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Article

Riverbank Erosion and Its Socio-Economic and Mental Health Impacts in Coastal Bangladesh

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How To Cite: Roy, B.; Khatun, M.M.; Khan, M.A.-A.; et al. Riverbank Erosion and Its Socio-Economic and Mental Health Impacts in Coastal Bangladesh. *Journal of Hazards, Risk and Resilience* **2025**, *1*(1), 2.

Received: 9 October 2025
Revised: 20 November 2025
Accepted: 25 November 2025
Published: 3 December 2025

Abstract: Riverbank erosion poses a serious threat in coastal areas, particularly in Bangladesh, with significant socioeconomic and mental health consequences. This study investigates the factors contributing to riverbank erosion, evaluates its socioeconomic and environmental impacts, and explores its implications for mental health. A cross-sectional survey was conducted among 230 participants in the Patuakhali district using a closed questionnaire, observation, and semi-structured interviews. Socioeconomic and mental health variables were analyzed using the Chi-square test, while outcome analysis was conducted through logistic regression to calculate adjusted odds ratios (OR) and 95% confidence intervals (CI). The findings indicate that 67% of respondents lost their homes, 97.4% lost livestock, and 86.1% suffered crop damage. In terms of mental health, 49.1% reported stress, 37% anxiety, and 31.3% depression. Logistic regression results show that displaced individuals experienced significantly higher odds of stress (OR = 2.175), anxiety (OR = 2.442), and depression (OR = 1.768), all with $p < 0.05$. Although low income did not show a significant relationship ($p = 0.353$), those residing in temporary housing were found to be more exposed and vulnerable ($p = 0.003$). This study recommendation includes erosion control, reduction environmental impacts like land loss, salinity intrusion, displacement patterns) and a specific set of policy recommendations (strengthening embankments, rehabilitation programs, early-warning systems, and mental-health support services). The findings provide valuable insights for policymakers, planners, and disaster risk reduction authorities to develop action-oriented frameworks for mitigating the impacts of riverbank erosion in vulnerable coastal communities.

Keywords: riverbank erosion; socio-economic impact; mental health; coastal Bangladesh; environmental hazards

1. Introduction

Riverbank erosion is the slow depletion of soil from river banks, accredited to the flow of water, and is often caused by anthropogenic and environmental components. In Bangladesh, the frequency and intensity of riverbank erosion are concerning [1]. Riverbank erosion impacts more than 17 regions in Bangladesh, mostly the people who live along the Jamuna, Ganges, Padma, Lower Meghna, Arial Khan, and Teesta rivers, destroying their crops, livestock, and other resources. Rapid discharges and gradual erosion present severe problems for Patuakhali, a coastal area, affecting both the local the people and the environment. Erosion of riverbanks affect the reduced and marginalized; 35 out of 462 upazila have serious erosion. Even with government initiatives, such as safety building

construction, this problem continues for people living in floodplains [2–4]. Remal the cyclone broke the bank again by eroding approximately 772 km of roads in eight Patuakhali upazila, in addition to Riverbank erosion which displaced nearly 200,000 people every year [1]. Erosion fuels poverty, unemployment, hunger, and even mental suffering. In Bangladesh, the most climate exposed nation, it is estimated that by the year 2050, one in seven people will be forced to migrate due to climate change issues [5]. It is estimated that about 5% of the total floodplain of Bangladesh is directly affected by erosion According to recent estimations [6], riverbank erosion erodes an average of 100 km^2 of land every year. Over the next fifty years, riverbank erosion is expected to accelerate by nine percent annually [7].

The erosion of riverbanks remains a substantial and poorly controlled damage-causing challenge of nature in Bangladesh, resulting from fluvial washing and bank erosion, especially at the later adoption of the Ganges, Brahmaputra, and Meghna (GBM) systems [8,9]. This erosion type occurs due to inadequate balance of sediment load within the transport medium (river) and movement of river channels in other directions [10], which causes loss of lands in a significant amount, mostly the fertile and agricultural fields [11,12]. In the Jamuna River the rate of erosion fluctuated from 2300 hectares per year in the 1990s to approximately 1200 hectares per year in the 2000s, having an estimated total of 15,196 hectares eroded from 2015 to 2019. Interestingly, in the year 2019 alone, 21 settlements and approximately 40 miles of Upazila roads were reported to be eroded [13]. Homeless coastal and deltaic erosion coupled with dwindling riverbed flows turned into a significant catastrophic issue [14–16]. The economic consequences of riverbank erosion are profound, including displacement of people, damage and loss of public physical structures and facilities, cessation or reduction in agricultural land and production output [7,17,18].

In Patuakhali, Bangladesh, this study employed both qualitative and quantitative techniques and methods to assess the effects of riverbank erosion. Focus Group Discussion (FGD), structured household surveys and key informant interview (KII) were employed to collect information regarding the socioeconomic factors, the impacts of erosion, and the understanding to cope with it. To evaluate the impact of stress, anxiety, or depression on those impacted, DASS 21 was incorporated into the study plan. For the mapping and visualization of affected areas, Geographic Information Systems (GIS) were utilized to analyze the spatial erosion patterns [3,19]. Statistical analyses were performed to find relationships between categorical variables using Chi-square tests, while logistic regression analysis was used to evaluate the likelihood of poor mental health outcomes in relation to the erosion exposure. Data processing and analysis was done using SPSS and MS Excel, socio economic and psychological consequences due to erosion it's all in the consequences [1,2].

