 doi:10.20944/preprints202207.0186.v1

Article

Impact of Riverbank Erosion on Rural Food Security in Bangladesh

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Abstract: Bangladesh is located in the alluvial floodplain of the Ganges–Brahmaputra–Meghna (GMB) river system and its numerous tributaries. In this country, the frequency, as well as severity, of riverbank erosion is high. To examine the impacts of riverbank erosion on rural food security, a baseline survey was conducted in Zajira, Bangladesh. The findings show that most people in the study area are affected by riverbank erosion. Moreover, agricultural production is gradually decreasing as a result of loss of farmland due to the catastrophe and its impacts. In some cases, people lose their entire homestead and are left with few income opportunities and low purchasing power. Consequently, they face the constant threat of a food crisis. The affected people follow some coping mechanisms to face these stressful situations, such as relying on less expensive or less preferred food items. While the local-government authorities have implemented some programmes to assist them, such as food aid and social-safety-net schemes, these are insufficient, due to the government's limited institutional resources and capacities. These findings suggest that for formulating effective rural-development plans, assessing the impact of riverbank erosion on the food security of people living in the affected areas is a prerequisite.

Keywords: food security, riverbank erosion, rural development, agriculture, local government.

1. Introduction

Bangladesh is increasingly being recognized by the world as a country prone to various natural disasters, such as riverbank erosion, floods, droughts, cyclones and storms [1], [2], [3], [4]. These calamities pose a great challenge to the country's sustainability in terms of food security. Approximately 40 million Bangladeshis are food-insecure and 11 million suffer from starvation [5].

The Ganges–Brahmaputra–Meghna (GBM) river system has a total catchment area of about 1.65 million km2 [6]. The GBM river system and other waterways carry approximately 1.1 billion tons of sediments annually [6], [7]. The amount of silt deposited in the GBM river basin is the highest in the world [8], [9], [10]. Due to this excess silt, the river system is losing depth, resulting in frequent changes in the alignment of the channels. These natural phenomena are the main cause of fluvial floods and riverbank erosion across the river basins of Bangladesh [11], [12]. Such natural disasters are responsible for the loss of lives and damage to land, biodiversity and infrastructure, causing a significant reduction in agricultural production and adversely affecting the country's food security, especially that of poor people living near the banks of huge river systems [13], [14], [15]. For instance, riverbank erosion causes a yearly loss of nearly 8,700 ha of homestead in Bangladesh, displacing almost 0.2 million people [16], [17], [18], [19]. Due to the low-lying nature of the Bay of Bengal, during the June–September monsoon, rains prevail over Bangladesh and adjacent regions [20], which are responsible for depositing huge

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amounts of silt on riverbeds. This silt deposition trend brings changes in the morphological dynamics of the rivers, resulting in the intensification of erosion in the basins of the GBM river system [21], [7]. The downstream channels of the international rivers, namely the Ganges and the Brahmaputra, are known as the Padma and Jamuna, respectively, which flow through Bangladesh [22], [23]. The Jamuna merges with the Padma, doubling the flow of the latter. This combined water flow accelerates the riverbank erosion tremendously in the basin of the Padma [24], [25]. Riverbank erosion has different devastating impacts on the basins of the major rivers in Bangladesh. The increasing influence of such natural disasters on food production has been a significant challenge for Bangladesh over the last few decades [26], [4], [27]. It is predicted that in the future, the natural hazards such as floods, cyclones, droughts and erosion will have catastrophic consequences on agriculture and food security in many parts of the world, particularly in developing countries like Bangladesh [28], [18], [29], [14].

In Bangladesh, food security has been a major concern since the country's independence, because it is closely related to poverty reduction programmes and the prosperity of the citizens. The nation recently achieved food sufficiency, having reduced its poverty rate from 62% in 1988 to 23.2 % in 2016 [30]. Production of rice, the staple food, increased from 16 million tons in 1970 to more than 50 million tons in 2010, that is, by more than three times [31]. Despite these successes, there are still many undernourished citizens [32]. Thus, the multidimensional impacts of riverbed erosion should be explored to ensure the country's food security situation, and effective steps must be taken to improve the socio-economic condition of the affected rural people [2], [4]. In this study, the aim was to investigate the impacts of riverbank erosion on the food security of rural households near the Padma river basin and their coping strategies.

