82.4%	1.3%	48.2%	-

(Source: BBS, 2011)

Most of the households at Southkhali, about 82.4% drink water from other sources i.e. Harvested rain water, pond water filtrated (PSF), purified water provided by NGOs etc. NGOs train up people on rain water harvesting, dig ponds and set up Pond Sand Filters (PSFs) to reduce the drinking water problem. Particularly Prodipon a national level NGO, has installed a water treatment plant which can filter 1000 liter water per day. They sell the water at BDT 0.5 per liter where per liter water treatment cost is BDT 24 to 25 (Field survey, 2012-13).

Figure 4.1: Modern filter installed by Prodipon at Sothkhali/Dakhinkhali

Figure 4.2: Pond Sand Filter (PSF) at Southkhali/Dakhinkhali

In Gabura, about 51.7% drink tube well water and they are in a high health risk as most of the tube well's water is saline. About 48.2% get water from other sources i.e. harvested rain water, pond water, purified water provided by NGOs etc. NGOs also train up the people of Gabura on rain water harvesting and setting up Pond Sand Filters (PSFs). In rainy season there is no problem of drinking water at Southkhali/Dakhinkhali and Gabura as people drink harvested rain water. In dry season generally water crisis occurs and then people drink water from PSFs or purchase water from NGOs. At Badarkhali and Gangapur, about 98.6% and 100% households drink tube-well water as ground water salinity and arsenic pollution at those unions are below the acceptable limit.

Figure 4.3: Rain water harvesting at Southkhali/ Dakhinkhali

4.2.4 Sanitation

Proper sanitation is the precondition of better health. Condition of toilet facilities at study areas is given bellow in Table 4.12.

Table 4.12: Toilet facilities at study areas

Types of Toilet	Southkhali	Badarkhali	Gabura	Gangapur
Sanitary (Water sealed)	38.3%	19.9%	21.6%	7.5%
Sanitary (Non-water sealed)	55.9%	40.1%	35.9%	51.0%
Non-sanitary	5.1%	35.7%	24.3%	38.9%
None	0.6%	4.3%	18.2%	2.5%

(Source: BBS, 2011)

Sanitation condition at Southkhali/Dakhinkhali is comparatively better (Table 4.13) than other unions, although about 5.1% households use non-sanitary toilet and 0.6% households have none. Sanitation condition at Badarkhali, Gabura and Gangapur is not satisfactory as about 35.7%, 24.3% and 38.9% households use non-sanitary toilet and about 4.3, 18.2 and 2.5% households have none respectively. It bears a great potential risk on over all public health of study areas.

4.2.5 Electricity

People of the study areas have a limited access to electricity supply. But, recently some households have installed solar panel with the help of NGOs. Recent condition of electricity supply at the study areas is given in Table 4.13.

Table 4.13: Electricity connection in the study areas

Union	Percentage of households having electricity connection
Southkhali	12.8%
Badarkhali	20.3%
Gabura	18.9%
Gangapur	15.5%

(Source: BBS, 2011)

4.2.6 Transportation

Transportation plays a key role in socio-economic development. Gangapur and Gabura have good road connection with corresponding district and upazila head quarter; others Badarkhali and Southkhali/Dakhinkhali have none. Transport network and road condition inside the all of four unions are not so good. Present types and conditions of road are given in Table 4.14.

Table 4.14: Road types in the study areas (in Kilometer)

Types of Road	Southkhali	Badarkhali	Gabura	Gangpur
Zila Road (Pucca)	6.36	8.97	1.50	
Upazila (Pucca)				5.74
Upazila Road (Katcha)	4.32	5.95	9.92	0.91
Union (Pucca)	-	-	-	-
Union (Katcha)	-	-	-	2.98
Village Road A (Pucca)	0.92	4.81		
Village Road A (Katcha)	29.91	24.12	8.92	8.27
Village Road B (Katcha)	28.77	28.50	47.27	11.55
Total	**70.30**	**72.36**	**67.61**	**29.45**

(Source: LGED, 2011)

4.2.7 Dam

Most of the dams in the unions are constructed by WAPDA. NGOs also have constructed several dam and road cum dams at Southkhali/Dakhinkhali and Gabura. Dams are constructed under food for work (KABIKHA), money for work (KABITA) etc. projects. Profile of dam in the study areas is given bellow in Table 4.15.

Table 4.15: Union protection Dam in the study areas

Union	Dam length (Kilometer)
Southkhali	29.9
Badarkhali	-
Gabura	25.69
Gangapur	15.02

(Source: LGED, 2011)

4.2.8 Cyclone shelter

Most of the cyclone shelters are constructed after cyclone **SIDR** and **AILA** hit the study areas. Inadequate number of cyclone shelters was one of the main causes of this high number of death. After those cyclones, LGED department and NGOs have constructed the cyclone shelters. Recent profile of cyclone shelter is given bellow.

Table 4.16: Cyclone shelter in the study areas

Union	No. of Cyclone shelters
Southkhali	16
Badarkhali	5
Gabura	7
Gangapur	6

(Field survey, 2012-13)

Figure 4.4: Cyclone shelter constructed by Prodipon at Souhkhali/Dakhinkhali

Figure 4.5: Cyclone shelter constructed by Shushilon at Gabura

CHAPTER 5
ASSESSMENT OF SOCIO-ECONOMIC VULNERABILITY DUE TO CLIMATE CHANGE

Socio-economic vulnerability to climate change is analyzed by individual vulnerability, collective vulnerability, institutional capacity and infrastructural condition of study areas. Main indicator of analysis of socio-economic vulnerability is income and distribution of income. Basic assumption is income is a good proxy to measure poverty and poverty determines socio-economic vulnerability to climate change, holding that poor people has less access to resources and they are both economically and politically marginalized.

5.1 Analysis of individual socio-economic vulnerability

An indicator of absolute poverty gives scope to measure individual vulnerability in a relatively simple manner. According to Adger (1998 - 2002) poor are deprived in access to resources in disaster situations, so they are more vulnerable during times of natural disaster. Thus individuals at the lower end of the distribution of income are more at risk to the impacts of extreme events because they have little diversity of income sources and fewer supports against shocks. The measures used are therefore the poverty measures: head count ration (HCR), poverty gap (PG), poverty severity (PS) developed by Foster *et al*. (1984) (as cited in Adger, 1998-2002) and widely used for quantitative analysis of income poverty. The data is based on income based measures of poverty. Table 5.1 shows that the poverty indicators for the four study areas and for Bangladesh. From the Table it can be seen that in terms of lower poverty line all four study areas are in poor condition compared to scenario of rural Bangladesh. The average poverty gap for Badarkhali (25.69%) and Southkhali/Dakhinkhali (25.18%) population is much higher than average for rural Bangladesh (3.7%). Especially Southkhali union is comparatively in worse situation than other study areas and rural Bangladesh. These differences between the four study areas and rural Bangladesh can be explained as these study areas have a higher proportion of poor people. Thus population of these study areas is highly vulnerable to climate change from socio-economic aspects. Therefore they are less capable of implementing adaptation strategies by private initiative. At the same time various climate change impacts like flood, erratic rainfall, storm surges, salinity etc. is also affecting income sources of the population and thus aggravating poverty. Thus it is making the population more vulnerable. This can be explained more effectively by Table 5.2 and 5.3.

Table: 5.1 Poverty and its sensitivity to poverty line estimates for study areas

	Lower Poverty Line (Per day per capital income BDT 50 or USD0.71)						WB Poverty Line (Per day per capital income USD 1.25)			
	South khali	**Gabura**	**Gangapur**	**Rural Bangladesh ****	**Badarkhali**	**Urban Bangladesh****	**South khali**	**Gabura**	**Gangapur**	**Badarkhali**
Head count ratio (%)	74	60	52	21.1	55	7.7	99	85	93	90
Poverty gap (%)	25.18	21.12	15.2	3.7	25.69	1.3	57.71	49.01	48.17	50.89
Poverty severity (%)	11.53	9.85	6.05	1	17.77	0.4	36.78	31.04	27.58	34.87

(Source: Field survey, 2012-2013, BBS, 2011)

** calculated by Cost of Basic Needs method using lower poverty line for the year 2010

From Table 5.2 it can be seen that, for all four study areas altogether income is highly dependent on climate dependent sources of income. Income is weakly related with diversity of income sources of households. So it is necessary to explore various sources of income in the study area and their nature of dependency on climate change.

Table 5.2: Correlation coefficient for income, household size, diversity and climate dependent income

	Income	**Household Size**	**Diversity**	**Y(CD)**
Income	1			
Household Size	.3 01	1		
Diversity	.116	.165	1	
Y(CD)	.779	.207	.0978	1

(Source: Field survey, 2012-2013)

Table 5.3 shows various sources of income for the study areas and their nature of climate dependency. From the Table it can be seen that for all the study majority of household income sources are climate dependent. Highest dependency is found to be 61.75% households of Gangapur are dependent on climate dependent income sources, while lowest is 39.25% households Southkhali dependent on climate dependent income. As large number of population depends on natural source based sources of income, they suffer mostly in times of extreme climatic event. So they also face the risk of livelihood collapse and falling below poverty line.

