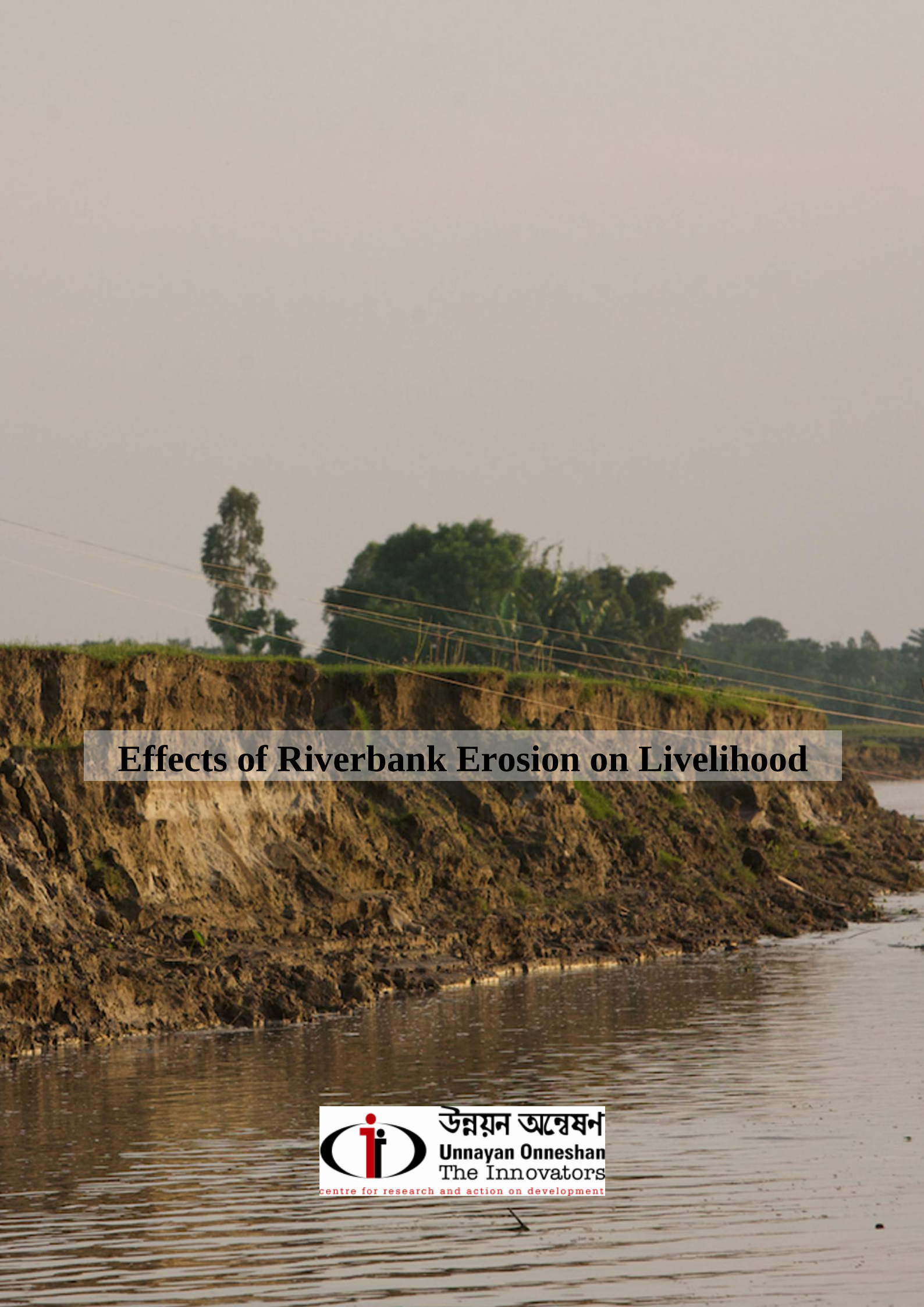

Effects of Riverbank Erosion on Livelihood

উন্নয়ন অন্বেষণ
Unnayan Onneshan
The Innovators
centre for research and action on development

Effects of Riverbank Erosion on Livelihood

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Acknowledgement

The report entitled 'Effects of Riverbank Erosion on Livelihood' provides the overall impacts of riverbank erosion on the livelihood status of the people who resides on the bank of rivers. This study also reveals how people cope up with this salient disaster. This report is an output of Climate Change, Biodiversity and DRR unit of Unnayan Onneshan, a multidisciplinary Policy Research Centre. Acknowledgement goes to the respondents of various Government and Autonomous Institutions, and respondents of Lalcamar (Gaibandha), Bishurigacha and Old Meghai (Sirajganj) who helped a lot providing their valuable opinion and information regarding riverbank erosion.

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EXECUTIVE SUMMARY

Riverbank erosion is one of the most unpredictable and critical type of disasters that takes into account the quantity of rainfall, soil structure, river morphology, topography of river and adjacent areas, and floods. Such calamity took tolls less in lives but more in livelihood as agricultural land and homesteads along with other livelihood options that are evacuated. The study was conducted in the most vulnerable regions of Bangladesh (i.e., Kapasia Union of Gaibandha District, and Kazipur and Khasrajbari Union of Sirajganj District) due to riverbank erosion. The study tried to find out the effects of riverbank erosion on livelihood and its associated displacement. The study employed both primary and secondary data sources to find out the effects. Primary data were collected through semi-structured questionnaire from households of the study areas using purposive random sampling techniques to understand the adverse effects of bank erosion. On the other hand, tracking through Global Positioning System (GPS) gives the current bank line and image analysis from Google Earth gives the amount of area eroded in this year.

The study findings revealed that on an average, 256.1 ha and 622.2 ha of total land area of Gaibandha and Sirajganj respectively were eroded per year during the period of 1973-2009. During this period, the study areas i.e., Kapasia, Kazipur and Khasrajbari observed 5.82 ha, 6.89 ha and 9.36 ha erosion per year respectively. In 2011, the erosion was found 60.8 ha, 178.76 ha and 203.36 ha of land respectively that is an indication of increased erosion rate. The main reason of such variation is because of climate change induced intensifying rainfall pattern and unplanned interverntions. From the study, it has been observed that the total economic loss arising from such erosion were 4448736 and 41939962 BDT in Gaibandha and Sirajganj respectively.

Respondents of poor income level have less opportunity in expending money on food consumption, educational expense and getting health care facilities. A vast majority of them (45.3 and 40.8 percent in Gaibandha and Sirajganj respectively) are in the income group of 3001- 4000 BDT. Among them, 45.4 and 49.9 percent in Gaibandha and Sirajganj respectively spend 1501- 2000 BDT for food consumption, which is inadequate for most of the time because of large family size. Apart from this, when disaster strikes, their income level drops in a substantial amount that forces them to take food meal once or twice a day.

Poor income also lessens the opportunity to invest in educational sector. However, bank erosion also evacuated schools and impedes the children in going to school that eventually increase the dropout rate. From the study, it is evident that almost one-fourth (22.7 percent) and more than that (27.3 percent) of the respondents do not spend a single amount of money for education in Gaibandha and Sirajganj respectively. An overwhelming majority of respondents (36.4 and 27.3 percent of the respondents in Gaibandha and Sirajganj respectively) argued that they are unsatisfied with their family health status. Empirical data shows that a vast majority of respondents (40.9 percent in both areas) pay only 301-500 BDT for seeking health care facilities. Moreover, during the period when bank erosion strikes, they faces enormous health burden.

The major agricultural production of a calendar year in Gaibandha is Boro-Pulse-Jute. In addition to this, they produce homestead vegetation to fulfil their daily demand. It was revealed from the study that in Gaibandha, lose of one-hectare of agricultural land produce a total profit loss of 17795 BDT. On the other hand, in Sirajganj, agricultural production in a

calendar year is Boro-*Gainja* (local variety of paddy)-Jute-Pepper. Loss of one- hectare agricultural land gives a total profit loss of 23165 BDT. People of those areas are generally poor and such loss makes them ultra-poor.

Such situation, in turn, makes them more vulnerable to migration and search for a hazardous job. Empirical data showed that bank erosion displaced a total number of 486 and 4028 inhabitants in Gaibandha and Sirajganj respectively during the study period. People aged between 20-35 moves to different districts of Bangladesh like Bogra, Chittagong, Dhaka, Dinajpur, Gaibandha, Sirajganj etc. while age groups of 31-35 and 26-30 years of age were found as the highest long distant migrants in Gaibandha and Sirajganj respectively. Those who were more than 35 years of age tried to maintain their livelihood by migrating in own district. Step migration pattern was observed during the study where people first relocated their homestead in nearby areas and tried to find out employment. After that, they migrated in a distant place to live a better standard of living but failed most often.

The marginalized and poor people not only lost property but also experienced socioeconomic deprivation through displacement. Because of the dynamic character of the braided channelled river and the failure of structural measures, the sufferings of the people continue. Long-term policies and strategies should be taken to cope up with bank erosion taking into account the social and institutional adjustment measures. Land relocation assurance is one of the appropriate strategies to cope up with such disaster. In addition, a flood plain zoning is essential to lessen the vulnerability of riverbank erosion.

TABLE OF CONTENTS

1. BACKGROUND AND OVERVIEW

Deltaic sediments of Quaternary formation characterize most of the lands of Bangladesh. The natural setting of Bangladesh is between the Himalayas and the Bay of Bengal together with the prevalence of tropical monsoon climate. The catchment area of the major rivers is about 1.65 million square km of which only 7.5 percent lies within the border of Bangladesh (Sarker *et al.*, 2003) that generates 1200 km^3 of run-off annually, only 10 percent of which is generated within Bangladesh. In addition to vast quantities of water, these rivers carry about 1.1 billion tons of sediment every year (EGIS, 2000; Sarker *et al.*, 2003) and are responsible for the prevalence of flooding and riverbank erosion in Bangladesh (Elahi, 1991). The combination of the large discharges and heavy sediment loads with high water content from the annual wet monsoon, a low degree of compaction, and a large amount of runoff materials result in highly variable and dynamic channel morphologies (Coleman, 1969) to adjust their bed configurations. The river channel may shift laterally by more than 300 meters (Haque and Hossain, 1988) in any season.

Study findings by Center for Environment and Geographic Information Services (CEGIS) based upon analysis of 30-year time series of satellite images reveals that the Jamuna and Padma rivers have widened more than three kilometres and destroyed about 130000 ha of floodplain land. Goodbred and Kuehl (2000) showed that during the early Holocene period, the sediments yielded by the catchment of the main rivers of Bangladesh were several times higher than that of present time as monsoon was stronger and the rate of sea level rise was very high (i.e., 1 meter per 100 years). One of the most influential phenomenons is that climate change is expected to disturb the sediment balance. It is difficult to forecast whether there will be net accretion or erosion.

Riverbank erosion has important implications for channel adjustment and long-term channel change, meander development, catchment sediment dynamics, riparian land loss and downstream sedimentation problems. (Lawler *et al.*, 1997). Because of poor understanding of riverbank erosion processes, river dynamics and sediment transport models are weakly integrated into river management strategies (Wang *et al., 1997)*. Furthermore, such knowledge gap complicated the relationship between flow energy and bank retreat rates (Lawler *et al.*, 1997) as both the fluvial and non-fluvial erosion processes take place in bank erosion system and because of the duration of process and response along with the lack of information on erosion or accretion.

Despite decades of research, the erosion of cohesive riverbanks remains difficult to predict (ASCE, 1998; Couper, 2004; Rinaldi and Darby, 2008). Models of cohesive river bank erosion must include a wide variety of erosional processes including fluvial erosion induced by hydraulic forces (Julian and Torres, 2006) and mass wasting processes related to soil strength and bank geometry (Thorne, 1982). Bank erosion is strongly influenced by the pore water pressures and the moisture content within the bank, which are influenced by hydrologic processes and riparian vegetation (Simon and Collison, 2002).

Two principal resources of Bangladesh are its land and people. The majority of the population is wholly dependent upon small land holdings (less than 0.8 hectares). It is estimated that more than half (52 percent) of rural population are functionally landless and they have limited opportunity to cultivate their tiny land with more than two crops in a

calendar year. In such a condition, any loss of land by a household is devastating. Annual inundation brings moisture, silt, and fertile soil for simple agriculture; but abnormal flooding and rapid riverbank shifts seriously disrupt human settlement and activities. However, channel migration and severe bank line erosion have taken place almost every year that dispossesses the only livelihood option of thousands of families. In addition to these, severe flooding affects cropping patterns and destroys standing crops. The socioeconomic impacts of flood in association with channel migration and bank erosion are sticking as the numbers of marginalized peoples are increasing day by day. Riverbank erosion has become a common phenomenon along with the major and minor rivers in Bangladesh mainly due to deltaic topography and it has been forcing people to migrate or resettle in areas which are more vulnerable (i.e. mid-channel islands or chars). Such displacement exacerbates the socioeconomic condition.

