

## **LIVELIHOOD IMPACT DUE TO RIVERBANK EROSION AMONG THE AFFECTED HOUSEHOLDS ALONG THE RIVER JAMUNA OF BANGLADESH**

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### **Abstract**

The present study examines the impacts of riverbank erosion on locals' lives and livelihoods in a particular area of the Jamuna River floodplain of Bangladesh. Riverbank erosion causes thousands of people to be affected, resulting in damage and loss of crops, cattle, housing structures, and farmland. It also erodes public infrastructures and communication networks significantly. This study undertakes empirical methods (including the open-ended questionnaire with a total of 155 households) to demonstrate the study's findings. The lack of adequate measures is the major factor associated with riverbank erosion in the study area. Land property loss becomes one of the major threats among the surveyed families. Some mitigation measures, such as using Geo bags and concrete blocks to protect the banks and operation of dredging machines to divert the water flow, are observed in the study area to reduce erosion. However, these measures are not bringing any effective solution to the local people's livelihoods due to the slow ongoing work processes.

*Keywords:* Riverbank erosion, livelihood, River Jamuna, Bangladesh

### **Introduction**

Bangladesh is one of the world's disaster-prone countries located downstream of the Ganges-Brahmaputra-Meghna (GBM) catchment area (Islam *et al.*, 2021). Due to the flat and low-lying deltaic topographic position, people's lives and livelihoods are susceptible to various natural hazardous conditions (Mojid, 2020). Bangladesh ranked 9<sup>th</sup> most disaster-risk-prone country among 193 countries (Atwii *et al.*, 2022), 27<sup>th</sup> among the 191 multi-hazard-prone countries in 2022 (IASC and EC 2022), and 7<sup>th</sup> among the 180 long-term disaster-affected countries of the world from 2000 to 2019 (Eckstein *et al.* 2021). Riverbank erosion is a natural phenomenon that is common to fluvial and coastal environments in many countries of the world (Das *et al.*, 2007; Pati *et al.*, 2008), having a wide range of effects on socio-economy depending on the level and capacity of disaster

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preparedness, emergency response and recovery (Mamun 1996). Among the major rivers of Bangladesh, the river Jamuna is a braided river most susceptible to bank erosion due to its sand-dominant bank material composition. In recent years, human interventions in the Jamuna River floodplain area have increased due to undertaking various projects relating to river management. The construction of the Bangabandhu Jamuna Bridge and bank protection structures at Sirajganj, Sariakandi, and Bahadurabad have influenced the changes in the river's width. These types of structures obstruct the normal flow of the water and enhance the riverbank erosion (Chowdhury 2015).

Riverbank erosion has become a significant threat to about 20 riverine districts out of 64 Bangladesh districts, destroying approximately 8700 ha of land yearly. This erosion affects around 200000 people by destroying their houses and/or agricultural land (Alam, 2017). Consequently, bank erosion causes enormous impacts on the socio-economic condition of the people of affected areas (Freihardt and Frey, 2023). Due to erosion, the displaced people become disconnected from their birthplaces, lose land income sources, and are forced to engage in new livelihood activities (Barua *et al.*, 2019). Moreover, it becomes responsible for erasing public infrastructures and communication networks. The unregulated behavior of the rivers and encroachment pattern not only interrupt the life of the floodplain population but also put pressure on the urban growth centers and surrounding environment. Thus, it is essential to reduce the vulnerability of riverbank erosion at the local level by adopting various structural measures (Shahriar, 2021; Hutton and Haque, 2003). This study investigates how riverbank erosion affects people in a particular part of the Jamuna floodplain of Bangladesh.

This study aims to examine the salient factors associated with riverbank erosion and evaluate the livelihood effect resulting from riverbank erosion among the vulnerable households in the study area.

