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Vulnerability Assessment of River-bank and Char People to Riparian Hazards in Lower Gangetic Basin

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Abstract

The lower reaches of the Ganga River are prone to many natural hazards such as floods and river-bank erosion, which results in the loss of land and livelihoods for riverine residents, endangering their lives and livelihoods. This article studies the differential pattern of livelihood vulnerability of two different communities, i.e., char and river-bank people in the face of floods and river-bank erosion, and also tries to identify some indigenous coping strategies of households living in the study area. The article is based on empirical research carried out in the Malda district of West Bengal. The livelihood vulnerability index (LVI) of Hahn et al. (2009) and LVI-IPCC have been used to analyse the livelihood vulnerability of these two communities. It is found that the LVI value of chars is higher than that of river-bank areas, indicating that they are more vulnerable to these hazards because of less accessibility of basic facilities due to physical remoteness from the mainland. To reduce the vulnerability, the inhabitants have adapted various adjustment strategies based on their farm category and occupation. The significant findings of this study are of high relevance to the public policies engaged in mitigating vulnerabilities and developing coping strategies.

Keywords: Floods; River-bank erosion; Livelihood; Vulnerability; LVI; Krushkal Wallis test

Introduction:

Natural hazards are becoming more frequent phenomena globally as a result of climate change. The ramifications of catastrophic hazards are often greater in developing countries due to the links between geographical location and the social, economic, and political conditions in these countries (Alcántara-Ayala, 2002).

The Ganga River being the largest river of India, causes devastation to human settlements through floods and river-bank erosion, mainly in the lower reaches. After entering Rajmahal, the River Ganga flows through the Malda district. From there, the river extensively erodes its left bank, where the river's strong water strikes the bank before making a ninety-degree bend to the south (Das and Samanta, 2022). The Farakka Barrage's proximity reduces the depth and water-holding capacity of the channel (Rudra, 2010; Mukherjee and Pal, 2018). In addition, uncurbed human interventions such as deforestation, changing land-use patterns, construction of dams, etc., have intensified the occurrence and magnitude of floods and bank erosion manifold. All of this contributes to

the left bank's erosion by the Ganga River in the Malda district. There are numerous examples of devastation caused by floods and river-bank erosion in Malda district. Approximately 103 sq. miles of land in Panchanandapur, Kaliachak, and Manikchak have been washed away by the river (Das et al., 2017). Over the last three decades, the left bank erosion of the Ganga River has displaced over 4.5 lakh people in the Manikchak, Kaliachak I, II, and III, and Ratua blocks. According to the Ganga Bhangon Pratirodh Action Nagarik Committee, the Manikchak and Kaliachak blocks have lost 750 sq. km in 30 years (Banerjee, 1999). The action of the river wipes away the lands, leaving a ruthless imprint on the socio-economic conditions of the sufferers.

The riverine people are exposed to hazards that leave a significant impact on their lives and livelihoods, and thereby make their lives vulnerable. According to Ellis (2003:3), "the term livelihood attempts to capture not just what people do to make a living, but the resources that provide them with the capability to build a satisfactory living, the risk factors that they must consider in managing their resources, and the institutional and policy context that either helps or hinders them in their pursuit of a viable or improving living." Due to river-bank erosion, resources such as land, home, livestock, and infrastructure face risk. Moreover, limited livelihood options, repeated migration, hazards, and unceasing levels of poverty increase the level of vulnerability (Kamal, 2011). Therefore, vulnerability assessment is needed to lessen the probable harm that disasters might cause (Anderson, 1995). The term 'vulnerability' has encompassed several meanings through the years as a result of the concept's evolution from a variety of academic areas (Adger, 2006). However, vulnerability is emerging as the most critical concept in disaster studies. Vulnerability is the degree to which someone's life and livelihood are endangered by a specific, recognisable occurrence in nature or in society (Blaikie et al., 1994 quoted in Hogan and Marandola, 2005: 462). According to the climate change report of the Intergovernmental Panel on Climate Change (2001: 6), "vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity." "According to United Nations Disaster Relief Organization (1980) Vulnerability is the degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude" (Cardona, 2003:7). Cutter (2010) defines vulnerability to natural hazards as the possibility of loss.

