

## **Trend Analysis of Bank Erosion of Jamuna River and Migration Impact: A Case Study on Teota Union of Shibalaya Upazila**

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### **Abstract**

Riverbank erosion is one of the major natural disasters in Bangladesh causing enormous and long term socio-economic consequences. Every year, approximately one million people are affected by river bank erosion. River bank erosion not only compels people to migrate or leave their place of origin, but also destroys their belongings. This research is conducted to analyze the river bank erosion scenario of Teota Union in Shibalaya Upazila of Manikgonj District located on the left bank of Jamuna River and also to analyze migration patterns. Teota union is the most vulnerable for river bank erosion due to char formation, shifting channels, and erosion. The amount of eroded and accreted areas of the study area in different periods from 1988 to 2014 has been computed from the satellite images of different years using GIS. During 1988-2014, the maximum bank erosion was occurred during 1988-1990 and 2606.22 acres of land was eroded during that period and the minimum amount of land (995.12 acres) was eroded during 2005-2010 in the study area.

### **Introduction**

Bangladesh is one of the most disaster-prone countries in the world. The state of Bangladesh is possibly the single largest concentration of people in a highly disaster-prone environment, with most of its 140.23 million people at significant risk to more than one form of natural hazards (Islam et al., 2014). Riverbank erosion in Bangladesh is no less dangerous than other sudden and devastating calamities. Though losses are slow and gradual, they are more destructive and far-reaching than other sudden and devastating calamities. It takes a few decades to make up the losses, which a family is incurred by river erosion (Disaster Management Bureau, 2010). Around 10,000 hectares land is eroded by river per year in Bangladesh (NWMP, 2001 as cited in Islam et al., 2014) and about 5% of the total floodplain is directly affected by erosion (Rahman, 2010). In a research, the Department for International Development (DFID) in association with Disaster Forum identified the river erosion as the topmost disaster concerning the losses (Chowdhury, 2007).

Between 1973 and 2015, erosion and accretion along the Jamuna River was 88,462 ha and 16,315 ha respectively. The imbalance between erosion and accretion is accorded to the widening of the river. Data of the last few decades show that the Jamuna is widening and both of its banks are migrating outwards at a high rate. During the last four decades (1973 to 2015), the net erosion along the 220 km long Jamuna River was about 88,462 ha. The rate of erosion has varied over time reflecting the response of the widening process (CEGIS, 2015).

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### Objectives and Methodology

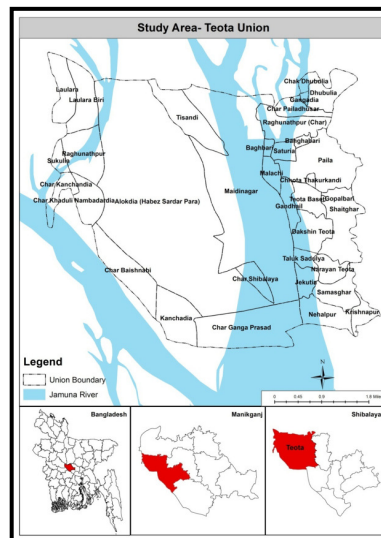
The main objective of the study is to identify the riverbank erosion scenario of the study area and to identify the migration pattern of affected people by riverbank erosion. Finally, the paper tries to provide some guidelines to mitigate riverbank erosion and improve livelihood condition of affected people.

This research is primarily based on both primary and secondary data and information. Satellite images of the study area of different years during 1988 to 2014 have been collected from United States Geographical Survey (USGS) and Arc GIS 10 software were used to identify the previous and present riverbank erosion scenario of the study area. Geometrical calculation gives the amount of eroded and accreted area of the study area from 1988 to 2014 using satellite images of different years. Total population in the study area is 33,622 and 400 sample was taken from the partially eroded and erosion free mouzas to identify the migration pattern of affected people by river bank erosion.

### Study Area Profile

Shibalaya, the second largest Upazila of Manikganj district in respect of population, came into existence in 1875 and located between 23° 44" and 23° 55" north latitude and 89° 41" and 89° 56" east latitude (Banglapedia, 2015). It is learnt that the previous name of the Upazila was Jaffarganj. In 1900, the Upazila headquarters was shifted to Shibalaya mauza due to river erosion of Jafarganj. It is generally believed that the Upazila might have been renamed as Shibalaya after its name.