This important research, which has been going on for a while, is primarily concerned with stopping erosion along riverbanks. To this end, a variety of structural techniques have been used, such as the construction of robust embankments, the installation of robust hard points, the strategic placement of groins, and the use of inventive bundle-like structures. These techniques combined with the tradition of riverbank preservation offer important insights into the intricate relationships between people and the natural world [20]. These strategies include planting plants on riverbanks and embankments, such as local morning glory and special grasses, throwing stones, and teaching newly emerged chars to control river flow [21]. In the past, researchers focused on the geographical, economic, environmental, sociodemographic, psychological, and political features of riverbank erosion [18,22–27]. Further investigations have been done on the impact of socioeconomics, livelihood, agricultural damages, and other vulnerabilities due to erosion [21,28–35].

This study attempts to address this deficiency by focusing on socio-economic conditions, consequences of riverbank erosion, and its mental health impact in the coastal regions. The objectives are: (i) examine the reasons for river erosion in coastal region, (ii) determine the impact, and (iii) assess the mental health impact in the region. Although some attempts have been made to study the bank erosion phenomena in Bangladesh [36,37], these studies have rarely concentrated on its effects and ways to address it [38]. The comprehensive policies that all together address erosion control and mental health services, community involvement, and climate change mitigation are necessary in future studies [4,5].

2. Materials and Methods

2.1. Study Area

The Patuakhali District of the Barisal Division, located in the southern region of Bangladesh, contains Bauphal Upazila (Figure 1). It is one of the most certainly destroyed coastal Upazila of Bangladesh with an area of 487.1 km^2. The geographical position is latitude 22°25′45.12″ N and longitude 90°30′50.04″ E in Bauphal upazila at Patuakhali district [39]. The western side it is bounded by Patuakhali Sadar and Bakerganj and towards the east is Bhola sadar, Burhanuddin and Lalmohan upazilas, to the north Bakerganj and Bhola Sadar upazilas, while Galachipa and Dasmina upazilas are situated towards the southern direction. Bauphal contains 135 mouzas,

147 villages, 1 municipality, 14 Unions and a total population of 304,951 [39]. Mean annual temperature has a minimum of 12.1 °C and a maximum of 33.3 °C with an annual average rainfall of 25.06 mm.

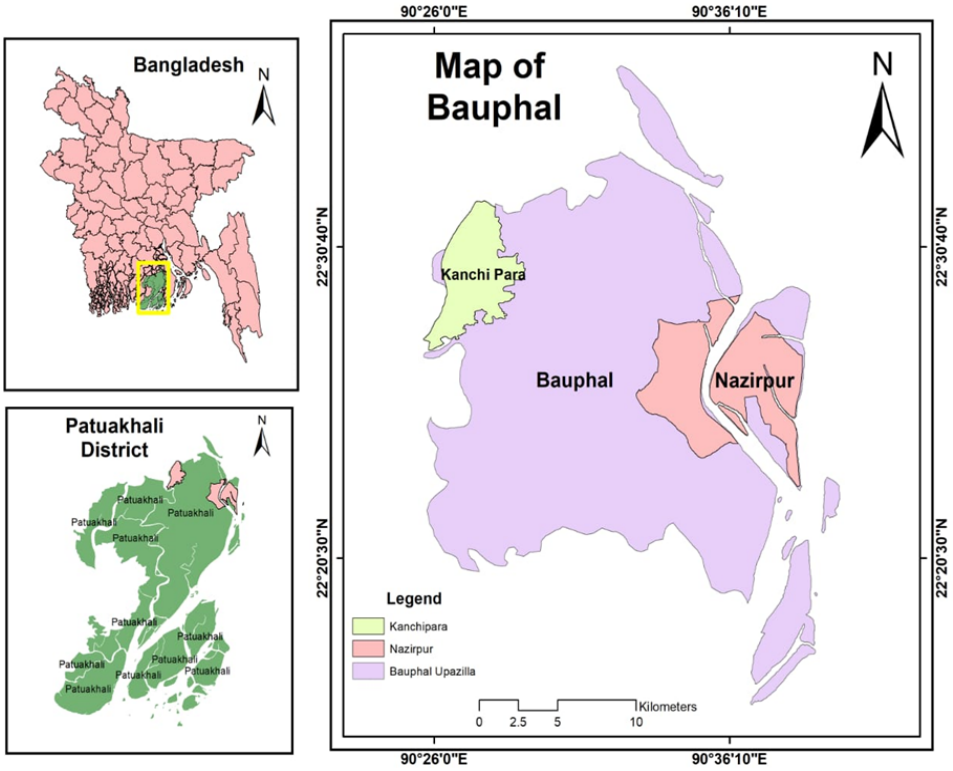

Figure 1. Map represents the study area Patuakhali District of the Barisal Division, located in the southern region of Bangladesh, contains Bauphal Upazila.

2.2. Sampling Method

This study used mixed methods, both qualitative and quantitative techniques [40]. Initially, we designed a questionnaire on riverbank erosion, socioeconomic aspects, livelihoods, mental health, and general information of the respondents of the study. We also added the "Depression Anxiety Stress Scales (DASS-21)" which is highly reliable and validated. Subsequently, from December 2022 onwards, we conducted cross-sectional surveys of households in the selected research areas using a questionnaire. In the beginning, we purposively chose two districts of rivers erosion, Patuakhali District to be our study area. Afterward, we purposively selected two Unions (Najirpur and Kachipara) from Baufol subdistrict. Then, by cluster sampling, we randomly selected 7 villages (Dhandi, Nimdi, Baherchor, Karkhana, West Karkhana, Singrakathi, Gopalia) from Najirpur and Kachipara Union. The sample size was calculated according to the Formula (1) for simple random sampling design as [26,41,42].