Table 5.3: Sensitivity of income sources to climate change

Climate dependency	Occupation Type	Southkhali	Gangapur	Badarkhali	Gabura
Directly climate dependent (%)	Farmer	5	12.25	12.25	1
	Fishermen/Fishing	31.5	37.75	30.75	23
	Wood /Honey collector	0.75	-	-	4.25
	Share Cropping	-	10.75	12	
	Shrimp culture	-	-	-	16.75
	Poultry Rearing	-	0.25	-	-
	Boatmanship	2	0.75	2	1.25
	Total	**39.25**	**61.75**	**57**	**46.25**
Indirectly or not climate dependent (%)	Service Holder	12	4	4	3.75
	Wage Labour	15	13.5	25	22.75
	Rickshaw/Van Puller/Carts Driver	3.75	5	-	1
	Small Trading	21.75	13	9	18.5
	Begging	-	1	-	-
	Paid Domestic Worker	-	0.25	2	1
	Handicrafts	-	-	1	-
	Others	5.25	1.5	2	2.75
	Total	**57.75**	**38.25**	**43**	**49.75**
Climate independent (%)	Remittance	3			4

** Climate dependent income: agriculture, fishing, aquaculture that is all source of income based on natural resources
(Source: Field survey, 2012-2013)

Table 5.4: Cross tabulation between per capita income of household members and natural resource dependency of primary occupation of household head

Natural resource dependent primary income	Poverty line in CBN method (50 BDT)											
	Southkhali			Badarkhali			Gabura			Gangapur		
	Above (%)	Below (%)	Total(%)	Above (%)	Below (%)	Total (%)	Above (%)	Below (%)	Total(%)	Above(%)	Below(%)	Total(%)
Yes	38.46	52.70	49	68.89	50.91	59	22.50	41.67	34	79.17	48.08	63
No	61.54	47.30	51	31.11	49.09	41	77.50	58.33	66	20.83	51.92	37
Total	**26**	**74**	**100**	**45**	**55**	**100**	**40**	**60**	**100**	**48**	**52**	**100**

*Using the Basic Cost Need (BCN) estimated by Bangladesh Bureau of Statistic as the poverty threshold USD 0.71 per person per day (BDT 50 per person per day or per capita per day calorie intake 2,122 kcal
(Source: Field survey, 2012-2013)

Table 5.4 shows relationship between poverty and climate dependent primary occupation of household heads for all the study areas. Here poverty is measured in BCN method which is

per capita 50BDT per day for each members of household. It can be seen that highest level of poverty (74%) is found in Southkhali union, Bagerhat. Of which 52.7% household head's primary income source is natural resource dependent. Lowest level of poverty (52%) is observed in Gangapur union, Bhola. Of which 48.08% households' per capita income is below poverty line. So from Table 5.4 it can be said that people living below poverty line depend significantly on natural resource dependent sources of income.

Thus people of the study area are individually vulnerable to climate change from socio-economic point of view. Because there is high level of poverty and they are significantly dependent on climate dependent income. Thus they have less affordability to cope with climate change impacts. This is a vicious circle, where being poor makes people vulnerable to climate change impacts and climate change impact makes them poor.

5.2 Analysis of collective social vulnerability

Collective social vulnerability includes income distribution, power relation and institutional aspects. From the Table 5.5 it can be observed that inequality rises with rise in per capita income. Lowest per capita income is found in Southkhali/Dakhinkhali is USD 185.87 (Field Survey, 2012), it also shows lowest level of inequality (Gini coefficient, 0.242). One reason behind this may be that Southkhali union was most severely affected by cyclone **SIDR** and **AILA**. In fact agricultural activity was very much hampered thus per capita income is low. Highest level of inequality is found in Gabura (Gini co-efficient 0.417), which also portrays highest level of per capita income. One reason behind high inequality and high per capita income could be shrimp culture in union. It has been observed from FGD with the inhabitants that some influential and wealthy people pursue shrimp culture. While due to presence of salinity in soil and ground water agricultural activities are impossible there. In fact embankments are breached to let saline water inside shrimp farms and it makes the embankments more likely to collapse during flood and storm surge. So in one hand shrimp culture is contributing to rise in income for a few; on the other hand it is causing low level of income and unemployment for many. Thus causing inequality and hampering coping strategies.

Table 5.5: Income distribution and inequality in study areas

Zila, upazila	**Union**	**Per capita income (US $)**	**People below poverty line (BCN method, 50 BDT per day)**	**Value of Gini Co-efficient**
Bagerhat, Sarankhola	Southkhali	185.87	74%	0.242
Barguna, BargunaSadar	Badarkhali	236.63	55%	0.389
Shatkhira, Shamnagar	Gabura	286.07	60%	0.417

Zila, upazila	Union	Per capita income (US $)	People below poverty line (BCN method, 50 BDT per day)	Value of Gini Co-efficient
Bhola, Burhanuddin	Gangapur	241.40	52%	0.287

(Source: Field survey, 2012-2013)

However from Table 5.5 it is evident that all the four study areas are facing poverty at much higher level than national level (per capita income US $848). So collectively people of these study areas are vulnerable to climate change, because they can pay less for coping strategies.

Collective social vulnerability to climate change also depends on relationship of people with responsible institutions. From focused group discussion and Venn diagram of institutional relationship it is found that people in study areas are closely related with NGO workers, Chowkidars and Ward members. They are moderately connected with health workers, agriculture officers etc. These institutions works at the local level to reduce climate change impacts and help adaptation to changed environment. It is said that local level institutions increase resiliency against vulnerability (Adger, 1998). But often these institutions are funded externally, they lack in planning and proper knowledge and professionalism. Thus in times of extreme needs these institutions are not adequate to fight with climate change impacts and support adaptation, mitigation and rehabilitation. It is also found that people are least connected with members of legislatives and policy makers. Thus in many cases policy measures for climate change impacts do not represent the actual need and practical scenario of climate affected people.

In the end it can be said that people in the study areas are suffering from high level of poverty. Their income sources are mostly dependent on natural resources, so their livelihood is vulnerable to climate change. So, they have less capability to implement adaptation measures on their own. From field survey it is found that people cannot implement adaptation measures like elevating plinth of their house, setting up PSF or establishing solar panels, because they do not have sufficient amount of money. They need assistance from government and NGO sectors to implement adaptation measures. Now, it is necessary to study what kind of adaptation measures are currently being practiced in study areas. It is discussed in next chapter.

CHAPTER 6
ANALYSIS OF ADAPTATION STRATEGIES PRACTICED BY GO AND NGOS IN THE COASTAL AREA

After the cyclone SIDR on 15th November 2007; GO and NGOs actually started to practice the adaptation measures in the coastal area of Bangladesh. Just after two years of SIDR on 25 May 2009, AILA the history breaking and most devastating cyclone hit the coastal belt of Bangladesh. It destroyed the life and livelihood of the people; agriculture, infrastructure, livestock, fishing, extracting natural resources from the Sunderbans and so on. After these events, Bangladesh Government in association with Non- Government Organizations (NGOs) took multifarious adaptation measures and programs to make people adaptable with the frequent intense natural calamities; which are the ultimate results of climate change. IPCC has proposed adaptation measures to climate change in 7 sectors including water, agriculture, infrastructure or settlement, human health, tourism, transport and energy (IPCC, 2007). In this chapter, currently practiced adaptation measures in our study areas are studied with respect to proposed adaptation measures of IPCC in fourth assessment report.

6.1Adaptation measures practiced in the study areas

6.1.1 Water

Due to ground and surface water salinity, water scarcity exists in the study areas. Water is mainly used in domestic and irrigation purposes. Before salinity intrusion, most of the people collected drinking water from tube well. Now the scenario has changed. Ground water salinity level and arsenic pollution in Badarkhali (Barguna) and Gangapur (Bhola) are within the acceptable limit. At Gabura (Shatkhira) and Southkhali/Dakhinkhali (Bagerhat) salinity in ground water is severe. This is compliant with the information given in Figure 6.1. From the figure it is obvious that without projected sea level rise 5 PPT salinity intrusion is present in Shatkhira and Bagerhat. However in reality this value is much higher since agricultural production is decreasing in this area due to salinity problem. In Bhola and Barguna 5 PPT salinity intrusion may occur if there is 60 cm sea level rise.

Current scenario for sources of drinking water in the study area is given bellow. At Gangapur about 100% and Badarkhali about 98.6% people drink tube well water. GO (particularly DPHE) and NGOs provide tube wells at the areas. At Gabura and Sothkhali people drink water from sources like rain water harvesting, pond sand filter (PSF) and water treatment plants.

