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Impact of floods and river-bank erosion on the riverine people in Manikchak Block of Malda District, West Bengal

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Abstract
Floods and river-bank erosion are the most frequent natural hazards in India, specifically in the deltaic regions. In West Bengal, floods and river-bank erosion predominantly affect Malda district as it is located in the moribund part of the Bengal delta. This article studies the recent trend of shifting course of the River Ganga and the effects of floods and consequent river-bank erosion on livelihoods of the residents of *chars* [The *chars* (called *Diara* in the upper reaches of the Gangetic plains) are virgin, low-lying river islands and sand bars occurring in the plains, particularly the deltaic parts of rivers (Lahiri-Dutt and Samanta, South Asia: J South Asia Stud 30:327–350, 2007).] and river-bank areas of Manikchak block in the Malda district. Around 300 sample households were selected by random stratified sampling technique from four gram panchayats of Manikchak block. Both primary and secondary data have been used. After analysing satellite images from the year 1973 to 2018, it has been observed that the River Ganga continues to shift eastwards and is eroding villages one after another. Inhabitants face multidimensional obstacles to run their households. Large numbers of people are displaced every year due to loss of land. Failure in facilitating the required assistance in the form of alternative spaces for resettlement and other disaster-mitigating public support systems against these hazards would make it impossible for the deplorable condition of the vulnerable people to improve.

Keywords Floods · River-bank Erosion · *Char* · Displacement · Occupational shift · Out-migration

1 Introduction

We know we will always be defeated in the battle against the Ganga River; every time our houses, lands are washed away, but still we reconstruct it again and again with courage and hope. We have learned through our repeated and conscious strug-

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gles that this breaking down and building up is an indispensable part of our lives.
Gopichand Mahato, 78-year-old man, living in Bhutni *char*.

Natural hazards are widespread and have a devastating effect on people around the world. Globally, natural hazards claim on an average 60,000 human lives every year (Ritchie & Roser, 2014). India witnesses numerous natural hazards every year, such as droughts, floods, cyclones, and earthquakes. Among these, floods and river-bank erosion are the most frequent hazards in India, specifically in the deltaic regions.

According to Annual Flood Report (2019) published by the West Bengal Irrigation and Waterways Department, the state, being a part of the great Gangetic delta belt, has numerous history of flood. Around 42.55% of area of this state is considered as a flood prone area. West Bengal had witnessed of major flood occurrences in the several years of recent past, i.e. 1913, 1942, 1954, 1965, 1956, 1959, 1978, 1993, 1995, 1999, and 2000. According to IPCC (2012), flood refers to the overflowing of river water in an area that is not usually submerged. Flood is a natural process of any river course, which contributes to making the land more fertile in the river basin areas. However, frequent floods simultaneously cause widespread damage to human life, livestock, land, property, and infrastructure. Floods and river-bank erosion are interrelated natural hazards. There are many examples of havoc caused by bank erosion during and after a flood, which is responsible for the frequent shifting of the bank line (Baishya, 2013). According to Das et al. (2017), river-bank erosion in India is one of the most harmful hazards that have the most severe long-standing impacts on human beings. These are common primarily along the Ganga as well as the Brahmaputra River.

The Ganga is a lengthy river flowing through several Indian states and transporting an extremely large volume of water. The effects of flooding and erosion are brutal in the lower courses of the Ganga, predominantly in West Bengal. Scholars such as Mondal et al. (2016), Islam and Guchhait (2015), and Thakur et al. (2011) have looked into the causes of floods and river-bank erosion and found that there are numerous factors that impact floods and bank erosion, such as topography, geomorphology, drainage, and rainfall variability, channel width-depth ratio, and channel slope. River-bank erosion is one of the most ubiquitous phenomena, especially in Malda district, which is located along the left bank of the River Ganga (Mitra, 2015; Mondal et al., 2016; Mukherjee & Pal, 2017; Saha, 2012), where the river's powerful current hits the bank before taking a ninety degree turn towards the south. River depth along with water carrying capacity of the Ganga is gradually decreasing due to changes in land-use pattern in the upper catchment area. Consequently a little surplus rain in the monsoon leads to floods and bank erosion in general in the lower flood plain of the Ganga River. In addition, the obstruction of natural water flow near the Farakka Barrage contributes to reducing the depth and water holding capacity of the channel. This accelerates subsequent floods and river-bank erosion in the study area, which is unique in that perspective. These anthropogenic factors accelerate floods and river-bank erosion manifold in the Malda district.

Floods of destructive character are of frequent occurrence in Malda. According to the District Disaster Management report (2016) and the District Human Development report (2006), numerous major floods have struck the Malda district over the years. A total of eight major flood events, between 1900 and 1950, and two major floods between 1950 and 1970 have occurred in the district. The frequency of floods has increased since 1970s. The floods of the year 1998 and 1999 were the worst examples of floods in the history of the district. After that, numerous floods have also occurred during the years 2006, 2007, 2008, 2014, 2016, and 2017. However, the latter ones were of

lesser intensity than that of the above-mentioned floods (GoWB, 2006, 2016 quoted in Ghosh & Kar, 2018). The last occurrence of flood has been observed in the year 2019 in four blocks, i.e. Ratua I, Manikchak, Kalliachak III, and English Bazar. Since the last five years, around six Gram Panchayats and approximately 20,000 people have been adversely affected by the floods (District Disaster Planning Book, 2020–2021).

There are many examples of havoc bank erosion during and after the flood, responsible for the frequent shifting of the bank line (Baishya, 2013). From the official data concerning land erosion in Malda district, it has been found that about 14,335 hectares of land were wiped out from the left bank of the Ganga River from the year 1931 to 1978. The sum of eroded land is calculated to be 4247 hectares for the period from 1979 to 2004. Therefore, more than 200 km^2 of exceedingly productive land has been lost due to bank erosion until 2004. In addition, an approximately equivalent area has emanated along the right bank of the river (Maitra, 2004, quoted in Mukherjee, 2011). According to the Irrigation and Waterway Department of West Bengal, every year, a large chunk of land gets eroded due to the Ganga River's constant swing to the left.

Besides land loss, floods and river-bank erosion have both short-term and long-term impacts on human lives and livelihoods. Short-term effects on the inhabitants comprise of loss of houses, assets, properties, and income sources. In the long-term, it has a direct impact on their livelihoods and has indirect effects on health, infrastructure, education, and so on. Usually, short-term impacts are examined in terms of requirements for post-flood assistance (Das et al., 2017). Momin et al. (2020) have analysed the impact of the Ganga River's morphological changes, which create incertitude regarding the life and livelihood of the residents of the Kaliachak-II Block. The authors have found that the shifting nature of the River Ganga is the basis of all the uncertainties regarding lands, livelihoods, and lives. The shifting of the river course continues to affect their lives even after migration due to the absence of documentary proofs. Islam et al. (2012) have also analysed the impact of river-bank erosion on different social groups living in different areas. Areal variation in the impact of river-bank erosion is prominent in those areas.