$$n = \frac{Z^2 P(1-P)}{d^2} \quad (1)$$

where n = sample size, Z = 1.96 (upper point of the 95% confidence level), P = expected prevalence or proportion (P if 20%, proportion of one 0.2, and d = precision (as a proportion of one; 5% becomes d = 0.05). Referring to Hossain et al., [26] considering P = 0.36, d = 0.05, with design effects of 1.5 along with an assumed 10% non-response rate, it was estimated that a sample size of 590 would be sufficient for statistical analysis. Thus, sample size is calculated in this method with the aid of the Formula (2) that was procured from [4],

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} \quad (2)$$

where, n_0 = sample size for infinitive population, N = population size. Lastly, the households from each of the chosen areas were selected with probability proportional to size (PPS) sampling. A sample of 230 respondents was achieved in Patuakhali District. We conducted an interview to the head of each respondent and in case of the head's absence, we conducted an interview to the proxy of the respondent.

2.3. Data Collection and Analysis

The study data was collated through a combination of qualitative and quantitative methods. These included key informant interviews (KII) focus group discussions and household survey questionnaires. There was a semi-structured household questionnaire survey where the face-to-face method was used from December 2022 to January 2023. The technique was applied top down to determine real riverbank situations and local management practices in the area and the participants were selected randomly. A field survey was conducted alongside talking to the local people before the questionnaire sheet was designed. The questions were arranged chronologically to address the subject of how various elements associated with social vulnerabilities and riverbank erosion interacted. The survey was broken up into four sections: (1) Recognition (2) Danger and consequences of erosion along riverbanks (3) The susceptibility of livelihoods to degradation (4) Mental health conditions. The questions which were asked to the respondents were translated into the local language and all the respondents were able to comprehend the meaning of the question. Information related to riverbank erosion and its impacts on livelihood, infrastructure, farming activity, etc. was gathered during the questionnaire survey. Interviews are conducted with local businessmen, farmers, fishermen, day laborers, housewives, and some other unspecified people. To understand the erosion and control of research issues, fieldwork is done.

Applying Parson's chi-square test, the associations between dependent and independent variables were analyzed. The effects of river erosion and other risk factors were examined by calculating the odds ratio (OR) and the 95% confidence interval (CI) using binary logistic regression analysis. In order to evaluate and quantify their impacts on mental health issues, the significant factors identified by the chi-square test were also included in the logistic regression analysis. To resolve the problem of multi-collinearity, we took out some of those significant variables from the logistic regression models. Given that our primary risk factor of interest, exposure status, was operationalized on the basis of the loss associated risk factors (changing residence, losing a pond, losing a garden, losing livestock, losing a house, losing agricultural land, and losing relatives), these factors were not included in the main logistic regression model. Resulting the guidelines for the research, secondary data was obtained from various sources. Different types of information included, but was not limited to, population, historic floods and river erosion, and spatial distribution of the respondents. Furthermore, supporting data and relevant documents were gathered from the internet, previously conducted studies, and survey data. These findings validate the questionnaire data. Statistical analyses such as descriptive analysis of community response, riverbank erosion threat, the erosion vulnerability livelihood, mental health condition, community's feedback, as well as Chi square, and logistic regression analysis were done to evaluate the possible association among different factors of the study. All statistical analyses were performed with the help of SPSS V29.0, MS Excel, ArcGIS 10.4.

3. Results & Discussion

3.1. Demographic Characteristics of the Respondents

The study respondents' demographic and socioeconomic characteristics were described by the following variables: gender, family size, age group, occupation, education level, income source, income level, housing kinds, and land ownership. These variables are shown in (Table 1). The data indicates that the respondents consisted of 66.5% male and 33.5% female. The respondents were divided into three categories in terms of the number of members in their families as provided in Table 1. 72.2% of the respondents are from families containing 4 to 6 members, which forms the great bulk of respondents. Happy families, which are families having less than 4 members, constitute about one in ten families (i.e., 10.6%). On the other end, there are 17% of families who seem to be at risk because they have 7 to 10 members. This corresponds with the national mean family size of 3 to 5, which is half of the population, 50% [43]. Only 2.2% of the total respondents, 200 in the sample, are under 20 years of age. A small group, 6.5%, belong to the age bracket of 20–30 years, while 30.4% are in the 41–50 years range. The age interval 31–40 years has the maximum respondents which is 39.6%. The rest 21.3% are above 50 years of age. It was shown, the younger to middle-aged respondents are predominant in the coastal regions of Bangladesh [44]. Over half (51.3%) of the respondents have a primary education. Nearly one-fifth (19.6%) have a secondary education, followed by 14.3% with a higher secondary education. The remaining 14.8% are illiterate. According to Kaiser, (2023) also found similar types of literacy rates in their research Only 22.6% support farming and 35.2% support other businesses in this area, whilst somewhat over half (42.2%) of families participate in non-agricultural ventures. Most of the respondents' incomes were rated in the following order from high to low: more than 100,000 takas (24.8%), 7000–10,000 takas (24.3%), 5000–7000 takas (26.1%), and 5000–7000 takas (24.8%), which was the least popular choice.

According [44], found that most of the residents are employed in farming, fishing, day labor, and similar occupations. Since these are typically low-paying jobs, it's likely difficult to achieve a comfortable standard of living. In line with this finding, the survey results showed very low incomes. The housing data also reflects this, with 87% of the sampled homes being classified as "katcha" (impermanent), 12.6% as "semi-katcha" (semi-permanent), and only 0.4% as "pucca" (permanent). According to Majumdar, (2018) also found the similar types of house in their research. This pattern likely stems from the residents' limited financial resources and the threat posed by floods and bank erosion. "Katcha" homes, which are impermanent structures, are often built alongside or near riverbanks due to their vulnerability. In terms of land ownership, the survey results showed a varied distribution. The largest group (57.4%) owned less than 1 bigha of land. Smaller proportions owned between 1 and 3 bigha (19.1%), 4 to 6 bigha (11.3%), and 7 to 12 bigha (2.2%). The remaining 10% of respondents reported owning no land. According to [41] also found similar land ownership in their research (Table 1).