2. Conceptual framework of the study

The most of Bangladesh's rural people relies on agriculture, which is particularly vulnerable to climate change. As a result, climate change issues in general, as well as the repeated riverbank erosion threat in particular, have an impact on riverine rural communities in Bangladesh. Climate change impacts are expected to alter the frequency of flooding [33], [34], increasing the erosion risk along rivers [35], [36]. Direct and indirect hazard impacts, as well as first and second order hazard impacts, are commonly used terms [37]. Riverbank erosion contributes to the annual loss of riverine households' land, homesteads, ponds, crops, trees, and other resources (Figure 1). Their income and work prospects have been reduced as a result of the loss of land and resources. Homeless/displaced persons typically seek shelter in open spaces, embankments, high land, as seen in Figure 1. Riverine households' livelihoods are at risk as a result of these conditions. Furthermore, they will likely experience an increase in mean annual temperature as a result of climate change, as well as uncertainty in rainfall, a likely loss in cereal crop productivity, and increased disease, insect, and weed burden on crops and animals [38], [39]. They are also vulnerable to flooding and water logging because to their proximity to rivers, which, along with erosion, creates a highly dynamic environment for them. Lower food production and job prospects, as well as instability in food costs, lead to households' reduced food entitlements, particularly for small farmers and landless laborers. As a result, in a society where the majority of households rely on agriculture, as in our study, food insecurity will be the most prominent first-order impact. Riverine households use a variety of coping and adaptation tactics to deal with the threats at this point (Figure 1).

These adaptation tactics might be implemented at the farm level or in a planned manner (by government policy). It should be highlighted, however, that not all households are equally affected by climate change and dangers, and so their responses differ based on their economic situation as well as the political and social ties involved [40], [41]. This means that while assessing the livelihood vulnerability of riverine households

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and their food security status, multiple livelihood options and resources for adaptation must be taken into account.

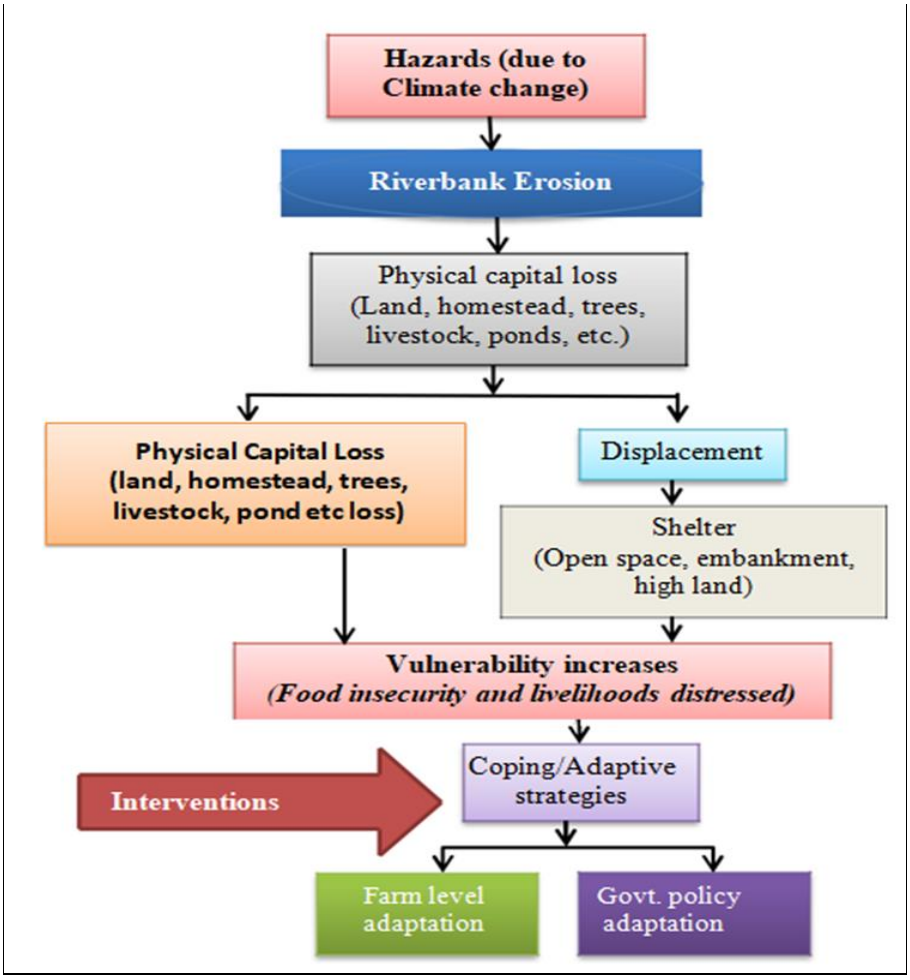

Figure 1: Conceptual framework of the study

Using cross-sectional survey data, this study examines how riverine rural households respond to such hazards and other climate change challenges in order to reduce acute livelihood and food insecurity circumstances that often lead to displacement and intra-country migration. Understanding household vulnerability and response tactics would help policymakers focus local adaptation efforts, which are seen as critical to reducing food insecurity and boosting poor farmer livelihoods [42], [43], [44].

3. Methodology

3.1 Brief description of the study Site

The study was conducted in Zajira sub-district of Shariatpur district, which is 100 km to the southeast of Bangladesh's capital, Dhaka. Zajira is situated to the south of the Padma (Figure 2). The total land area of this sub-district is 239.53 km2, and its total population is 194,019 [45]. The frequency of riverbank erosion is rather high in this region. Most of the people here are involved in agriculture.