In Malda district, the erosion-affected blocks are Manikchak, Kaliachak, and Ratua. Since the 1960s, a huge portion of land has been engulfed by the river, and since the rate of this erosion is very high, it leads to bank cutting and population displacement in these blocks every year. Alam et al. (2016) have analyzed the effects of natural hazards such as river-bank erosion on communities living on the river-banks and *chars* of Bangladesh. The study has identified that *char* households are more vulnerable than the river-bank households. *Char* inhabitants are more defenceless against climate changes. The leading indicators of vulnerability are livelihood strategies, food and water accessibility, and health facilities. Riverine households are more susceptible because of their inaccessibility and low livelihood status. The livelihood conditions of the *char* dwellers are pitiable and inadequate. In *chars*, residents are generally poor, and their livelihood is readily influenced by the floods and river-bank erosion, shaped by poverty, displacement, remoteness, inaccessibility (Kamal, 2011). Sarker et al. (2003) found that the inhabitants of the *chars* have diverse livelihood strategies, but mainly, they depend on agriculture. There are continuous disputes regarding land ownership. *Char* inhabitants are compelled to live in complex and risky circumstances encompassed by numerous floods that result in repetitive displacements. They have no alternatives except to relocate their homes on accreting *chars*. They are mainly dependent on livestock, agriculture, fishing, and boating. However, the severity and intensity of the devastation vary in time and space accordingly. These hazards have resulted in enormous harm to inhabited areas of both *chars* and river-bank areas. *Chars* get submerged when floods occur,

leading to temporary homelessness. The inhabitants are compelled to leave the place for the sake of survival.

The purpose of this article is to investigate the recent trend of shifting of the River Ganga, as well as the effects of floods and river-bank erosion on livelihoods of the residents of the riverine areas of Manikchak block. Apart from that, this article attempts to offer some practical solutions for reducing the impact on residents and improving their living conditions.

2 Material and methods

2.1 Study area

Malda district of West Bengal was selected as the study area (Fig. 1). The study area covers 3733 km^2, with total population of 359,071 (Census of India, 2011). The district shares its boundaries with Bihar in the west and Bangladesh in the east, and in the south-west, the River Ganga flows. Its northern boundary is North Dinajpur district, and the southern boundary is Murshidabad district. Physiographically, the district is divided into three parts: Tal, Barind, and Diara (Ghosh & Lepcha, 2019). The area defined by the north-western portion of River Mahananda and northern portion of River Kalindi is mainly referred to as the Tal. This includes Harischandrapur1, Harischandrapur 2, Chanchal 1, Chanchal 2, Ratua 1, and Ratua 2 blocks. Barind extends eastward from the Mahananda River, which is usually upland (Saha, 2012). This includes Habibpur, Old Malda, Bamongola, and Gazol blocks. The Diara extends around the western and southern part of the Mahananda River. Diara has mainly been formed due to the siltation of River Ganga (Saha, 2012). The slope of the district is from north to south. The highest elevation is 39.6 m above mean sea level. The district has fifteen community development blocks. These are Harischandrapur1, Harischandrapur 2, Chanchal 1, Chanchal 2, Gazol, Ratua 1, Ratua 2, Manikchak, English Bazar, Habibpur, Old Malda, Bamongola, Kaliachak 1, Kaliachak 2, and Kaliachak 3. Among these, Manikchak block has been selected as the study area, as this block falls under the high river-bank erosion zone.

2.2 Database

The present article is an example of analytical research and is based on the inductive research approach where conclusions are drawn from empirical observations. Both primary and secondary data have been used for analysis. Socio-economic and demographic data have been collected from field survey (2019–2020). The Census (2011) data have been utilized for calculating Deprivation Index. Data related to floods, river-bank erosion have been collected from the Land Reform office, office of the Revenue Inspector, and Irrigation Department. Mouza maps of the study area have been downloaded from the Institutional Strengthening of Gram Panchayats website. Shifting courses of the River Ganga have been analyzed using satellite images of different years (1973, 1980, 1990, 2000, 2011, and 2018) downloaded from United States Geological Survey (USGS). The present location of the Ganga River and the selected mouzas has been identified using Google Earth images.

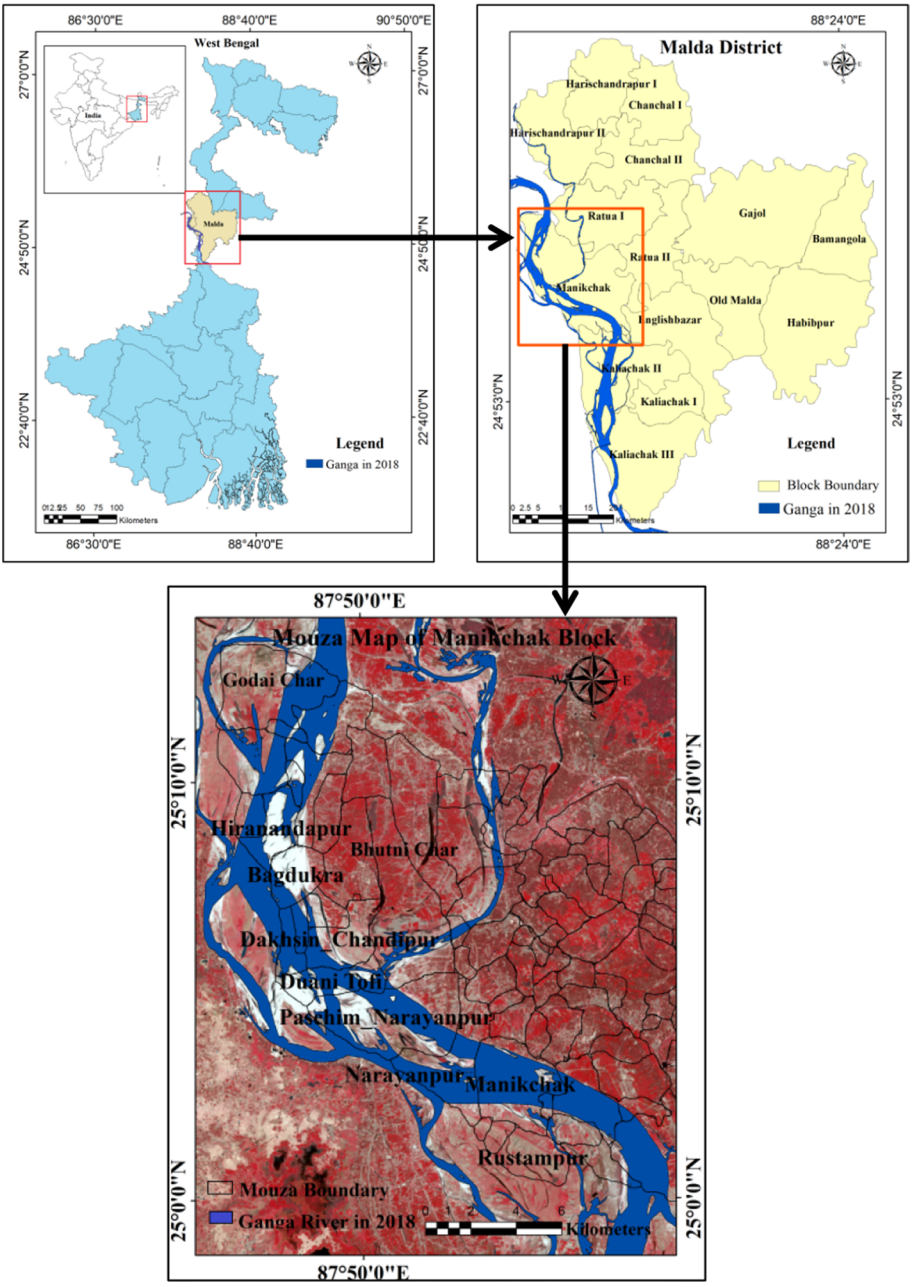

Fig. 1 Study area

2.3 Sampling procedure

In the first stage, the Manikchak block of Malda District has been chosen. According to the Disaster Management Plan of Malda District (2020–21), the Manikchak block falls under the high river-bank erosion zone and the two prominent *chars* namely Bhutni and Godai are situated in this block. After that, the whole study area has been divided into two parts in the next stage, i.e. *char* households and riparian mainland households. The total sample size for this study is 300 households. This sample size is selected on the basis of standard table for sample size selection prepared by Gill et al., 2010 where the table is prepared on the basis of population size and the sample size is calculated based on the desired accuracy having confidence level of 95% (Taherdoost, 2016). Following that table, the sample size for this study area should be 383. However, due to lockdown situation in 2020, only 300 households have been surveyed.