Table 1. Demographic and socio-economic status of respondents.

Characteristics	Categories	Respondents	
		N	**(%)**
Gender	Male	153	66.5
	Female	77	33.5
Family size	<4	25	10.9
	4 to 6	166	72.2
	7 to 10	39	17
Age group	<20 Year	5	2.2
	20 to 30 Year	15	6.5
	31 to 40 Year	91	39.6
	41 to 50 Year	70	30.4
	Above 50 Year	49	21.3
Occupation	Farmer	43	18.7
	Business	33	14.3
	Service	19	8.3
	Day labour	42	18.3
	Others	93	40.4
Education level	Illiterate	34	14.8
	Primary	118	51.3
	Secondary	45	19.6
	Higher secondary	33	14.3
Income source	Farming	52	22.6
	Non-farming	97	42.2
	Others	81	35.2
Income level (Monthly)	5000 tk	60	26.1
	5000 to 7000 tk	57	24.8
	7000 to 10,000 tk	56	24.3
	>10,000 tk	57	24.8
House types	Katcha	200	87
	Pacca	1	0.4
	Semi-pacca	29	12.6
Land Ownership	No	23	10
	1 to 3 Bigha	44	19.1
	4 to 6 Bigha	26	11.3
	7 to 12 Bigha	5	2.2
	Above	132	57.4

3.2. Impacts of Riverbank Erosion in Coastal Area

From Table 2, the maximum number of respondents (97.4%) said that they had expended most of the impact on livestock, 86.1% of respondents said that had expended loss of agriculture, 67.8% change their living place, 36.5% loss of pond, 20.9% loss of garden. The rest of the people said that no effect on erosion. 86.1% of people do not lose any relatives and 13.9% lose relatives. According to Das & Samanta, [43] also found that the floods and river-bank erosion in the area are quite severe, and these hazards have a wide range of negative impacts on people who reside there. The inhabitants are constantly under the threat of losing their agricultural lands, horticulture, farmlands, their lives, houses, and livestock.

Table 2. River erosion-related factors.

Characteristics	Categories	Respondents	
		N	(%)
Change your living place	Yes	156	67.8
	No	74	32.2
Loss of agriculture	Yes	198	86.1
	No	32	13.9
Loss of house	Yes	154	67
	No	76	33
Loss of pond	Yes	84	36.5
	No	146	63.5
Loss of garden	Yes	48	20.9
	No	182	79.1
Lose any relatives	Yes	32	13.9
	No	198	86.1
Impact on livestock	Yes	224	97.4
	No	6	2.6

3.3. Causes of River Erosion in Coastal Area

Rivers erosion for natural reasons, according to about 50.4% of respondents, over 15% (15.7%) attributed the erosion to fast-moving launch traffic, while a smaller percentage (around 13%) cited sand extraction from the riverbed. Other contributing factors, mentioned by progressively fewer respondents, include erosion caused by streams and trawlers (10.4%), soil runoff (7%), and flooding (2.6%) (Figure 2). The remaining respondents mentioned a reduced river width as a contributing factor [2] found that heavy rainfall in upstream, heavy siltation in the river bed, along with sudden excessive rainfall in the study area are the prime causes of severe riverbank erosion.

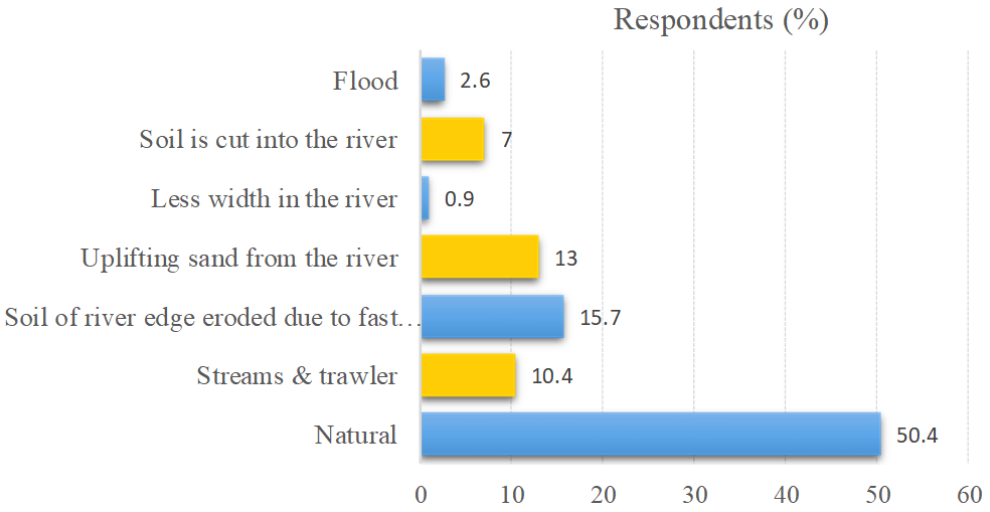

Figure 2. Main causes of river erosion by perception of respondents.