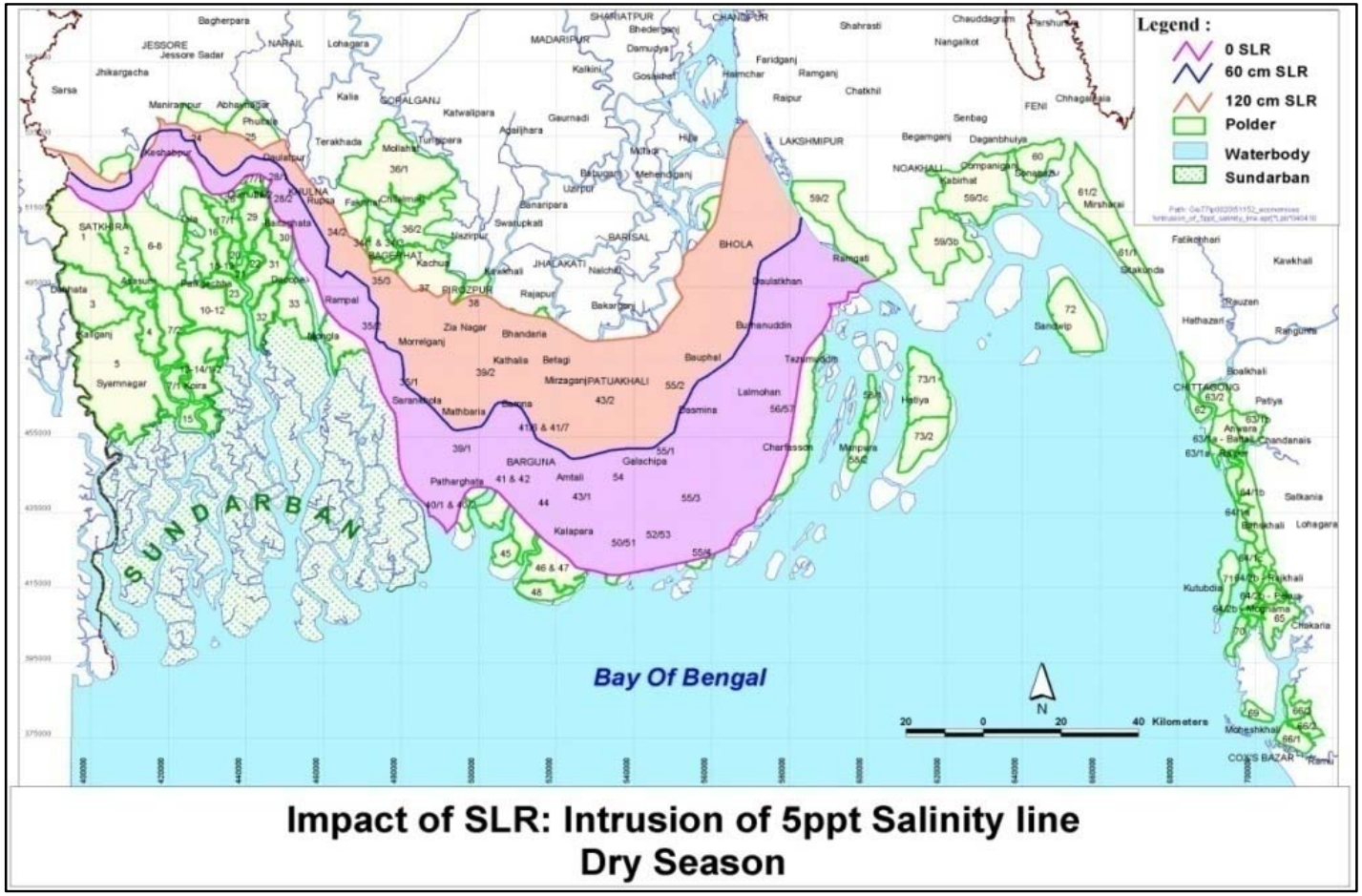

Figure 6.1: Sea Level Rise and Salinity Intrusion
(Source: Institute of Water Modeling, 2004)

Table 6.1: Drinking water sources in Study area

Source of Water	Southkhali (% of Household)	Gabura (% of Household)	Gangapur (% of Household)	Badarkhali (% of Household)
Tap	6.4	0.1	0	0
Tube-Well	11.2	51.7	100	98.6
Others	82.4	48.2	0	1.3
Total	100	100	100	100

(Source: BBS 2011)

Rain Water Harvesting, Pond Sand Filter and Treatment Plant

At Southkhali most of the households, about 82.4% drink water from other sources (Table 6.1). NGOs give training to people on rain water harvesting and setting up Pond Sand Filters (PSFs) to reduce the drinking water problem. At Gabura, there is also scarcity of pure drinking water. Here about 51.7% drink tube well water and about 48.2% households drink water from other sources i.e. harvested rain water, filtered pond water, filtered water provided by NGOs etc (Table 6.1). In Southkhali,"Prodipon", a national level NGO, has installed fresh water treatment plant which can filter 1000 liter water per day.

Figure 6.2: A pump house of filter installed by Prodipon at Southkhali/Dakhinkhali

Figure 6.3: A damaged PSF at Gabura

Performance of water related adaptation programs

People complain that PSF filters set up by NGOs often breaks down and there is no training facility for people on how to repair it. NGOs have also trained up the people of Gabura and Southkhali/Dakhinkhali on rain water harvesting; setting up Pond Sand Filters (PSFs). But, their effort is not enough to support the entire union. So this solution for drinking water problem does not sustain in the long run. One major problem at Gabura is saline water percolation from the surrounding rivers (Kapotakkho and Kholpotua River) to sweet water reservoir ponds. Ponds excavated by the NGOs do not work out properly due to this saline water percolation. Shrimp and crab culture at Gabura is also responsible for surface water salinity. Water treatment plants, installed by the NGOs only work for fresh water supply. So for sustainable drinking water supply at Gabura, water desalination plants are needed. Water desalination plants will be needed for all other study areas in future, if current climate change

trend continue. The GOs and NGOs having projects on drinking water supply in the study areas are given in Table 6.2.

Table 6.2: GO and NGOs having drinking water projects in the study areas

Union	**Concerned GO bodies and NGOs**
Southkhali	Prodipon, Islamic Relief World Wide Bangladesh, Nobolok
Badarkhali	DPHE; Oxfam , Plan BD
Gabura	Shushilon, Rupantar, CCBD
Gangapur	DPHE

(Source: Field survey, 2012-13)

6.1.2 Agricultural adaptation

Agriculture in the coastal area of Bangladesh is severely affected to climate change. Salinity in soil and water hampers traditional agricultural activities. Agricultural adjustment strategies include cattle and poultry farming, shrimp culture, tree plantation, rescheduling of cultivation pattern etc. Following adaptation measures have been found in the study area.

Livestock and poultry farming

At Gabura, NGOs organize training programs on poultry farming. NGOs established livestock and poultry farm; but these attempts were spoiled due to lack of sweet water and grazing land. At Gabura, still today water is so saline that even grass does not grow (Field survey December, 2012). As a result farmers switched to crab and prawn culture. At Badarkhali, Gangapur and Southkhali, there is enough grazing land and people rear livestock. At Badarkhali, Oxfam has constructed a high land and at Southkhali, Muslim Aid and WAPDA have constructed dam cum livestock shelter to save the livestock from flood.

Figure 6.4: A training program on poultry farming at Gabura

At Gangapur, no such adaptation measures are practiced. BRAC distributed livestock after AILA among the most vulnerable households as relief. After AILA, attempts were made to distribute livestock among the most vulnerable households under “JagoNari” project. However that project did not work out in the end (FGD, 2012)

Shrimp culture

At Gabura, people take brackish water shrimp and crab culture as an agricultural adjustment as cropping is not possible due to intense salinity. Among the four unions, economic gain of Gabura is significant (as mentioned at Chapter 5) due to shrimp and crab culture and people are switching to shrimp culture from agriculture day by day. But, this brackish water shrimp culture has several detrimental effects such as:

- Delaying the agricultural recovery (particularly cropping) and hamper the local food security.
- Increasing scarcity of fresh drinking water.
- Low labour demands for shrimp culture (FGD, 2012)

Except Gabura, in other three study unions, shrimp and crab culture does not exist.

Tree Plantation

At Badarkhali, Oxfam distributed trees under RE-CALL project to reduce the coastal erosion. Oxfam has done same work at Gabura, but the plantation could not survive due to salinity. As an adaptation measure it is necessary to provide training on planting schedule, crop variety and seed bed relocation etc. to save the agro production. Block Supervisors of Agricultural Department give some suggestions to the farmers about it. However, the program is not organized and adequate.

6.1.3 Settlement and Infrastructural Adaptation

About 98.72% (BBS, 2011) houses (includes semi-pucca, kutcha, and jhupri/thatched) of the study area cannot resist disasters (particularly cyclone, storm surges and flood). Pucca houses, about 1.28% mainly includes cyclone shelters, schools, union council, forest office and several NGOs offices. Disaster resilient infrastructural development is needed to reduce people's vulnerability to climate change and extremes. GO and NGOs have taken the following infrastructural adaptation measures in the study area:

Infrastructural adjustments

a) House rebuilding

In the study areas, about 30.75% households have rebuilt their houses after cyclone SIDR and AILA. Most of the households, about 86.17% rebuilt their houses on their own. Rest of the households, about 13.83% have rebuilt with the help of donor agencies and NGOs i.e. Saudi Government, Rupantor, Karitas, Hope Bangladesh, Ummah Welfare Trust UK, Shushilon etc. (Field survey, 2012-13)

b) Construction of new cyclone Shelter

Inadequate number of cyclone shelter was one of the main causes of heavy fatality due to cyclone **SIDR** and **AILA**. After these cyclones, GO and NGOs have constructed new cyclone shelters. Statistics of current cyclone shelters is given bellow:

Table 6.3: Number of cyclone shelters

Union	2007	2013	Government shelters	Capacity of Govt. shelters	population
Southkhali, Bagerhat	4	16	11	9,300	24,980
Gabura, Shatkhira	3	7	5	4,775	31,115
Gangapur, Bhola	2	6	6	7,250	16,724
Badarkhali, Barguna	2	6	6	4,890	26,201

(Source: Field survey, 2012-13 and CDMP, 2010)

Most of the cyclone shelters are constructed by government organizations (particularly LGED) and NGOs also have constructed several cyclone shelters. Highest number of cyclone shelters is located in Southkhali/Dakhinkhali union. After devastating effect of SIDR the number of cyclone shelter in South Khali quadrupled. It is also understood from table 6.3 that numbers and space in cyclone shelters are not enough to accommodate the vulnerable population. People also demand space for livestock in the cyclone shelter as people do not want to go cyclone shelter without their livestock in cyclone period (FGD, January, 2013). There is a demand for designated space for women in the cyclone shelters to ensure safety and privacy. Most of the cyclone shelters are used as primary school, madrasa and maintained by school or madrasa committee (FGD, 2012-2013). Approximate location of cyclone shelters is demarcated on Recourse Maps (Appendix I). Cyclone shelters in Badarkhali are concentrated in the north and southern part of the union, as result a significant portion population (people of the eastern part of the union) is far away from the shelters. In Gangapur shelters are located far away from the settlement. In Gabura and Southkhali/Dakhinkhali, cyclone shelters are evenly distributed.

c) Elevation of plinth of houses

After the **AILA,** at Gabura NGOs (particularly Shusilon, Rupantor, LEADERS, Karitas etc.) helped people elevating their house plinth above than normal flood level. According to the local community, 80% people got this help. People of other three study areas did not get this facility. As elevation of plinth level requires monetary investment poor people of the study area could not manage the sum on their own.

Locational adjustmentorChange

About 24.25%, households of the study areas have shifted their houses over the last 15 years. Locational change rate at Badarkhali and Gangapur is higher than at Southkhali and Gabura and it is about 44% and 43% respectively. River erosion is the main cause of this higher rate of habitation shift at Badarkhali and Gangapur Current scenario of river erosion is shown in

flood maps (Appendix II). GO and NGOs take several measures to reduce river erosion such as tree plantation, dam construction and repairing etc. but these measures do not work out properly (Field survey, 2012-13).