Teota union is located at Shibalaya Upazila of Manikganj district covering 14,254 acres or 50.63 sq. km area of land. This union is bounded by Daulatpur Upazila on the north, Uthali union on the east, Goalanda Upazila on the south and Bera Upazila on the west (Figure 1).



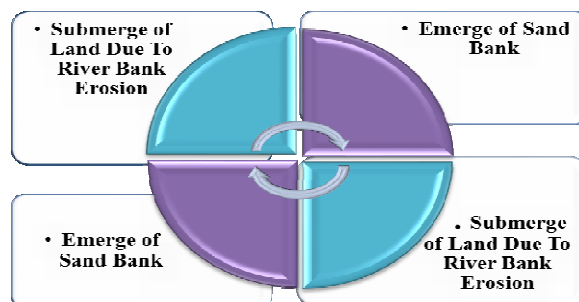
Source: LGED & CEGIS, 2015 (modified by authors)

Figure 1: Location map of Teota Union

### River Bank Erosion and Population Displacement

From ISPAN made study, it was found that a total of 728,439 people were displaced from their original homesteads by river bank erosion during 1981-1993. It was also estimated that annually the number of displaces to be 63,722. While no recent figures are available, historic studies from the mid-1980s, indicate that in some slums in Dhaka more than 40% of the population named river erosion as primary cause for their migration into slums (Islam et al, 2011). The life on the flood embankments and in slums results in special hardship, such as a lack of minimum services, drinking water, ration cards, schooling for children, health facilities, and attention of the local government.

The displacement of people in erosion affected area is typical. It is of the nature of “continuous forced migration”, i.e., displacement, then settlement, then displacement, then again re-settlement and so on (Figure 2).



Source: Das et al., 2014

Figure 2: Continuous process of forced migration

### Causes of River Bank Erosion in the Study Area

Water level and discharge have a great impact on erosion and accretion of river and adjacent floodplain. More erosion occurs in the river bank when river go on with high water level, energy increases and high water discharge. There is progressive correlation between water level and discharge with erosion. Reduce of water level and discharge show negative contact on erosion.

### Relationship between River Bank Erosion and Maximum Water Discharge

The following diagram (Figure 3) depicts that, the best-fit lines for the relationship between annual maximum discharge and annual rate of erosion at the right and left banks are

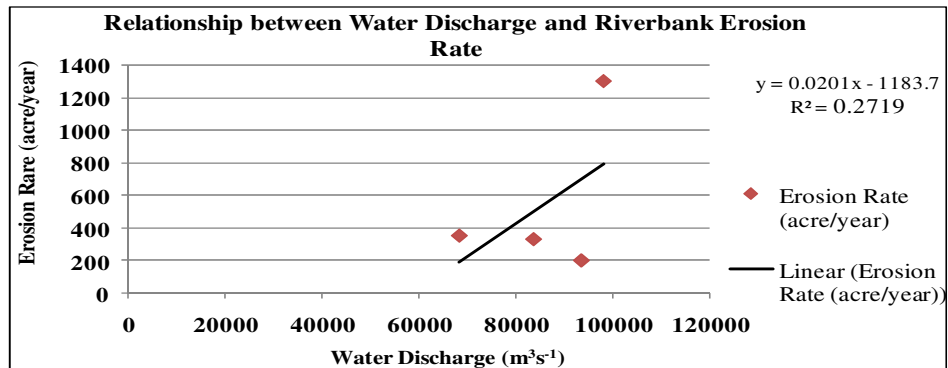
( $r^2= 0.2719$ ):

$$E = 0.0201Q_{\max} - 1183.7$$

Where, E = annual riverbank erosion (acre)

$Q_{\max}$  = annual maximum discharge ( $m^3s^{-1}$ )

So, it can be stated that erosion rate and maximum water discharge have positive relationship. The left bank of Jamuna River i.e. the study area is very susceptible to maximum water discharge and causes a high rate of erosion.



Source: Computed by authors, 2016

Figure 3: Relationship between maximum discharge and bank erosion rate of Jamuna River in the study area

The above mentioned equations show that a 10% increase in the annual maximum discharge (flood discharge) will generate 24% increase in erosion along the bank of Jamuna River.