Physical and engineering aspects of flood control, protection and management were the main issues to be studied until the late 1980s to address the effects of riverbank erosion. Social, economic, demographic and other human issues were inadequately addressed (Elahi et al., 1991; Haque, 1997). Gender, age and other critical socioeconomic variables related to the processes of hazards-induced were studied later on (Hutton and Haque, 2004) to determine the effects of floods and their associated displacements, specifically in relation to the impoverishment and marginalisation of the rural poor. However, researches have rarely examined the effects of bank erosion on livelihood that enhance hunger and landlessness. An attempt has been made in this study to find out the process of marginalization of the poor people in the paradigm of riverbank erosion.

2. AIM AND OBJECTIVES

Riverbank erosion is one of the major natural calamities of Bangladesh that took place in almost every year. The effect of this disaster is widespread. The main aim of the study is to find out the effects of riverbank erosion on the livelihood of the affected people.

Furthermore, some objectives have been identified to fulfil the study goal, which are:

1. To find out the root causes of bank erosion in the study area
2. Accounting the losses incurred by the affected people due to bank erosion
3. To find out the rate of increased involuntary migration due to riverbank erosion and associated food insecurity

3. STUDY AREA

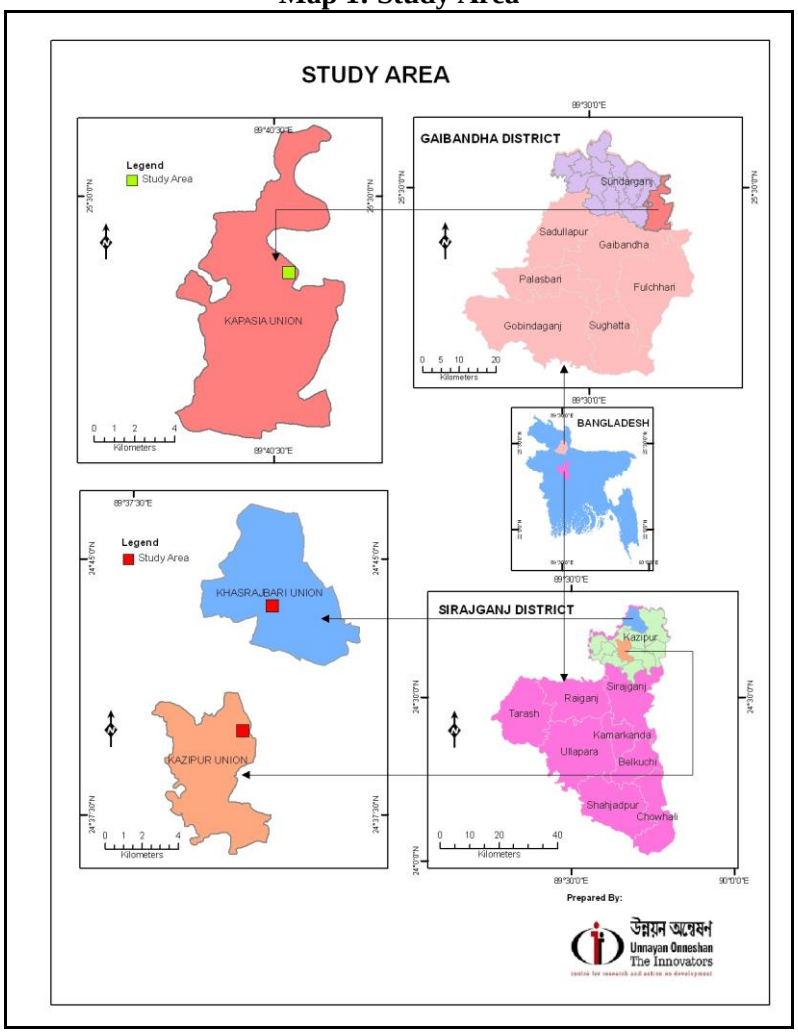
Bangladesh is one of the most densely populated countries in the world, with over 140 million people living in an area of 147000 square kilometres. According to the Household Income and Expenditure Survey (2010), it is estimated that 31.5 percent of its population still lives below the upper poverty line- as measured by income, consumption, and ability to meet basic human needs- making Bangladesh one of the poorest countries in the world. With 13 people per hectare, the person-to-land ratio is among the highest in the world and is projected to reach 20 people per hectare by the year 2020 (WB and BCAS, 1998).

Being a country on the delta of the Ganges-Brahmaputra-Jamuna river system with numerous tributaries and distributaries, Bangladesh is also highly vulnerable to the effects of flooding

and riverbank erosion. Total catchment area of Bangladesh is 1.65 million square kilometres while the complex river system has more than 150000 kilometres of riverbank line (Hutton and Haque, 2004). Islam and Islam (1985) estimated that 2000 to 3000 kilometres of bank line experience erosion annually. Analysis also shows that 10 percent increase in maximum discharge makes around 25 percent increases in riverbank erosion of the Jamuna River.

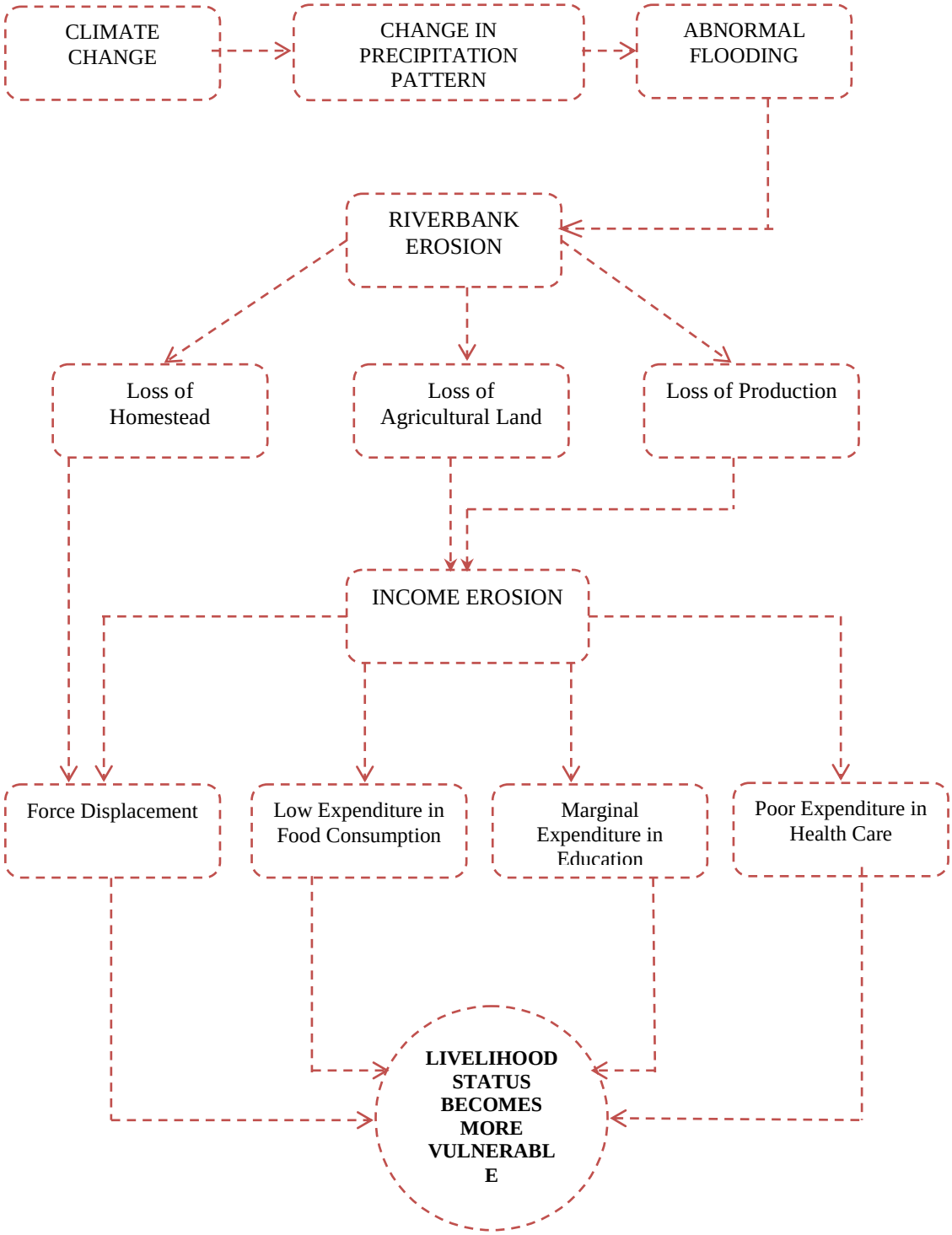
Study areas were selected (Map 1) considering the highest and average erosion-prone areas respectively. Since the birth of Bangladesh, Sirajganj district has been considered as the most disaster prone area to bank erosion and numerous studies were conducted on this study area to analyse the vulnerability. In addition to this, many government interventions (both structural and non-structural measures) were initiated in this area. On the other hand, Gaibandha is located on the bank of the Tista. The initial bank line erosion started at this tip and gradually eroded downstream adjacent areas. To generate a concise picture about the misery of bank line people, it is very important to compare the livelihood option and opportunity left behind the people of two areas. Considering such issues, study areas were selected in the Lalcamar Village of Sundarganj Upazila of Gaibandha District and Bishurigacha and Old Meghai village of Kazipur Upazila of Sirajganj District.

Map 1: Study Area



4. CONCEPTUAL FRAMEWORK

Bangladesh is one of the most vulnerable countries in the world due to climate change. Sea level rise, uneven distribution of rainfall, abnormal flooding, more frequent and intense tropical cyclones, drought, riverbank erosion, heat and cold waves are recurrent phenomenon that affect the lives and livelihoods of the seventh largest populous country in the world.



Due to climate change, rainfall pattern is ever changing and it produces abnormal flooding. Such flooding in addition to increased flow of river water from the upper catchment countries

increases the intensity of riverbank erosion. Riverbank erosion put enormous stress to the people who reside along with riverbanks as they lost their homestead, agricultural lands and overall agricultural production. The cumulative effects of such losses are income erosion that forces people to displace from their origin and poor (most often marginal) expenditure in food consumption, education, health care sectors. People of Bangladesh are poor in economic conditions that force them to maintain a poor livelihood status and effects of riverbank erosion makes the status more vulnerable.

5. METHODOLOGY

Riverbank erosion is a recurrent and highly unpredictable phenomenon. It is merely recognizable that riverbank erosion is taking place due to climate change. However, study reveals that it does not occur due to climate change rather it happens through accelerating the rate of erosion through uneven distribution of precipitation and increased surface run-off.

To attain the aim and objectives of the present study, two-track methodology was used while in the first, secondary literature were reviewed to find out the causes of riverbank erosion by tracking the historical data on losses incurred due to bank erosion and process of migration.

On the other hand, the second track intended to gather empirical data through a mixture of research techniques such as Key Informant Interview (KII), In-depth Interview using semi-structure questionnaire and Case Study to know the effect of such calamity on the livelihood of the inhabitants who settled on the bank of the river. Participatory social mapping in two study areas were prepared to understand the main features of the settlements of the community. Moreover, to calculate the eroded area during the study period, tracking was conducted using Global Positioning System (GPS).

Calculating Eroded Area

To calculate the eroded area of the study area, modern technology (i.e. Geographical Information System) was used. Data were collected through Global Positioning System by tracking and overlapping on Google Earth maps. Those data were analysed using systematic procedures of Arc Map 10, Arc View 3.3 etc. Geometrical calculation gives the amount of eroded area for the year 2011.

Key Informant Interview

Key informant interviews are qualitative in-depth interviews with resource person including community leaders, professionals, or residents who have first-hand knowledge about the concerned issue. The purpose of key informant interviews is to collect information on particular issue and to understand the nature of problems and make recommendations for solutions. To understand the causes of riverbank erosion and problems faced by the people, seven key informants were interviewed. One of the informants was from Bangladesh Water Development Board (BWDB) and the others were the Chairperson and member of the Union Parishad (fourth hierarchy of the administrative unit of Bangladesh), and the oldest inhabitants in both the study areas were interviewed. Face-to-face interview was conducted to gather key informants' views and knowledge regarding riverbank erosion.