Migration

Migration rate in the study areas is 10% and it is more or less same at all of four unions. Most of the migrants migrate in the nearby divisional or district towns and in Dhaka.

Table 6.4: Population changing trend in the Study Areas

	Population in 2001	**Population in 2011**	**Change in population**
Badarkhali	25,840	26,201	361
Gangapur	24,517	16,724	-7,793
Gabura	32,417	31,115	-1,302
Southkhali	24,090	24,980	890

(-ve denotes reduction and +ve denotes increasing in population over 10 years)
(Source: BBS, 2011 & 2001)

From the Table 6.4, at Gangapur and Gabura population has decreased by 7,793 and 1302 over the 10 years. It means these people have migrated over the 10 years (some people have also died by natural extremes i.e. cyclone SIDR and AILA). Population at Badarkhali and Southkhali in 2011 is also growing at a very low rate (BBS, 2011); which indicates people have migrated over the 10 years. From field survey in total seven cases of migration was identified. Apart from that contact details of 33 migrants were collected. Livelihood failure and destruction of income sources are the main causes of migration (FGD, 2013).

Case Study of migration

***LitonHawladar**, age 35, is a migrant from Southkhali/Dakhinkhali, Sarankhola (Bagerhat). He has a family of five. He migrated with his family right after the attack of cyclone SIDR. Before SIDR he was a small businessman and farmer in Southkhali/Dakhinkhali. After the attack of cyclone he lost his capital, facing livelihood failure. Moreover his homestead was destroyed in the storm and he did not get any kind of credit to rebuild his home and livelihood. So he was forced to migrate from Southkhali/Dakhinkhali. At first he went to Khulna but there he did not get any job. Then he moved to Chittagong to work as a garment worker. But finally he moved to Dhaka. Now he is working as a paid laborer in a wholesale paper store at Keranigan, Dhaka. Before SIDR he used earn 20,000 BDT per month, but now he has to run his family with only 8,000 BDT per month. So his standard of living has degraded. His children went to school before migrating to Dhaka. But Dhaka's educational expenses are very high so they have dropped out of school. Mr. Liton is now saving up money in a co-operative society. He hopes if he can save enough capital to start a new business, he will go back to Southkhali/Dakhinkhali one day. (Source: Field survey, 2012-13)*

6.1.4 Human health

No program on climate-sensitive diseases related adaptation measures are found in the study areas. NGOs have some projects on health care at Gabura, but it is not climate related. Other three study union has none.

Emergency medical services

Community clinics mainly provide emergency medical services in the study areas. Facilities of the Community clinics are not improved and there is lack of medicine and trained health worker. Health workers and family planning workers don't perform their job properly. They have no plan or idea how they will face climate change occurring catastrophic situation. There is no climate-sensitive disease surveillance and control cell.

Improved sanitation

Proper sanitation is the precondition of healthy life. Present scenario of sanitation condition is given in Table 4.13. Sanitation condition in the study areas is not satisfactory as about 29.6% (considering all 4 unions) households use non-sanitary toilet and 6.7% people have none. It bears a great potential risk on over all public health of the area i.e. various water borne diseases can break out at any time. In order to reduce the sanitation problem NGOs provides sanitary toilets; but it is not sufficient. People allege that most of the toilets were captured by the rural influential and touts.

6.1.5 Tourism

The Sunderbans is UNESCO recognized world heritage site and largest mangrove forest in the world. But there are no minimum tourism facilities for the tourist. Moreover cyclone **SIDR** and **AILA** destroyed the main communication lines with divisional and district towns and still now all of those roads have not reconstructed. As a result, local and foreign tourists are discouraged and government loses revenue. Bangladesh has a great opportunity to earn foreign currency from the Sunderbans through providing modern tourism facilities. Improvement of tourism sector will reduce local unemployment problem, increase local people's income and finally increase people's access to adaptation measures in the study area. But, any program on tourism development has not found in the study area.

6.1.6 Transport

Transportation plays a key role in socio-economic development. Only Gabura has a good road connection with upazila and district headquarters, but inside the union road condition is poor. At Gabura all the roads were constructed by NGOs except union protection dam. Condition of transport networks at Southkhali/Dakhinkhali, Badarkhali and Gangapur is very poor. Zila road which connects Southkhali/Dakhinkhali, Badarkhali and Gangapur with respective upazila and district headquarter, was severely damaged by Cyclone SIDR and AILA. But, government agencies did not take proper step to reconstruct it and people suffer a lot due to it i.e. economic loss, diminishing job options, getting better health care etc. WDB reconstructed the union protection dam cum roads and several NGOs also constructed some roads inside the unions. All roads are earthen and constructed under work for money, work

for food etc. Those roads were earthen road and in the rainy season they become unusable. Now, it is needed to pave the roads.

Dam and road construction

All of 4 study area is bounded by rivers and generally in the rainy season these rivers become full with brim and flood the unions. After **SIDR** and **AILA**, protection dams of all 4 unions were destroyed. In order to save the people and their property, WDB reconstructed the dams under Work for Money, Work for Food etc. project. There is an objection of people of Badarkhali that they have not got their full allotted sum still now, although their work was completed in 2008. Remarkably, at Southkhali/Dakhinkhali there is not enough sluice gate or spill way to remove excess rain water from inside the union; as a result people frequently cut the dam to remove the stagnant water. NGOs also constructed dam cum road cum livestock shelter in all 4 unions specifically at Gabura. Lack of proper maintenance of the dams is found and it is a main cause of dam failure in the rainy season. Now, dams need to be elevated and widen as Highest Flood Level (HFL) is increasing day by day due to sea level rising.

6.1.7 Energy

Almost 16.87% households have electric connection in the study area (considering 4 unions) (BBS, 2011). But, recently many people have installed solar panel with the help of NGOs i.e. people depend on renewable energy. Still around 80% people do not have access to electricity supply.

6.1.8 Technical Adjustments

In order to reduce loss of lives due to cyclone, GO and NGOs have taken the following adaptation measures:

- GO and NGOs train up the people about the cyclone signals and what to do after hearing the signal through multifarious training programs.
- Train up people about primary medical treatment.
- Making disaster management CBOs.
- Giving hand mike, life jacket , signal flag to disaster management CBOs

6.2 Comparison between adaptation measures proposed by IPCC and adaptation measures practiced by GO & NGO at study areas

Now, present adaptation scenario of the study areas are compared with respect to IPCC proposed adaptation measures in fourth assessment report (Table 6.5). The following symbols are used to represent the level of practice.

√√= Perfectly practiced

√= Moderately practiced

×= No practice

Water related Adaptation measures proposed in IPCC fourth assessment reports like increasing irrigation efficiency, water re use and desalination are not found in the study areas. Rain water harvesting and water storage through ponds are not found in Barguna and Gangapur. These two unions are less affected with salinity and people collect drinking water from tube well.

Table 6.5: Adaptation measures practiced in study area

Sector	**Adaptation measures proposed by IPCC**	**Southkhali, Sorankola, Bagerhat**	**Gabura, Shamnagar, Satkhira**	**BargunaSadar, Barguna**	**Gangapur, Borhanuddin, Bhola**
Water	Expanded rainwater harvesting	√	√	× (drinking water from tubewell)	× (drinking water from tubewell)
	Water storage and conservation techniques	√	√	× (drinking water from tubewell)	×(drinking water from tubewell)
	Water re-use	×	×	×	×
	Desalination	×	×	×	×
	Irrigation efficiency	×	×	×	×
Agriculture	Adjustment of planting dates and crop variety; crop relocation.	√	×	×	×
	Improved land management, e.g. erosion control and soil protection through tree planting.	√	√	√	√
Human health	Heat-health action plans	×	×	×	×
	Emergency medical services	√	√	√	√
	Improved climate-sensitive disease surveillance and control.	×	×	×	×
	Safe water	√	√	ÃÃ	ÃÃ
	Improved sanitation	√	√	√	√
Tourism	Diversification of tourism attractions and revenues.	×	×	×	×
Transport	Realignment/relocation	√	√	√	√
	Design standards and planning for roads, rail and other infrastructure to cope with warming and drainage	√	√	√	√
	Reduced dependence on single sources of energy	×	×	×	×

Sector	Adaptation measures proposed by IPCC	Southkhali, Sorankola, Bagerhat	Gabura, Shamnagar, Satkhira	BargunaSadar, Barguna	Gangapur, Borhanuddin, Bhola
Energy	Use of renewable sources	√	√	√	√
	Strengthening of overhead transmission and distribution infrastructure	×	×	×	×

(Source: Field survey, 2012, 2013)

It is clear from Table 6.5 that agricultural adjustments and measures which have already been taken are not adequate. GO and NGOs should give attention on agricultural adaptations such as adjustment of planting dates and crop variety, crop relocation, improved land management e.g. erosion control and soil protection through tree plantation etc. which are proposed by IPCC in fourth assessment report.

Only human health related adaptation measure found in the study areas is emergency medical services provided by community clinics. No program on climate-sensitive diseases related adaptation measures are found in the study areas. Safe drinking water from tubewell is available in Barguna and Gangapur. Safe water supply in Gabura and Southkhali is not available. Sanitation programs are present in study areas but it is not satisfactory.

Transportation related adaptation measures proposed in IPCC like realignment and relocation of roads, improved design standards for transport networks etc are practiced in study areas, but in a very limited scale.

Now, for energy use related adaptation measures people are adopting solar power. But strengthening of overhead transmission and distribution infrastructure, underground cabling for utilities, reduced dependence on single sources of energy etc. adaptation measures are needed to make a disaster resilient utility service system.

So it can be concluded from this discussion that some adaptation measures are being practiced in the study areas. However these programs are not adequate if compared to local people's needs and IPCC proposed list of adaptation measures.