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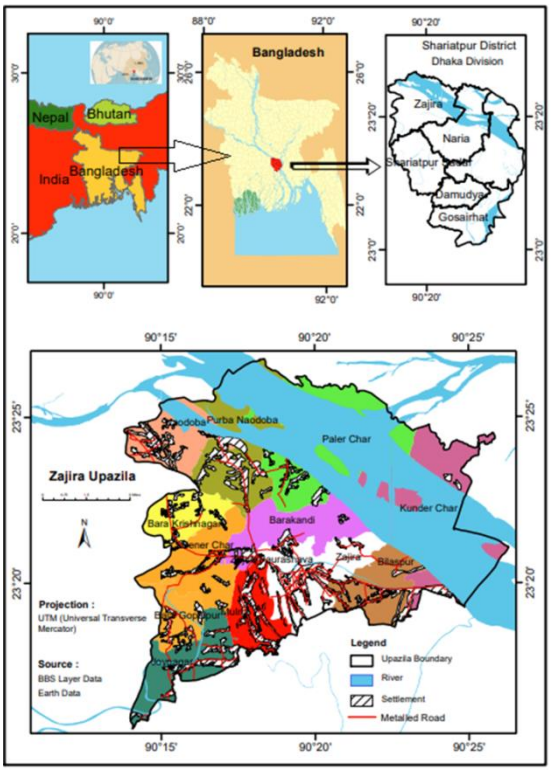

Figure 2: The study area showing in the map of Bangladesh (Source: BBS, 2019)

Zajira belongs to the Lower Ganges River Floodplain Agro Ecological Zone [46]. The organic-matter content in the soil here is low, which is mainly responsible for its low-fertility status [47]. The main agricultural crops in Zajira are rice, oil seed, spices and pulses [36]. Some pictures of Padma (Zajira) riverbank erosion and livelihoods are presented here in Figure 3.

Figure 3: Riverbank erosion and livelihood in the study areas in Zajira, Sariatpur.

3.2 Primary Data Collection

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In the study under discussion, multistage sampling was done to collect both qualitative and quantitative data. A personal interview and a questionnaire survey were conducted among inhabitants of the Padma riverbank and local public representatives in the affected area [48], [49]. Researchers had obtained ethical clearance (APD Ethical Clearance Application Number: 1088C) from the University of Reading before starting the field survey. A total of 60 villagers and 20 local public representatives were selected for the study on a random basis. Computer-generated numbers were allocated for the questionnaires to ensure random sampling of the interviewed household heads or members (in the absence of household heads). The enumerators moved to another participant when a respondent was non-responsive, and thus they continued interviewing till the required number of respondents was reached.

The questionnaire used to conduct the survey was semi-structured and contained mix open-ended and closed questions. First, a draft questionnaire was developed based on previous research findings and suggestions of the research supervisor. Before starting the final survey, arrangements were made for pre-testing the draft questionnaire to eliminate any ambiguity in the questions and ensure collection of accurate and sufficient data. While the questionnaire for the local-government representatives had only one section, the questionnaire for the riverbank-erosion-affected people had three sections: Section A covered demographic data, section B was used to collect information on socio-economic aspects, and section C contained questions on riverbank erosion, its impact on the local people and their coping strategies. The enumerators are government servants working at the union level under the supervision of the Upazila (sub-district level) and the Department of Agricultural Extension (DAE) of the government of Bangladesh. The survey and interview of the participants were conducted in August 2019.

3.3 Data Validation

Some techniques were followed to ensure the validity and reliability of the survey, such as developing and finalizing the questionnaires in a comprehensible language. Researchers ensured that all participants understood the questions before starting the interview through Skype, and the research supervisor also briefed them about the questionnaire. Under the research supervisor's guidance, the questionnaires were finalized. All the interviews were audio-recorded with the respondents' consent for ensuring the credibility of the interview process. Further, the data provided by the study participants were compared with different reports of relevant research organizations to ensure validity and reliability of the results.

3.4 Secondary-Data Collection

Secondary data were collected to support the primary data collected from the respondents. The sources for these data were published reports and the websites of different organizations under the Bangladesh government.

3.5 Data Analysis

The data were analysed using the PRIMER v7.0.21 [50] and SPSS v22 software. Using an appropriate scoring technique, the qualitative data were converted into quantitative data wherever necessary. To describe different variables, statistical measures, such as means and number and percentage distributions, were used.

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4. Results

4.1 Demographic Features

Most of the study respondents were male (90%), and the remaining 10% were female (Figure 4). Moreover, it was found that many of them were middle-aged; those belonging to the age groups of 31–45 years and 46–59 years constituted 31.7% and 33.3% of the participants, respectively. Regarding marital status, it was observed that 95% of them were married and only the remaining 5% were unmarried. Further, the majority of the respondents (70.0%) had a large family, whereas very few (1.7 %) had a small family.