#### Relationship between Riverbank Erosion and Maximum Water Level

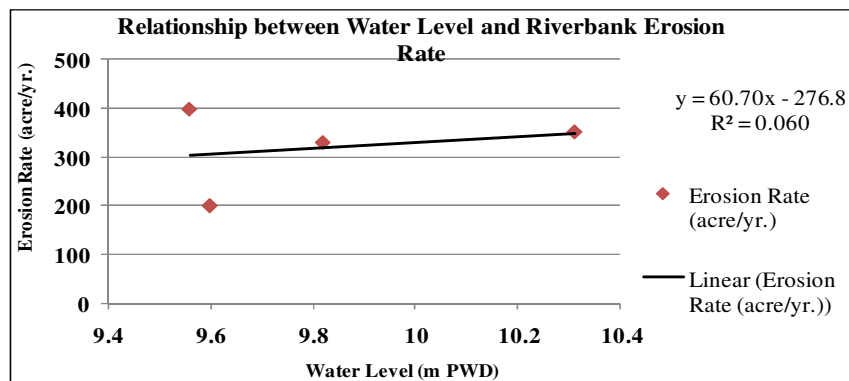
An attempt has been taken in this study to find out response of riverbank erosion on maximum water level (flood level) and erosion rate in the study area. For the bank in the study area, very positive but poor relationship has been found ( $r^2 = 0.0601$ ).

Figure 4 shows the relationship for river banks in the study area. The best-fit lines for the relationship between annual maximum water level and annual rate of erosion at the left and right banks are:

$$E = 60.706W_{\max} - 276.81$$

Where, E = annual riverbank erosion (acre),

$W_{\max}$  = maximum water level (m PWD)



Source: Computed by authors, 2016

Figure 4: Relationship between maximum water level and bank erosion rate in the Jamuna River in the study area

### Trend Analysis of River Bank Erosion in the Study Area

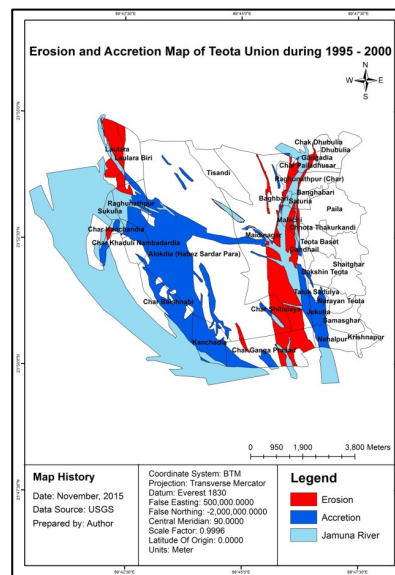
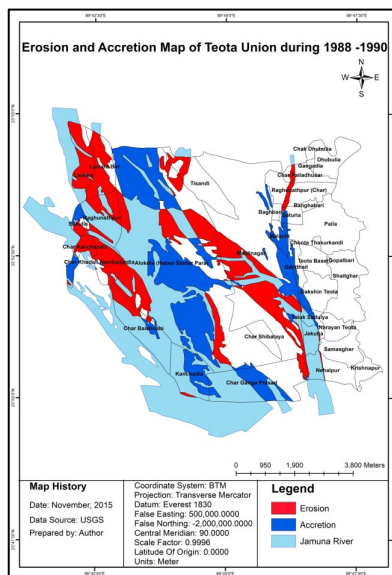
Teota Union is a riverine area. Jamuna River is flowing along this Union. Every year many parts of the river bank under this union are eroded by river. The extent of eroded and accreted areas of Teota Union from 1988 to 2014 is computed using GIS from satellite images of different years and are presented in maps as shown in Figure 5. Accretion and erosion areas have been identified by overlapping of river banks. In these maps, erosion and accretion are respectively presented by red and blue color. Bank line shifting of Jamuna River in the study area during different time periods is also presented. Visual overview of the channel layout from year to year data help to identify the channel movement of river from bank to bank.