3.4. Impacts of Riverbank Erosion on Livelihoods in Coastal Area

In the study for human assets, Food insecurity, and malnutrition, 24% of the respondents perceived it as having low impacts, while 29% considered it moderate and 47% severe (Table 3). The majority (42%) of the households have faced moderate migration impacts due to erosion while 32% have low, and 26% have severe. Livelihood pattern change, 61% of respondents perceived low impact, while 34% have moderate and 5% have severe. Unemployment caused river erosion 52% have low impact, 42% have moderate and 6% have severe. The majority (43%) of respondents have faced moderate heath impacts, 34% have low impact and 24% have severe due to erosion. 48% of respondents perceived as having low impacts of the food crisis, 37% have moderate and 16% have severe impacts due to river erosion. Latrine facilities caused river erosion 44% have a severe impact, 36% have a moderate and 20% have a low (Table 3). The riverbank erosion is the most susceptible natural hazard that contributes to the loss of land and livelihood resources resulting in increased vulnerability to food insecurity malnutrition, and poverty [4]. The main cause of the mass continuous movement of people is riverbank erosion.

Furthermore, there are severe and often significant socioeconomic and demographic issues regarding erosion in this area. Due to a lack of funds and destitution. Roughly 50% of all homeless persons are unable to restore their homes due to erosion.

Table 3. Rank the impact of river erosion by perception of respondents (n = 230).

Assets Types	Impact/Threats	Levels of Impact and Threat						Score	Rank
		Low		Moderate		Severe			
Human Assets	Food insecurity and malnutrition	56	(24%)	66	(29%)	108	(47%)	512	9
	Migration	74	(32%)	96	(42%)	60	(26%)	446	12
	Livelihood pattern change	140	(61%)	78	(34%)	12	(5%)	332	28
	Unemployment	120	(52%)	96	(42%)	14	(6%)	354	25
	Health/Disease	78	(34%)	98	(43%)	54	(24%)	436	14
	Food crisis	110	(48%)	84	(37%)	36	(16%)	386	20
	Latrine facility	46	(20%)	82	(36%)	102	(44%)	516	7
Physical Assets	Loss of homestead property	30	(13%)	64	(28%)	136	(59%)	566	5
	Roads and Embankments damaged	104	(45%)	48	(21%)	78	(34%)	434	15
	Loss of market place	180	(78%)	42	(18%)	8	(4%)	288	29
	Electricity/Transport	84	(37%)	140	(61%)	6	(3%)	382	21
	Loss of life	206	(90%)	14	(6%)	10	(4%)	264	33
	Loss of institutions (school, mosque, etc.)	12	(5%)	74	(32%)	144	(63%)	592	2
Agriculture Assets	Damages of agricultural crops field	6	(3%)	42	(18%)	182	(79%)	636	1
	Depletion of agricultural land into river	10	(4%)	82	(36%)	138	(60%)	588	4
	Change of cropland pattern	138	(60%)	54	(24%)	38	(17%)	360	24
	Loss of soil fertility	138	(60%)	70	(30%)	22	(10%)	344	26
	Damage of crops	24	(10%)	110	(48%)	96	(42%)	532	6
	Loss of production	44	(19%)	120	(52%)	66	(29%)	482	11
Economic Assets	Market access	198	(86%)	26	(11%)	6	(3%)	268	32
	Income from agriculture	34	(15%)	114	(50%)	82	(36%)	508	10
	Savings	182	(79%)	42	(18%)	6	(3%)	284	30
	Risk of poverty	78	(34%)	90	(39%)	62	(27%)	444	13
	Access to landholdings	68	(30%)	156	(68%)	6	(3%)	398	18
	Damage status of crops, livestock and assets	26	(11%)	46	(20%)	158	(69%)	592	2
Social Assets	Displacement	26	(11%)	122	(53%)	82	(36%)	516	7
	Educational	64	(28%)	148	(64%)	18	(8%)	414	17
	Residential facility	128	(56%)	96	(42%)	6	(3%)	338	27
	Medical facilities	118	(51%)	90	(39%)	22	(10%)	364	23
	Organizational support	186	(81%)	42	(18%)	2	(1%)	276	31
	Farmers to farmers cooperation	128	(56%)	46	(20%)	56	(24%)	388	19
	Occupational shift	88	(38%)	136	(59%)	6	(3%)	378	22
	Social instabilities	64	(28%)	132	(57%)	34	(15%)	430	16

For physical assets, most of the people 59% of the respondents perceived that erosion has severely impacted homestead property, 28% had a moderate, and 13% had a low impact. The majority of the respondents (45%) have perceived erosion as low low-damaged road and embankment, 34% have severe, and 21% perceived moderate impact. The marketplace and loss of life low, moderate, and severe perceived impacts ratios were 78%, 18%, and 4% and 90%, 6%, and 4%. The electricity/transport and institutions' low, moderate, and severe perceived impacts were 37%, 61%, 3%, 5%, 32%, and 63% (Table 3). Riverbank erosion continues to destroy physical structures while it progressively eliminates the financial stability of local residents. This study, shows that physical and agricultural assets face unequal erosion effects which create rising risks for people to sustain their livelihoods [4].

For agriculture assets, 79% of respondents have perceived that erosion has severely impacted agricultural crop fields, while 18% have a moderate and the rest of 3% have low impacts. The majority (60%) of respondents have a severely impact on the depletion of agricultural land into rivers, 36% have a moderate and 4% have a low impact. Some agriculture assets features are represented in Table 3. Agricultural land is enormously eroded and

depleted into the river by erosion, and also the crop fields are damaged, forcing farmers to change their cropland patterns [4]. The impact of river erosion on social assets and their impact/threat and levels are shown in Table 3. Therefore, economic assets, a large majority (69%) of respondents reported that erosion has significantly impacted livestock. Around 20% indicated a moderate impact, and 11% had a low impact. The economic assets are represented in Table 3. One of the most dangerous risks that fundamentally disturbs Bangladesh's economy is riverbank erosion [4].