In the Manikchak block, there is eleven Gram Panchayats. Out of all the eleven Gram Panchayats, four Gram Panchayats, namely Hiranandapur, Dakshin Chandipur, Gopalpur, and Dharampur, have been selected on the basis of deprivation index of the households to basic facilities and also the severe impact of the floods and river-bank erosion. Among these panchayats, sample mouzas are selected based on the pilot survey, newspaper reports, accessibility to the *chars* and a list of vulnerable mouzas prepared by the Disaster Management Plan of Malda District (2020–21). From each of the selected mouzas, around 5% of households have been selected at random basis. Sampled mouzas of riparian mainland are Gopalpur (100 households), Jot Bhabani (25 households), and Dharampur (45 households). Around 30 households have been surveyed from Godai *char* and 100 households have been surveyed from Bhutni *char*. Sampled villages of *chars* are Godai (30 households), in Godai *Char*, and Naobarar Jaigir (70 households) and Dakshin Chandipur (30 households) in Bhutni *char*.

2.4 Data collections

A field survey using semi-structured questionnaire has been conducted to gather information on the level of crisis faced by the village communities affected by flood and river-bank erosion. A questionnaire survey, Focus Group Discussion (FGD), in-depth interviews and direct observation were conducted as primary data collection methods. A semi-structured questionnaire was constructed based on the review of relevant literatures and pilot survey. The questionnaire contained both open-ended and closed-ended questions. There are 20 open-ended and 22 closed-ended questions. The closed-ended questions provided a limited set of responses that allowed various types of quantitative analyses. The open-ended questions helped to get unstructured responses. The observation method has been used to observe respondents' language and gesture on problems, present condition of houses, and lands, etc. Focus Group Discussions (FGD) have been carried out to validate the information received from the questionnaire survey.

Quantitative data have been analyzed through different descriptive statistics such as pie, bar, line graphs. Some data have also been analyzed through SPSS with methods such as Regression, Mann–Whitney and Kruskal–Wallis test. For preparing the Ganga River shifting maps, the satellites images of 1973, 1980, 1990, 2000 and 2018 were transported in Arc GIS. After that, the raster and spatial have been analyzed through different tools such as image analysis, unsupervised classification, extraction, Intersect,

Table 1 Some selected socio-economic profiles of the households

Characteristics	Respective measuring unit	
	Chars	River-bank
Gender of the household head		
Male	131 (87.33)	124 (82.67)
Female	19 (12.67)	26 (17.33)
Age of the household head		
< 30 years	11 (7.33%)	6 (4%)
31–45 years	28 (18.67%)	31 (20.67%)
46–60 years	72 (48%)	71 (47.33%)
61–65 years	39 (26%)	42 (28%)
Family size		
3	51 (34%)	41 (27.33%)
3–5	74 (49.33%)	77 (51.33%)
> 6	25 (16.67%)	32 (21.34%)
Education level of the household head		
Illiterate	79 (52.67%)	62 (41.33%)
Primary (level 1–5)	56 (37.33%)	57 (38%)
Secondary (level 6–10)	11 (7.33%)	20 (13.33%)
Higher secondary (level 11–12)	4 (2.67%)	11 (7.33%)
Main occupation		
Cultivator	22 (14.67%)	20 (13.41%)
Agriculture labourer	46 (30.67%)	42 (28%)
Wage labour	77 (51.33%)	80 (53.33%)
Others	5 (3.33%)	8 (5.33%)
Farm category		
Large (> 10 bigha[a])	12 (8%)	10 (6.67%)
Medium (5–10 bigha)	26 (17.33%)	18 (12%)
Small (< 5 bigha)	71 (47.33%)	79 (52.67%)
Landless	41 (27.33%)	43 (28.67%)
Labour migration		
Out-migration	Mumbai, Gujarat, Delhi, Punjab	Mumbai, Delhi, Bankura, Kerala, Gujarat
In-migration	Jharkhand, other parts of Manikchak	Manikchak, Kaliachak

Source: Field survey, 2019–2020

[a]Bigha is an Indian unit of measurement of land. Around 3 bigha land is equal to one acre

and Geometry calculation. River body has been extracted by the river body extraction method. Finally, erosion and accretion of the land areas have been calculated using geometry calculation tool.

3 Results and discussion

3.1 Socio-economic profile of the study households

The study of the socio-economic and livelihood characteristics is beneficial to understand the overall financial and social conditions of the households which finally help to recommend effective policies. As seen in Table 1, most respondents fall under the 40–60 year age groups in both areas (*chars* and river-bank). Most of the household heads are male. There are also a few female-headed households. The average family size of the study area is around five. More than 50% of households on the river-banks have three to five members, and almost 22% have six members. Most of the residents are illiterate. Almost 52% of household heads in the *chars* and 41% of household heads in the riparian mainland area have never attended school (Table 1). Most of them have small farmlands (less than 5 bighas). Due to frequent floods and river-bank erosion, some portion of their land gets washed away by the river every year. In both study areas, around 27% of respondents do not have their own land (Table 1). Thus, people are compelled to migrate. Migration is a common phenomenon in the study area. People come from Jharkhand and other parts of Manikchak to live in the *chars*. They mainly practice transhumance. They do not have permanent homes, and most of them have temporary houses made of thatch, mud, and bamboo. They live in these temporary houses as they cannot afford to make permanent houses because of high land cost and high rate of uncertainty of land, since it can be washed away by the river at any point of time. They leave their homes in the *chars* and go away to other places in mainland areas during the monsoon, and after the monsoon season is over, they come back. Most of their family members have migrated to other cities such as Gujarat, Delhi, Mumbai, and Kerala in search of jobs. They work mainly as daily wage labourers. Labourer migration is primarily temporary in nature. After 6–8 months, they come back to their respective homes.

3.2 The shifting courses of the river ganga in different years in Malda District

This section will present the shifting courses of the river Ganga from the year 1973 to 2018 in the study area. The changing course of the Ganga River has been continuously reshaping the boundary of Malda district. Rivers transfer millions of tons of sediment with their flow. These sediments accumulate in the plains every year, creating many problems such as decreased river width and depth due to siltation. When the amount of discharge increases, bank erosion is initiated, causing floods and river-bank erosion (Thakur et al., 2011). In the districts of Malda and Murshidabad, the Ganga's shifting path has been resulting in large-scale disaster in terms of floods and bank erosion. Scholars such as Mukherjee and Pal (2017), Mondal et al. (2016), Mitra (2015), Hossain (2013), Saha (2012), Thakur et al. (2011), and Rudra (2010) have studied the shifting courses of the Ganga River over time.