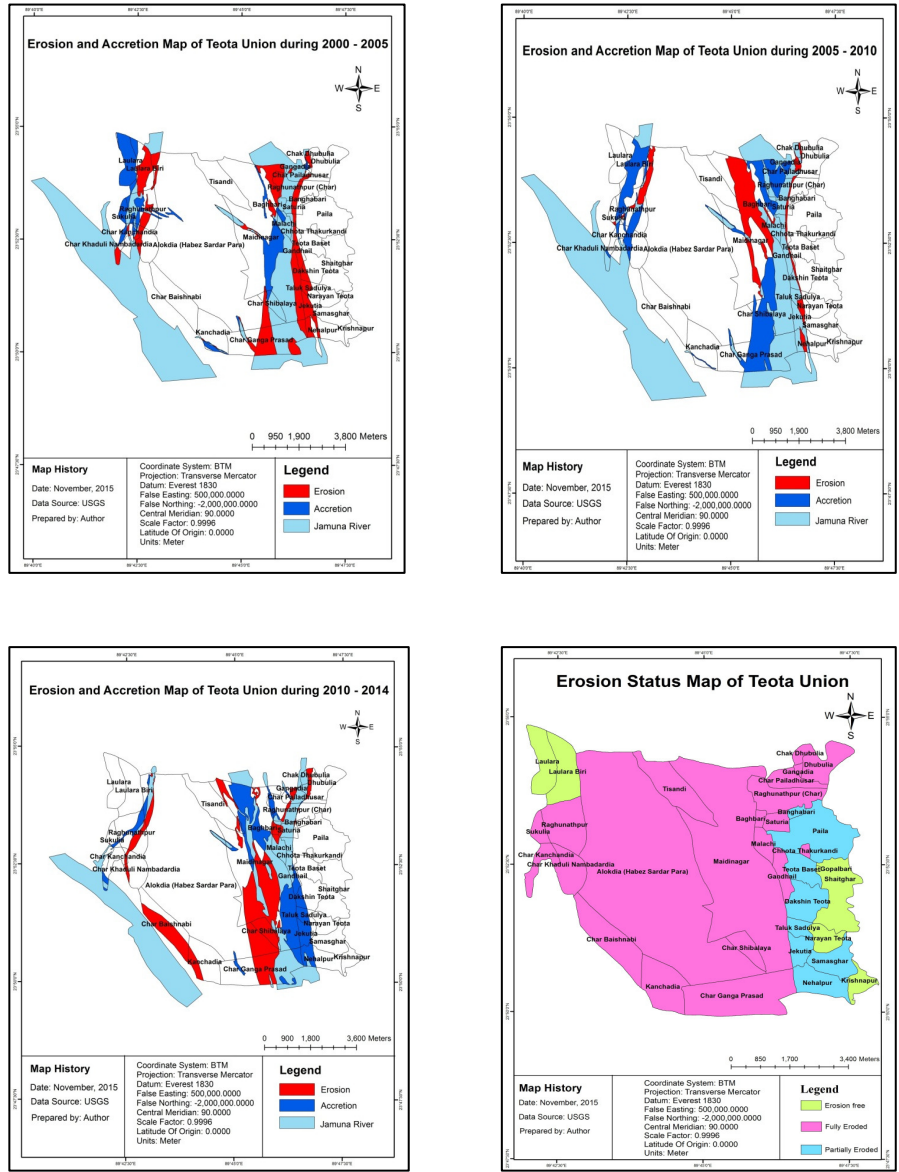
#### Erosion and Accretion in the Study Area during 1988 to 1990

During 1988-1990, the total erosion was 2606.22 acres and total accretion was only 2558.02 acres in the study area. So it can be depicted that erosion was more than accretion but during this period, accretion was also in good quantity. From Figure 5, it can be depicted that some mouzas of north-west and west were fully eroded and Maidinagar, located at the center of the study area was partially eroded.

#### Erosion and Accretion in the Study Area during 1990-1995

During 1990-1995 some areas of Alokdia (Habez Sadar para), Raghunathpur, Kanchadia, Bhangbari, Saturia were eroded while Laulara, Laulara Bri, some areas of Alokdia (Habez Sadar para), Maidinagar, Char Ganga Prasad were accreted. During 1995-2000, total 3195.922 acre land was accreted whereas 1646.279 acre land was eroded in the study area. So it is clear that the area of accreted land was higher than eroded land.