3.5. Mental Health Problem in Coastal Area

The study shows various mental health conditions which emerge from river erosion effects on people. The research shows that erosion causes major stress because 52.6% of participants stated they experienced stress from it. More than 47.4% of participants in the study showed no symptoms of stress. 41.7% of respondents reported depression because of erosion but 58.3% did not experience depression. Nearly half of the participants (48.7%) experienced anxiety but 51.1% did not report any anxiety as shown in Figure 3. This research shows the severe impact on mental health. The riverbank erosion leads to anxiety and stress and depression in the majority of respondents [7].

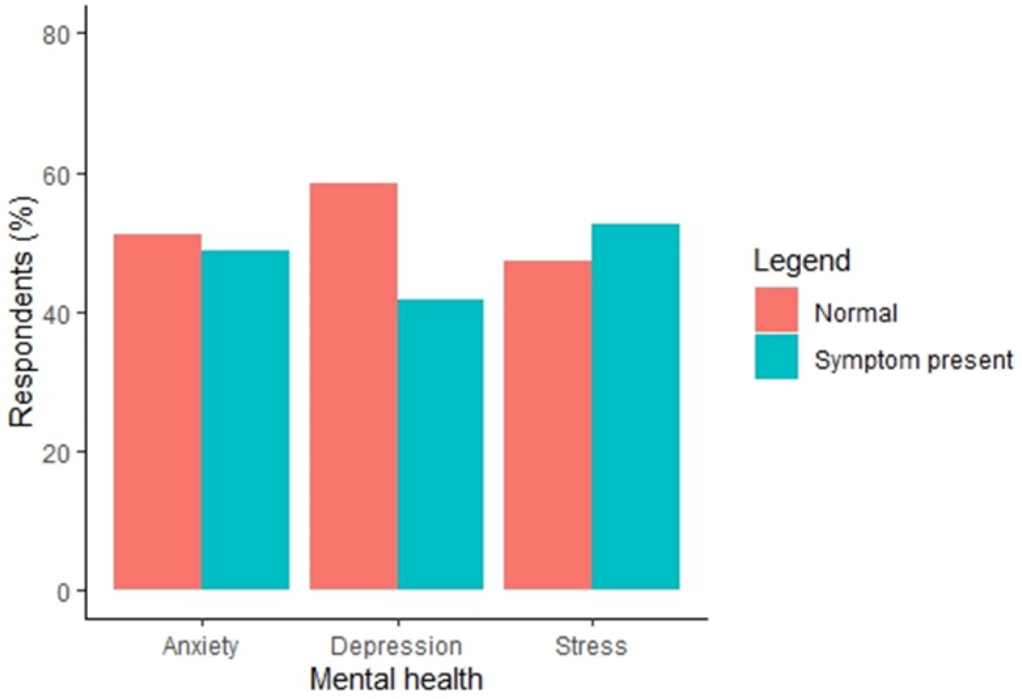

Figure 3. Mental health factors associated with anxiety, depression, stress.

The differences pertaining to the participants' socioeconomic evolution, demographic characteristics, mental health condition, and exposure to river erosion is presented in Table 4. For stress, anxiety and depression, the exposed respondents suffered significantly more than their counterparts (stress: 49.1% vs. 3.5, $p < 0.001$; anxiety:37.0% vs. 11.7, $p < 0.001$; depression:31.3% vs. 10.4%, $p < 0.001$). This was noted too by [24] where it was established that concerning the erosion of the riverbanks, the sufferers reported much higher scores of stress and anxiety and depression as compared to the non-sufferers. This corroborates previous findings from Bangladesh as well as other investigations in the globe.

Table 4. Distribution of mental health with demographic and socio-economic factors.

Characteristics	Categories	Mental Health Problem				χ^2-Value	*p*-Value
		Yes		No			
Gender	Male	90	(39%)	63	(27%)	7.080	0.008
	Female	31	(13%)	46	(20%)		
Family size	<4	8	(3%)	17	(7%)	4.820	0.09
	4 to 6	91	(40%)	75	(33%)		
	7 to 10	22	(10%)	17	(7%)		

Table 4. *Cont.*

Characteristics	Categories	Mental Health Problem				χ^2-Value	*p*-Value
		Yes		No			
Age group	<20 Year	1	(0%)	4	(2%)	11.047	0.026
	20 to 30 Year	7	(3%)	8	(3%)		
	31 to 40 Year	57	(25%)	34	(15%)		
	41 to 50 Year	38	(17%)	32	(14%)		
	Above 50 Year	18	(8%)	31	(13%)		
Occupation	Farmer	26	(11%)	17	(7%)	3.807	0.433
	Business	18	(8%)	15	(7%)		
	Service	8	(3%)	11	(5%)		
	Day labour	25	(11%)	17	(7%)		
	Others	44	(19%)	49	(21%)		
Education level	Illiterate	13	(6%)	21	(9%)	4.711	0.194
	Primary	69	(30%)	49	(21%)		
	Secondary	23	(10%)	22	(10%)		
	Higher secondary	16	(7%)	17	(7%)		
Income source	Farming	26	(11%)	26	(11%)	13.775	0.001
	Non-farming	64	(28%)	33	(14%)		
	Others	31	(13%)	50	(22%)		
Income level (Monthly)	5000 tk	29	(13%)	31	(13%)	3.265	0.353
	5000 to 7000 tk	27	(12%)	30	(13%)		
	7000 to 10,000 tk	35	(15%)	21	(9%)		
	>10,000 tk	30	(13%)	27	(12%)		
House types	Katcha	113	(49%)	87	(38%)	11.544	0.003
	Pacca	1	(0%)	0	(0%)		
	Semi-pacca	7	(3%)	22	(10%)		
Land Ownership	No	10	(4%)	13	(6%)	1.244	0.871
	1 to 3 Bigha	24	(10%)	20	(9%)		
	4 to 6 Bigha	14	(6%)	12	(5%)		
	7 to 12 Bigha	2	(1%)	3	(1%)		
	Above	71	(31%)	61	(27%)		