CHAPTER 7
PEOPLE'S PERCEPTION REGARDING ADAPTATION STRATEGIES

A number of adaptation strategies are in practice in the study areas to combat adverse impacts of climate change. It is important to review the perception of local people about these strategies and the effectiveness of the programs to attain desired goals. This chapter also discusses the level of awareness among inhabitants of the study areas regarding the impacts of climate change and the strategies adapted.

People's perception regarding GO and NGO programs, benefits derived from those programs and reasons for not getting expected benefit from some of the programs are discussed in this chapter.

7.1Community's knowledge about adaptation measures

Through questionnaire survey and focus group discussion, it has been tried to understand, how far the local people are aware of the adaptation strategies practiced by GOs and NGOs in the study areas. About 88.5% of the sample population responded positively about presence of adaptation measures in the study areas and remaining 11.5% of the respondents said they did not know about any adaptation measures. When people were asked about their involvement in adaptation measures, only 14% respondents gave positive response that they themselves or any relative of theirs are engaged in adaptation programs. That is majority of local people (about 86%) is not directly involved in adaptation measures taking place in the study areas.

Government organizations undertook a number of programs to address climate change impacts. Local people were asked to state their preference about the GO programs in the study areas.

Table 7.1: People's priority about adaptation measures taken by Government

Measures taken by GOs	**Frequency (Total respondent 354 out of 400)**	**Priority**
Dam cum road construction and repairing	140	1st priority
Construction of cyclone shelters	134	2nd priority
Relief	44	3rd priority
CPP (Red Crescent)	29	4th priority
New Housing	7	5th priority

(Source: Field survey, 2012- 2013)

It is evident from Table 7.1, among the government adaptation programs, the respondents gave highest priority to dam cum road construction and repairing. It seems that people considers flood as the major threat. Construction of cyclone shelters is their second priority followed by relief activity (3rd priority), Cyclone Preparedness Program (CPP) (4th priority) and construction of new house (5th priority). Local people have given priority to various infrastructural development program performed by government. However, relief operations do not actually fall under category of adaptation measures.

Table 7.2 shows people's priority about adaptation measures taken by NGOs. Similar to GO programs, in case of NGO programs, local people also gave first highest priority to dam repair and construction by various NGOs and second priority to Cyclone Preparedness Program (CPP). The CPP program disseminates information on early warning and prepares the community to face the disaster event. Third preference was given to micro credit programs of NGOs to recover from extreme climatic impacts. As the fourth priority, they identified pure drinking water projects NGOs (specifically Prodipon, Islamic Relief World Wide, Nobolok, Oxfam, Shushilon etc.). Cyclone shelter by the NGOs got comparatively lower priority as most of the Cyclone shelters are built by GOs. People need training and knowledge on adaptation to address climate change impacts. NGOs arrange these training programs (seventh priority). Habitat and housing development, tree plantation programs etc. of NGOs got lower priority; though tree plantation is an effective tool for erosion control.

Table 7.2: People's priority about adaptation measures taken by NGOs

Measures taken by NGOs	**Frequency (Total respondent 354 out of 400)**	**Priority**
Dam repair and construction	68	1st priority
Cyclone Preparedness Program	65	2nd Priority
Micro credit	60	3rd priority
Drinking water	59	4th priority
Cyclone shelter	30	5th priority
Training	26	6th priority
Relief	24	7th priority
Habitat, housing	19	8th priority
Tree Plantation	3	9thpriority

(Source: Field survey, 2012- 2013)

7.2 Community's perception about adaptation measures

This section is based on analysis of people's perception regarding adaptation measures taken by Government and NGOs. This includes their opinion about getting benefit from adaptation measures, identification of specific benefits by the respondents and their level of satisfaction regarding adaptation measures.

First of all people were asked if they have been benefitted from existing adaptation measures. About 260 respondents answered to this question. About 70.84% have expressed that they have been benefitted from adaptation measures and 29.16% respondents have reported that they did not get any benefit.

From, Table7.3, it can be seen that relief activity has been identified as the most beneficial activity. Although relief activities are not an adaptation measure, but people gave it highest rank as it meet their emergency need during disaster period. Then knowledge and training, construction of cyclone shelter got second and third priorities as both are needed to save loss of both human lives and property. Next comes infrastructural strengthening (Construction of disaster resilient houses, latrine, elevation of plinth etc). Employment and income has got 5th rank. Water supply, road, loan, protection of life, tree plantation and tiger protection have got lower priority to the people. An interesting observation is that people have given priority to water supply by NGOs in terms of benefit. But it is given low score (frequency) as adaptation measures. Relief works has got highest priority for benefit but it is given lower priority (Table 7.2) as adaptation measures. So it is clear that while people consider about getting benefit from adaptation measures they give high priority to those programs where there is no cost involved. But improvement of crop production techniques are absent from list of beneficial measures. Though there is presence of adjustment of crop production measures in study areas. So it can be assumed that there is less awareness among people regarding adjustment of crop variety etc.

Table 7.3: People's rank about benefit derived from various adaptation programs

People's perception	**Frequency (Total responses184 out of 260)**	**Rank**
Relief	45	1st
Knowledge and training	40	2nd
Construction of cyclone shelter	22	3rd
Infrastructural strengthening(house, toilet, plinth)	20	4th
People's perception	**Frequency (Total responses184 out of 260)**	**Rank**
Employment and income	17	5th
Water supply	16	6th
Road	13	7th
Loan	6	8th
protection of life	3	9th
Tree Plantation	1	10th
Tiger protection	1	

(Source: Field survey, 2012- 2013)

It needs to be noted that 29.16% people have said that they did not receive any benefit from adaptation measures. This is a large percentage, therefore reasons behind not getting any benefit has been investigated. While identifying reasons for not getting benefit, the

respondents identified the reasons as inadequate relief works and training for adaptation measures. They also noted the following issues which includes lack of job opportunity through adaptation programs, corruption, insufficient financing, high interest rate of loan etc. (Table 7.4). Finally people said inadequate number of water purifier and lack of training for operation and maintenance of these purifiers as a reason for failure of adaptation program. One interesting observation was that people are more dependent on external support (NGO support) for adaptation rather than getting self reliant.

Table 7.4: People's rank about reasons for getting no benefit from various adaptation programs

Reason for no benefit	**Frequency** (Total responses76 out of 260)	**Rank**
Lack of relief and training	21	1st
Could not create employment	16	2nd
Nepotism and corruption	13	3rd
Absence or insufficient financing	8	4th
High interest rate of loan	6	5th
Creating dependency on NGO help	6	
insufficient infrastructure	2	6th
Lack of technical knowledge to run water purifier	2	
insufficient number of water purifier	2	

(Source: Field survey, 2012- 2013)

Table 7.5 shows people's satisfaction regarding adaptation measures. This was an open ended question and respondents gave their opinions. After that this responses were classified in three classes. Here 8.25% of respondents said that there are no projects in their area. 29.75% of respondents said that they are satisfied with adaptation measures. Where 17% is moderately satisfied and 45.5% said that they are not satisfied. There is 8.25% response that there is no project hence level of satisfaction is irrelevant.

Table 7.5: People's level of satisfaction regarding adaptation projects

Level of satisfaction	**Frequency**	**Percentage (%)**
Moderate	68	17
Satisfied	119	29.75
Not satisfied	180	45.5
No project	33	8.25

(Source: Field survey, 2012- 2013)

So in the end it can be said that there is still lack of awareness among local people regarding adaptation measures. They have identified and given preference to various climate change adaptation related and disaster management related Government and NGO programs. But they are still giving high priority to relief works as adaptation measures. In the meantime people are giving less priority to water purification, crop diversification and plantation

programs. However in general, people are aware that various training on climate change adaptation can increase their adaptive capacity. People have also mentioned reasons behind adaptation measures not being beneficial. They have talked about insufficient relief, training, loan activities, corruption, too much dependence on NGO projects, infrastructural weakness etc. They have also pointed out that adaptation measures could not create employment and interest rate of loan is very high. Thus it is clear that more focus is needed on socio-economic development of the coastal areas to make adaptation measures fruitful.

CHAPTER 8
CONCLUSION

After analysis of people's vulnerability, currently practiced adaptation measures by GOs and NGOs and people's perception regarding those adaptation measures; some important findings are found. Those include that, people are unable to take adaptation measures on their own due to poverty, adaptation measures are inadequate and some important measures proposed by IPCC is absent in the study areas. Finally, people are aware of adaptation measures and in many cases they are not satisfied with the current situation. Thus some recommendations are proposed in the following sections for betterment of the current condition.

8.1 Recommendation

In order to make the communities resilient to climate change induced natural hazards, GOs and NGOs should be more constructive, responsive and technologically advanced in their work. For the four unions, following recommendations are proposed to make the communities disaster resilient and less vulnerable to climate change.

- Poverty reduction programs are required in the study areas. This can be done through introducing multifarious climate independent job opportunities.
- It is evident from the study that a significant number of residents are dependent on climate dependent natural resources for their living. Thus severely affected by natural calamities. Alternative source of income is an important issue.
- Training on water purification and mechanism of PSF repairing.
- Installing desalination plant.
- Adjustment of agricultural system with changing climate through change of planting time of crops, introduction of saline resilient varieties of crops, introduction of floating bed cropping in flood monsoon etc.
- Constructions of new cyclone shelter with even spatial distribution with improved accessibility is a dire need, as most of the study unions do not have enough cyclone shelters to accommodate local people. Gender issues must be considered in designing cyclone shelters. Separate space for livestock is also needed. Controlling salinity intrusion for shrimp culture and encouraging the fish farmers to fresh water shrimp culture. Co-existence of agriculture and fresh water shrimp culture will bring a economic wellbeing for the people.
- Loan at a low rate of interest to recover from post disaster situation.
- Repairing, maintenance and construction of roads and embankment for better transportation network.
- Emergency relief and cyclone preparedness program needs to be strengthened to fight with increased climatic events.
- Advanced research and establishment of health care facilities in the study areas for preventing climate induced diseases.
- Various research program to incorporate local knowledge for climate change adaptation is required

- Education and training program for general people for climate change adaptation
- Increased financing in both Government and NGO sectors for climate change adaptation

8.2 Conclusion

In the end it is definite that climate change is a glaring reality for low income coastal countries like ours. Various government and NGO programs are in action to fight with various impacts of climate change and adaptation to that change. Now it is time to reassess the impact of those programs on climate change scenario of our country. For this purpose assessment of perception of climate affected communities shall be very helpful. As these communities are experiencing the success or failure of the aforementioned programs.