Source: USGS, prepared by authors, 2016

Figure 5: Trend of riverbank erosion and accretion in the study area during 1988-1990 (analyzed using GIS)

### Erosion and Accretion in the Study Area during 2000 to 2005

During this period, right bank line shifted from east to west in the study area. Figure 5 illustrates that Laulara, Jekutia, Taluk Shadulya was eroded and several areas of Laulara Bri, Raghunathpur Sukulia and Maidinagar were accreted. During this time, the amount of eroded area was much more than accreted area. The eroded and accreted land was respectively 1756.67 and 1007.54 acre.

### Erosion and Accretion in the Study Area during 2005-2010

Figure 5 illustrates that Laulara Biri, Gangadia, Char Pailadhusar, Raghunathpur (Char) were accreted and Bhangabari and few areas of Maidinagar was eroded during 2005-2010. During 2005 to 2010 erosion was not so devastating. 1654.10 acre land was accreted, whereas 995.12 acre land was eroded.

### Erosion and Accretion in the Study Area during 2010-2014

Due to river bank erosion, the width of the river increased. Figure 6 illustrates that Char Baisnabi, Kanchadia, Char Ganga Prashad and Char Shibalaya was partially eroded. Taluk Sadulya, Dakshin Teota and Jikutia were accreted. During 2010-2014, both erosion and accretion was comparatively enormous in amount in the study area. But the Jamuna River was very destructive as 1991.46 acre land was eroded. On the other hand 1421.31 acre land was accreted during that period.

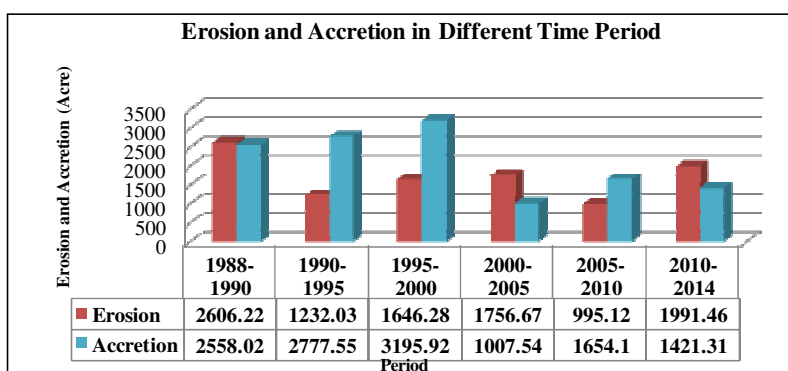


Figure 6: Graphical representation of erosion and accretion in the study area during 1988-2014

The highest bank erosion was happened during 1988-1990 and 2606.22 acre land was eroded. On the other hand, during 1995-2000, 3195.92 acre land was accreted which was more than erosion during that period. Moreover, substantial amount of land (1421.31 acre) was eroded during 2010-2014. The lowest amount of land (995.12 acre) was eroded during 2005-2010.

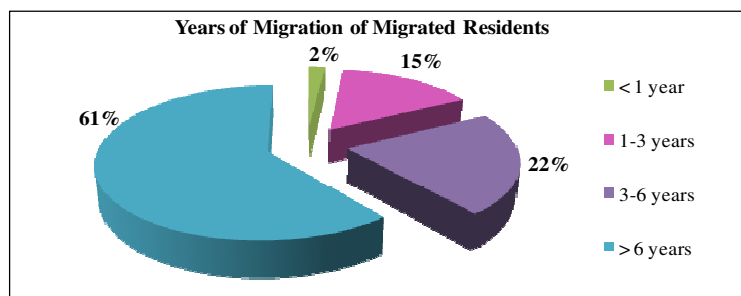
### Migrated Residents in the Study Area

Migration is the movement of people from one place to another for taking up permanent or semi-permanent residence, usually across a political boundary. Forced resettlement tends to be associated with increased socio-cultural and psychological stresses and higher morbidity and mortality rates. Population migration therefore disrupts economic and socio-cultural structures. Unfortunately, 87.30% people in the study area have been migrated from their place of original residence and the remaining 12.70% are living at their original place of residence.