Vulnerability assessment has been taken into account in many researches on the risk and adaptation to climate change, and the majority of them understand vulnerability as a pre-existing state, while some others consider it as a consequence (Jurgilevich et al., 2017). It is necessary for disaster risk reduction initiatives to move their focus away from analysing hazard events and instead look towards minimising social vulnerabilities. A crucial step in this approach is conceptualising and evaluating vulnerability in terms of social indicators (Burton et al., 2018). The vulnerability assessment tries to determine the extent to which people are vulnerable to climate change in terms of their livelihoods. Several attempts have been made to define, measure, index, and model this vulnerability. In general, vulnerability can be assessed through either an indicator-based approach or vulnerability variable evaluations. However, the most popular method for quantifying

vulnerability related to climate change at present is indicator-based assessment (Neset et al., 2019; Hoque et al., 2019). Initially, a vulnerability framework was developed by Turner et al. (2003) based on the definition of vulnerability given by the Intergovernmental Panel on Climate Change (IPCC) to measure vulnerability. Later, an indicator-based vulnerability assessment index was generated by Hahn et al. (2009), which accounted for household adaptation strategies, which were considered necessary to comprehensively evaluate livelihood risks resulting from climate change. The vulnerability status of households was displayed using a scale from 0 (least vulnerable) to 1 (most vulnerable). Despite the fact that each major indication had a few sub-indicators, they all contributed equally to the index. All factors received equal weight. Presently, several scholars have used this indicator-based index to evaluate vulnerability in a different context (Hahn et al., 2009; Shah et al., 2013; Simane et al., 2016; Bhuiyan et al., 2017; Richardson et al. 2018; Bhattacharjee and Behera, 2018; Sarkar et al., 2019; Zhang et al., 2019; Mekonen and Berlie, 2021; Venus et al., 2022; Singha and Pal, 2022; Salman et al., 2022; Phuong et al., 2023). Some of the aforementioned literatures have noted that livelihood vulnerability caused by hazards differ geographically in diverse social groups over time. The *char* and river-bank inhabitants are very much exposed to floods and river-bank erosion that makes their lives vulnerable. However, *chars* are at higher risk because of their remote location and limited livelihood options. Families dwelling in these areas frequently suffer from the loss of their homes, domestic animals, and standing crops, which can escalate to eventually either taking their lives or compelling them to live with the constant fear of the next flood event. Therefore, it is of high relevance to analyse the livelihood vulnerability of the inhabitants living in vulnerable places such as *chars* and river-bank areas.

These hazards cause enormous harm to the livelihoods of the inhabitants of the riparian areas as well as of *chars*, although the intensity of vulnerability differs geographically. People living along the river-bank are affected by bank erosion and floods, but the impacts are more severe in the *char* areas. Therefore, this article aims to analyse the livelihood vulnerability of *char* and riparian mainland or river-bank people. This article also tries to identify the survival (short-term and long-term) strategies undertaken by the households to adjust to the vulnerability and risk aggravated by flood and river-bank erosion in *chars* and river-bank areas. The significant findings of this article are of great relevance to public policies focused on mitigating vulnerabilities and developing coping strategies.

Materials and Methods:

Study Area

The study area of this article is Malda district (Figure 1). There are fifteen community development blocks in the district, namely Manikchak, English Bazar, Habibpur, Harischandrapur 1, Harischandrapur 2, Chanchal 1, Chanchal 2, Gazol, Ratua 1, Ratua 2, Old Malda, Bamongola, Kaliachak 1, Kaliachak 2, and Kaliachak 3. Among these, Manikchak block has been selected as the study area because this block has faced several and severe floods and river-bank erosion (Table 1) which cause large-scale devastation.