After reaching the Rajmahal hills in Jharkhand, the river enters its lower reaches in Bengal. The Ganga used to flow on the opposite side of Rajmahal till 1810. After that, between 1875 and 1900, the river moved to the westward (Saha, 2012). Then again, the river shifted its course in the eastern direction (towards Malda district), distorting the Diara region, harming acres of lands in Kaliachak, Manikchak, and some parts of English Bazar, among others. After completing its middle courses, the river took a southern sweep to enter the district near Bhutni *char* (Saha, 2012) and continued to flow along the north-eastern

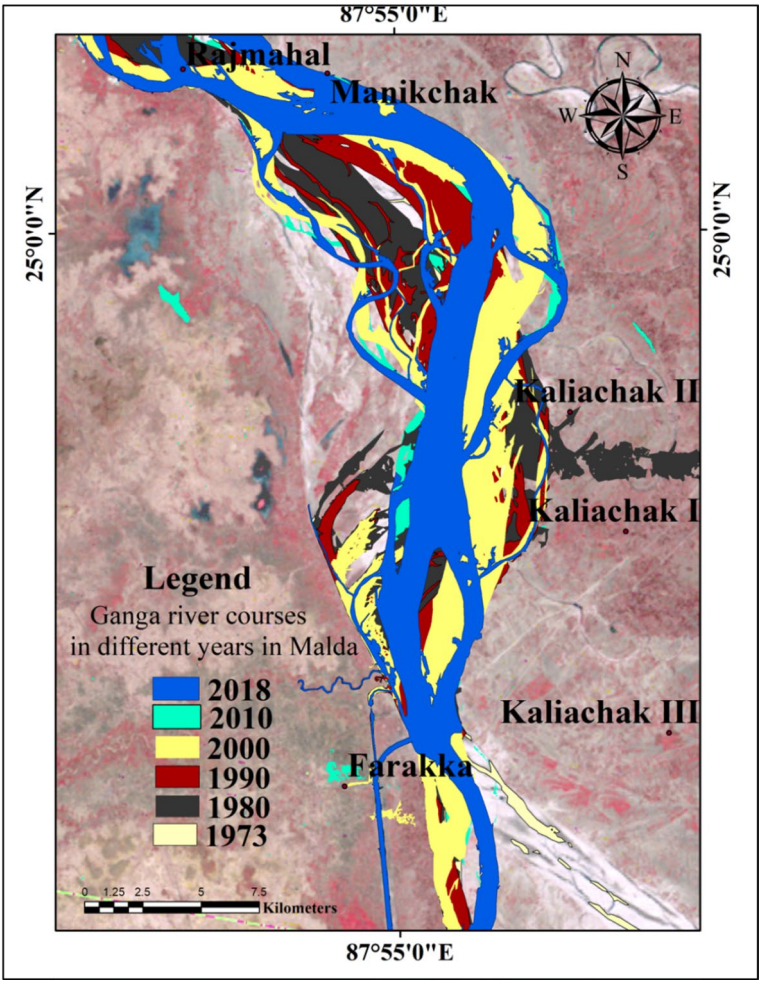

Fig. 2 Shifting courses of the River Ganga from 1973 to 2018 in Malda District

side of Bhutni. Today, the river flows through the south-western side of the island (Fig. 2). According to Mitra (2015), the major course of the Ganga River was violent towards its right bank between the years 1921 and 1931, and the vast river island called Bhutni Diara came to existence. This study reveals that the river was striking the Rajmahal hills along the right bank and flowing around 72 km before reaching the Farakka barrage after entering Bengal. The river failed to erode much at the right bank, as the Rajmahal Hills are mainly composed of hard rocks. Due to the construction of the Farakka barrage (between 1962 and 1971) across the Ganga River, the whole river course has been altered, and gradual meander formation has started between the Rajmahal hills and Farakka (Mukherjee, 2011). The river has widened gradually from 1973 to 2010 and subsequently the shifting of river course has continued towards the east (Fig. 2). After that, from 2010 to2018, the river has continued to flow along its left bank, passing through Manikchak, Kaliachak I, Kaliachak II and Kaliachak III Gram Panchayats (Fig. 2). The Ganga River has been flowing

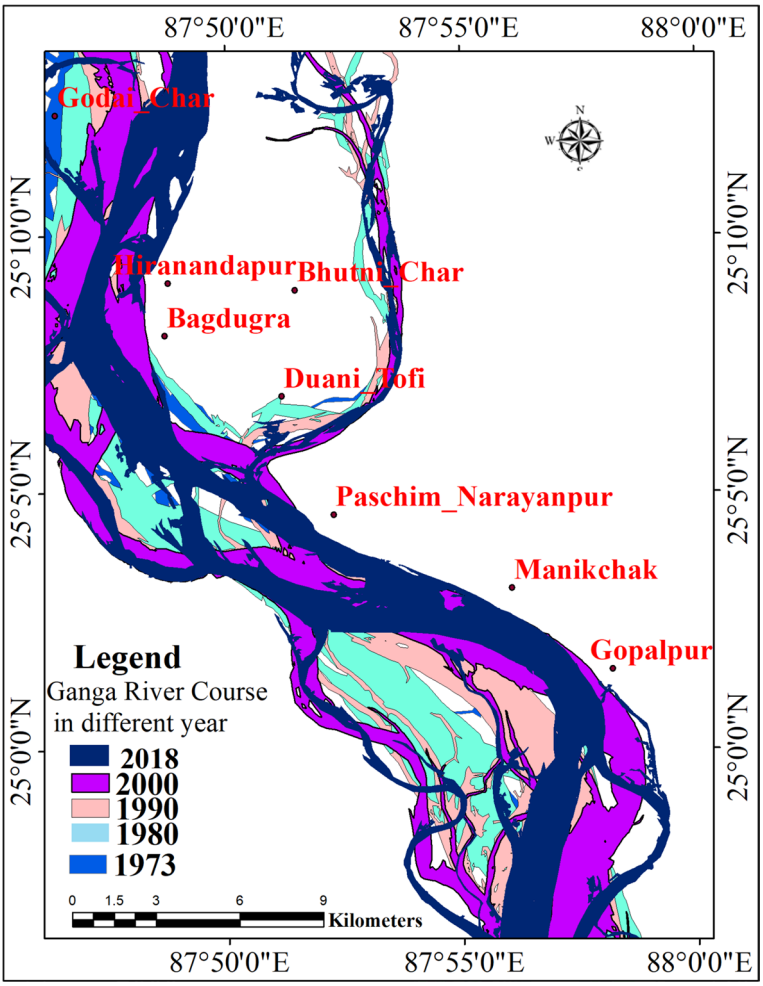

Fig. 3 Temporal shifting of the River Ganga (1973–2018) in the study area

along the eastern side of Gadai *char*, eroding the *char* on a regular basis (Fig. 3). During the rainy season, the *char* is inundated every year. After analysing satellite images from 1973 to 2018, it has been observed that the Ganga River continues to shift its bank eastward (western side of Bhutni *char*), thereby eroding villages such as Hiranandapur, Dakshin Chandipur, Gopalpur, and Dharampur, among others (Fig. 3).