### Years of Migration of Migrated Residents

In Teota union, most of the residents in the study area (61%) have been migrated to the present place of resident more than 6 years and 22% people have been displaced from

their origin 3 to 6 years. It is also evident that most of these destitute families do not want to return to their place of origin, rather they wish to stay permanently at the new residence where, at least, they can get employment.



Source: Field survey, 2016

Figure 7: Years of migration of migrated residents

### Displacement due to River Bank Erosion

Among the displaced people (87%), the maximum displacement (46.55%) found 3 to 4 times of displacement and 6.87% people were displaced more than 6 times which was the highest in number among the affected people. This maximum range of frequency of displacement is experienced by fisherman (3.64%), farmer (2.67%) and day labor (0.76%). So they are more affected than others. It is also mentionable that medium businessman, small trader and service holder have been displaced comparatively fewer times than others. It is evident that this multiple shifting, took these affected people quickly to go under the poverty line. Their living status and livelihood pattern also changed simultaneously.

Table 1: Frequency of displacement in a lifetime by river bank erosion in the study area

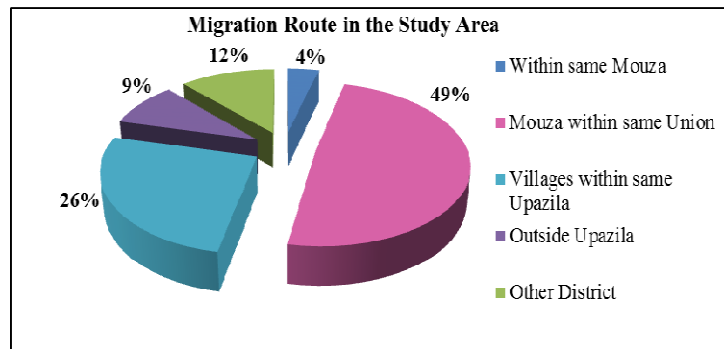
Occupation	Frequency of Displacement of Affected People (%)				Total
	1-2 times	3-4 times	5-6 times	> 6 times	
Day labor	8.01	11.45	2.67	0.76	22.89
Small trade	0.38	0.76	-	-	1.14
Medium businessman	0.38	0.38	-	-	0.76
Farmer	1.91	16.03	6.87	2.67	27.48
Service holder	3.05	1.15	-	-	4.2
Rickshaw puller	4.58	3.05	1.52	-	9.15
Unemployed	-	0.76	0.76	-	1.52
Housewife	6.49	7.25	0.76	-	14.5
Fisherman	5.72	5.72	2.67	3.44	17.55
Total	30.51	46.55	15.25	6.87	100

Source: Field survey, 2016



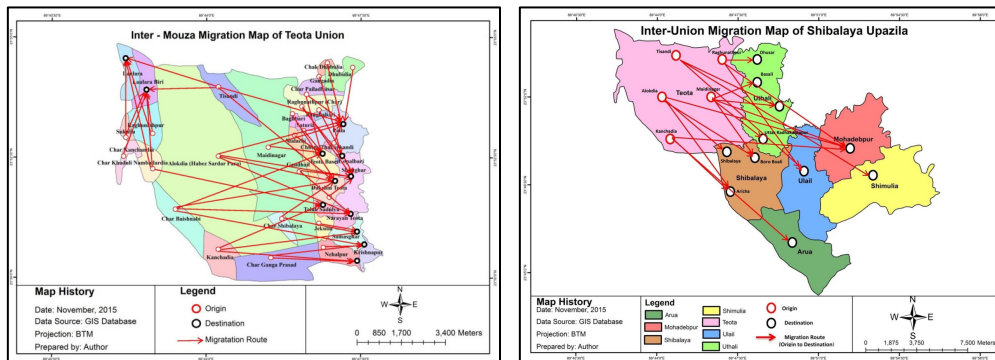
### Permanent Migration Route

People in the study area do not want to migrate permanently from their place of origin but they forced to move permanently due to landlessness by erosion hazard. From the analysis of peoples’ perception about migration route, it can be stated that when people migrate permanently, they mostly prefer to migrate short distance. Almost half of the respondents (49%) people migrated to the mouza within same union where 27% identified that people permanently migrate to villages within same Upazila.