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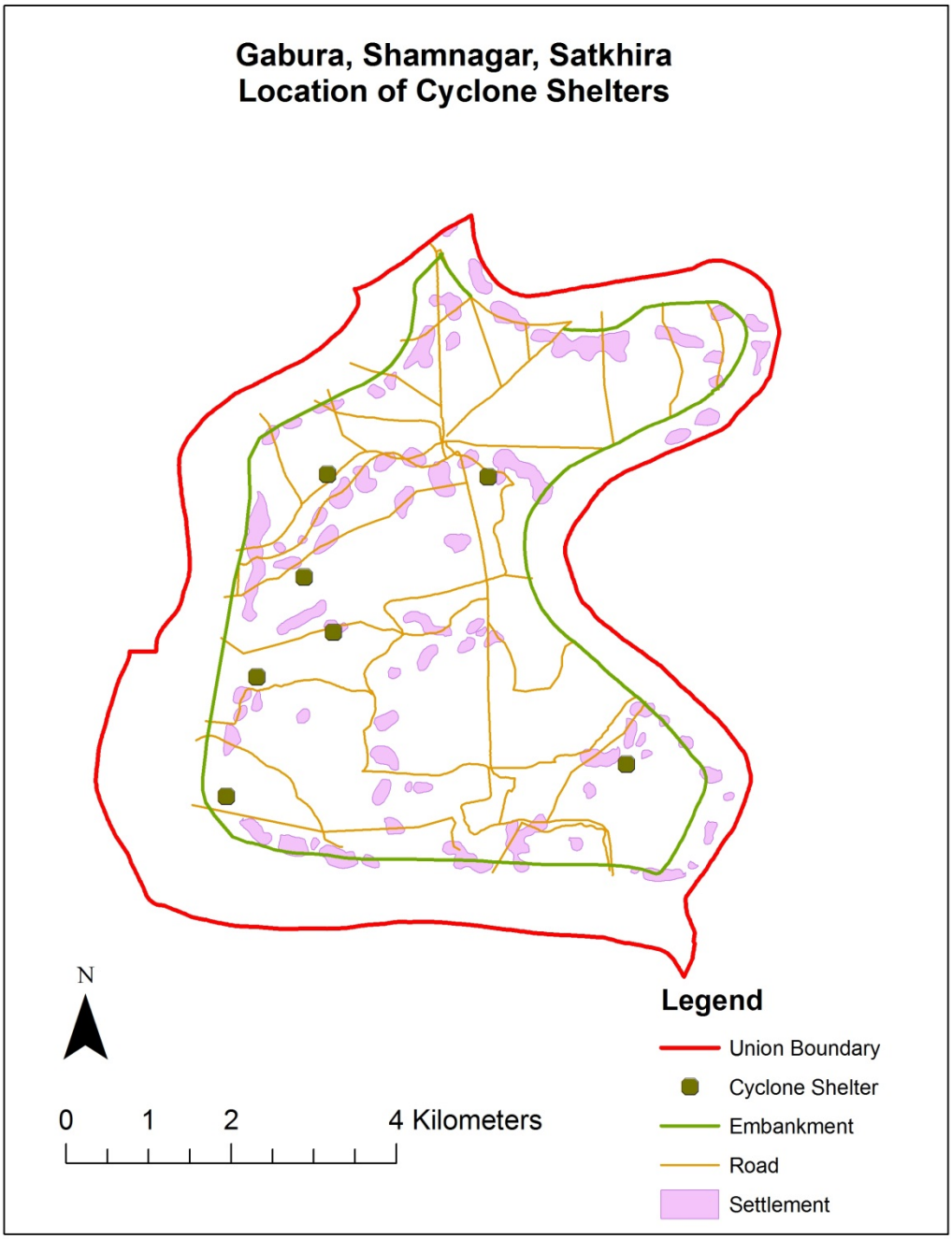
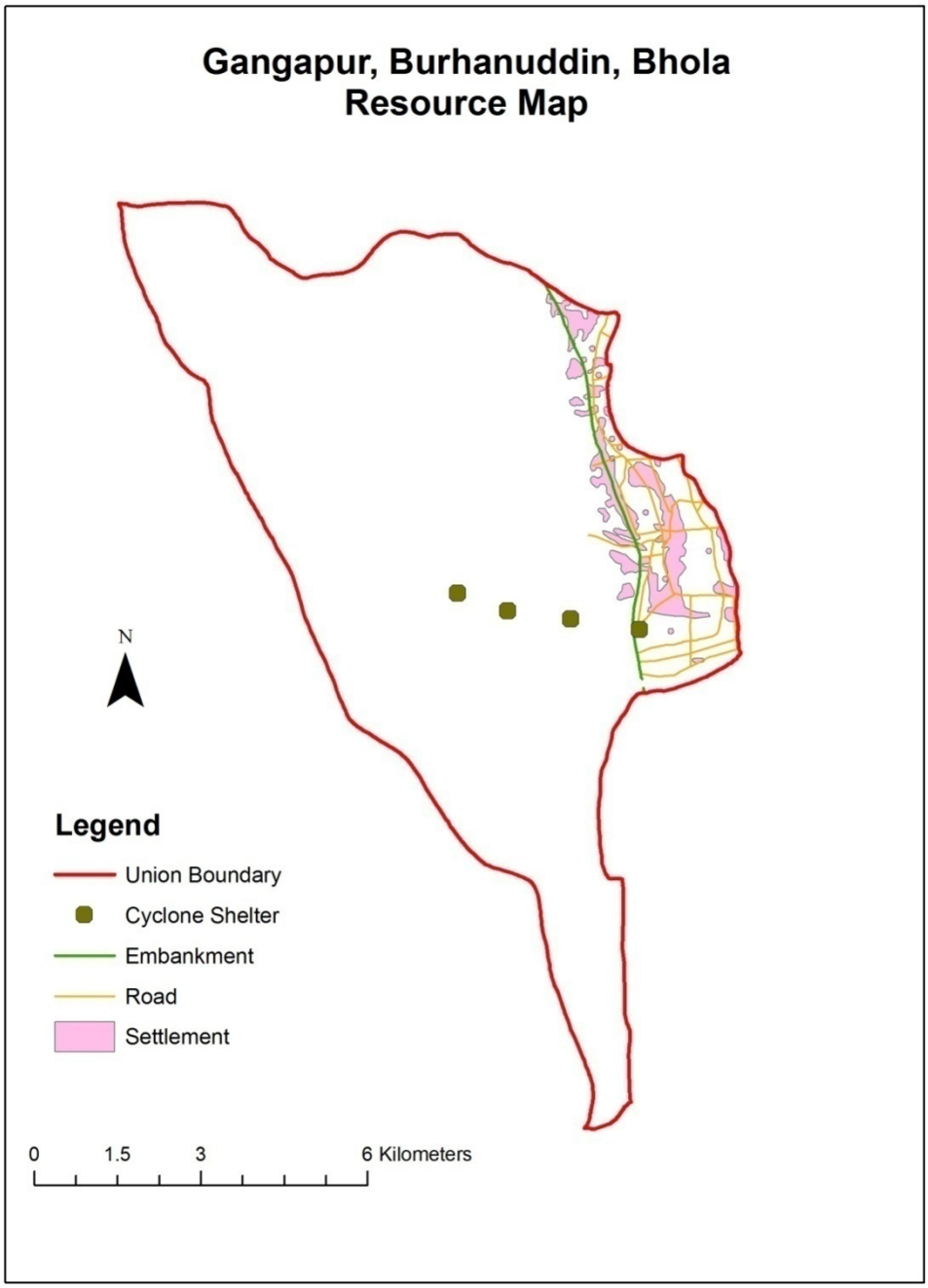
APPENDIX I



Source: LGED and field survey 2012-13



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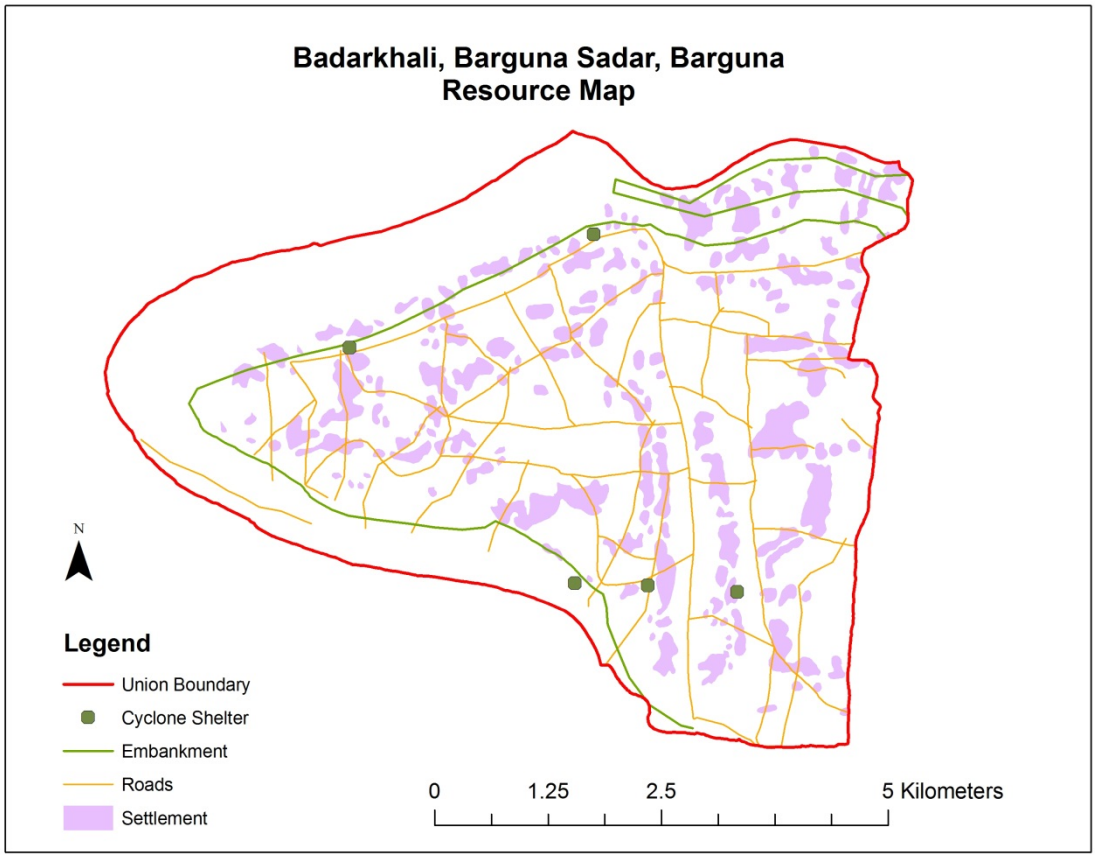