According to Disaster Management Plan of Malda District (DDMC, 2020–21) in 2016, around 2100 individuals from Manikchak Gram Panchayat, 1500 people from Hiranandapur Gram Panchayat, and 200 inhabitants from Dakshin Chandipur faced devastating floods and river-bank erosion. In the year 2017, 2000 individuals from the Gopalpur Gram Panchayat, 320 people from Hiranandapur and 200 residents from Dakshin Chandipur were affected by floods and river-bank erosion. In the year 2018, approximately 1300 inhabitants from Hiranandapur, Gopalpur, and Dakshin Chandipur were affected by flood and river-bank erosion. However, in the year 2019, around 43,000 people were affected by floods

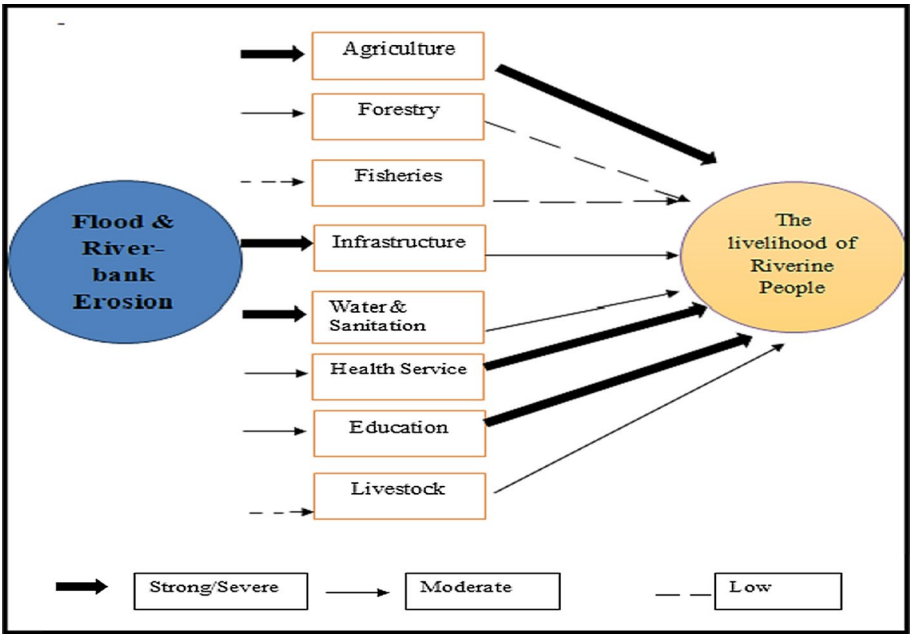

Fig. 4 Impacts of floods and river-bank erosion on different sectors in the study area

and river-bank erosion. The most severely affected villages are Godai, Rajkumartola, Santinagar, Jagannathtola, Ramnagar, Balutola, Duanir *char*, Lutihara, Gopaltola, Kamaltipur, Narayan *char*, Utsabtola, and Bhimtola, among others. The frequent shifting of the River Ganga towards its left bank and consequent bank erosion are the foremost reasons behind these devastating floods.

3.3 Impact of floods and river-bank erosion

This section will present the impact of floods and river-bank erosion on the livelihoods of the inhabitants. The floods and river-bank erosion in the study 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. They frequently have to displace their households to other places, leaving behind their homeland, which creates social instabilities and leaves them reeling under psychological distress. Due to the loss of land and resources, their income and employment opportunities are also reduced. Displaced people are compelled to resettle in open spaces, embankments, *patta*[1] lands, or other parts of the emerging *chars* or river-banks, making their lives and livelihood more vulnerable.

Figure 4 shows the severity of the impacts of floods and river-bank erosion on various sectors of the local economy such as agriculture, education, and infrastructure in the study area, which together impact the food security and livelihood of the studied households. In

[1] According to Gupta (2016) 'Patta are those lands which have been officially declared as ceiling surplus land and have not been disputed by the original owner. The receivers of patta are considered direct tenants of the state'.

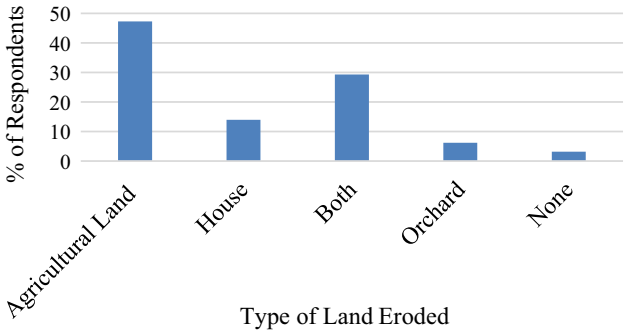

Fig. 5 Types of land eroded during floods and river-bank erosion in the study area

the study area, it has been noted that fisheries and livestock sectors remain almost safe and secure from the effects of floods and river-bank erosion. Sectors such as health, education, and forestry are moderately affected, whereas the most affected sectors are agriculture, infrastructure, water, and sanitation. In *chars* and river-bank areas, river-bank erosion most significantly affects the agricultural sector. Among these sectors, agriculture directly impacts the livelihoods of the *char* and river-bank people because most of them are engaged in agriculture as cultivators or agricultural labourers. As the households of the study area mainly depend on agriculture for a living, changes in land size significantly impact the households' food security. After the loss of their lands, they not only become homeless but also jobless. It becomes very challenging for them to get a job, which has a direct negative impact on their lives. Therefore, most people migrate to other metropolitan cities to work as wage labourers. They suffer from food shortages and homelessness. Thus, the impacts of floods and river-bank erosion on human life and livelihood are of different kinds: social, economic, education, health-related, and at times political. In the study area, economic and social impacts are particularly severe, which are discussed in the following section.

3.3.1 Economic impact

The impacts of river-bank erosion and floods are multifarious. Among them, the economic impact is severe. In terms of economic impact, inhabitants of the affected places suffer a lot. They have to move to other areas or shift their sources of income, which negatively impacts their lives and livelihoods. Agricultural lands, homes, and furniture all get washed away by the river. Loss of enormous amounts of multiple-cropped land has severe effects on mankind, as it tends to increase unemployment, creates continuous pressure on land, and increases the number of surplus labourers. All these factors collectively result in huge monetary loss.

3.3.1.1 Land loss River-bank erosion creates land loss at a large scale. Several hectares of land, including homesteads, fertile lands, and mango gardens/orchards, are washed away by the river due to river-bank erosion. In the gram panchayats such as Gopalpur, Dharampur, Hiranandapur, some people have lost more than half of their land.