In-depth Interview

To understand the causes of riverbank erosion, losses experienced, way to cope up and to understand the migration pattern, 22 in-depth interviews were conducted in two study areas through a predesigned semi-structured questionnaire. Employing a *purposive-random sampling technique*, interviews were carried out in Lalcamar village of Gaibandha district, Bishurigacha village and Old Meghai of Sirajganj district depending on bank erosion prone households.

Social Mapping

Representatives of the population of the study areas who are handy in maps helped in preparing social maps. The prime objective of such mapping was to build up a rapport with the local people to provide adequate and authentic information of their loss and to identify the vulnerable settlements and other infrastructures of the study area. Such mapping would help a lot in further planning to fight against bank erosion. Two maps were prepared within the study areas.

Mobility Index

Riverbank erosion marginalized people and forced them to migrate or displace from their origin. They lost their only livelihood option with this natural disaster and to survive, they have to move to distant places in search of job. Such involuntary migration is a very common phenomenon in most of the bank line areas. Using Snowball Sampling techniques, such index were prepared which will be helpful to understand the pattern of migration that is indicative of their economic condition.

Case Study

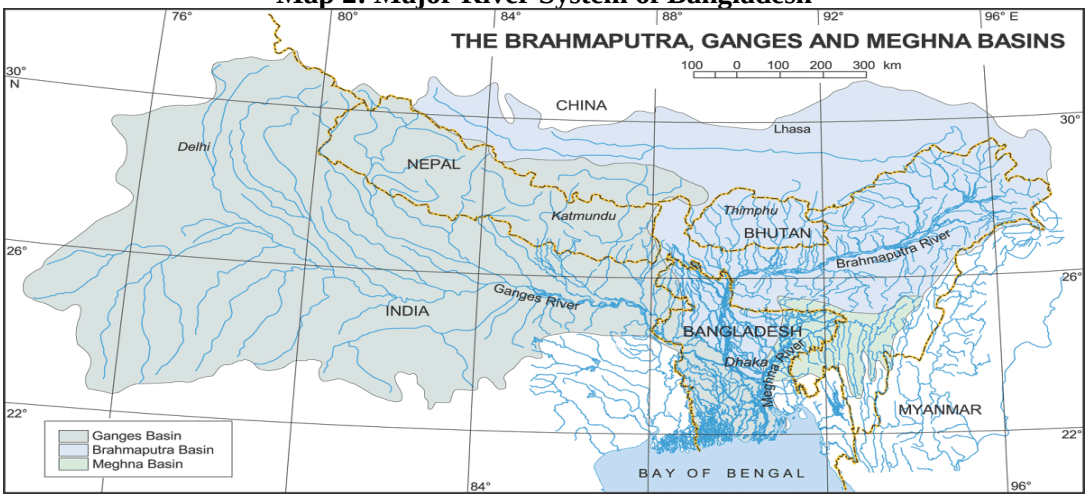
Three cases studied were conducted in three-study areas to understand the effect of riverbank erosion on livelihood. Cases were selected considering the highest displaced or affected people of the study area.

6. MAJOR RIVER SYSTEM OF BANGLADESH

The rivers of Bangladesh are very extensive. There are 230 rivers with their numerous tributaries and distributaries, which are not evenly distributed. For instance, they increase in numbers and size from the northwest of the northern region to the southeast of the southern region. The total length of all rivers, streams, creeks and channels is about 24,140 km. The system can be divided into four major networks: (1) Brahmaputra-Jamuna river system, (2) Ganges-Padma river system, (3) Surma-Meghna river system, and (4) Chittagong region river system. This study mainly focused on Brahmaputra-Jamuna river system.

The first three river systems together cover a drainage basin of about 1.72 million sq. km., although only 7 percent of this vast basin lies within Bangladesh. The combined annual discharge passing through the system into the Bay of Bengal reaches up to 1,174 billion cumec. Most of the rivers are characterised by fine sandy bottoms, flat slopes, substantial meandering, banks susceptible to erosion, and channel shifting.

Map 2: Major River System of Bangladesh



Source: Banglapedia, 2006

The Brahmaputra-Jamuna River is about 280 km long and extends from northern Bangladesh to its confluence with the Ganges. Before entering into Bangladesh, the Brahmaputra has a length of 2,850 km and a catchment area of about 583,000 sq. km. The river originates in Tibet as the Yarlung Zangbo Jiang and passes through Arunachal Pradesh of India as Brahmaputra (son of Brahma). Along this route, the river receives water from five major tributaries, of which Dihang and Luhit are prominent. At the point where Brahmaputra meets the Tista in Bangladesh, it is called the Jamuna. The Brahmaputra-Jamuna throughout its broad valley section in Assam and in Bangladesh is famous for its braided nature, shifting sub channels, and for the formation of chars (island/sandbars) within the channel.

The recorded highest peak flow of Brahmaputra-Jamuna is 98,000 cumec (cubic meter per second) in 1988; the maximum velocity ranges from 3-4 m/sec with a depth of 21-22m. The average discharge of the river is about 20,000 cumec with average annual silt load of 1,370 tons/sq. km.

Within Bangladesh, the Brahmaputra-Jamuna receives four major right-bank tributaries - the Dudkumar, Dharla, Tista and Hurasagar. The first three are flashy, rising in steep catchment on the southern side of the Himalayan system between Darjeeling and Bhutan. The Tista is one of the most important rivers of the northern region. Before 1787, it was the principal water source for the Karatoya, Atrai and Jamuneshwari. A devastating flood of 1787 brought in a vast amount of sand wave through the Tista and choked the mouth of the Atrai. As a result, the Tista burst into the course of the Ghaghat River. The Tista has kept this course ever since. The present channel within Bangladesh is about 280 km long, and varies between 280 to 550 m in width. It joins the Brahmaputra just south of Chilmari upazila. The Dharla and Dudhkumar flow parallel to Tista. The Dharla is a fast flowing river in the monsoon but with the fall of water level, it becomes braided. The Dudhkumar is a small river and flows southeast to join the Brahmaputra. The combined discharge of the Atrai and Karatoya passes through the Hurasagar to the Jamuna.

The old Brahmaputra and the Dhaleshwari are the important left bank distributaries of the Jamuna. Prior to the 1787 Assam flood, the Brahmaputra was the main channel; since then the river has shifted its course southward along the Jhenai and Konai rivers to form the broad, braided Jamuna channel. The old course, named the Old Brahmaputra is now essentially a

high-flow spill channel, active only during the monsoon. Taking off at Bahadurabad, the Old Brahmaputra flows to the southeast, passes by Jamalpur and Mymensingh towns and joins the Meghna at Bhairab Bazar. Along its south-easterly journey, Dhaleshwari bifurcates at least twice. Two of its important branches are the Kaliganga and Buriganga. The Dhaleshwari eventually meets the Shitalakshya at Narayanganj.

7. BANK EROSION ALONG WITH THE MAJOR RIVER SYSTEM OF BANGLADESH

Bangladesh is one of the most disaster prone countries around the world with severe cyclone, destructive floods and associated riverbank erosion, drought etc. The funnel shaped coast and lowering topography makes the country vulnerable to different disasters. As a country of temperate region, Bangladesh experienced huge rainfall during monsoon. In addition, abundant water run after the upper catchment areas increase the intensity and vulnerability of floods and associated riverbank erosion.

The Brahmaputra–Jamuna river faces frequent and rapid bank line erosion at a rate of 160 meter per year (m/y) between 1973 and 1992 (Khan and Islam, 2003). In addition, the river has migrated westwards at an average movement rate of 50 m/y during the period of 1830–1992 while an average width was 6.2 km and 10.6 km in 1830 and 1992 respectively indicating the severity of erosion hazard along the river. The widening rate of the channel has increased form the year 1914. The channel has widened at an average rate of 27 m/y before 1914 while an average rate of 65 m/y was followed afterward as the average width of the river has increased about 130 m/y since 1973 (Khan and Islam, 2003). Inadequate accretion has taken place in the middle and lower reaches north of the east bank and in the extreme north of the west bank of the river that cannot lessen the misery of distressed people.

Major rivers like the Jamuna, the Ganges and the Padma eroded around 1590 square km flood plains making 1.6 million people homeless since 1973 (CEGIS, 2009). It has been found that the Jamuna River is widening and both banks are migrating outwards at a high rate for the last few decades. During the period, net erosion along the 240 km long Jamuna River was about 80690 ha. The rate of erosion varies over time in association with climatic variables mainly precipitation in the form of rainfall and with locational factors. It is mention worthy that the most erosion prone area in Bangladesh is Sirajganj. In addition, Gaibandha experienced annual inundation and bank erosion on a regular basis. It is evident from CEGIS study that over the period of 36 years (1973-2009), Gaibandha and Sirajganj district faced total land erosion at a rate of 256.1 ha and 622.2 ha respectively (Table 1).

Table 1: Eroded area due to bank erosion during 1973-2009

District	Total Area (ha)	Total Eroded Area (ha)	Rate of Erosion (ha/year)	Percentage of total land (%)
Gaibandha	217927	9220	256.1	4.23
Sirajganj	249792	22400	622.2	8.97

Source: Author's calculation based on CEGIS, 2009

On an average, 256.1 ha and 622.2 ha of total land area of Gaibandha and Sirajganj respectively eroded per year during the period of 1973 to 2009. The rate of erosion per year is much higher in Sirajganj than Gaibandha. The main cause behind such variation is locational factor. The Jamuna is bifurcated into several channels due to mid-island char that put

enormous water pressure on both side of the river. Eventually, riverbanks are collapsing each year along with huge number of cultivable land and homesteads.

8. RIVER MORPHOLOGY DETERMINES THE INTENSITY OF BANK EROSION

Rainwater flowing down slopes come together to form a stream flow. The space where a stream flow runs is a channel. A river is the general term for a channel and the water in it. The area supplying water into a channel is a drainage basin. A drainage pattern is a plan of a river system. A river develops various landforms through channel processes. The main channel processes are erosion, transportation and sedimentation.

The materials brought to the lower reaches in a channel are sediment load. Weathering of the rocks composing slopes is the main cause of production of sediment load and they are transported through the flow of water. The higher the water velocity, the more capacity a river possesses for transporting sediment load. Sediment load is deposited to form an alluvial plain. Three basic channel patterns are detected in alluvial plains. They are braided, meandering and straight.

A flood caused by heavy rain carries a huge volume of bed load from mountains to the plain. When a flood flows from the mountains to a plain, the capacity to transport bed load suddenly reduced. Particles of bed load are deposited in order of their size, and an alluvial plain is formed. An alluvial fan composed of gravel is formed in the uppermost reaches of an alluvial plain. The surface of an alluvial fan is like a segment of a cone. The radial profile toward the lower reach is concave and the cross-sectional profile is convex (Matsuda, 2004). A delta being developed near a river mouth consists of fine materials and sand. The morphology of a delta is derived from the interaction of fluvial and marine processes.

A flood plain consisting of natural levees and back swamps occupies the transitional area between an alluvial fan and a delta. A natural levee is composed of sand and silt. Clayey deposits distribute in back swamps are lower and wetter than natural levees. The channels on an alluvial fan are interconnected and show a braided pattern. When a large flood flows down from mountains, the channels on an alluvial fan often change their course, and the newborn channel is maintained until the next flood. The former channel is abandoned and is supplied water only by groundwater. The lower reaches of the abandoned river remain as a feature on floodplains and deltas. River morphology is explained by channel patterns and channel forms (Matsuda, 2004), and is decided by such factors as discharge, water surface slope, water velocity, depth and width of the channel, and river bed materials, etc. These factors are not independent but inter-related to each other.

Erosion predominates in the upper reach area of a drainage basin, and valleys composed of channels and slopes are formed. Erosion is a hydraulic action and is derived from the energy of running water that makes a channel broader and deeper. These processes are also called lateral erosion and deepening erosion respectively. A canyon formation takes place where deepening erosion predominates while channel with a broader riverbed is formed through lateral erosion. The weathered materials deposited in a valley bottom are scoured by running water and carried to the lower reaches.

9. CAUSES OF RIVERBANK EROSION

Riverbank erosion occurs primarily through a combination of three mechanisms: sub-aerial weakening and weathering, fluvial erosion, and mass failure. Sub-aerial processes are often viewed as 'preparatory' processes, weakening the bank prior to fluvial erosion (Mengoni and Mosselman, 2006). Sub-aerial processes dominates in the upper reaches, fluvial erosion in the middle, and mass failure in the lower reaches of a river. Fluvial erosion is the detachment of particles from the bank surface by the direct action of the flowing water; mass failure is the collapse of bank material under the action of gravity; weakening processes are modifications of soil characteristics that increase bank erodibility, and thus induce bank erosion.