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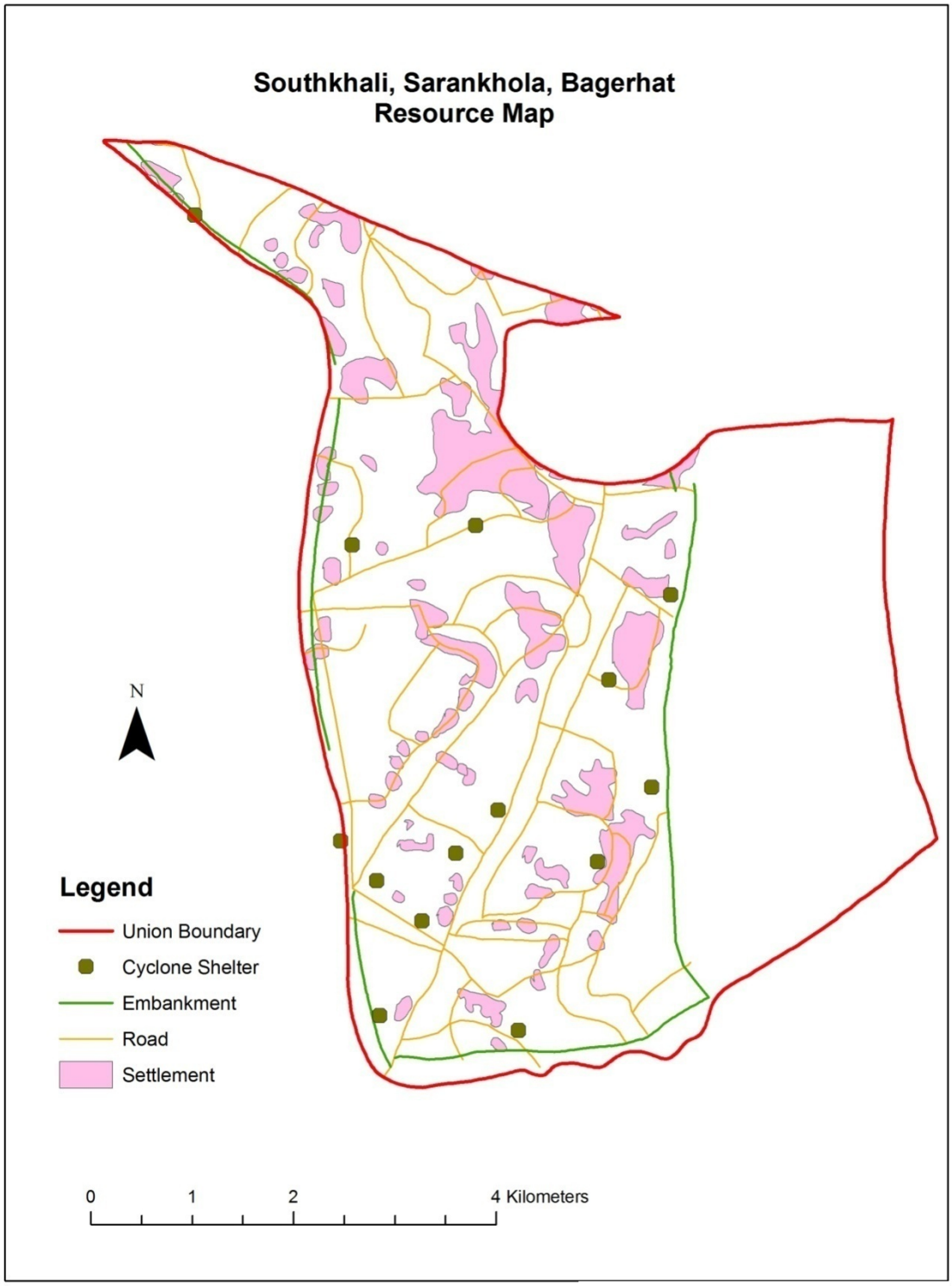
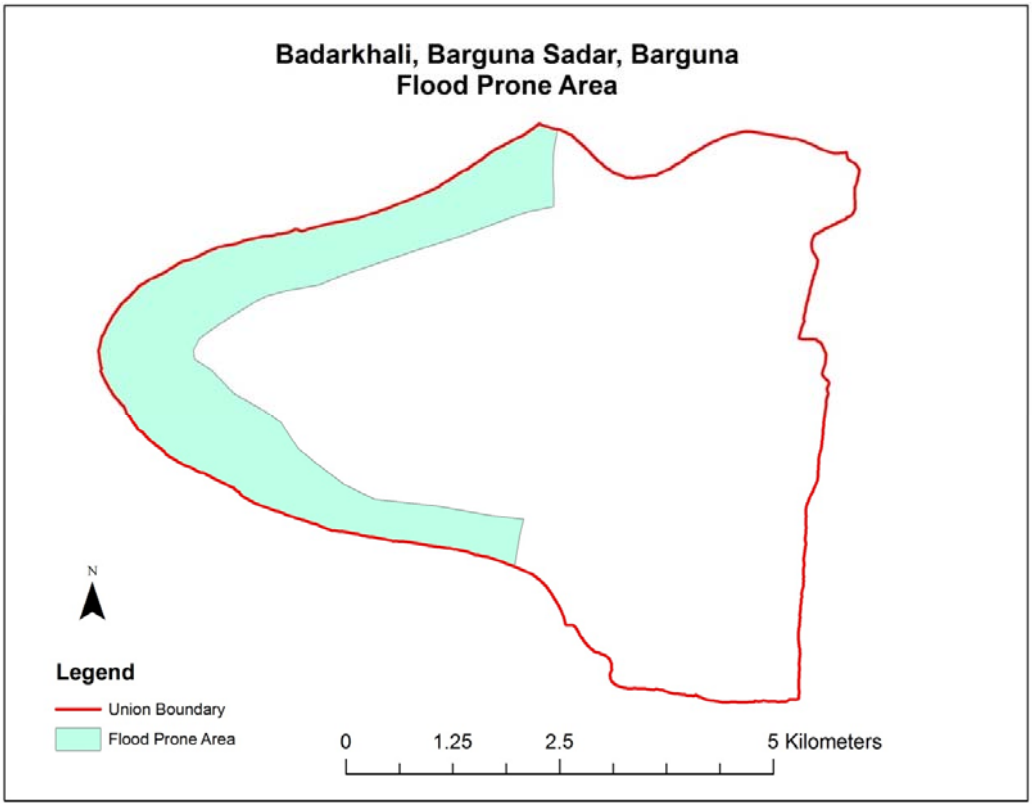
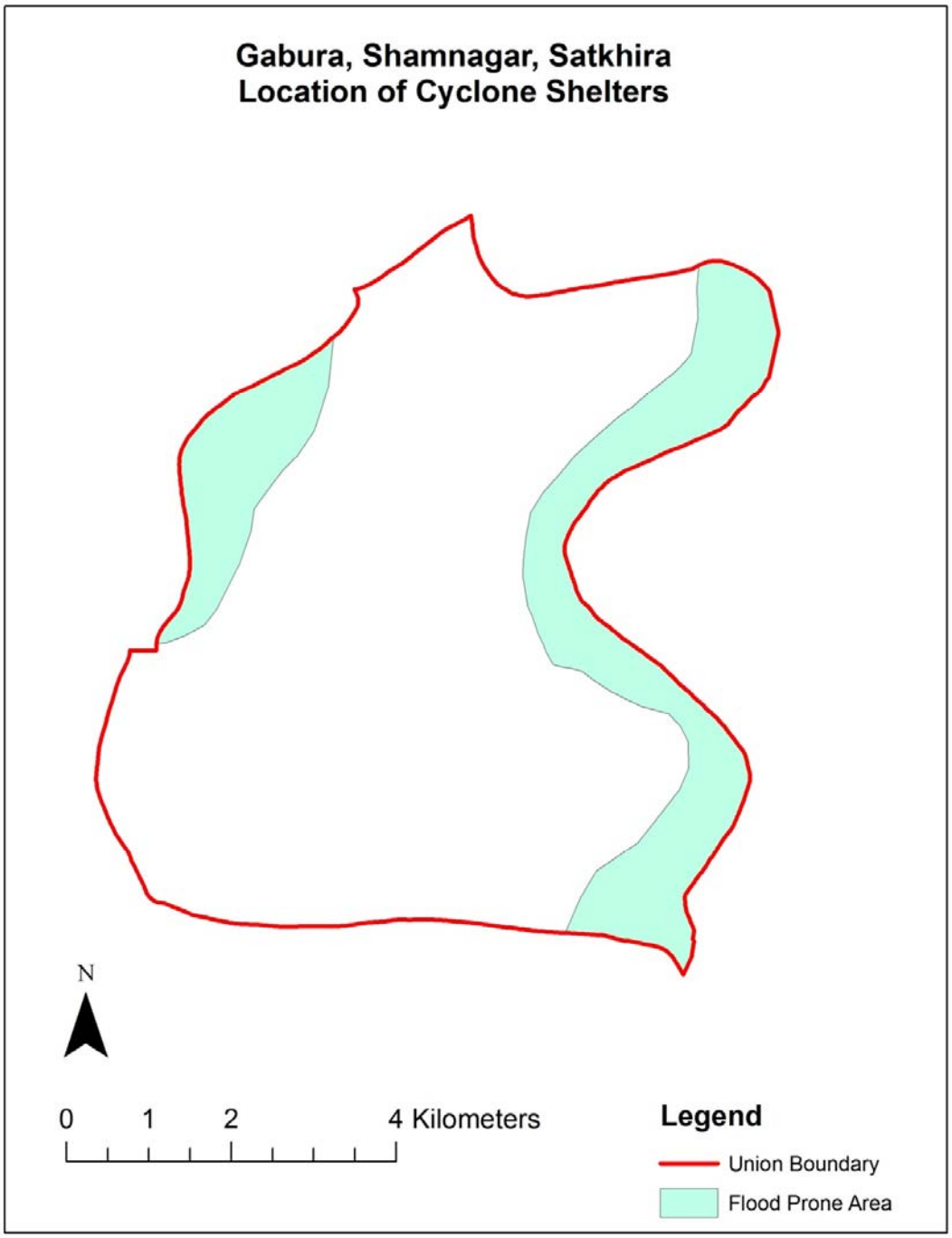
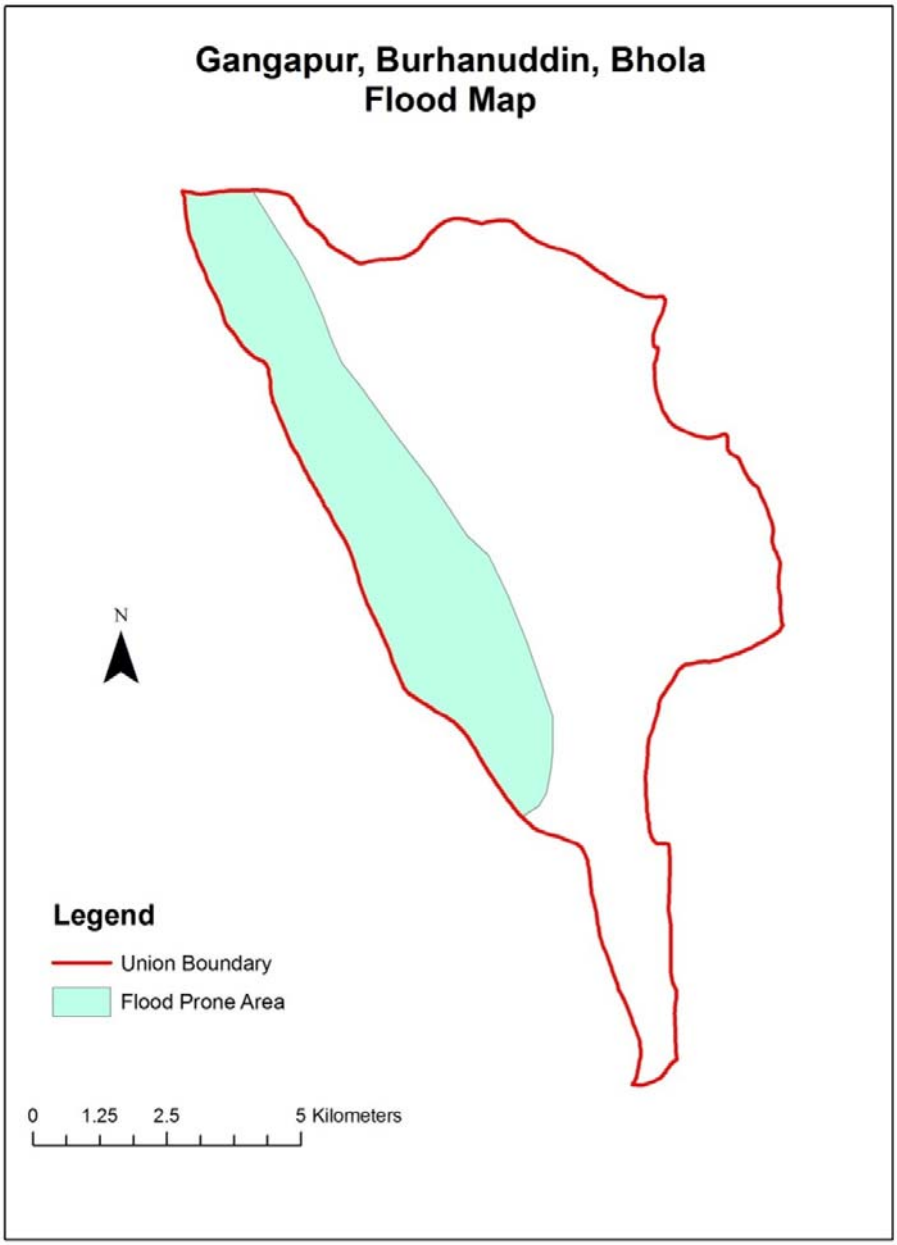