The Manikchak block covers 316.39 sq. km. There are 11-gram panchayats, 89 mouzas, and 72 inhabited villages. The Ganga River enters West Bengal for the first time near the Manikchak block of the district. Physiographically, this block is a part of the Diara region. In the transitional zone between the Barind and the marshy area of Tal, the Diara is a flat terrain formed by the fluvial deposits. The Diara region is most affected by devastating

floods as it is situated along the River Ganga. Floods in the Diara region are caused by a combination of reasons such as heavy rainfall, rising water levels in the Ganga and Fulahar Rivers, embankment breaching, and a low-lying flat landscape with mild slope.

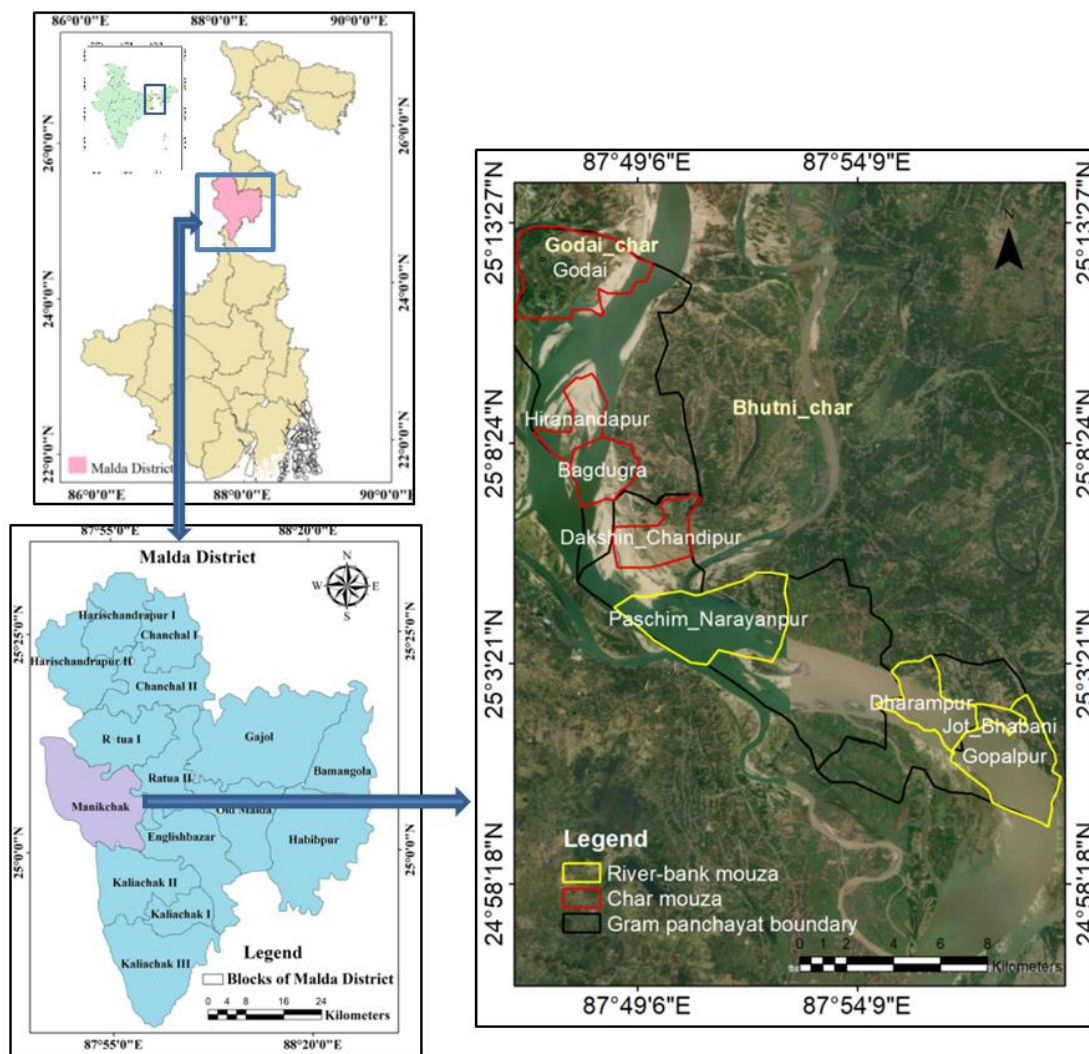


Figure 1: Study Area

Sample Size

The households have been divided into two parts, that is, *char* and riparian mainland households. In the Manikchak block, there are 11-gram panchayats, of which four-gram panchayats, namely Hiranandapur, Dakshin Chandipur, Gopalpur, and Dharampur have been selected. The total sample size for the empirical study is 340 households. Half of the sample households have been selected from *char* villages, and the remaining samples are selected from the river-bank villages based on field survey and the report of the District Disaster Management Planning Authority. Two prominent *chars*, namely Bhutni and Godai *char*, have been selected for this study. The selected mouzas from the *chars* are Godai, Hiranandapur, Dakshin Chandipur, and Bagdugra. Selected mouzas in the riparian

mainland are Gopalpur, Dharampur, Jot Bhabani, and Paschim Narayanpur. About 5 per cent of the households in each of the chosen mouzas were chosen at random.

Data Collection Methods

A field survey has been conducted to gather information on socio-demographic profile, health, water, food, natural hazards and climate variability using semi-structured questionnaire through the snowball sampling method. Focus Group Discussions (FGD) have been carried out to validate the information received from the questionnaire survey.

Data Analysis Techniques

The livelihood vulnerability index (LVI) of Hahn et al. (2009) has been used in this study to analyse the vulnerability of the households of the study area. LVI calculation includes seven major components. These are: the socio-demographic profile, health, water, food, natural hazards and climate variability. Under each major indicator, there are some sub-indicators. The LVI has been calculated using the following steps:

Step 1: The first method of calculating LVI is data standardisation. Each indicator needs to be standardised to make the dataset scale-free and direction-free. Each indicator is to be calculated on a different scale, so it is vital to standardise each component. The equation for data standardisation is:

$$\text{Index}_{sd} = \frac{S_d - S_{\min}}{S_{\max} - S_{\min}} \dots\dots\dots (1)$$

S_{max} and S_{mins} are the maximum and minimum values for each sub-indicator. These values help to standardise the dataset. For the sub-indicators, the frequencies are to be measured.

Step 2: After data standardisation, an average of the sub-indicators of each component is to be calculated using the following equation.

$$M = \frac{\sum_{i=1}^n \text{Index sdi}}{n} \dots\dots\dots (2)$$

Where, M is the main components, that is, Socio-demographic profile (SDP), Food (F), Water (W), Social Network (SN), Livelihood Strategies (LS), Natural Hazard and Climate vulnerability (NHCV). **Index_{sdi}** refers to the sub indicators indexed by i that formulate each main component; **n** represents the total number of sub-indicators in each component.

Step 3: After the values of all the major components have been calculated for the study area, they are to be averaged using the following equation to get the final LVI:

$$\text{LVI} = \frac{W_{SDP}SDP_d + W_{LS}LS_d + W_{SN}SN_d + W_HH_d + W_FF_d + W_WW_d + W_{NDC}NDCV_d}{W_{SDP} + W_{LS} + W_{SN} + W_H + W_F + W_W + W_{NDC}} \dots\dots\dots (3)$$

Where, LVI is the final Livelihood Vulnerability Index of the study area, the weighted average of all seven major components. Here weight is determined by the number of sub-indicators.

Equation-4 was utilized to combine the three dimensions by producing the LVI (IPCC) following the computation of exposure, sensitivity, and adaptive capacity.

$$\text{LVI - IPCC} = (\text{Ed} - \text{Ad}) * \text{Sd} \dots\dots\dots (4)$$

Where, LVI-IPCC = the level of vulnerability of a community using the IPCC framework; Ed = score calculation from community exposure; Ad = score of adaptive capacity of a community; Sd = score of sensitivity of a community

Krushkal Wallis H test

On a three-point Likert scale, the degree of livelihood vulnerability was identified and the responses were arranged into groups. The mean difference between groups of adaptive capacity indicators was used to calculate the rate of livelihood vulnerability using the Kruskal-Wallis H test. One of the best ways to evaluate the relationship between nominal and ordinal variables is to use the Kruskal-Wallis H test (Khan et al., 2021).