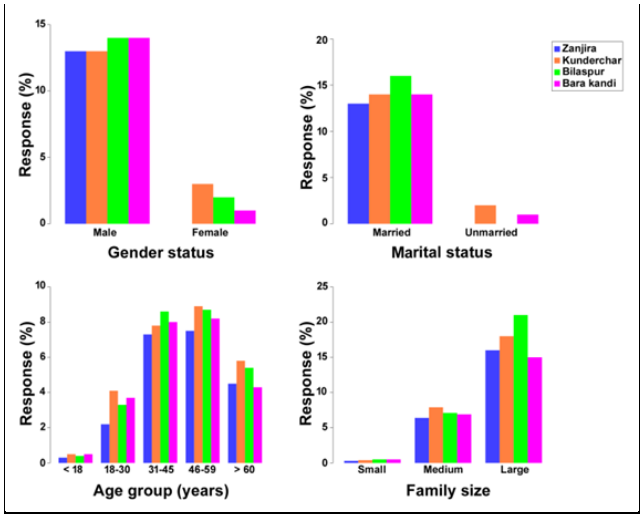

Figure 4: Demographic information of the respondents

4.2 Socio-economic Characteristics

The researchers found that many of the study participants (71.7%) practised agriculture as their main occupation, whereas a negligible percentage (1.7%) earned primarily through livestock farming (Figure 5). Regarding landownership, the majority of the participants (63.3%) reported having land of their own, while 36.7% did not own land (Figure 5). Further, most of the respondents (91.7%) stated that their own produce did not fulfil the annual food demands of their family. While 60% of them mentioned they purchased food to satisfy their family's requirements, 35% stated that they received food aid and also purchased food to fulfill their household demands (Figure 5).This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

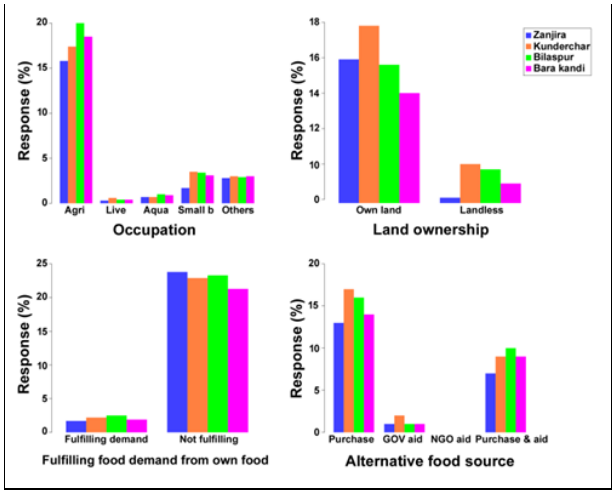

Figure 5: Socio-economic features of the respondents

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Bangladesh being an agricultural country, rice is the main food and the success or failure of the crops and water scarcity in any year is always viewed with the greatest concern. Agriculture sector plays an important role in the overall economic development of Bangladesh. The agricultural sector (crops, animal farming, forests and fishing) contributes 14.74 percent to the country's GDP, providing employment to about 41 percent of the labour force according to Quarterly Labour Force Survey 2015-16. A major portion of annual rainfall over Bangladesh is received during summer monsoon season (June–September). Seasonal variation in rainfall is one of the most distinctive features of monsoon regions in the world. About 70% of the rainfall in Bangladesh occurs during the four monsoon months from June to September with large spatial and temporal variations over the country [51]. Such a heavy concentration of rainfall results in a scarcity of water in many parts of the country during the non-monsoon period. Annual fluctuations in monsoon rainfall from time to time lead to extreme hydrological events (widespread droughts and floods) which lead to dangerous decline in agricultural production and affect the huge population and the national economy. A normal monsoon with rainfall evenly distributed across the country is a wealth, while an extreme event of floods or droughts across the country or a smaller area poses a natural hazard. Hence, the variability in monsoon and annual rainfall and temperature can be considered as a measure to examine climate variability / change over Bangladesh in the context of global warming. Therefore, for Bangladesh, where agriculture has a significant influence on both the economy and livelihood, the availability of adequate water for irrigation under changed climatic scenarios is very important. The agricultural output is primarily governed by timely availability of water.

4.3 Riverbank Erosion

The first question posed to the local people during their interview was, 'Do you live in the Padma river basin?' All the participants answered in the affirmative. Then, they were questioned about the existence of riverbank erosion in their area. Again, all respondents stated that they observed riverbank erosion in their locality. Approximately 97% of them (Table 1) said that they were affected by riverbank erosion. Despite the fact that riverbank erosion proceeds slowly and progressively year after year, it has long-term and irreversible consequences [52]. The main concern is that riverbank erosion reduces the total area of arable land every year in a country where arable land is scarce: in Bangladesh, arable land is 0.05 ha/person [53]. This results to a decrease in aggregate food production and, as a result, has a negative influence on the food and livelihood insecurity of the vulnerable riverine population. Erosion is also a common cause of displacement and intra-country migration in the country. The risk of riverbank erosion is regarded as one of the major impediments to Bangladesh achieving its MDGs, particularly those aimed at reducing hunger and poverty [54].