Figure 5 shows the types of land which generally get eroded during floods and river-bank erosion. It has been found that around 47.31% of respondents have lost agricultural

Table 2 Shifting direction of the river Ganga and changes in land areas since the year 1980 to 2018 in Malda District

Year	Changes in Direction of the River Ganga	Changes in Land Areas (km^2)	
		Erosion	Accretion
1980–1990	Eastward	56.34	126.04
1990–2000	Eastward	59.94	74.11
2000–2010	Eastward	98.89	62.23
2010–2018	Eastward	78.83	73.73

Source: Calculated by the author

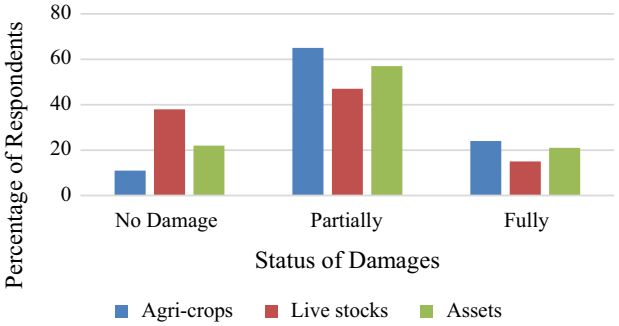

Fig. 6 Status of damage during floods and river-bank erosion in the study area

lands which forced them to shift their occupation into wage labouring. Around 14% respondent have witnessed of swallowing of their house, whereas 29.33% of households reported that they have lost both farmlands and house. Some of them (6.24%) have also lost their orchard. After detailed analysis, it has been observed that most of the households in both areas (*chars* and river-bank areas) have lost their fertile lands, which make their lives even more challenging. Some respondents have lost hundreds of bighas of farmland, and thus, they are compelled to migrate to other states for employment. After the asset and land losses that they have sustained, most marginal cultivators residing along the riverine areas have switched over to wage labour for their main livelihood, while a few are now combining marginal cultivation with wage labour to make ends meet. Because of river-bank erosion, many erstwhile cultivators in the survey area have, in many cases, been reduced to landless individuals.

Table 2 shows the transformation in the farming status due to river-bank erosion. It has been observed that individuals, who had large farms before bank erosion, have mostly become medium (28.57%), small (34.69%) or landless (30.61%) farmers. This situation is prevalent in the *char* as well as river-bank areas. After losing the fertile lands or homes, they have settled in the newly emerged *chars* and embankments. The extent of large farm holders being reduced to small or medium land holders has been recorded. With the changing status of farmland, their livelihood options have become increasingly insignificant. They face several challenges, and most of them have chosen wage labour activities as an alternative means of livelihood.

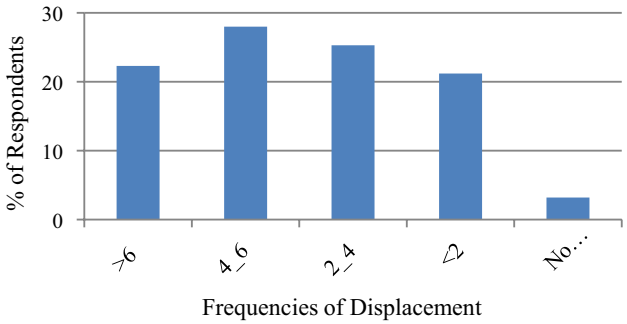

Fig. 7 Frequencies of erosion-induced displacement in the study area

3.3.1.2 Status of damage to crops, livestock, and assets Floods and river-bank erosion tend to damage assets such as property, crops, livestock, and so on. However, the intensity of damage differs from time to time. After the field survey, it has been found that 38% of respondents stated that no injuries to livestock occurred. Around 22% of respondents claimed that no damages to properties or assets have taken place (Fig. 6). Therefore, it is found that the majority of the respondents faced damage to agricultural production and household assets during the floods and bank erosion in 2019 and 2020.

3.3.2 Social impact

My family and I have shifted houses about 10 times from the river-bank, every time we tried to escape from the river, the river has caught us. (Alam Sheikh, 82 years old man, living in Gopalpur Gram Panchayat)

3.3.2.1 Displacement Among the different social impacts, one of the most critical impacts is the displacement from their birthplace. Due to frequent displacement, they have lost their source of income which makes their lives very challenging. Due to river-bank erosion, a considerable portion of land gets eroded away into the river, and the inhabitants residing there have to leave their homeland. Therefore, they resettle on the newly emerged *chars*, Bhutni char, river-bank villages (Balutola, Gopalpur, Embankment No. 7, etc.). The inhabitants of these *chars* or sandbars continuously have to relocate, which adds to their pre-existing challenges. They have to adapt to the new environment or new place. This situation also limits their livelihood options. Most of them, who earlier used to be cultivators, have become daily wage earners. The frequent displacement and relocation of the inhabitants living along the river-bank or *chars* is one of the pitiable results of river-bank erosion in the Malda district.

During field survey, it has been observed that several people residing along the river-bank or in *chars* have become homeless due to bank erosion. Around 22.24% of respondents have been displaced more than six times from their place of origin, while around 28% of respondents have been displaced four to six times. About 25.32% have been displaced two to four times, while 21.23% of households have been displaced less than two times from their birthplace (Fig. 7). According to the people, they were forced to migrate in order to remain alive under critical conditions. After calculating the result using the Kruskal–Wallis test, it has been observed that there is a significant relationship between the

Table 3 Changes in farming status due to river-bank erosion in the study area

Land ownership	% of the Households before bank erosion	At present	% of Change
Large (> 10 bigha)	98 (32.67%)	Large	6 (6.12%)
		Medium	28 (28.57%)
		Small	34 (34.69%)
		Landless	30 (30.61%)
Medium (5–10 bigha)	117 (39%)	Medium	5 (4.27%)
		Small	64 (54.71%)
		Landless	48 (41.02%)
Small (< 5 bigha)	66 (22%)	Small	28 (42.42%)
		Landless	38 (57.58%)

Source: Field survey, 2019–2020

Table 4 Relationship between farm size and frequencies of displacement of the study households

Frequencies of displacement (%)	No displacement	< 2	2–4	4–6	> 6	Total
Farm size (%)						
Landless	0	4 (1.33)	17 (5.67)	64 (21.33)	27 (9)	121 (37.33)
Small	1 (0.33)	6 (2)	34 (11.33)	53 (17.67)	0	94 (31.33)
Medium	3 (1)	15 (5)	37 (12.33)	16 (5.33)	0	71 (23.66)
Large	6 (2)	13 (4.33)	4 (1.33)	0	0	23 (7.66)
Total	10(3.33)	38 (12.66)	92 (30.66)	133 (44.33)	27 (9)	300 (100)

Source: Field survey, 2019–2020

present occupation of the households and displacement status. Frequencies of displacement are significantly high in the lower-income groups. Therefore, it can be stated that poor people get more frequently displaced. It has been found that most of the displaced people are wage labourers. Some of them are agricultural labourers in the villages such as Aswintola, Balutota, and Elahitola. Most of the people have been displaced from their source of origin.

From Table 3, it can be stated that frequencies of displacement are higher among the landless and small farm holders. After calculating linear regression in SPSS between frequencies of displacement (dependent variable) and farm size (independent variable), it is found that frequencies of displacement have increased with decrease in farm size. People who have large farms are not seen to have been displaced several times. After losing their homeland as well as agricultural lands, many people, especially from the Bhutni *char*, Dakshin Chandipur, and Uttar Chandipur, have resettled in other parts of the *char* land (Table 4).