Generally, the process of declination of bank line in the major river channels can be attributed to both the liquification and flowage of bank line, or to the shearing away of bank material. Such erosion process takes place both during the flood and the low flow season. In the low flow season, the damaged edges or materials of riverbank expose to further erosion due to collapsing by wave action and internal water pressure. During the downturn of floodwaters, pressure against the channel walls decreases and water moves from the formation back into the channel run-off, resulting in consequent erosion (Thorne, 1982).

The study areas are facing both fluvial erosion and mass failure in the course of riverbank erosion. As monsoon period starts, abundant rainfall occurred in those areas and in the upper reaches that loosen the soil structure. More acutely, fluvial erosion prevailed in those areas as the natures of rivers are braided. Such erosional process influence mass failure in some regions.

Photographs 1: (a) Mass wasting in a distant place from homestead and (b) erosion nearby study area

(a) (b)

Major causes of riverbank erosion:

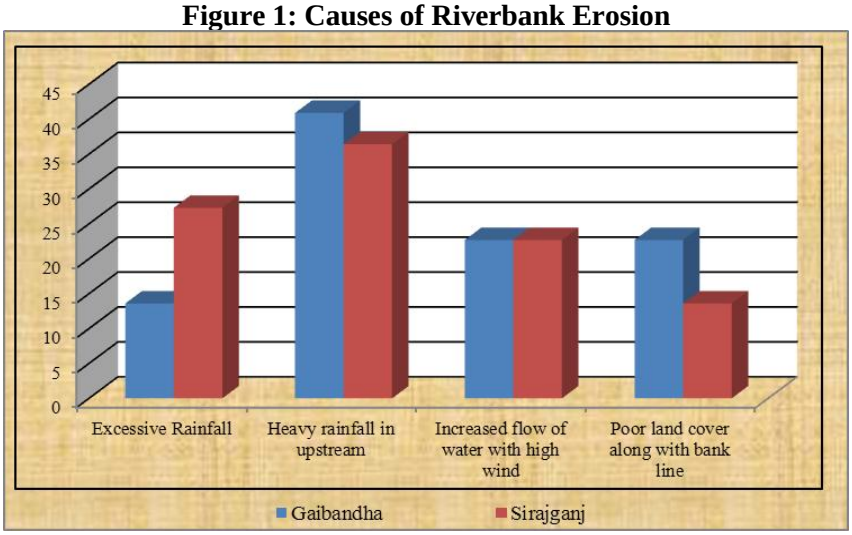
a) Due to heavy siltation in the south-western part of Bangladesh and newly formed char land, the flows of rivers are changed to another direction. As a result the bank of rivers are facing new stress which expose them into erosion;
b) Deforestation along with the major river system of Bangladesh;
c) Lack of national forecasting system for the erosion; and
d) As the results of the Green House Gases (GHGs) emission, the atmosphere is getting warm day-by-day resulting the glacier liquefy. The huge quantities of melted water

from Himalaya are speeding up River Erosion in Bangladesh through the Ganges and Brahmaputra river network.

Mamun (1996) suggests that two predominant views regarding the causes of riverbank erosion exist in Bangladesh where the first group perceives erosion as being caused by currents in the river; on the other hand, the second group consider erosion as an act of God. Further, the perception of erosion, and adjustment measures aimed at coping with the threat of riverbank erosion, appear to be related not only with the personal experience of victims, and environmental setting, but also largely on aspects of resource control (land ownership) or social entitlement (occupation) to resources.

The present study reveals that an overwhelming majority of the respondents are in view of increased flow of water in association with high wind is the major cause of riverbank erosion in both the study area (Figure 1).

Figure 1: Causes of Riverbank Erosion



Source: Field Survey, 2011

The respondents of Lalcamar (Gaibandha) said that heavy rainfall in the upstream country (40.9) is the most prominent cause of bank erosion while respondents of Bishurigacha and Meghai (Sirajganj) emphasised on increased flow of water in association with high wind flow (38.7 percent).

10. RIVERBANK EROSION IN THE STUDY AREA

Disaster is a calamitous event that occurs suddenly and causes great loss of life, damage, or hardship. It may be defined as 'any occurrence, that causes damage, ecological disruption, loss of human life, deterioration of health and health services, on a scale sufficient to warrant an extraordinary response from outside the affected community or area'.

Riverbank erosion is one of the most unpredictable and critical type of disaster that takes into account the quantity of rainfall, soil structure, river morphology, topography of river and adjacent areas, and floods. Such calamity took tolls less in lives but more in livelihood as agricultural land and homesteads along with other livelihood options that are evacuated. People's perception is one of the most important tolls to understand the existing problems and to take different measures to lessen the adverse impacts of any natural hazard or disaster.

During the study, an attempt was made to understand the same regarding different disasters especially riverbank erosion. They classified different categories of disaster in relation to different months.

Table 2: Intensity of Different Disasters by Months

		Months			Total
		July-August	September-October	January-March	
Intensity of Disaster	Severe	36.4	27.3	0.0	63.6
	Moderate	4.5	13.6	4.5	22.7
	Poor	0.0	0.0	13.6	13.6
Total		40.9	40.9	18.2	100.0

Source: Field Survey, 2011

Empirical data shows that respondents face three types of disaster (Table 2) in both the study area. The monsoon period in Bangladesh starts from late June and ends up at late August. Sometimes, this period extends up to September. Bangladesh experiences enormous rainfall during this period. In the months of July to August, most of the areas of Bangladesh are flood affected as additional water from the upper catchment areas overflow the banks of the rivers. Respondents (36.4 percent) of the study areas face flooding problem during this period severely. In addition, the soil composition of riverbanks loses its composition during flood and the capacity of resistance against erosion is destroyed. With decreasing trend of river water after the monsoon period, the velocity of current increases that washes out the riverbank easily. In this circumstances, 27.3 percent of the respondents argued that during the lean monsoon season (September-October) they face severe bank line erosion while 13.6 percent of them termed the disaster as of moderate intensity. Furthermore, only 4.5 percent of the respondents argued that they faced water scarcity moderately during January to March. Overall, 40.9 percent of the respondents faced flood and riverbank erosion each within the study area while 63.6 percent of them perceived these disasters as severe.

Table 3: Prediction about Bank Erosion by the Method of Forecasting

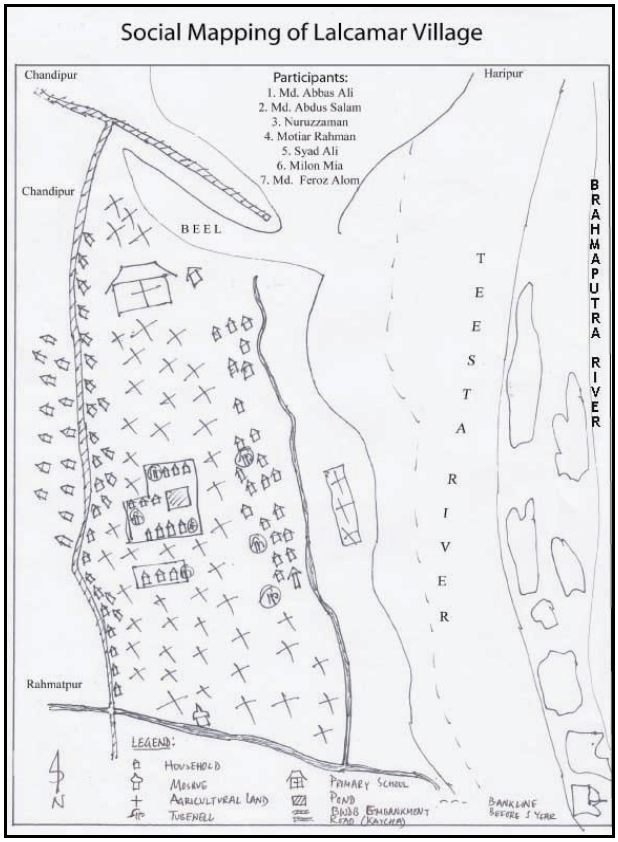
		How do you forecast?		
		Current behaviour (%)	Wind flow (%)	Total (%)
Can you predict about the bank erosion?	Yes	45.5	13.6	59.1
	No	18.2	22.7	40.9
Total		63.6	36.4	100.0

Source: Field Survey, 2011

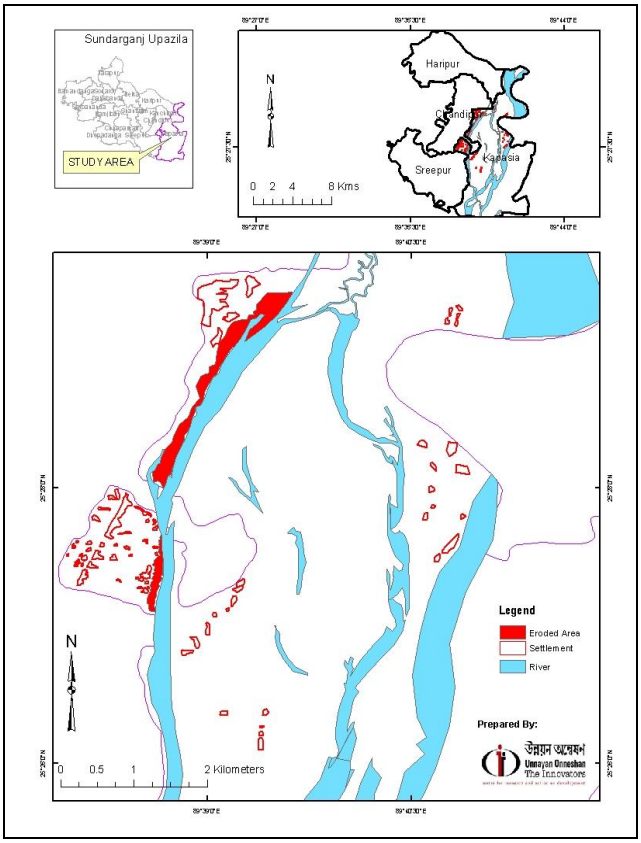
They emphasized on riverbank erosion as it takes place both during the flood and after the flood when the water in river decreases. To elucidate the knowledge on prediction about riverbank erosion, a question was asked to the respondents. Almost three-fifths (59.1 percent) of them replied in affirmative that they could predict the bank erosion (Table 3). They predict such calamities through analysing the current behaviour (45.5 percent) with their indigenous knowledge and experience, and by observing the flow of wind (13.6 percent) that increase the velocity of current. It is evident that erosion takes place where the current of water strike most. Banks with the concave slopes and vertically erected banks are more prone to erosion. Their prediction is much more scientific and very impressive. However, they have the capability to predict the bank erosion. Most of the time they wait for the last moment to be eroded. The main cause behind such behaviour is that their social structure and infrastructures are within such a limitation that they can neither redistribute their homestead nor migrate to a

distant place before the erosion takes place. An attempt has been made during the study to understand the social condition of the study area and different externalities to bank erosion through participatory social mapping.

Map 3: Social Map of the Study Area



Map 4:Eroded Area Map of the Study Area



Source: Field Survey, 2011

Lalcamar village of Kapasia union, the study area within the Gaibandha District is situated on the bank of the river Tista and it is open faced toward the bank of the river with no sturctural measures. Most of the areas of the village belong to agricultural land and homestead. With such a condition, the village is prone to bank erosion. There was a embankment constructed by Bangladesh Water Development Board to protect the village during 1960. However, after the devastating flood of 1988, the embankment destroyed. Another one is remaining as the only hope of the eroded people on the west side of the village (Map 3). To figure out the eroded area and population displacement due to bank erosion in the study area, GPS tracking was conducted. Those tracks were ovelapped on Google Earth Image and found out the eroded area by geometry calculation using Arc Map 10.