### **Materials and Methods**

The present study was conducted by using both primary and secondary data. The relevant literature was reviewed mainly from online sources and published documents. Secondary sources of data and information were published, as well as unpublished research pertinent to the study topic. These included books, journal articles, research reports, government reports, NGO reports, conference proceedings, locally published reports, maps, and official websites.

The primary data and information were collected from selected households using semi-structured open-ended questionnaires. The respondents were selected based on a random sampling method. Face-to-face personal interviews provided the opportunity to gain in-depth information from respondents. These interviews provided information regarding the factors associated with riverbank erosion, impacts due to riverbank erosion, and the probable solution to this disaster.

*Sample Size Determination for Household Survey:* Sampling involves the selection of a subset of individuals from a larger group or population. The sampling process aims to select a proper population and gain participation to obtain accurate field-level data (Blair 2017). The respondents of the households were randomly selected from the population of the selected village of Shahzadpur Upazila in the Sirajganj district of Bangladesh. The sample size was calculated using the following formula (Yamane 1967), based on the number of households in the study villages, with a precision level of seven percent.

$$n = N / (1 + N \times e^2)$$

In the case of this study,  $n$  = sample size (number of households chosen to interview);  $N$  = total households in the study areas;  $e$  = level of error. To minimize the risk of presenting a required sample size determination, a 95 percent confidence level and a precision level of seven percent were used. Based on the population of the selected villages, the proposed sample size was 155.

### Data analysis

*Weighted Average Index:* The weighted average index (WAI) was the main statistical tool used, following the scaling technique (Khongsatjaviwat and Routray, 2015). The WAI identified the degree of importance of each indicator; it is considered a quick technique to assess the differences in respondent perceptions (Pakzad *et al.*, 2016). The WAI for each indicator was calculated by adding the response numbers, multiplying them by a weighted value between 0 and 1, and dividing the sum by the number of total responses (Pakzad *et al.*, 2016). This gave an overall weighted average score for each particular indicator. The formula for the calculation of WAI is as follows (Ha and Thang, 2017):

$$WAI = \sum S_i F_i / N$$

Where, WAI is the weighted average index ( $0 \leq WAI \leq 1$ ),  $S_i$  is the scale value assigned at its priority,  $F_i$  is the frequency of household respondents, and  $N$  is the total number of observations. These indices were designed based on social scale; the value of each index was kept from 0 to 1. The type of each index is described as follows.

### *Perception Index*

A perception index was applied to evaluate the level of heads of household perceptions of climate change governance practices in the study sites. It includes five levels (Table 1).

**Table 1: Perception index levels.**

Categories	Very good	Good	Medium	Poor	Very poor
Scale	1	0.75	0.5	0.25	0

### *Satisfaction Index*

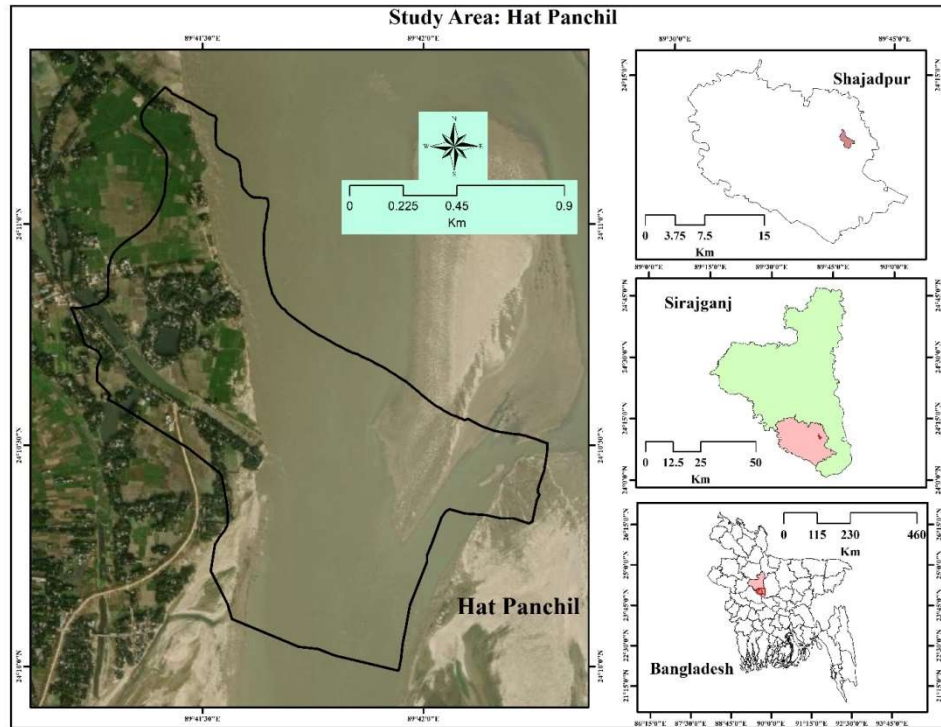
The formula for calculating the satisfaction index is as follows:

$$WAI = (1.00 \cdot f_1 + 0.75 \cdot f_2 + 0.50 \cdot f_3 + 0.25 \cdot f_4 + 0 \cdot f_5) / N$$

WAI is the weighted average index ( $0 \leq WAI \leq 1$ );  $f_1$  is the frequency of the first scale choice;  $f_2$  is the frequency of second scale choice;  $f_3$  is the frequency of third scale choice;  $f_4$  is the frequency of fourth scale choice;  $f_5$  is the frequency of fifth scale choice. The overall assessment (OA) is calculated from the average WAI value (Nooriafshar *et al.*, 2004).

*Quantitative Data Analysis:* IBM SPSS Statistics 24 software was used to analyze the quantitative data collected through household surveys to evaluate riverbank erosion issues in the study area. Moreover, ArcGis 10.8 Software was used to develop the study area map, and Landsat 8 image Source USGS Earth Explorer was applied to get the result.

The present study was conducted in Hat Panchil village (Fig. 1) of Kojjuri Union of Shahjadpur Upazila under the Sirajganj district of Bangladesh. The study village has a history of facing bank erosion, and the process is still unabated, as appears on the map.



**Fig. 1.** The location of Hat Panchil and the surrounding landscape. Note that the river Jamuna has devoured a large chunk of the village.

## Results and Discussion

The people of the present study area have suffered a lot due to riverbank erosion for the last few years. The present study identified the factors associated with riverbank erosion and inventoried the effect of erosion on local people's livelihood based on the field survey conducted in 2023. The details of the surveyed respondents are placed in Table 2.

### Factors Associate with the Riverbank Erosion

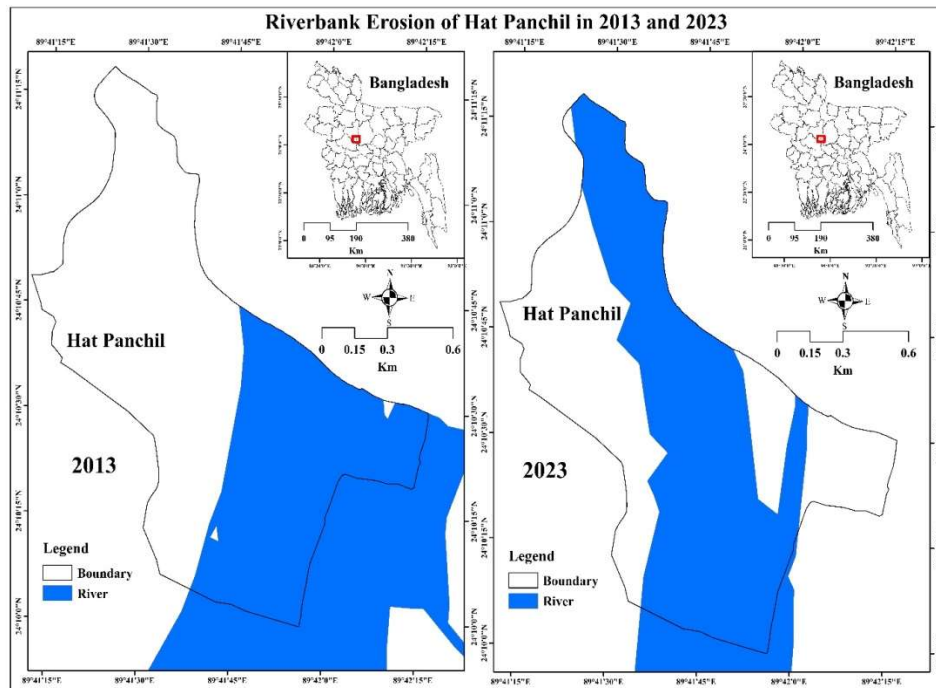
Sirajganj district is considered one of the most erosion-prone areas in Bangladesh. According to the Center for Environmental and Geographic Information Services (CEGIS), 2009, the land loss was reported to be 622.2 ha/year. The location of the study village is close to the Jamuna River. When the riverbank erosion begins, this study area