Source: Field Survey, 2016

Figure 8: Peoples’ perception about permanent migration route in the study area



Source: Union Land Office, Teota, and Upazila Office, Shibalaya, 2015

Figure 9: Inter-mouza and inter union migration map of Teota union

### River Erosion, Migration and Impact on Livelihood

**Change of Profession:** In Teota union, 20% people have changed their occupation due to riverbank erosion and most of them were farmer. The number of temporary occupants has been increased than before erosion.

**Income Erosion:** 31% affected people’s income has been decreased as many of them have occupied low waged temporary job. But this income erosion is experienced by the people whose income is comparatively poor i.e. poorer are becoming more poor. It is also alarming that maximum people (47%) have become poor after erosion.

**Low Expenditure on Food, Health and Education Sector:** The affected people have become unable to expend on food, health and education sector like before erosion and this causes degradation of quality of life.

**Loss of Asset:** Loss of asset like homestead, cultivable land, tree, and latrine are very common in this area. More or less all the people have lost these items. Maximum population (78%) in Teota union have lost their homestead land their monetary loss due to this was also mentionable. The people who have cultivable land experienced serious impact on crop production like damage of crop and declination of cropping pattern. Most of them have lost cultivable land two times and the amount of cultivable land loss was maximum more 100 decimal. But 46.67% affected people have claimed their most severe bitter experience due to riverbank erosion is being homeless.

**Lack of Health Care Facility:** Unfortunately the health care facility in the study area is acute. There is a healthcare center in the Shibalaya upazila. But due to bank erosion the communication system is in worse condition. Only 22% people can receive facility from it and the remaining 79% have to go local pharmacy house. There is no NGO health care center in this area.

### **Recommendations**

From findings it is clear that in Teota union, no such structural and non-structural measures are taken which can protect river bank erosion and improve the livelihood condition of affected people. Without sustainability no measures can bring long term benefits. Some guidelines are provided to mitigate the bank erosion and its' impact on affected people effectively.

Guidelines are provided to improve two types of measures:

- Structural Measure
- Non-Structural Measure

#### **Structural Measures**

The following structural measures are recommended in the study area to manage river bank erosion.

##### ***Construction of Embankment***

In Teota union, no permanent protective measure has been taken yet for river bank erosion. An enduring and stable embankment along Jamuna River can protect this union from the destruction of the river. The following guidelines can be effective to serve this purpose:

- The length of the embankment is proposed by BWDB to be 2 km protecting Dhubulia, Char Poyladhusar. Raghunathpur and Sauria. This length should be extended to protect the other vulnerable mouzas from bank erosion.
- According to BWDB, the height of the embankment is needed to be raised up to 11.5 m. and the width to be 14 ft. at the top and 80 ft. at the bottom level. This height and width should be maintained during construction.
- Regular monitoring and inspection should be conducted to repair any damage.

### ***Provision of Shelter***

Shelter should support community coping strategies, incorporating as much self-sufficiency and self-management into the process as possible. Well-planned shelter maximizes opportunities for the affected communities to maintain or establish livelihood support activities and for this purpose following guidelines can be maintained:

- Shelter should be established in erosion free areas as the existing shelter is anticipated to be eroded in next year and there should be adequate space in each shelter to accommodate the affected people.
- Women, children and elder people are vulnerable to attack and care should be given to ensuring adequate separation from potential threats to their personal safety.

### **Non-Structural Measures**

From the analysis it is evident that there is acute problem in non-structural measures taken by the authority. Following guidelines are provided to improve the non-structural management measure.

#### ***Creating Employment Opportunity***

Many people in the study area forced to change their occupation and most of the time they cannot occupy the job of their status. Following proposals can be helpful to create employment opportunity in the study area:

- It is needed to create employment opportunity in Teota union to make the affected people economically empowered as well as to engage the right person in right work, which is one of the preconditions of retaining social status.
- Cottage industries, handicrafts, and agro processing industries within & nearby the resettled areas can be developed.
- Government should provide the affected women some legislative priority in employment to become part of productive contributors both at household and community levels.