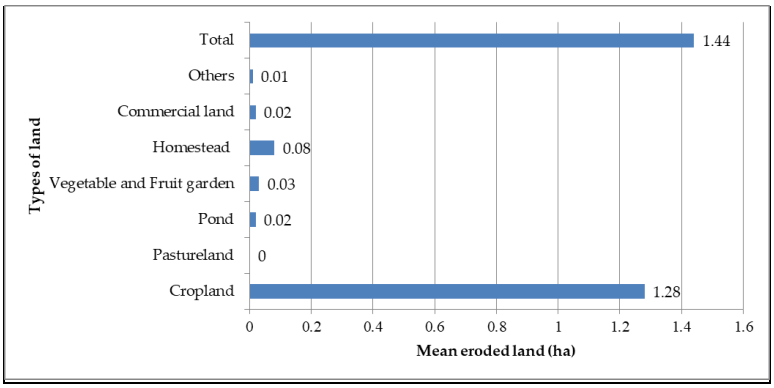

Figure 6: Types of land eroded over the last 20 years in the study area

The interviewees also provided information about the different types of land eroded. They had lost their cropland. They had also lost ponds, vegetable and fruit gardens

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and homestead, commercial and other lands due to riverbank erosion. The participants' responses are presented in **Figure 6**. Riverbank spills and erosion are common during the monsoon season in Bangladesh. Riverbank erosion in Bangladesh is mostly caused by the braided character of the rivers, which is exacerbated by excessive rainfall, particularly upstream, and increased water flow. The pace of riverbank erosion has recently accelerated dramatically as a result of climate change, culminating in the unexpected collapse of riverbanks and the devastation of entire Unions and Upazilas.

Table 1: Participants' experiences of riverbank erosion and their food security status

Participants' experience	Response	Percentage
Experience regarding riverbank erosion	Yes	96.7
	No	3.3
	Do not know	0
Experience regarding their household food security status before riverbank erosion	Secure	90.0
	Not secure	6.7
	Not sure/do not know	3.3

Every year, riverbank erosion affects millions of people by causing damage to and loss of crops, cattle, housing structures, and farmland. It also deteriorates public infrastructure and communication networks. The unexpected shifting behavior of rivers and their encroachments harm not just the rural flood-plain population, but also urban growth centers and infrastructures. The Padma River's bank lines are very unstable. Recently, the right bank of the Padma has been threatened by severe erosion, particularly in Zajira Upazila [45] of Shariatpur district.

4.4 Household Food Security and Livelihood

Regarding household food security, some parameters were used to evaluate the effects of riverbank erosion on the people's lives and livelihoods, such as food shortage, decline in income sources, disruption in communication, destruction of homestead, trouble in availing public services and disruption in transportation (Figure 7).

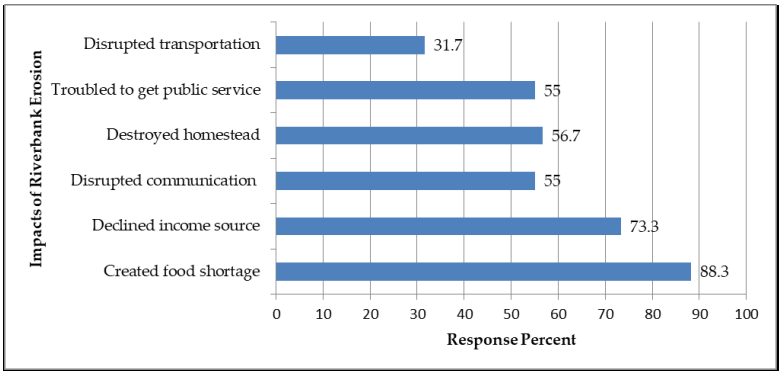

Figure 7: Effects of riverbank erosion on the lives and livelihoods of the affected people

The majority of the respondents (88.3%) stated that riverbank erosion had caused food shortage in their households, and 73.3% of them mentioned that their income sources had declined due to the disaster (Figure 7). Bhuiyan et al. [55] recently published a study which found that the loss of agricultural land leads to a decline in total crop yield. However, their research was conducted in Harirampur, Manikgonj district, on the Padma River. Our results were nearly identical to theirs, although the location was different. Their responses to the interview question 'What is your household food security situa-

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tion throughout the year?' that are presented in Table 2. Between January and June, food was secured by around 53% of the respondents, whereas the others mentioned that their household food security was inadequate during that period. In contrast, only 15% of them reported securing food for their households during July–December, while the majority (61.7%) revealed food scarcity.