Table 4, represents the distribution of mental health problems with demographic and socio-economic factors. The prevalence of mental health problems was higher among the male's participants than the females (the rate of mental health problems in males 39% versus females 13%, $p = 0.008$), had more than family sizes 4 to 6 and it was percentage 40% ($p = 0.09$), and raised with the increase of middle age 32 to 40 year (25%, $p = 0.026$). Also, the respondents with occupation 19% of other sectors faced mental health problems and 11% mental health problems faced by farmers and day laborer's ($p = 0.433$). Of the respondents who were primary-level educated, which is 30% had mental health problems in erosion ($p = 0.194$). Among the 28% of non-farming people who suffered from riverbank erosion and $p = 0.001$, 31% of land owners suffered from mental health problems ($p = 0.001$) and had middle-level income showed the highest rate of mental health problems ($p = 0.353$). Regarding types of houses, the mental health problem rate was the highest among the katcha houses (49%, $p = 0.003$) in erosion because of easy damage. As previously noted, women appeared to have a greater chance of suffering from psychological issues [26]. Supporting his research, less educated individuals seemed to suffer from more mental health issues.

This study demonstrate that mental health status remains independent of educational achievement levels. The study revealed that anxiety rates measured by DAS appeared to increase as people aged. The age group of 38 to 45 and those older than 45 showed elevated anxiety levels compared to people who were 37 years old. The topic has been examined in multiple past studies which have produced similar findings. Our research found that people with more children in their family experienced increased rates of DAS but financial problems became worse for them when trying to support their extended family. The richer respondents (having monthly income >15,000 Taka) were less likely to be depressed compared to the poor respondents (monthly income of 10,000 Taka) as the higher income group had more opportunities to cope with the shock. The depression rate was the highest among housewives whereas the anxiety and stress rates were the highest among the day laborer's. When compared to people who owned land, those without land had higher probabilities of experiencing anxiety. For feelings of depression, anxiety, and stress, inward relocation was a key influence. Comparing individuals who were not displaced with those who had to relocate due to river erosion, we found that the prevalence of DAS was considerably greater among the former group.

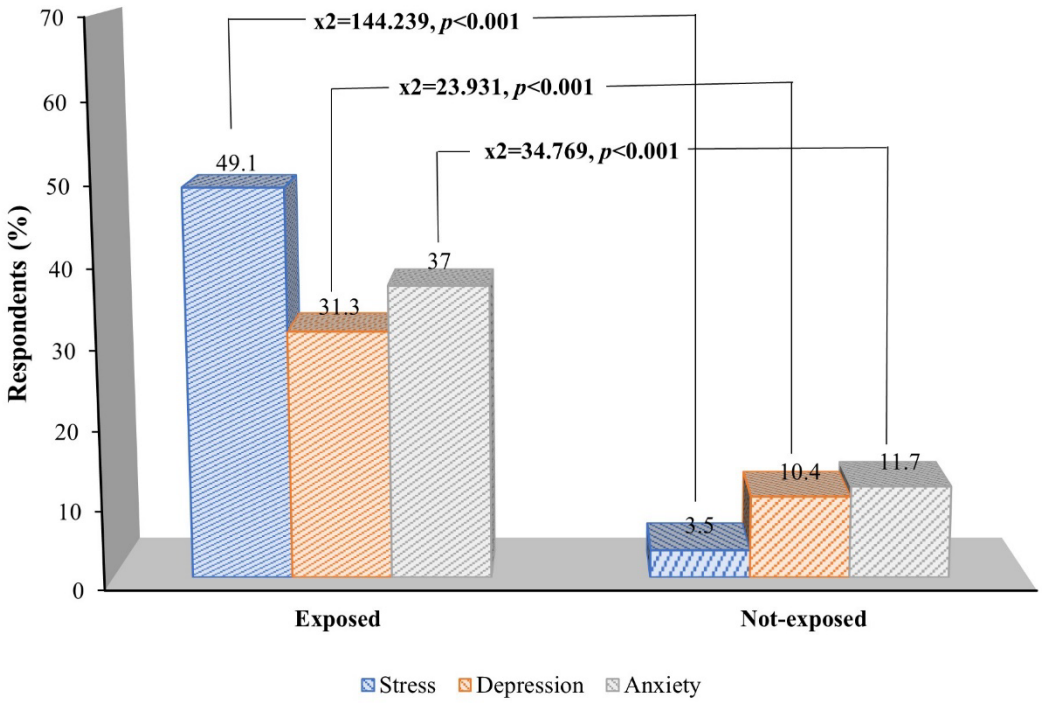

Figure 4. Rate or proportion of depression, anxiety, and stress among exposed and non-exposed groups.