#### ***Resettlement of Affected People***

The displaced people in the study area lead a miserable life and all of them need permanent residence to live. Some guidelines are provided below to resettle the migrated people in planned manner:

- For documenting the issue of displaces and for their proper rehabilitation and resettlement (housing and livelihood), pilot surveys should be undertaken in erosion prone areas.
- Government can use its 'Khas' lands for accommodation of the affected people.
- Alluvion land (Payasty land) can be distributed among the owner of deluvion land (Shikosty land) as early as possible by the government.
- 'Guchchhogram' (Cluster village) project can be introduced in order to provide permanent homestead land to the landless people. From Bangladesh's experience this cluster village project is quite effective to cope with the destruction of riverbank erosion.

### *Provision of Financial Support*

After riverbank erosion most of the people in Teota union have become financially unable and they badly need financial support to improve their economic condition. Some suggestions are provided here to this issue:

- Affected people should be provided with some loans or capital by which they can create employment opportunity.
- With sufficient political will, innovative financial services can be developed to reduce the vulnerability of some of the poorest and most marginalized populations.
- Insurance schemes at soft premiums can be introduced to minimize the effects of loss of property.

### **Local Erosion Management Association (LEMA)**

The establishment of local erosion management association (LEMA) could be an effective platform for ensuring the participation of the affected people through institutional frame following the roles and responsibilities before, during and after bank erosion. A standard layout of a LEMA, which could be followed as a constitutive document, is illustrated in figure 10. Local Erosion Management Association (LEMA) must prepare a local erosion management plan which should start with adequate erosion mitigation measure by the local need.

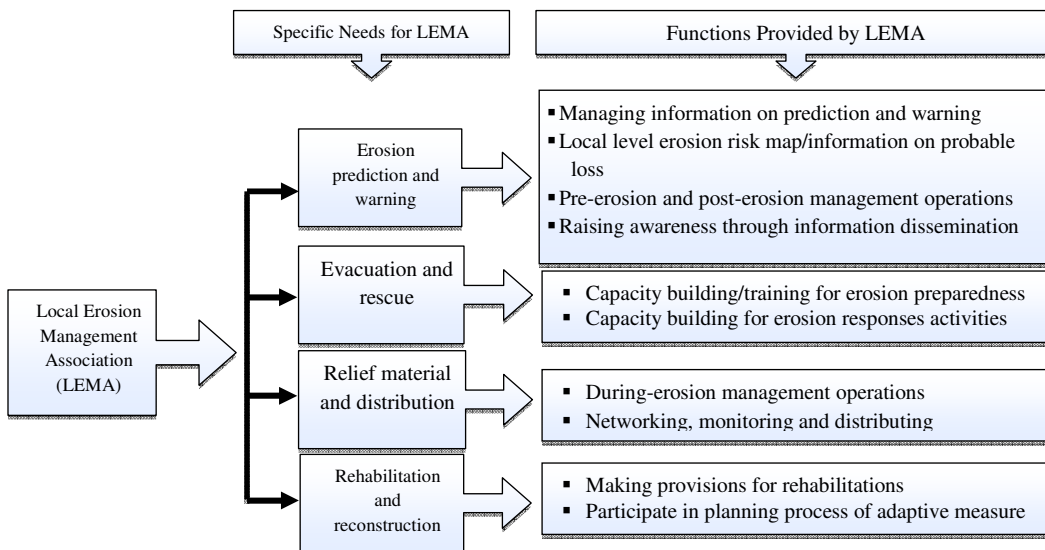


Figure 10: Functions of Local Erosion Management Association (LEMA)

### **Conclusion**

The river Jamuna has historically played a significant role in the lives and livelihood of people in Teota union in Shibalaya Upazila. The Teota union is under the threat of riverbank erosion due to the presence of Jamuna River. Riverbank erosion events are frequently occurred in this area. The different sectors and element are too much vulnerable due to bank erosion of Jamuna River.

This study has been conducted to identify the amount of eroded land of Teota Union in different time period. In the study area, river bank erosion was most devastating during 1988-1990 and 2606.22 acre land was eroded. On the other hand, the lowest amount of land (995.12 acre) was eroded during 2005-2010.

From times immemorial, near bank floodplains have been the preferred locations for human settlement, agricultural development, growth-centers and socio-economic development. Unfortunately, some of the river banks erode and cause considerable loss of lives, livelihoods, property, adverse impacts on the economy and people's safety. Therefore, living in the erosion affected vulnerable areas near river bank floodplain is a challenge.

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