Table 4: Eroded Area of Lalcamar Village and Displacement Due to Bank Erosion

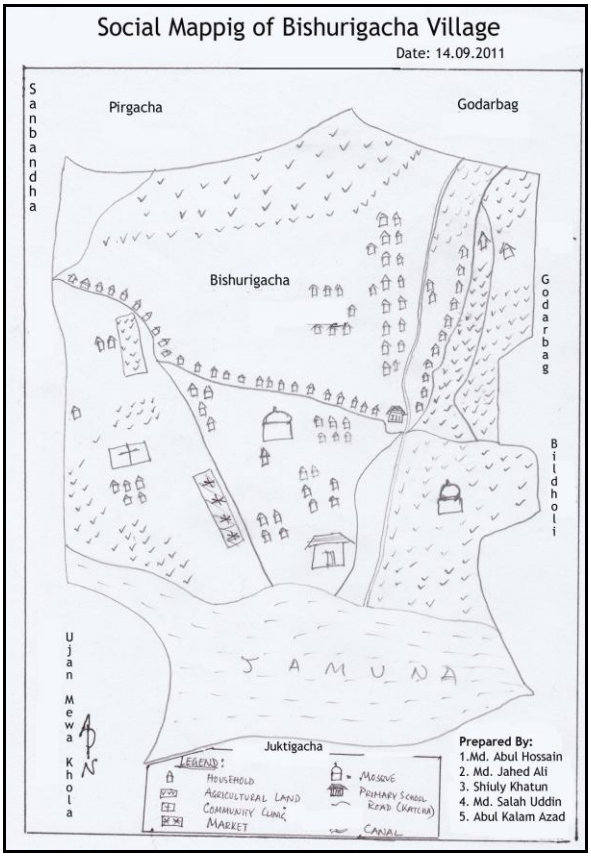
Study Area	Total area except river (in hectare)	Eroded Area (in hectare)	Percentage of total land	Population Density (according to census-2011)			Displacement due to erosion
				per sq.km	per hectare	Density for rural areas per hectare	
Kapasia Union	4951.85	60.8	1.23	1078	10.78	8	486

Source: Field Survey, 2011

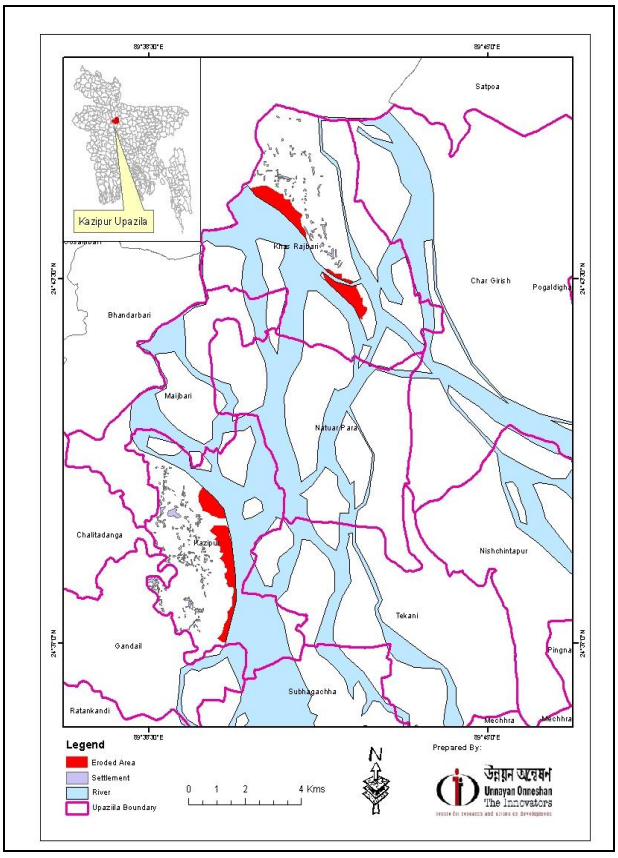
It is evident from the study that the area has experienced a loss of 60.8 ha of land during this year which is 1.23 percent of total land (Table 4). When erosion strikes, people relocated their homestead and took shelter along with that embankment. Increased dependancy and over exploitation of sourroundings of embankment may lessen the capacity to resist it from further erosion and flooding. It is very much necessary to take proper initiatives to relocate the destitute people in such a place from where they would be able to manage their minimum level of standard living. Population density is measured through the number of inhabitants per square kilometers (sq. km.). The preliminary results of 2011 census show that the average population density of Gaibandha district is 1078 inhabitants per sq. km. or 10.78 inhabitants per ha. To evaluate the total displacees, it was estimated that 8 inhabitants per ha is living in the study area considering the distance from the administrative unit of the Gaibandha. The study finds that due to erosion, a total of 486 people displaced or relocated their homestead this year.

Similarly, Bishurigacha village of Kashrajbari Union is a mid-island char and the old Meghai village of Kazipur Union, Sirajganj District, is severely prone to bank erosion. Social mapping was prepared for the first one that is almost similar to the second one. The village was formed by the accretion of land. The age of this char land is almost 14 years. It is in a stable condition to practice all kinds of agricultural activities.

Map 5: Social Map of the Study Area



Map 6:Eroded Area Map of the Study Area



Source: Field Survey, 2011

The social components (Map 5) of Bishurigacha village is composed of homesteads, agricultural lands, market, community clinic, mosque etc. and the area is surrounded by the river Jamuna. Once the erosion starts, it is very likely to erode the whole village within a short period, as there is no structural measures like embankment, dam etc. to protect it from further erosion.

Table 5: Eroded Area of Kazipur and Khasrajbari Union and Displacement Due to Bank Erosion

Study Area	Total area except river (in hectare)	Eroded Area (in hectare)	Percentage of total land	Population Density (according to census-2011)			Displacement due to erosion
				per sq.km	per hectare	Density for rural areas per hectare	
Kazipur Union	2767.93	178.76	6.46			12.30	2198
Khasrajbari Union	3757.78	203.36	5.41	**1230**	**12.30**	9	1830

Source: Field Survey, 2011

From the study, it is evident that erosion in Khasrajbari union is more prominent than Kazipur union in terms of the amount of lost land. Total eroded area in Khasrajbari union is 203.36 ha that is 5.41 percent of total land area while the number represents 178.76 ha (6.46 percent of total area) for Kazipur Union. Though Khasrajbari union is situated in the mid-island char, the population density is low. The average density is considered as 9 inhabitants per ha considering the average population density for the Sirajganj District (12.30 person per acre). On the other hand, the average population density of Sirajganj District is considered for Kazipur union. The study finds that due to riverbank erosion 2198 and 1830 people displaced or relocated this year (Table 5) in Kazipur and Khasrajbari union respectively. Such losses increase the rate and amount of involuntary migration.

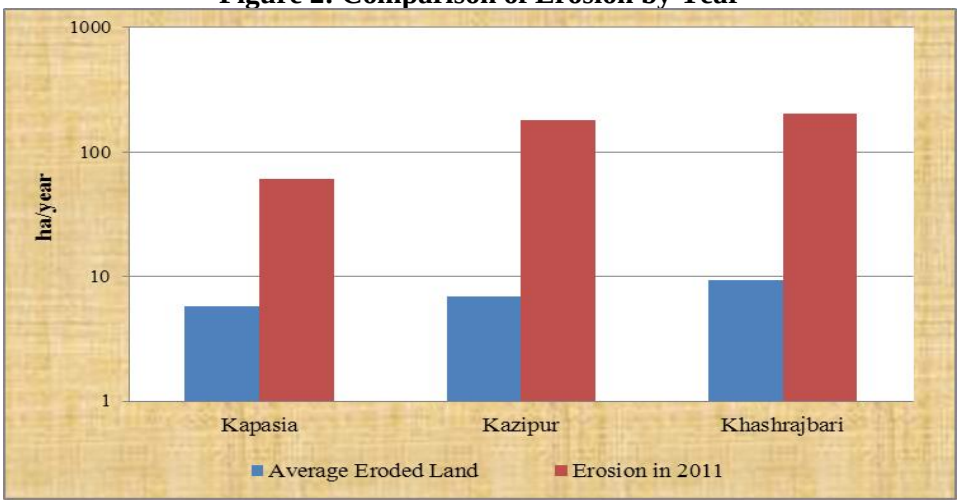
Table 6: Eroded land in 2011 in comparison to 1973-2009 (year wise)

Study Area (Union)	Total Area (ha)	Average Eroded Land (ha/year)	Erosion in 2011 (ha)	Percentage of total land (%)
Kapasia	4951.85	5.82	60.8	1.23
Kazipur	2767.93	6.89	178.76	6.46
Khasrajbari	3757.78	9.36	203.36	5.41

(Source: Author's calculation based on CEGIS, 2009 and Field Survey, 2011)

It was observed by analysing the data of 1973-2009 that the intensity of riverbank erosion is increasing. Over the period of 36 years, average eroded land in Kapasia, Kazipur and Khasrajbari Union was found 5.82, 6.89 and 9.36 ha per year. However, the study revealed that erosion in 2011 was 60.8, 178.76 and 203.36 ha. The main reason of such variation is the uneven erosion over the year.

Figure 2: Comparison of Erosion by Year



Source: Author's calculation based on CEGIS, 2009 and Field Survey, 2011

Riverbank erosion had changed its intensity and it is gradually increasing from the year 1973. It was revealed from the study that in recent years, bank erosion has been amplified for more than 10 to 20 times higher. It is not only because of climate change but also due to unplanned human interventions as well.

11. LOSSES OCCURRED DUE TO RIVERBANK EROSION

Disaster can significantly impede the development procedures. The damage occurs in many ways and the impacts can be as complex as the economy itself. Riverbank erosion has an adverse impact on livelihood as homesteads are destroyed, cultivable lands are wiped out and employment opportunities are reduced. In most of the cases, homesteads in riverbank areas are located after the agricultural fields. Wiped out of homesteads implies that the family or individual lost the total assets. Such loss push them to displace in such a place where little or no opportunity remains to survive. People of the erosion prone areas have to take different initiatives to cope up with the devastation of riverbank erosion. An attempt has been made to understand the losses occurred due to riverbank erosion in the study area. In view of this, losses were accounted through the loss of agricultural land and production, loss of homesteads, loss of cattle etc.

As riverbank erosion is largely related with land, it is very essential to determine the value of land first. Price of land varies from area to area and region to region in Bangladesh with respect to fertility of soil. Moreover, valuation also differs with distance from roads or rivers. The more distance form the major road network the less the price, the more distance from the river the higher the price of land and vice versa. To calculate the losses occurred due to riverbank erosion, respondents were asked to evaluate their land value.

Table 7: Valuation of Land

Quality of Land	Distance from river (Km)	Price per Unit of Land (BDT/Hectare)	
		Sirajganj	**Gaibandha**
Very Good	2 and above	1463414	731707
Moderate	1-2	365853	292682
Poor	<1	109756	73170

Source: Field Survey, 2011

It emerged from the study that land value is determined by the distance from river (Table 7). Lands that are adjacent to river (less than one kilometre) are termed as of poor quality with lower price than others are, and this valuation is considered throughout the paper as the study was conducted on most erosion prone areas. It is evident from the Table that, on an average, the prices of lands are higher in Sirajganj than that of Gaibandha. Considering such amount, total losses arising from bank erosion in Gaibandha and Sirajganj are 4448736 and 41939962 BDT respectively.

11.1. Loss of Agricultural Land

Agricultural land is the vital resource for the people living in Bangladesh specially those who live in rural areas and bank line. Almost 48 percent of the total population live on agriculture (BBS, 2011). The poor had less amount of land to support their family. In study areas, most of the respondents are heavily dependent on agricultural land in terms of both primary and secondary occupation. A very little loss in cultivable lands put the marginalized people in more vulnerable situation.

Table 8: Total Land Occupied by the respondents by Agricultural Land

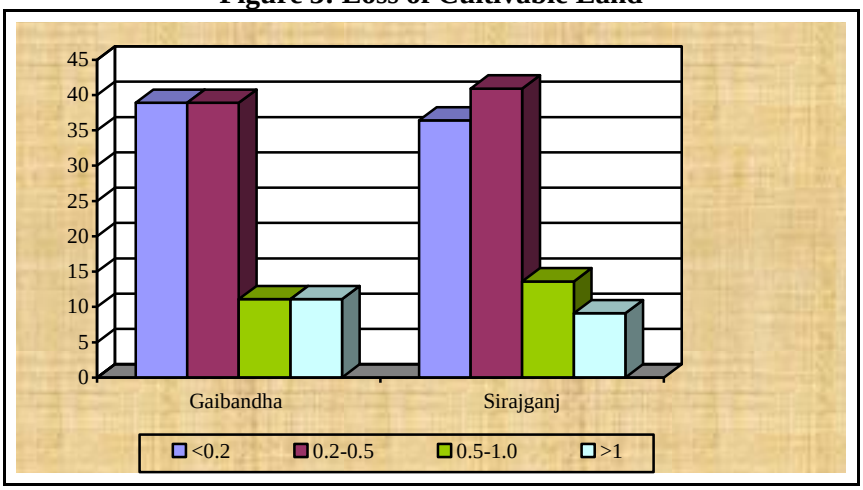
		Agricultural Land (ha)		
		Landless	<0.2	Total
Total Land (ha)	Landless	27.3	0	27.3
	<0.2	22.7	9.1	31.8
	0.2-0.5	9.1	18.2	27.3
	0.5-1.0	0	9.1	9.1
	More than 1	0	4.5	4.5
Total		59.1	40.9	100.0

Source: Field Survey, 2011

It is evident from the study that almost three-fifths (59.1 percent) of the respondents are landless while the rest (40.9 percent) have less than 0.2 ha of agricultural land (Table 8). Most of the people (31.8 percent) are occupied with tiny land area of less than 0.2 ha of land.