Table 5 represents the results (odds ratio and its 95% confidence interval) of logistic regression analysis. The binary logistic regression analysis revealed that gender participants were respectively 1.691, 0.703, and 0.405 times more likely to be stressed, depressed, and anxious. The respondent's family size had a negative significant effect on stress −1.164, depression 0.878, and significant anxiety level 1.916. Although the respondent's age has a substantial effect on stress, depression and, the odds of anxiety were respectively 0.329, 0.212, and 0.498 times. The respondents with occupation significant effect on stress 1.157, depression 0.294, and anxiety significant level 0.776. Among the education levels, those who had a considerable level of education were respectively −0.098, 0.147, and 0.482 times more likely to have stress, depression, and anxiety. Also, the respondents of income source were affected by stress, depression, and anxiety respectively 0.481, 1.296, and 0.348 times. The respondents with monthly income respectively the odds of stress, depression, and anxiety compared to those having monthly incomes of 0.165, 0.119, and 0.015. The odds of stress and depression were respectively house types 1.610 and 0.476 times larger for the respondent's anxiety significant level of 1.021 times house changes in erosion. The people having ownership of land had 2.442 higher anxiety than those who have land (stress 2.175 times and depression 1.768 times). In this regard, found that people who experienced riverbank erosion were more likely to develop DAS disorder and experience worse mental conditions [24]. We also observed that the odds of mental illness problems were higher among females or housewives, older, uneducated, poor, and had >4 children compared to their respective counterparts. Riverbank erosion is a common occurrence brought on by a combination of natural and human factors.

Table 5. Logistic regression final model showing the adjusted odds ratio of predictors of stress, depression, and anxiety (n = 230).

Characteristics	Stress/Tension			Depression			Anxiety		
	β-Value	95% C.I. for EXP(B)		β-Value	95% C.I. for EXP(B)		β-Value	95% C.I. for EXP(B)	
		Lower	Upper		Lower	Upper		Lower	Upper
Gender	1.691 ***	0.055	0.613	0.703	0.172	1.425	0.405	0.237	1.879
Family size	−1.164 *	0.091	1.074	0.878	0.127	1.357	1.916 ***	0.042	0.518
Age group	0.329 *	0.951	2.028	0.212	0.867	1.764	0.498 ***	1.127	2.402
Occupation	1.157	0.698	14.492	0.294	0.339	5.314	0.776	0.525	8.996
Education level	−0.098	0.57	1.442	0.147	0.737	1.82	0.482 **	1.014	2.584
Income source	0.481	0.374	7.005	1.296 *	0.07	1.072	0.348	0.363	5.52

Table 5. *Cont.*

Characteristics	Stress/Tension			Depression			Anxiety		
	β-Value	95% C.I. for EXP(B)		β-Value	95% C.I. for EXP(B)		β-Value	95% C.I. for EXP(B)	
		Lower	Upper		Lower	Upper		Lower	Upper
Income level (monthly)	0.165	0.824	1.686	0.119	0.801	1.584	0.015	0.718	1.437
House types	1.610 ***	1.789	13.983	0.476	0.623	4.163	1.021 **	1.03	7.485
Land ownership	2.175 *	0.789	98.201	1.768	0.564	60.863	2.442 *	0.769	171.807
Constant	0.549			0.157			0.531		

***, ** and * indicate significant level at 1%, 5% and 10% respectively.

4. Conclusions

River bank erosion causes vast damage, and it economically affects the riverine village people. The Tetulia and Karkhana River's annual activity leads to the erosion of a significant portion of agricultural land. Due to extreme distortion of land by river bank erosion, agricultural land has transformed into barren land. River erosion affects adversely the lives of survivors socially, economically, psychologically, and culturally and can influence the behavior of these areas' people. Every year, a large number of the population is displaced due to riverbank erosion. Due to facing economic problems, a food crisis, loss of life, saving, damaged cropland, and being homeless by river erosion. The affected people had a higher likelihood of developing mental health issues and certain social security systems. Policy is planned and implemented using a top-down methodology in our nation. If the public's input has been heard, effective policy formulation and implementation would be simpler to accomplish. There is no ideal way to manage this, but if policy planners are sincere and dedicated, then appropriate policy planning is achievable. By talking with stakeholders and working with people, it is simple to battle disasters like riverbank erosion.

Author Contributions

B.R.: Writing—review & editing, Writing—original draft, Visualization, Methodology, Formal analysis, Conceptualization, Validation, Supervision, Resources. M.M.K.: Writing—original draft, Methodology, Formal analysis, Conceptualization. M.A.-A.K.: Writing—review & editing, Data curation, Formal analysis, Methodology, Resources, Visualization. M.R.I.: Writing—review & editing, Data curation, Formal analysis, Methodology, Resources. S.S.: Writing—review & editing, Data curation, Resources. M.M.I.T.: Writing—review & editing, Data curation, Resources. All authors have read and agreed to the published version of the manuscript.

Funding

This study received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Institutional Review Board Statement

This study was conducted under the Department of Environmental Science and Geography, Islamic University, Bangladesh, and involved minimal-risk social and behavioral research such as structured surveys, interviews, and field observations. No clinical interventions or biological sample collection were undertaken. In accordance with institutional ethical guidelines and the Declaration of Helsinki (1975, revised 2013), formal IRB approval was waived, as no identifiable personal data were collected and the research posed no foreseeable risk to participants.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The datasets and materials used and/or analysed during the current study are available from the corresponding author on reasonable request.

Acknowledgments

The authors would like to express their sincere gratitude to the Upazila Nirbahi Officer (UNO) of Baufol Upazila for their support and cooperation during the study. Special thanks are also extended to all the respondents who generously shared their time, experiences, and insights, which were invaluable to the success of this research.

Conflicts of Interest

The authors declare no conflicts of interest.

Use of AI and AI-Assisted Technologies

The authors minimally used ChatGPT for idea enhancement; all content was reviewed and approved.

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