3.3.2.2 Out-migration Out-migration is a very common phenomenon in the study area. Migrant labour is a rapidly emerging livelihood option for the *char* and river-bank inhabitants. Several small farm holders and landless people have migrated to different metropolitan towns such as Delhi, Gujarat, Kerala, Mumbai, Kolkata, Asansol, and Bardhaman. They were once engaged in agriculture, but presently, they have become wage labourers due to the

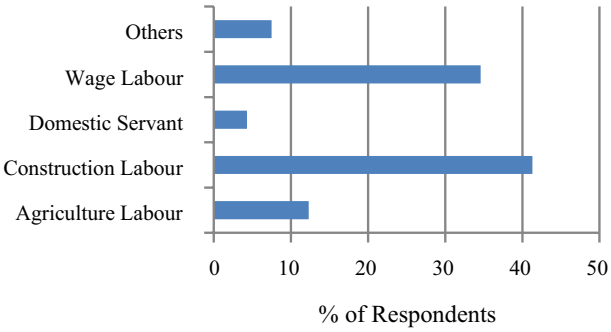

Fig. 8 Purposes of out-migration of the study households

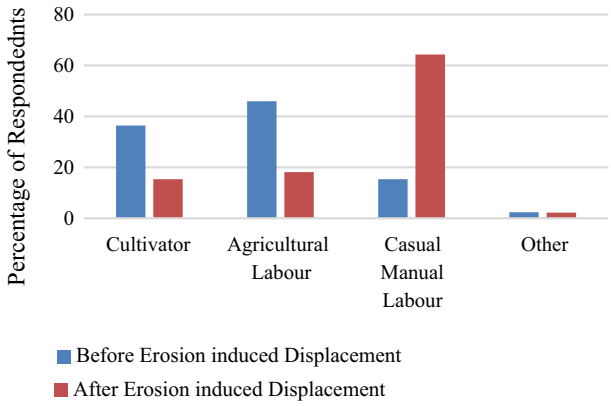

Fig. 9 Occupational shift after erosion-induced displacement in the study area

loss of their agricultural lands. In the slack period, they tend to return to their homelands. Most of the migration is seasonal or temporary in nature. People mainly migrate during the rainy season when there is acute shortage of rural work and fewer opportunities of earning a livelihood. Therefore, the migrants return after the monsoon season and when bank erosion has stopped. Sometimes, they also return when crops are harvested or the mango and litchi cultivation happens. The impact of constant losses incurred by the river-bank erosion is also a contributing factor for out-migration.

It is seen that out-migrated people from the study area are subjected to work as inter-state migrant workers, due to scarcity of local alternative jobs. They primarily work as wage labourers, construction workers, and agricultural labourers in the metropolitan cities (Fig. 8). After calculating the Mann–Whitney test in SPSS, it has been observed that the income of the non-migrated groups is statistically higher than that of the migrated group. Therefore, it can be said that people who relocate usually have lesser income than the non-migrated groups, because it is primarily the people who have lost their lands in river-bank erosion who migrate to other places in search of work. On the other hand, people who receive employment opportunities would continue to reside there.

3.3.2.3 Occupational shift After losing their land holdings, people are forced to relocate and resettle their homes in different places (newly emerged *chars*, embankments, and *patta* land). After displacement, they also lose their sources of income. Therefore, they have to shift their occupation. From Fig. 9, it can be stated that around 36.41 respondents were cultivators before the erosion-induced displacement, while around 45.92% of the respondents were agricultural labourers. However, there is a slight decrease in the number of agriculture labourers after erosion-induced displacement. A massive enhancement has been noticed in the percentage of the casual manual labourers, which was 15.34% before erosion-induced displacement, but rose to 64.33% after the displacement. According to the people's perception, the leading cause of this occupational shift is the loss of fertile agricultural lands.

After analysis the result of Mann–Whitney test, it has been found that occupational change is significantly higher in groups with more displacement. Thus, it can be said that people tend to change their occupations after frequent displacement due to river-bank erosion. After being displaced, respondents who were earlier cultivators become landless labourers or agricultural labourers, and they have to choose migration as a remedy. After changing their occupation, their income also gets reduced as the source of income becomes fragmented. The new place offers fewer employment opportunities, and therefore, they have to become daily wage earners or migrate to other cities. The study shows that they mainly choose to become migrant labourers. The reduction in the number of cultivators and agriculture labourers provides evidence of rising livelihood anguish and out-migration. The relocated families, who were once engaged in cultivation, thus lose their familiar and established means of livelihood. The families involved in riverine activities, such as fishing or boating, are also affected by the bank erosion and floods.

3.3.2.4 Social instabilities Floods and river-bank erosion not only impact people physically but also create social instabilities—mainly deteriorating their mental condition. They feel utterly insecure as they do not have any means of livelihoods, not even homes of their own. To recover from this situation, some people take loans from Samitis. Homelessness is a common phenomenon due to flood or by bank erosion. Most of the respondents from Godai *char* agree that flood triggers homeless conditions in every year in monsoon period. They frequently have to displace their households to other places, leaving behind their homeland, which creates social instabilities and leaves them reeling under psychological distress. For sustaining the economy, male members have moved outside the local area for work. Such social instabilities make their lives miserable.

The inhabitants of both areas have to endure the diverse impacts of floods and the river-bank erosion, including loss of lands, houses, livestock, and crops. Families are compelled to migrate six or seven times on an average from their original place of residence. Their houses, lands, farmlands, and belongings get washed away by the waves of the Ganga River. Every time they shift their home from the affected place, the cost of building materials incurred increases. Their household expenditures increase as they have to move to rented houses from their own residences. The unified source of family income is now divided among the male members. This journey from being cultivators to daily wage earners causes fragmentation of family bonding, reduction in per capita income, and weakening of the standard of living. Most of the respondents have become landless due to bank erosion. Some of them have small farmlands where they perform homestead gardening.

The yield is used only to feed their families. Besides cultivation, they rear domestic animals. The male members of the families are often forced to leave their families behind and migrate as labourers to cities in order to earn a living. Thus, the psychological stability of the family gets disturbed. The female members of the families are mainly engaged in *beedi*[2] making. They are not compensated for their losses in monetary terms. They are often also forced to sell their cattle due to the lack of space and finance to maintain them. Sometimes, they have to choose migration as an adaptive strategy to tackle the recurrent hazards.

The Government has taken several initiatives as protective measures to tackle floods and river-bank erosion in the study area. Some concrete embankments and criss-cross concrete pillar embankments have been constructed along the riverside to protect from further bank collapses and floods (such as Embankment 7, Dharampur embankment). Bank protection by boulder pitching and sandbags has also been attempted on the left bank of the Ganga River. A sluice gate has been made near Gopalpur village to allow the excess monsoon water in the River Ganga to pass. The land-lost poor people are provided temporary shelter, food, canvas sheets, and so on, and some families are also given *Patta* land by the Government. Some families have been enlisted under the PM Awas Yojana-Gramin (PMAY-G) and Bangla Awas Yojana. A Bhutni bridge has been constructed over the River Ganga, which connects the *chars* with the mainland—a significant initiative taken by the Government. Although the Government has taken several initiatives to reduce the impact, all these initiatives are not implemented well. There is need for quick work and a proper rehabilitation program for the poor people.

3.4 Strengths and limitation

Malda district is relatively vulnerable to floods and river-bank erosion as it is located along the Ganga River basin. Every year, a large portion of land is eroded away by the river in this area, and many people become homeless, which makes them vulnerable. However, the intensity of erosion varies with time and space accordingly. People living along the river-bank are affected by erosion, floods, but the impacts are more severe in the *char* areas. This article helps in achieving a proper insight regarding the impacts of floods and river-bank erosion on the inhabitants. This article further provides the government input to frame policies to improve the livelihood of the affected people.