Source: LGED and field survey 2012-13

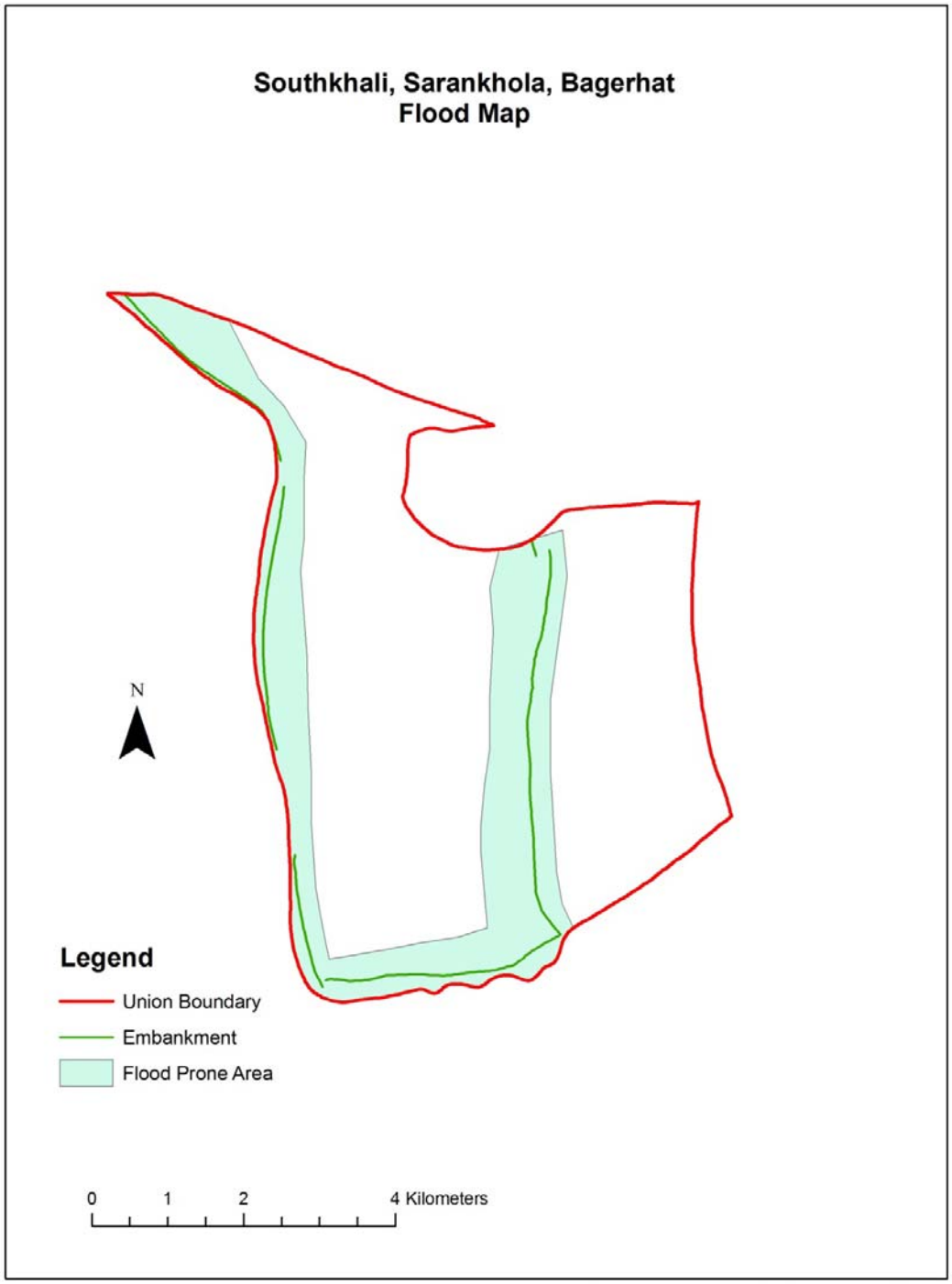
Appendix II


Badarkhali, Barguna Sadar, Barguna
Flood Prone Area
N
Legend
Union Boundary
Flood Prone Area
0
1.25
2.5
5 Kilometers


Gabura, Shamnagar, Satkhira
Location of Cyclone Shelters
N
0
1
2
4 Kilometers
Legend
Union Boundary
Flood Prone Area



Source: LGED and Field Survey, 2012-13



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