becomes vulnerable to erosion. It has been observed that a large portion of the village eroded in the last 10 years between 2013 and 2023. In 2013, only a portion of the town was eroded; later, a large portion disappeared by 2023 (Fig. 2). The rest of the village might go to 'Nadi Shikhasti' (river erosion) unless adequate measures are taken immediately.

**Table 2. Demographic Characteristics of the Surveyed Households at the study village, Hat Panchil.**

Factors	Classes	Percentage
Gender	Male	87
	Female	13
Age range	18-24	2
	25-34	25
	35-44	31
	45-54	20
	55-64	14
	65+	8
Level of education	Illiterate	10
	Primary	55
	Secondary	30
	Technical/vocational	1
	College/university	4
Occupation	Farming	55
	Fishing	8
	Business	17
	Services	7
	Housekeeping	13
House type	Pucca	2
	Semi-pucca	16
	Kutchha	82

*Source:* Field Survey, 2023



**Fig. 2. Riverbank erosion of Hat Panchil village in 2013 and 2023. Note, a large part of the land has gone under 'Nadi Shikhashi' along the north-south axis, and two newly accreted land masses emerged as 'Nadi Payasti'- char land between 2013 and 2023.**

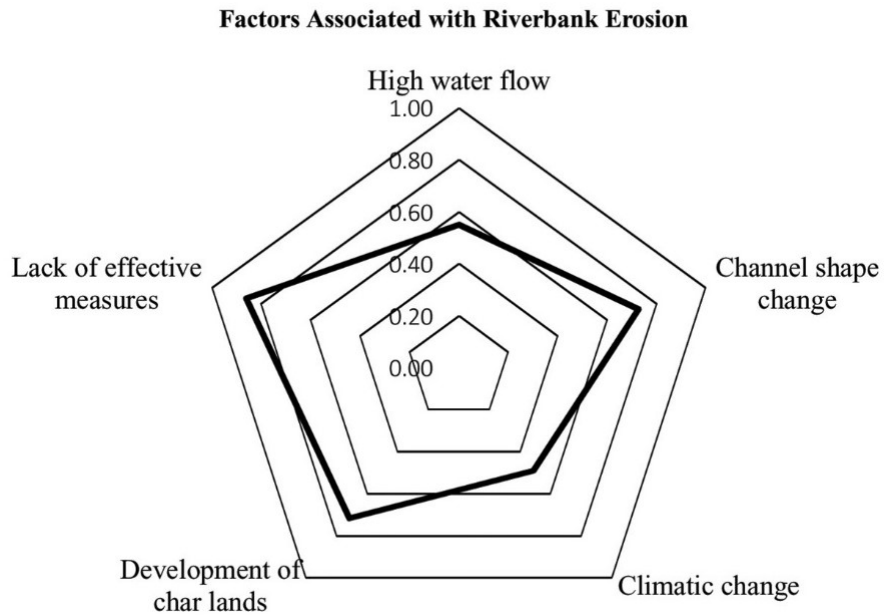
The Jamuna River exhibits intense bank erosion of the char land, its bank composition with sandy materials, impart due to the braided nature, heavy monsoonal rainfall in upstream areas, causes variable water flow with characteristics seasonality in water levels in the river.