Table 2: Household food security status throughout the year

Time period	Answer/Category	Responses (%)	Mean
January to June	Adequate	53.3	1.47
	Inadequate	46.7	
	Scarce	0	
July to December	Adequate	15.0	2.47
	Inadequate	23.3	
	Scarce	61.7	

Household Food Security Status

With respect to household food security, the first question posed was, 'Were members of your household anxious about the lack of sufficient food during the last three months?' Almost 98% of the respondents stated that they were sometimes anxious over lack of sufficient food during the previous 3 months (Table 3).

Table 3: The situation of household food insecurity perception

Food insecurity status	Answer category	Response(%)
A. Were members of your household anxious about the lack of sufficient food during the last three months?	No	1.7
	Yes	98.3
	If yes	
	Most of the time	0
	Sometimes	98.3
	Sudden	1.7
B. Were you or any member of your household bound to eat fewer than three meals in a day due to the unavailability of sufficient food during the last three months?	No	100
	Yes	0
	If yes	
	Most of the time	-
	Sometimes	-
	Sudden	-
C. Did you or any other member of your household go to bed hungry due to lack of sufficient food during the last three months?	No	100
	Yes	0
	If yes	
	Most of the time	-
	Sometimes	-
	Sudden	-

The next questions were, 'Were you or any member of your household bound to eat fewer than three meals in a day due to the unavailability of sufficient food during the last three months?' and 'Did you or any other member of your household go to bed hungry due to lack of sufficient food during the last three months?' In both cases, all respondents answered 'No' (Table 3).

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Availability of Self-Produced Food

With regard to the availability of different kinds of food from their own produce, the interviewees mentioned that rice covered the highest period of 2.55 months, followed by milk (1.9 months), whereas meat sustained them for only 0.32 months (Table 4).

Table 4: Availability of different kinds of food self-produced by the respondents'

Types of food	Average months covered	Types of food	Average months covered
Rice	2.55	Pulse	0.76
Wheat	0.38	Spices	0.80
Fish	0.38	Oil	0.57
Meat	0.32	Fruits	0.63
Egg	1.60	Vegetables	1.05
Milk	1.90	-	-

4.5 Riverbank Erosion Impacts on Household Indicators

The impacts of riverbank erosion on household indicators were measured through 17 questions (Table 5). The answer options were 'No change' (0), 'Deteriorated' (1) and 'Improved' (2). Most (91.7 %) of the respondents stated that their housing condition had deteriorated due to the disaster. Further, 88.3% of them reported that occupation opportunities for their household members had declined. However, some also mentioned that electricity and health, transport, education and marketing facilities in their area had improved (Table 5).

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Table 5: Riverbank Erosion Impacts on Household Indicators

Items	After Riverbank Erosion (response %)			Reason
	No Change	Deteriorated	Improved	
Housing condition	3.3	91.7	5.0	I: Business D: Damage of house
Occupation opportunities	3.3	88.3	8.3	I: Small business D: Lack of work, loss of agril. land
Income of the household	10.0	76.7	13.3	I: Migration to city D: Shortage of work
Education facilities	0	56.7	43.3	I: Migration to city D: Financial problems, destruction
Health facilities	0	58.3	41.7	I: Migration to city D: Poor health facilities
Electricity	5.0	53.3	41.7	I: Expansion of electricity D: Destruction electricity supply
Sources of drinking water	8.3	50.0	41.7	I: Availability of water sources D: Destruction of water sources
Sanitary (toilet) conditions	3.3	55.0	41.7	I: Hygienic toilets for use D: Higher population, poor
Transport facilities	5.0	33.3	61.7	I: Migration to city D: Damage to roads
Communication facilities	3.3	51.7	45.0	I: Availability of network D: Disruption in communication
NGO services	15.0	61.7	23.3	I: Good NGO services D: No food programme
Institutional credit (banks)	28.3	65.0	6.7	I: Loan from bank D: Bank not interested
Farm Machinery	21.7	76.7	1.7	I: Government-provided D: Need to buy machinery
Household assets	1.7	83.3	15.0	I: Increase in income D: Sold
Food security condition	91.7	8.3	-	I: Migration to city D: Loss of land
Availability of labour	1.7	98.3	0	I: No need D: Loss of agricultural land
Marketing facilities	6.7	58.3	35.0	I: Coming near to market place D: Not necessary

N.B: I = improved; and D = deteriorated.

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4.6 Coping Strategies of the Riverbank-Erosion-Affected People

Fifteen questions were posed to the study participants regarding their coping strategies towards food security, with the answer options being 'regularly' (3), 'occasionally' (2), 'rarely' (1) and 'not at all' (0). Their responses are presented in Table 6. The majority of them (61.7%) mentioned that they migrated to the city when their food security came under threat due to riverbank erosion. The respondents' views on the existence of government and non-government food programmes for them are illustrated in Table 5. Among them, 78.3% confirmed that there was no food aid programme for those who lost land to erosion in their area. However, 68.3% mentioned that their family members were under government safety net programmes. Nevertheless, 93.3% of the participants reported that these programmes were inadequate. Furthermore, none of them was under any NGO food programme.