Empirical data shows that 38.9 and 40.9 percent respondents of Gaibandha and Sirajganj respectively lost 0.2-0.5 ha of their agricultural land (Figure 3) in comparison of the total agricultural lands occupied by them in the year 2010. Total economic losses arise from such loss may be counted as value of land, total agricultural production of that particular land and labour force engaged in that occupation.

Figure 3: Loss of Cultivable Land



Source: Field Survey, 2011

To recover from such loss is very unbearable for the poor tenants. They have to spend 3000 to 5000 BDT to maintain minimum livelihood status. It was observed that 50.1 percent respondents of Gaibandha spend more than 3000 to 5000 BDT to cope up with such losses while 68.2 percent respondents of Sirajganj spend more than 5000 BDT (Table 9). Such spending shows that peoples of Sirajganj are more vulnerable to adjust their livelihood option due to riverbank erosion in comparison to Gaibandha.

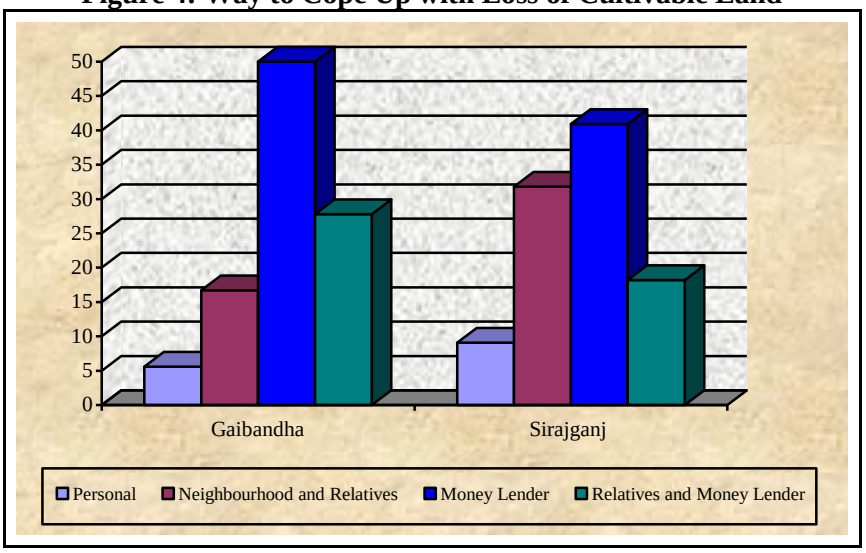
Table 9: Cost to Recover the Loss of Cultivable Land

Total Cost	Gaibandha (N=18)	Sirajganj (N=22)
≤ 3000	22.0	13.6
>3000- ≤ 5000	50.1	18.2
>5000	27.9	68.2

Source: Field Survey, 2011

Losses occurred from cultivable land is quite expensive which hinders the respondents to bear the spending. In such a condition, they have to rely on relatives, moneylender, neighbourhood etc. It is evident that to cope up with the losses of cultivable land, majority of them rely on moneylender (50 and 40.9 percent in Gaibandha and Sirajganj respectively). It was reported that sometimes moneylenders lent money to relocate household and spent money to buy foods in exchange of their eroded land that eventually makes them landless.

Figure 4: Way to Cope Up with Loss of Cultivable Land



Source: Field Survey, 2011

However, marginalized people have nothing to do but borrow money from different sources mostly from moneylender (Figure 4) in spite of high rate of interest.

11.2. Loss of Agricultural Production

Fertile soil belongs to different regions of Bangladesh due to sedimentation through flooding. Such fertility enhances agricultural production. Due to bank erosion, a vast area of agricultural land goes into the river. To calculate the losses of agricultural production of the study area, different crop production in a calendar year was taken into consideration. It is evident from the study that both of the areas have limited opportunity of cultivation. They can cultivate three crops in a calendar year along with subsistence homestead gardening (i.e. vegetables). The main causes of such limited cultivation is abnormal flooding and associated bank erosion.

Table 10: Agricultural Production in Gaibandha

Agricultural Products	Production (Maund*/ha/ Year)	Total Earnings (BDT)	Total Costing (BDT)	Total Profit (BDT)
Boro	17	13000	7245	5755
Pulse	7	7700	4500	3200
Jute	9	13600	4760	8840
Total		**34300**	**16505**	**17795**

Source: Field Survey, 2011
*Note: 1 Maund= 37.32 Kilograms

The major agricultural production of a calendar year in Gaibandha is Boro-Pulse-Jute (Table 10). They also produce homestead vegetation to fulfil their daily demand. It was revealed from the study that in Gaibandha, lose of one-hectare of land produce a total profit loss of 17795 BDT. Such a loss brings great misery to the little earning peoples.

Table 11: Agricultural Production in Sirajganj

Agricultural Goods	Production (Maund*/ha/ Year)	Total Earnings (BDT)	Total Costing (BDT)	Total Profit (BDT)
Boro	19	15400	9814	5586
Gainja (Local variety during Aman season)	9	8450	4856	3594
Jute	7	10800	5465	5335
Pepper	34	22000	13350	8650
Total		**56650**	**33485**	**23165**

Source: Field Survey, 2011
*Note: 1 Maund= 37.32 Kilograms

On the other hand, in Sirajganj, agricultural production of that area in a calendar year is Boro-*Gainja*-Jute-Pepper. *Gainja* is a local variety of paddy cultivated during Aman season. Loss of one-hectare of agricultural land gives a total profit loss of 23165 BDT (Table 11). People of those areas are generally poor and such loss makes them ultra-poor. In addition to these, such loss makes hindrance in carrying out normal livelihood option.

11.3. Loss of Settlement/Homestead

The severe impact of bank erosion is the loss of homestead that makes the population more vulnerable to live a descent life. When erosion strikes, people have no option left behind them except bearing the losses. They never change location of their homestead before the erosion takes place. The main reason behind such behaviour is that they have little earnings that never allow them to replace their homesteads before it totally collapses. In both of the study areas, it was observed that due to bank erosion most of the respondents lost less than 0.2 ha of household area (53.3 and 60 percent in Gaibandha and Sirajganj respectively).

Table 12: Loss of household Areas

Area (in Hectare)	**Gaibandha (N=15)**	**Sirajganj (N=20)**
<0.2	53.3	60.0
0.2-0.5	46.7	40.0

Source: Field Survey, 2011

In Gaibandha, the economic loss from destruction of homestead is 14634 BDT without the costing for housing. As most of the housing is constructed with bamboo and straw, the average cost of housing is 4000 BDT that implies that loss of a less than 0.2 ha of homestead area. They bear a loss of 18634 BDT. On the other hand, in Sirajganj, the price of land is higher than Gaibandha that comprises a total loss of 25951 BDT.

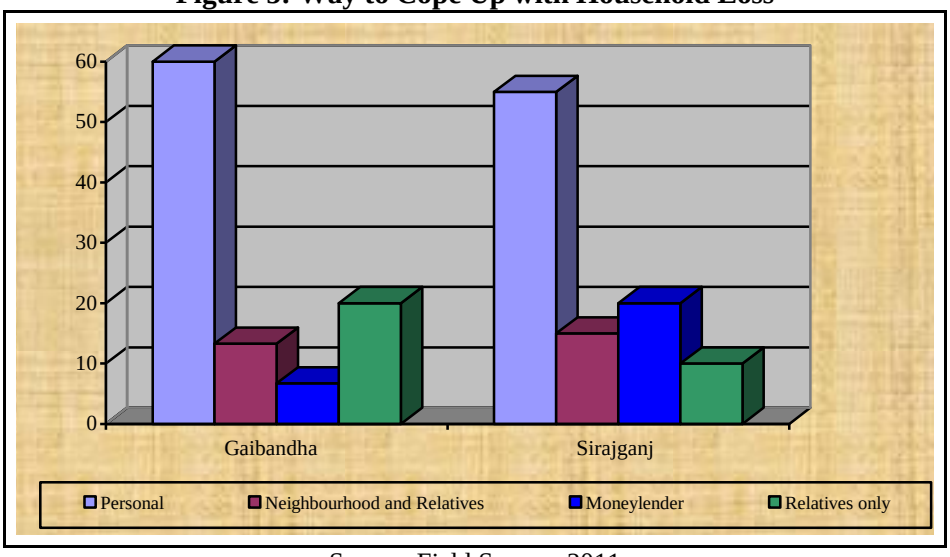
Table 13: Cost to Recover the Homestead Loss

Total Cost (BDT)	**Gaibandha (N=15)**	**Sirajganj (N=20)**
≤ 2000	33.3	15.0
>2000- ≤ 3000	53.4	40.0
>3000	13.4	45.0

Source: Field Survey, 2011

Further, most of them (53.4 and 40.0 percent in Gaibandha and Sirajganj respectively) have to construct another house to resettle with a cost of 3000 BDT (Table 13). In total, with a wrapped up of a 0.2 ha of homestead land they have to bear a loss of 21634 BDT (Gaibandha) to 28951 BDT (Sirajganj) that makes them ultra poor.

Figure 5: Way to Cope Up with Household Loss



Source: Field Survey, 2011

To resettle their household after the disaster, most of them have to rely on their personal earnings in both the study areas (Figure 5). However, people in Sirajganj (20 percent) have to rely on moneylender more than that of in Gaibandha (6.7 percent). Such difference is an indicative of poor income generating opportunity.

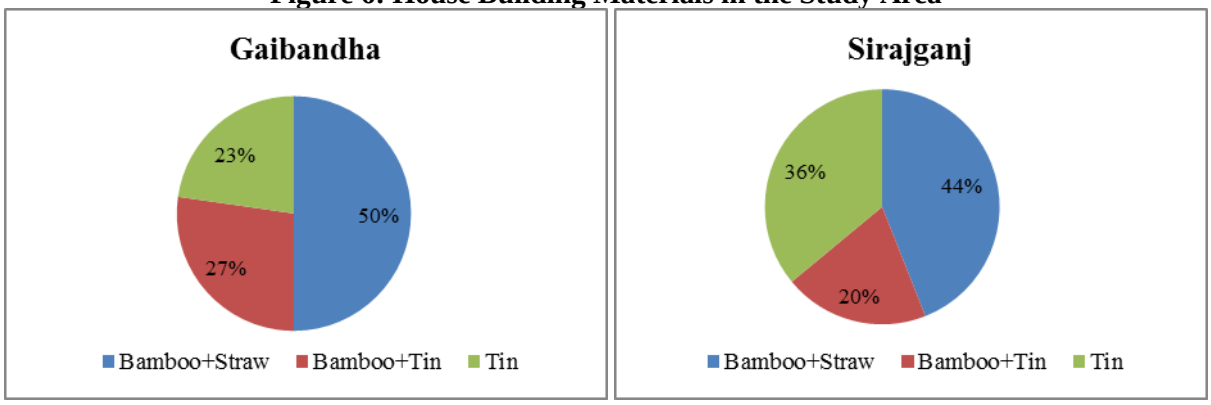
Apart from those losses, bank erosion reduced the opportunity of employment, which is one of the most indirect impacts of disaster. When bank erosion took place, those people who are engaged in agricultural and other primary occupation, lost their job. Due to lack of experience and skill, they can neither shift in secondary occupation nor remain involved in primary occupation. In such a situation, they have to migrate temporarily to the nearby headquarters or large cities to search job opportunity. However, in most cases, they failed to earn a substantive amount of money or they have to get involved in hazardous jobs that have negative health impacts. These situations impede them to fulfil their food security.

12. SUSCEPTIBILITY OF HOUSEHOLD FROM BANK EROSION

12.1. Housing Structure

Housing structure determines the susceptibility due to bank erosion. The stronger the housing structure the lesser the susceptibility of erosion. People of the study area know that their household can be evacuated at any time. For that reason, they construct their households with such building materials that can be relocated within short period during disaster. Such provision makes them less vulnerable in managing the cost of housing. During the study, it was observed that almost half of the respondents (50 and 44 percent in Gaibandha and Sirajganj respectively) construct their houses with bamboo and straw (Figure 6).