The river flow decreases downstream when the water level declines in the dry season. As a result, the upstream part of the river becomes dry quickly, and erosion occurs more during that time. The riverbank erosion issue of the present study area has appeared in different leading newspapers and television channels in the past (ACAPS and Start Network 2019).

**Table 3. Factors associated with riverbank erosion in the study area.**

Factors	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	N = 155	
						WAI	OA
High water flow	26	20	18	25	11	0.55	M
Channel shape change	5	10	28	30	27	0.73	M
Climate change	30	28	22	8	12	0.49	M
Development of char lands	12	17	14	15	42	0.72	M
Lack of effective measures	0	6	10	32	52	0.86	H

Note: Strongly disagree (SD): 0.01–0.2; Disagree (D): 0.21–0.4; Neutral (N): 0.41–0.6; Agree (A): 0.61–0.8; Strongly agree (SA): 0.81–1; WAI: weighted average index; OA: overall assessment, M=Medium, H=High.



Source: Field Survey, 2023

**Fig. 3. Factors associated with riverbank erosion in the study village.**



Riverbank erosion became a common scenario in the study area. People are suffering a lot due to the unpredictable nature of bank erosion. Most respondents (WAI=0.86) mentioned that inadequate measures are causing substantial riverbank erosion in this area (Fig. 3). Channel shape and development of chars within the river channel were also responsible for erosion in the study area, and the WAI values were 0.73 and 0.72, respectively. Few respondents focused on the climatic change issue linked to riverbank erosion, and the WAI value was 0.49 (Table 3).

### Impacts of Riverbank Erosion

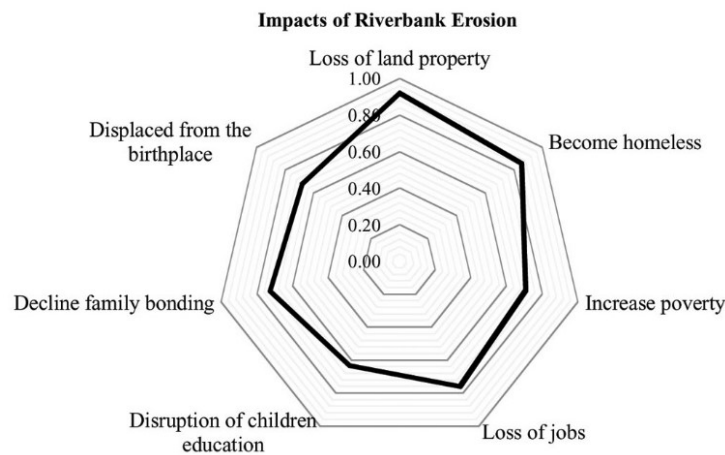
The study village's people have been suffering from riverbank erosion for a long time. The population's economic loss and social vulnerability due to bank erosion have consistently increased in recent years. The effect of land loss involves the loss of homestead land, housing structures, crops, cattle, trees, and household utensils (Table 4). Loss of homesteads forces people to move to new places without any alternative options and puts them in disastrous situations.