Table 6: Coping strategies of the affected people towards food security

Food Security Strategy	Degree of the Responses* (%)			
	3	2	1	0
Reducing amount of food per meal	5.0	8.3	10.0	76.7
Reducing number of meals per day	1.7	1.7	21.7	75.0
Going to bed without food	-	3.3	-	96.7
Relying on less preferred food	5.0	83.3	8.3	3.3
Reducing purchase of children's food	1.7	76.7	8.3	13.3
Purchasing food on credit	1.7	46.7	35.0	16.7
Borrowing money from NGOs/Government organizations	1.7	16.7	1.7	80.0
Borrowing from moneylenders	6.7	15.0	3.3	75.0
Migrating to a city or another area	61.7	13.3	-	25.0
Relying on casual labour for food	6.7	58.3	1.7	33.3
Selling cattle/livestock	-	83.3	-	16.7
Spending money from savings	1.7	83.3		15.0
Borrowing money or food from	-	73.3	1.7	25.0
Selling land and other assets	-	66.7	3.3	30.0
Selling labour in advance	-	8.3	-	91.7

Note: 3 = Regularly; 2 = Occasionally; 1 = Rarely; and 0 = Not at all

4.7 Role of Local-Government Representatives

Of the interviewed local-government representatives, 85% revealed severe riverbank erosion in their area. The respondents had been representatives for 9.55 years on average. Almost all of them reported that there were food aid programmes to ensure food security for the local people, and according to them, on average, 281.80 people were beneficiaries of such programmes in their respective areas. When the local-government representatives were asked if they had seen any migration tendencies among the affected people in their jurisdiction, almost all of them answered in the affirmative. In addition, they mentioned that on an average, 414.75 affected people had migrated to cities or other places over the previous 5 years commencing in 2015. Regarding strategies to mitigate

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riverbank erosion in their area, about 65% of the respondents stated that they had action plans, whereas the rest had none (Table 7).

Table 7 : Views of local government representatives, their plans for the affected people

Questions	Response category	Response (%)	Mean
Are you a local government representative from the riverbank erosion affected area?	Yes	85	-
	No	15	
If yes, how many years have you played role as a local government representative	-	-	9.55
Do you have any food aid programmes to ensure food security of local people	Yes	100	
	No	0	
If yes, how many affected people are beneficiary of the programmes?	-	-	281.8
Have you seen any migration tendency among the people affected by riverbank erosion in your union area?	Yes	100	
	No	0	
If yes, how many affected people migrated from your union during last 5 years?	-	-	414.75
Do you have action plans to mitigate riverbank erosion in your area?	Yes	65	

4.8 Action Plans for Erosion Control in the Study Area

The study participants mentioned some action plans, which are summarized in the Table 8. The local-government representatives were involved in implementing some measures to control riverbank erosion, such as throwing geotextile bags, setting cement concrete blocks and dredging the riverbeds taken by other government agencies. They supported the agencies and motivated local people to participate in the implementation processes. The respondents also mentioned that mitigation plans against riverbank erosion were hindered by lack of institutional capacity, resource constraints and gaps in coordination among the relevant organizations.

Table 8: Some potential action plans to reduce riverbank erosion in the study area

Summary of the respondents views of action plans, benefits and drawbacks	
Action plans	Throwing geo bags
	Dredging river beds
	Setting of cement-concrete (CC) blocks
Benefits of action plans	Saving agricultural land
	Saving agricultural land
	Protecting homestead area
	Improving livelihood Status
	Protecting school, health centre, garden, markets, etc.
Drawbacks of action plans	Limited resources
	Local representatives not entitled to implement big projects with huge budgets
	Lack of coordination among governmental agencies

5. Discussion

Riverbank erosion is a regular phenomenon in most parts of Bangladesh and affects around 1 million people every year [39], [40], [41]. This disaster has more long-term effects than any other disasters on the people or even on the country [39], [42], [43], [44].

 doi:10.20944/preprints202207.0186.v1

Ahmed [45] reports that riverbank erosion significantly affects the physical, social and economic conditions of a particular locality. Moreover, it makes marginal and impoverished people more vulnerable due to their lower capacity to cope with such disasters [46], [23].

In the study area, riverbank-erosion-affected people were involved in various occupations, among which agriculture was the main income source for most of them. On the other hand, livestock farming, aquaculture and fishing were insignificant sources of income for them. Furthermore, the income source of many affected people was not specific. The study participants mentioned using a significant portion of their income to purchase food, since the majority of them could not produce sufficient food of their own [15], [45], [47]. However, many of them were brought under government safety net programmes such as Vulnerable Group Feeding, programmes to cope with natural disasters and other shocks, employment generation programmes.