Figure 6: House Building Materials in the Study Area

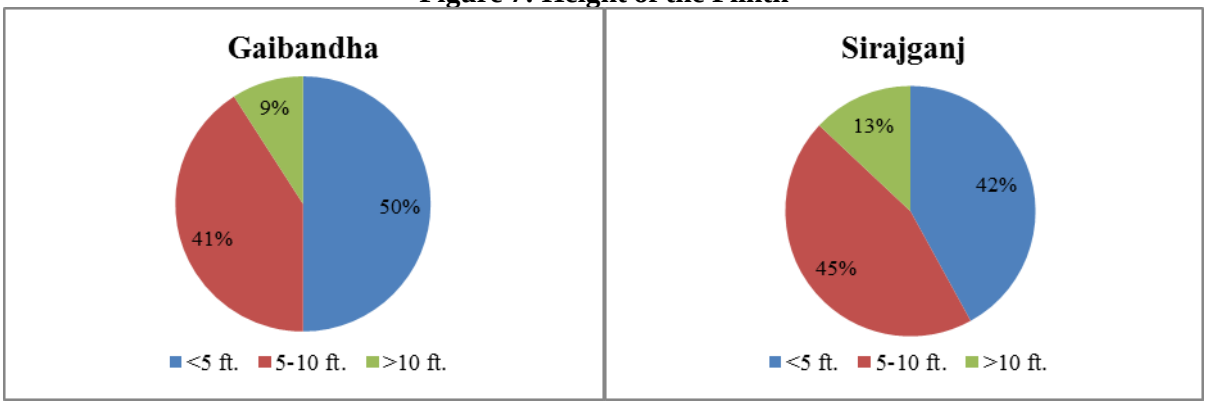


Source: Field Survey, 2011

12.2. Height of the Plinth of Households

Height of the plinth is one of the most determinants in the bank erosion regime. Most of the households are made up with mud floor that makes the household vulnerable to erosion as the soil structure looses its composition during flood. Elevated plinth of the household protects it from further erosion. In most cases (Figure 7), the plinth is less than five feet that is prone to erosion.

Figure 7: Height of the Plinth



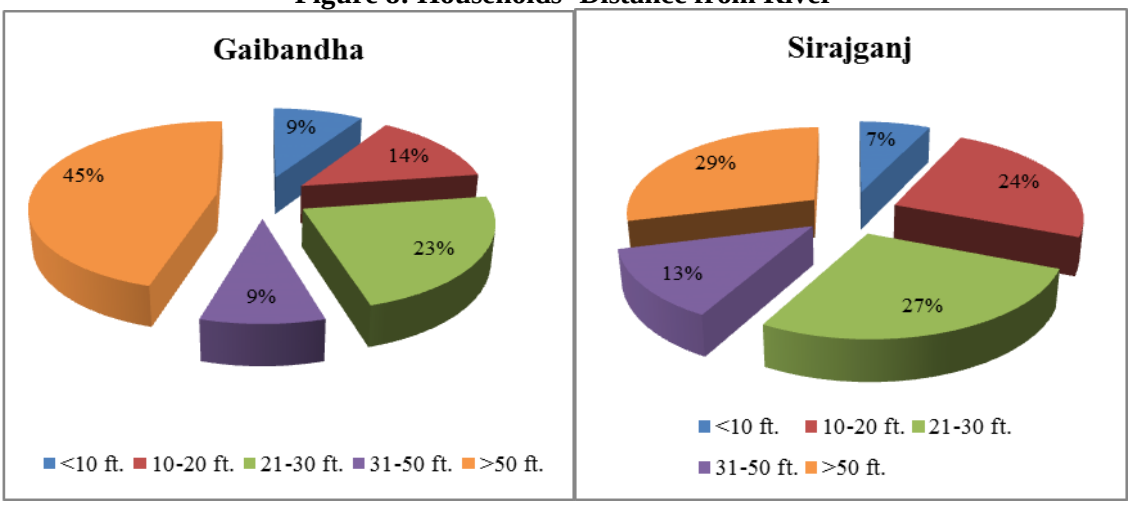
Source: Field Survey, 2011

Only 9 percent and 13 percent of households were found at the height of more than 10 feet in Gaibandha and Sirajganj respectively. Such findings indicate that people are unable to construct more resilient household due to poor financial condition.

12.3. Distance from the River

Bank erosion has been causing great miseries to thousands of people every year living along with the riverbanks. Those who live very close to riverbank are more prone to erosion. An attempt has been made to understand the locational factors which make them vulnerable to disaster.

Figure 8: Households' Distance from River



Source: Field Survey, 2011

Study findings show that 50 to 70 percent of households are very close to river bank (Figure 8). In Sirajganj, seven-tenths (71 percent) of the households are at a distance of less than 10 to 50 feet. These households are located in such a distance that erosion may displace them within one year erosion. In contrary, 45 percent of people in Gaibandha reside more than 50 feet from the river. However, those who reside along with bank line (55 percent) are also facing this disaster more acutely.

13. LIVELIHOOD STATUS OF THE STUDY AREAS

Most of the people of both of the study areas live on agriculture and other primary activities. They have very little earning with large family size. In most of the cases, they are unable to fulfil their daily food requirement due to insufficient monthly household income. However, riverbank erosion exacerbates the situation as the income related activities are going to be limited. Monthly expenditure pattern of an individual elucidate his livelihood status. High expenditure on basic necessary elements e.g. food consumption, education, health care etc. provide a high livelihood status and vice versa. It was evident from the study that those necessities are inadequately addressed and hence lowering the livelihood status.

13.1. Monthly Income

Low monthly income is lowering the ability of an individual to maintain a minimum standard of living and to cope with adverse impact of any natural disaster.

Table 14: Monthly Household Income by Area

Income Group (BDT)	Gaibandha (%)	Sirajganj (%)
≤ 2000	13.6	13.6
2001-3000	36.3	40.8
3001-4000	45.3	40.8
4000+	4.5	4.5

Source: Field Survey, 2011

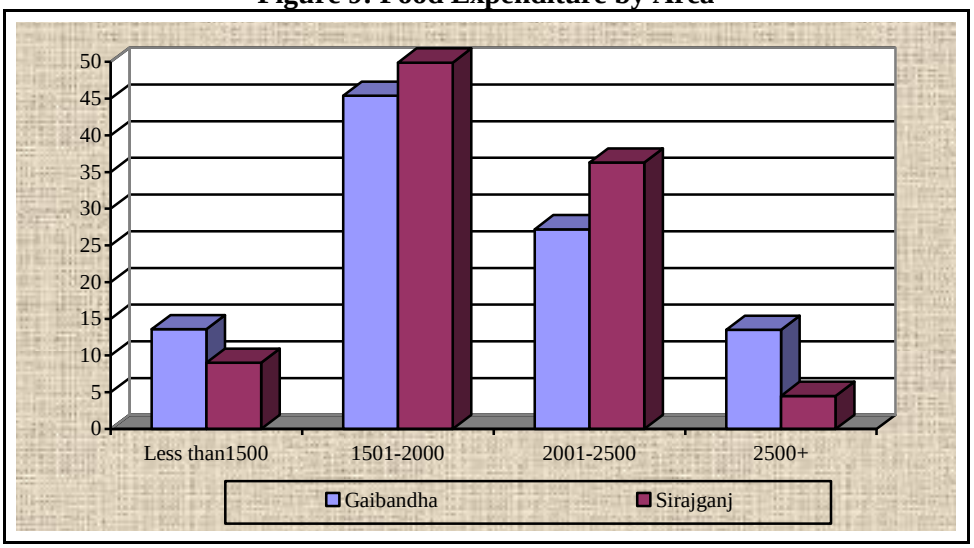
It is evident from the study that respondents of both of the areas are poor in their income level. A vast majority of them (45.3 and 40.8 percent in Gaibandha and Sirajganj respectively) are in the income group of 3001- 4000 BDT. Such low income impedes them in

expending money on food consumption, educational expense and health care facilities. To understand the livelihood status, expenditure on those variables are analysed below.

13.2. Expenditure for Food

Poverty is measured using the kilocalorie (Kcal) intake by food habit. The study calculated expenditure for food rather than calorie intake.

Figure 9: Food Expenditure by Area



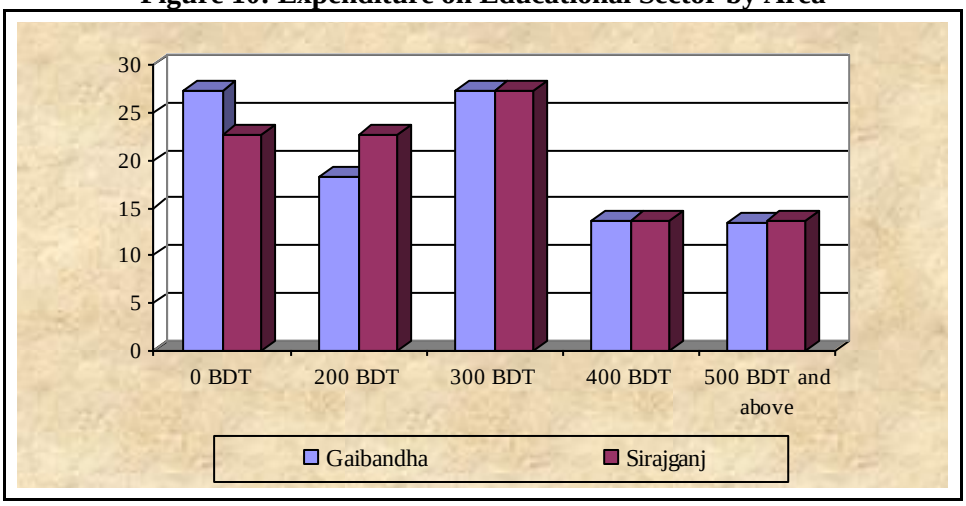
Source: Field Survey, 2011

Empirical data shows that most of the respondents (45.4 and 49.9 percent in Gaibandha and Sirajganj) spend 1501- 2000 BDT for food consumption from their monthly income (Figure 9). Such expenditure is inadequate most of the time because of large family size. In addition, a major portion of their income is occupied by such expenditure that hinder in further investment in producing household assets or other sector of livelihood like education, medical expenses. Apart from this, when disaster strikes, their income level drops in a substantial amount that makes them to take food for once or twice a day.

13.3. Expenditure on Educational Sector

Education makes a man competence to serve the nation as well as running his life with full of advantage. An illiterate man, in most cases, is occupied by primary economic activities with little knowledge on how to improve or modify his activities. When disaster strikes, most of them do not know what to do or how to cope with losses. Poor income lessens the opportunity to invest in educational sector. In addition, disaster impedes the children in going to school and enhances dropout rate. Respondents were asked about their expenditure on educational sector. Most of them replied that their poor economic condition hinders them to invest. Bank erosion destroys the school. Due to the lack of money, they can neither reconstruct their school nor get much education. Such situation, in turn, impedes the children in getting education and forces them to search for a job at an early stage of life to contribute in the family income.

Figure 10: Expenditure on Educational Sector by Area



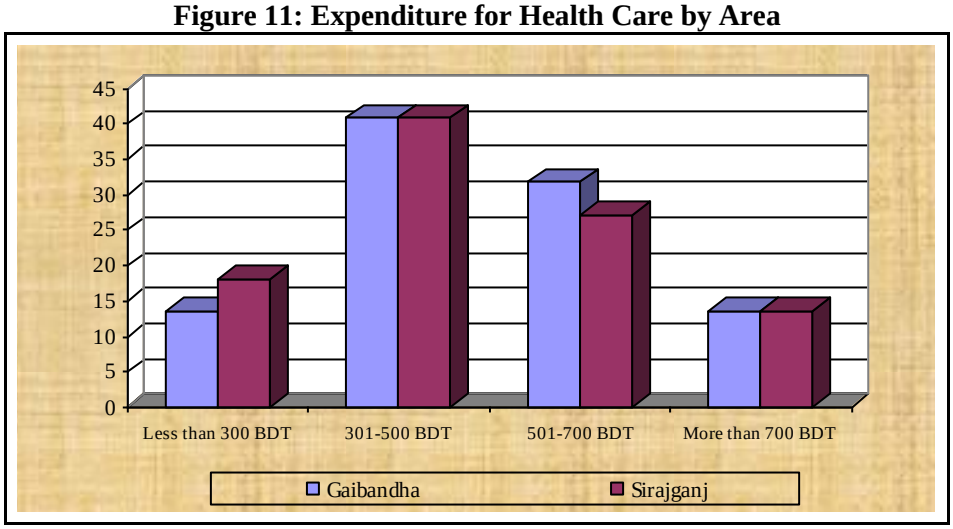
Source: Field Survey, 2011

From the study it is evident that almost one-fourth (22.7 percent) and more than that (27.3 percent) of the respondents do not spend a single amount of money for education in Gaibandha and Sirajganj respectively. Such a situation indicates a very poor livelihood status of the study areas. On the other hand, 27.3 percent of the respondents invest 300 BDT for education in both the areas. To improve livelihood status and to increase the income level, education is the ultimate choice, and people have to pay more attention in this sector.