**Table 4. Relative Grading of Impacts of Riverbank Erosion by Respondents as Reflected in Survey.**

Factors	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	N = 155	OA
							WAI
Loss of land property	82	10	4	2	2	0.92	VH
Become homeless	69	18	5	3	5	0.86	VH
Increase poverty	52	20	6	4	6	0.71	H
Loss of jobs	55	23	5	5	12	0.76	H
Disruption of children's education	32	27	10	24	7	0.86	VH
Decline family bonding	55	14	9	10	12	0.73	H
Displace from the birthplace	45	14	19	12	10	0.68	M

Note: Strongly disagree (SD): 0.01–0.2; Disagree (D): 0.21–0.4; Neutral (N): 0.41–0.6; Agree (A): 0.61–0.8; Strongly agree (SA): 0.81–1; WAI: weighted average index; OA: overall assessment, VH=Very High, H=High, M=Medium.

From the field survey, it has been observed that the respondents focused more on land property loss (WAI=0.92). People in the surveyed area reported becoming homeless due to riverbank erosion (WAI=0.86). The WAI values for loss of job, disruption of children's education, and decline in family bonding were 0.76, 0.63, and 0.73, respectively (Fig. 4). The effect of riverbank erosion increased the poverty of the affected families, and the WAI value was 0.71. Many people were displaced from their birthplace due to riverbank erosion in the study area, and the WAI value was 0.63. So, riverbank erosion threatens the surveyed households' lives and livelihoods in the study area.



*Source: Field Survey, 2023*

**Fig. 4. Impacts of riverbank erosion in the study village**

#### **Measures Undertaken to Reduce the Riverbank Erosion**

To cope with the bank erosion process, various mitigation measures have been undertaken in the study area partly by the Water Development Board (BWDB). Geo bags covered some portions of the embankment in the study area to protect the area from erosion. However, in many bank sections, such measures have collapsed and are yet to be repaired. One of the structural measures to protect the river's shoreline is making concrete blocks. Many workers are engaged in making the blocks that will be placed on the vulnerable river bank to protect the area from erosion. The local people expect a long-lasting measure to cope effectively with the erosion problem. BWDB is dredging at the opposite side of the study village to develop a secondary channel that would support draining out extra water differently and save the area from erosion. Moreover, the

dredged sands are thrown into the riverbank erosion-prone areas for sedimentation or accretion of sands in the vulnerable portions.

The erosion-affected people of the area try to return to everyday life later, but it is a difficult task for them. The affected people did not receive the expected support from the government departments or others, so they suffered. Local print and social media provide good coverage of the situation. The relevant government departments have taken initiatives to protect the area from riverbank erosion. To supplement the government effort, the following points to be under consideration:

- Timely completion of the project: The ongoing projects to control the riverbank erosion of the study area should be finished on time so that vulnerable people can be saved from the erosion problem. The local people expect these projects to be completed with due diligence.
- Provision of financial support: The affected people need some financial support to restart their livelihood-related activities, and they can cultivate the available lands.
- Rehabilitation support for housing: Many people already lost their lands and homesteads due to erosion. These homeless people took shelter on the government embankment or other rented lands. So, they need to get land to rebuild their homes.
- Enlisting vulnerable families: The vulnerable families should be enlisted and provided the required support to improve their living conditions.
- Coordination with local NGOs: Various government departments and NGOs work in this area to support the people. Coordination among these organizations is essential to make their efforts more effective.

### **Conclusion**

Riverbank erosion is one of the major natural events in Bangladesh, as it is responsible for thousands of people becoming homeless and landless every year. Jamuna River plays a significant role in affecting people's lives and livelihoods. The present study area is one of the worst-hit areas of riverbank erosion, and erosion is affecting the overall condition of the surveyed area significantly. The study revealed that factors such as high water flow, lack of effective measures, development of char lands, and channel shape change are the main reasons for river erosion in the study area. Government departments are undertaking various measures to reduce the erosion of the study area, and these measures are underway. However, people are passing difficult times due to the enormous effects on their lives and livelihoods. Effective measures relating to erosion can bring significant changes in people's livelihoods and will support rehabilitating the affected communities.

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