There are some limitations in this study. Some secondary data such as land loss, human displacement, land ownership are not available for the study area which could help to get more insight about the impact of the river-bank erosion. The main limitation of this study is in conducting the field survey in the Godai *char* because of its physical isolation from the mainland. The only mode of transport is the boat which is also not available all the time. During the monsoon season, the whole *char* gets submerged under the river. This situation continues for three to four months every year. Therefore, it was not possible to go to survey in this *char* during the monsoon season. The lockdown due to COVID-19 also restricted the field visit that limited the availability of in depth information. However, these limitations did not affect the quality of this article.

[2] *Beedi* is a crude cigarette in which tobacco is rolled in a small *beedi* leaf (*tendu*) and tied with a cotton thread. A *beedi* is smaller and less expensive than a cigarette; it is considered the poor man's cigarette (Dharmalingam, 1993).

4 Conclusion and recommendations

River-bank erosion and floods are unpredictable, devastating hazards in the study area. Their impacts put the livelihood of the inhabitants at risk, forcing them to live lives full of uncertainty. However, all the communities prone to floods and river-bank erosion are not equally vulnerable. The impact may vary according to time and space. People living along the river-bank are affected by bank erosion and floods, but the impacts are more severe in the *char* areas. The people of the *char* are more vulnerable and prone to hazards than river-bank people due to its isolation from the mainland. However, the situation of the people residing along the river-bank is not straightforward either. River-bank erosion takes away everything from the poor inhabitants, including their homes, leaving them with no option other than migration. They are compelled to resettle in open spaces, on embankments, in areas of *patta* lands, or in other parts of the emerging *chars*, further making their lives and livelihoods vulnerable. Due to frequent erosion-induced displacement, the households who were once owners of large farms have been transformed into landless people overnight. As a result, a paradigm shift of occupational structure has become a fundamental condition of living, and most of the cultivators have become agricultural labourers or daily wage labourers. As the families of the study area mainly depend on agriculture for a living, changes in land size significantly impact the households' earnings.

The floods and river-bank erosion have hazardous impacts on the study area because of the low level of management and planning. Therefore, the Government needs to take more effective measures to reduce the impacts of floods and river-bank erosion. Besides taking preventive and protective measures, there should also be some rehabilitation and livelihood-oriented measures, which would help the vulnerable people to find their way back to mainstream society. To tackle floods and river-bank erosion, there should be a proper rehabilitation and evacuation process developed for them on a priority basis. A wider, more comprehensive plan has to be developed to manage excessive flood water passing through the Farakka Barrage, which is mainly responsible for river-bank erosion and floods in the study area. This superabundant amount of water can be used for irrigation in the fertile Malda district and also utilized to abate the water scarcity in nearby Jharkhand state. It is essential to ensure quality employment at the affected places, which would pose a barricade to the out-migration of male demography from the vulnerable areas. A specific fund under the PM Awas Yojana (Gramin) or Bangla AwasYojana should be allocated for these vulnerable people exclusively to ensure speedy house construction for them. Crop insurance coverage for this area should be increased. Malda district is covered in highly fertile alluvial land, which has enormous potential for extensive commercial farming. Thus, this area can be considered as a labour incentive area. Increasing erosion of the river-bank coupled with the floods is making the inhabitants' lives, already crippled by landlessness and poverty, increasingly challenging. Therefore, it is an undeniable fact that their lives are sailing on an ocean of uncertainty. This study helps in gaining a better understanding of the effects of floods and river-bank erosion on such residents, which will assist the Government in formulating policies to improve the livelihood of those who are affected.

Appendix

1. Name of the Respondent: 2. Mouza:
3.Religion: 4. Caste:

5. Socio-demographic profile:

Sl. No.	Name	Relation with head of the family	Age	Education Attainment	Occupation

6. Do you live in your own house? a) Yes ☐ b) No ☐
7. Type of houses: Permanent/ Semi permanent/ Temporary
8. Do any of your family members migrate to outside District/State for Work?
a) Yes ☐ b) No ☐ (Specify where…….)
i) If yes mention no. of family member ……..
9. Type of migration: Temporary/Seasonal/Permanent
10. Type of work he/she/they do: Agri-labour /Construction/Domestic Servant/Factory worker/Wage Labour/ Others
11. Time duration he/she/they back to home…….....
12. How much do you earn as daily wage ……
13. Mention the reason for migration……
14. Do you have animal livestock? a)Yes ☐ b) No ☐
15. Have you/ your family member been taken loan in the last 5 years?
a) Yes ☐ b) No ☐
16. Do you changed sowing and cropping pattern for river bank erosion or flood? a) Yes ☐ b) No ☐
17. Do you have own agricultural land? a) Yes ☐ b) No ☐
18. If yes,

Land Holdings (Bigha)	<5	5-10	>10-20	>20

19. Cultivation type: a) only for food b) sell in market c) Both
20. How much money do you earn from selling the surplus…….
21. Type of Farmers: Marginal/Small/Semi-Medium/Medium/Large

22. How many harvests do you get per year…….

23. Irrigation Facilities available : a) Yes ☐ b) No ☐

24. Source of Irrigation Facilities: a)Shallow Tube well b) Deep Tube well

25. Distance of market from field ……meter/km

26. By which transport do you take your crop to the market ……

i) If boat, is it available for all time a) Yes ☐ No ☐

27. Do you change your profession during last 30 years? a) Yes ☐ b) No ☐

i) If yes, Now ……..Then…….(Specify)

ii) If Yes, How many times you have changed during this period?

28. Have your income increase due to change in profession? a) Yes ☐ b) No ☐

Please mentioned the reason…….

29. How many times your locality facing bank erosion during last 30 years?

30. Did your land erode ever? a) Yes ☐ b) No ☐

31. If yes, type of land had eroded? a) Agricultural Land b)Household c)Horticulture land d) Other types (How much…….)

32. Status of damages made during flood and bank erosion during the last year:

Damages	No Damage	Partially	Fully
Agri-crops			
Livestock			
Homestead			
Lands/Assets			

33. Impact of river-bank erosion on different households indicators:

Indicators	At Present	Before Bank Erosion (last 30 years)
Land Size		
Main income source		
Assets		

34. Does your land submerge during Monsoon? a) Yes ☐ b) No ☐

35. No. of times your land submerge during a year. a) One b) Two c) Three d) More than three

36. Do you need to leave your home during flood? a) Yes ☐ b) No ☐

37. Do you ever shift your home from the earlier place during the last 30 years? a) Yes ☐ b) No ☐

38. How many times you have to shift your house from earlier place……

39. During that time, do you face any difficulty getting food? a) Yes ☐ b) N ☐

40. Does any bank erosion happen in other than rainy season? a) Yes ☐ b) No ☐

41. When have you faced severe flood in past? a) <5 b) 5-10 c) 10-15 d) >15 years ago

42. Rate of the frequency of the flood in every year? a) Increasing b) Decreasing c) Varies in every year.

43. Does any flood happen in other than rainy season? a) Yes ☐ b) No ☐

44. Did anyone in your family injure/die in the flood/erosion? a)Yes ☐ b)No ☐

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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