Riverbank erosion poses a big threat to the food security situation of Bangladesh [48], [49]. To overcome this long-term disaster, coping is always a significant option [23], [51]. According to the survey results, all the respondents were living near the Padma, and almost all reported that they had been distressed by riverbank erosion during the previous 10 years. They mentioned that in the affected area, cropland suffered the highest erosion among the different classes of land.

The lives and livelihoods of the people were upset because of the food shortage, destruction of homestead, decline in income sources, trouble in availing public services and disruption in communication and transportation caused by riverbank erosion. The situation regarding food security varied from month to month. The participants indicated that from January to June they could secure food, but during July–December their situation deteriorated [52], [53], [54]. The probable reason behind this is that July–September is the most vulnerable time for crop production, whereas January–March is the safest period for this activity [45].

In terms of household indicators, the majority of the respondents mentioned that their housing condition had deteriorated due to damage to their houses caused by riverbank erosion [45]. Regarding their coping strategies for food security, they revealed that when stressed they migrated to urban areas to earn some extra money. Moreover, some people coped with food scarcity through relying on less expensive or less preferred food items and spending money from their savings [56], [41], [56]. The survey results confirm that in the study area food aid programmes are limited. However, the majority of the erosion-affected people are under government safety net programmes, which include food-for-work and cash-for-work schemes. Such initiatives are implemented by different government organizations.

Rahman and Rahman [19] state that riverbank erosion has many impacts on riverine villagers. However, the respondents in the present study were found to follow some coping mechanisms. In previous studies too, researchers have found riverbank-erosion-affected people to follow several coping strategies. The important coping strategies they have identified are finding part-time work, treating diseases, undertaking emergency house refurbishment, living on embankments or highland temporarily and changing occupations [2], [3].

The government and non-government institutional setting is very important in the selection of coping options for riverbank-erosion-affected people [50]. The study shows that local-government representatives of the study area have provided some help to the affected people, implementing food aid and safety net programmes. However, the number of beneficiaries under such programmes is not significant. The representatives indicated in the study that a considerable number of affected people migrated to cities

 doi:10.20944/preprints202207.0186.v1

and other places. Further, they mentioned that they have implemented some action plans for protecting people from riverbank erosion. While these schemes were mainly implemented by some other government agencies, they played their role through supporting these initiatives and motivating the local people to help them. However, they also mentioned that they had little capacity to take mitigation steps against riverbank erosion due to resource constraints and lack of coordination among the relevant organizations.

Lastly, besides outside support, the traditional knowledge and skills of the locals are important factors that may significantly help them overcome the challenges posed by natural disasters. This argument is supported by Islam et al. [26], who state that an appropriate system for forecasting the water flow of rivers and floods and the integration of local techniques and modern technologies can help reduce the impacts of riverbank erosion.

6. Conclusion

Riverbank erosion is the most common natural disaster in the riverine Bangladesh. According to the present research, in Zanjira sub-district of Shariatpur district, a densely populated area, most of the people, who are also poor and marginalized, are affected by this natural disaster. Many even lose their entire homestead. Therefore, in many cases, the people migrate to urban areas. Due to loss of their farmlands, their agricultural production is decreasing day by day. Moreover, their purchasing capacity is quite low because of the lack of other income sources. Thus, they are regularly affected by food scarcity, especially during July–December. Consequently, almost all people are anxious about shortage of food, though the number of hungry locals is quite small in the study area. While many residents have been brought under social-safety-net and food aid programmes of the government, these are not sufficient to help all the affected people.

Besides the government's initiatives, the distressed locals follow some coping mechanisms during stress situations. Others cope with food scarcity through relying on less expensive or less preferred food items and spending money from their savings. The local government representatives also play their part in assisting the riverbank-erosion-affected people through government schemes. However, the beneficiaries of such programmes are few in comparison to the total affected people. Further, although the representatives have the responsibility of implementing action plans to mitigate riverbank erosion through executing different projects of other government agencies, due to limited resources and lack of appropriate policies; they have little ability to provide sufficient assistance and aid to all the affected people.

Author Contributions

Conceptualization, M.M.B. and A.M.; methodology, M.M.B.; software, J.T.; validation, M.J.H., and M.M.B.; formal analysis, A.M.; investigation, M.M.B. and A.M.; resources, A.M. and J.T.; data curation, M.J.H.; writing—original draft preparation, A.M.; writing—review and editing, M.S.A.R.; visualization, A.M..; supervision, M.S.A.R.; project administration, M.M.B.; funding acquisition, M.M.B. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Data Availability Statement

Data will be provided by corresponding authors upon reasonable request.

Acknowledgments

This research was a part of MSc in Applied International Development at the School of Agriculture, Policy and Development, University of Reading, United Kingdom. The study program was funded by the "Strengthening Government through Capacity Development of the Bangladesh Civil Service Cadre Officials Project, Phase II", administered by the Ministry of Public Administration, Government of the People's Republic of Bangladesh, Dhaka 1000.

Conflicts of Interest

The authors declare no conflict of interest.

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