13.4. Expenditure for Seeking Health Care Facilities

To maintain a descent life and to perform the economic activities efficiently, health is the prime factor. Lack of proper treatment and sickness cause people to remain unhealthy and this in turn reduces the income level. During different natural disasters, different types of health hazards prevail. In addition, after a devastating loss, people bear huge mental shock that need extra-long period to recover. Such health related problems make their situation even worse.

Figure 11: Expenditure for Health Care by Area



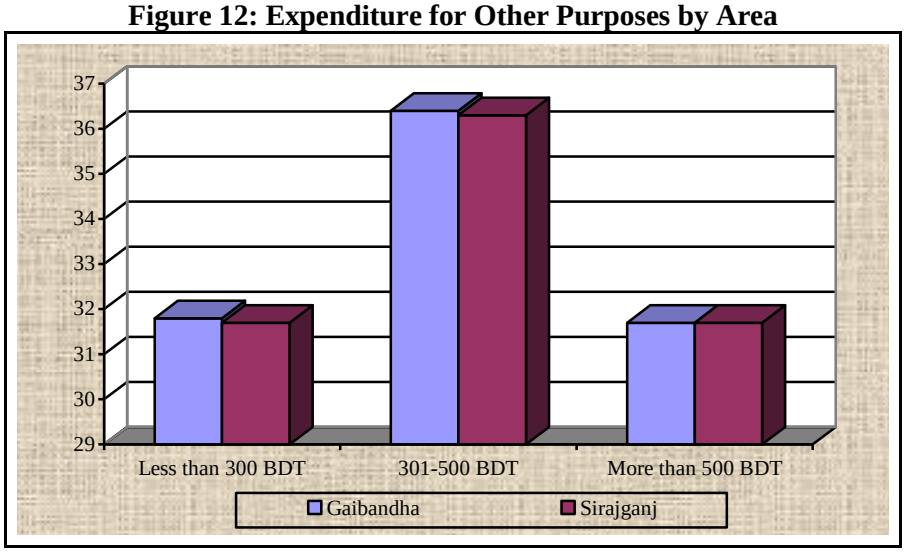
Source: Field Survey, 2011

Empirical data shows that a vast majority of respondents (40.9 percent in both of the areas) pay 301-500 BDT for seeking health care facilities. 36.4 and 27.3 percent of the respondents in Gaibandha and Sirajganj respectively argued that they are unsatisfied with their family health status. Moreover, during disaster, they faced enormous health burden, as the medical centre is located in a distant place. In contrary, the respondents of Sirajganj mentioned that though they have a nearby community medical centre, they do not get adequate treatment because of the absence of service provider (i.e. doctor). Very few of them (13.6 percent) have the ability to spend more than 700 BDT per month in this purpose.

13.5. Expenditure for Other Purposes

Other purposes include clothing, strengthening house structure, invest in different income generating sources, savings, recreation etc. Respondents of the study area are poor in terms of their income and thus they are less capable to expend more money for other purposes. Most of them have to spend rest of their monthly expense to combat with the bank erosion.

Figure 12: Expenditure for Other Purposes by Area



Source: Field Survey, 2011

An almost similar trend of expenditure for other purposes is prevailing in both the study areas while most of them (36.4 and 36.3 percent in Gaibandha and Sirajganj respectively) spend 301-500 BDT per month. Such low amount of spending can neither improve their livelihood nor make a huge change by savings.

Overall, the livelihood status of the study areas is too low to live a descent life. Furthermore, riverbank erosion makes them spend a large amount of money and eventually they become ultra-poor.

14. INVOLUNTARY MIGRATION

Migration is the movement of people from one place to another for taking up permanent or semi-permanent residence, usually across a political boundary. There are several types of migration like internal migration, external migration, emigration, immigration, impelled migration, step migration, seasonal migration etc. considering several principles of migration as:

- Most migration is rural to urban.
- Most migration occurs in steps.
- Most migrants travel only a short distance.
- Migrants, travelling long distance, usually settle in urban areas.
- Each migration flow produces a movement in the opposite direction.

The unpredictability of river encroachment is devastating for households settled in vulnerable area (Hossain, 1993). Population displacement due to erosion is endemic throughout Bangladesh. It has been estimated that about one million people are directly affected every year by riverbank erosion (Elahi, 1991). Embedded socioeconomic inequalities enhance the vulnerability of the poor while more than one-half of rural households have almost no direct access to land (Rogge and Haque, 1987) which implies that a vast majority of them survive on subsistence livelihood with little savings opportunity. When a natural calamity strikes, they have less opportunity to cope up with their savings. That is why, they sell land, livestock, housing materials and personal belongings (Haque, 1997).

Elahi (1972), Islam (1976) and Khan (1982) calculated that the rate of urbanization has been increasing by more than 60 percent per decade since the independence of Bangladesh, which is mainly attributed to rural-urban migration rather than a natural increase in urban population. It was observed that such increase has caused escalating the growth of slums and squatters in many urban centres (Hutton and Haque, 2004). One quarter of slum dwellers migrated from rural areas to urban centres particularly in Dhaka city because of the uprooting caused by natural disasters (Akhter, 1984) and almost one-tenth of the riverbank erosion induced marginalized people to migrate in urban centre in searching for livelihood option (Hossain, 1984). Multiple displacements are a common phenomenon of char land settlements, particularly for the marginalized people. The rapid changes in river courses and lateral movement of the bank destroys valuable agricultural land (most often the only option of livelihood), homesteads, markets and other establishments, and they become destitute and landless. However, re-emergence characteristics of char lands give the landless people a hope to resettle. The existing power dynamics to take control over a newly emerged char land results in violent fights between groups and hence a considerable proportion of displaced people (10 to 25 percent) determine to migrate. These involuntary migrants become permanent squatter settlers in the cities and towns (Hutton and Haque, 2004). Furthermore, people who become destitutes by losing all lands are compelled to live on an active railway line, abandoned brickyard and along the flood protection embankments.

Riverbank erosion largely affects poor and marginalized people as they have the least capacity to resist and to recover from the natural hazards (Greenberg, 1986; Rogge and Elahi, 1989). The physical, economic, social and political situations of Bangladesh accelerate the rate of marginalization. Most of them try to rely on existing tenancy structures to recommence their livelihoods in rural areas; but widespread erosion destroy the attempt and push the impoverished people to migrate from rural areas to urban centres. However, in the case of riverbank erosion induced displacement, people attempt to stay within the vicinity of their origin. Such intention is rooted in several factors (Hutton and Haque, 2004) that make them more vulnerable to erosion:

- poor economic condition;
- not to destroy existing social bonding; and
- hope of regaining the lost land

Table 15a: Migration Pattern observed in Gaibandha

Age Group	Migration Place (N=22)				
	Bogra (%)	Chittagong (%)	Dhaka (%)	Dinajpur (%)	Gaibandha (%)
20-25	13.5	22.5	18.2	4.5	-
26-30	13.5	13.5	36	9.0	-
31-35	22.5	4.5	22.5	4.5	-
36-40	9.0	9.0	9	4.5	4.5
41-45	-	4.5	-	-	-
46-50	-	4.5	-	-	-
50+	-	-	-	-	-

Source: Field Survey, 2011

It is evident that (Table 15a and 15b) temporary migration is prevalent in both of the study areas. People in both of the study areas migrate in temporal scale rather than permanent one. They migrate to distant places most often in search of jobs. Respondents identified that because of the lack of money, they cannot migrate with their family to a place where erosion does not take place. Therefore, they relocate their homestead in a nearby area immediately after the disaster strikes and the people who are able to do laborious job, migrate to distant places in order to cope up with losses incurred from riverbank erosion. Moreover, people of Lalcamar village (Table 15a) relocated themselves nearly to their destroyed homestead, which they never consider as migration. However, they have to migrate in different districts of Bangladesh to get jobs to perform their livelihood. Contrary to this, the people of Bishurigacha and Old Meghai village move to nearby place first (in case of char land they migrate to another char and in other cases, towards the Upazila headquarters) and then to Sirajganj (Table 15b). Tendency towards migration to long distance is also prevalent here as they frequently move to Tangail and Bogra.

Table 15b: Migration Pattern observed in Sirajganj

Age Group	Migration Place (N=22)					
	Bogra (%)	Chittagong (%)	Dhaka (%)	Mymensingh (%)	Sirajganj (%)	Tangail (%)
20-25	9.0	13.5	27	-	4.5	13.5
26-30	4.5	9.0	31.5	-	-	9.0
31-35	4.5	-	9.0	4.5	-	-
36-40	4.5	4.5	22.5	4.5	31.5	4.5
41-45	9.0	9.0	4.5	-	18	9.0
46-50	4.5	-	-	-	4.5	-
50+	4.5	4.5	-	-	13.5	4.5

Source: Field Survey, 2011

The study reveals that people between 20-35 years of age move to different districts of Bangladesh like Bogra, Chittagong, Dhaka, Dinajpur etc. while age groups of 31-35 and 26-30 were found as the highest long distant migrants in Gaibandha and Sirajganj respectively. Those who are more than 35 years of age, try to maintain their livelihood by migrating to their own district level living through different occupation like rickshaw/ van puller, day labourer etc. Such migration pattern makes them return to their locality after minimum of

three days to maximum of 15 days staying. It was also observed that people who are more than 50 years, tried to stay in their household as they are less capable to do hard work.

15. GOVERNMENT STRATEGIES TO LESSEN THE IMPACT

Government response to this problem at local, regional and national levels has been limited to structural measures i.e., embankments, barrages, etc., and very little attention has been paid in developing non-structural and self-help strategies. Most often, measures are taken immediately after the disasters and interventions are taken in the form of relief provisioning.

The majority of the population (77 percent) live in the rural area because of the predominance of the primary economic activities (agricultural sector) and slow pace of the development in the secondary (industrialization) and tertiary (service sector) economic activities. Most of the areas are covered by river floodplain that supports numerous indigenous and high-yielding varieties (HYV) of paddy, jute, sugar cane, tobacco, *rabi* crops, oilseed and vegetables. However, the cumulative income from such cultivation can only support a subsistence livelihood among the majority of small cultivators (Hutton and Haque, 2004).

Repeated displacements are common in the erosion-prone districts of Bangladesh and such frequent movement hinders the implementation of recovery and the long term rehabilitation programmes. Evidence shows that two-thirds of the inhabitants of the Jamuna-Brahmaputra floodplain were displaced at least once in their lifetime. About 17 percent were displaced for three times and 15 percent for 10 times (Haque, 1988).

Riverine areas of Bengal became distinctive as the Bengal Alluvion and Diluvion Regulation (1825) was enacted and implemented (Haque, 1997). The regulation was not intended to introduce any new rule of law but it declared the supremacy and applicability of the rules of usage. According to the regulation, claims and disputes over emerged char lands were decided upon by considering the local use of payasty (alluvion) and sikosty (diluvion). In view of the regulation, gradual accreted lands were annexed to the tenure of the person whose estate is adjoined (Ali, 1980) but a submerged estate that subsequently became attached to an adjoining estate would not fall under the legal control of the later estate upon re-emergence (Hutton and Haque, 2004). The Act of 1950 by the government of Pakistan abolished the permanent settlement with the proprietors and emphasised on de-facto possession of land mainly occupied by Muslim peasants and tried to establish legal rights for the marginalized, smaller landowners. In reality, even today, larger landowning class dominates the power structure and they determine the possession of re-emerged land from the riverbeds. However, it is important to remember that newly accreted land may take up to 15 years to develop full production potential, whereas the land that was lost into erosion is in most cases, valuable agricultural land.

16. CONCLUSION

The marginalized and poor people not only lose property but also experiences socioeconomic deprivation through displacement. Because of the dynamic character of the braided channelled river and the failure of structural measures, the sufferings of the people are assumed to continue. Long-term policies and strategies should be taken to cope up with the bank erosion taking into account the social and institutional adjustment measures. Land

relocation assurance is one of the appropriate strategies to cope up with such disaster. In addition, a floodplain zoning is essential to lessen the vulnerability of riverbank erosion. Furthermore, measures should be taken in different level to minimize the loss:

a) Sustainable embankment construction and its maintenance
b) Training on disaster preparedness involving local institution/ local government
c) Massive afforestation with the experience of local knowledge and its maintenance
d) Action against deforestation
e) Form an alliance among SAARC countries in order to ensure water distribution within the subcontinent.

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