Variables	Unit
Dependent	
Level of livelihood vulnerability	Ordered;0=Low, 1=Moderate;2=High
Independent	
Age group	<60=0; >60=1
Attended school	Yes=1; No=0
Dependent person	Yes=1; No=0
Grow crops	Yes=1; No=0
Rear livestocks	Yes=1; No=0
Agricultural sources as main source of income	Yes=1; No=0
Wage labour as other source of income	Yes=1; No=0
Access to support form relatives	Yes=1; No=0
Access to support form government	Yes=1; No=0
Variables	Unit
Dependent	
Level of livelihood vulnerability	Ordered;0=Low, 1=Moderate;2=High
Independent	
Age group	<60=0; >60=1
Attended school	Yes=1; No=0
Dependent person	Yes=1; No=0
Grow crops	Yes=1; No=0
Rear livestock	Yes=1; No=0
Agricultural sources as main source of income	Yes=1; No=0
Wage labour as other source of income	Yes=1; No=0
Access to support form relatives	Yes=1; No=0
Access to support form government	Yes=1; No=0

Results:

General description of the households

Table No. 1 lists the respondents' most essential socioeconomic characteristics from the study area. The majority of households in both areas are found to be led by men. The

majority of houses in both areas are inhabited by three to five people. In char regions, the percentage of illiterate household heads is close to 52%, whereas in river-bank areas, it is closer to 41.3%. Aside from this, the majority of the heads in both communities have simply completed their primary schooling. Although farming was the primary source of occupation, the majority of respondents in both areas are wage workers. The majority of the household became landless as their land was lost to erosion, and they either moved to other locations in search of employment or worked as wage labour.

Table 1: Socio-economic profile of the study households

Age of the HH Head	Char HHs	Riverbank HHs
< 25 years	5.25	4.2
25-50 years	16.40	21.4
50-65 years	42.10	44.15
>65 years	36.25	30.25
Family Size		
<3	22.50	27
3_5	42.25	50.6
>6	35.25	22.4
Education		
Illiterate	52.56	41.3
Primary	34.11	37.46
Secondary	12.10	17.1
Higher secondary	1.23	4.14
Main occupation		
Agriculture and allied activities	34.35	17.3
Wage labour	59.25	65.1
Petty business	4.10	11.3
Others	2.30	6.3

Livelihood Vulnerability Assessment of the Studied Households:

Exposure

Exposure includes elements of natural hazards and climatic variability. The livelihood vulnerability index result showed that, in terms of exposure, river-bank households are less vulnerable than char dwellers. It is found that both the communities, that is, *char* and river-bank people are vulnerable to bank erosion and floods. However, the *char* people are more vulnerable to hazards because of less accessibility of basic facilities due to physical remoteness from the mainland. Chars are affected by an annual flood as well as erosion risk every consecutive year. Char dwellers have faced severe damages due to hazards. However, the houses along the riverbank have also suffered losses due to land loss.

Sensitivity

Sensitivity includes components such as health, water and food. Results depicted that char dwellers was found to be the more vulnerable to health facilities. Sub component score indicated that the most health vulnerability in term of the households' not getting treatment from a qualified doctor had most in chars, this situation makes the lives of the inhabitants truly heartrending. During any critical health emergency, they have to go to

the district hospital, which is about 11 km away. In the riparian mainland, villages such as Gopalpur and Dharampur have nearby health centres where primary treatments are done.

People have suffered for food during the crisis period. This is an important factor to measure vulnerability. The indexed value of food is greater for *char* households than the riparian mainland households (Table 2), since most families in *chars* fail to save food or grains for the future because they practice subsistence agriculture. The role of livestock in food is also negligible overall. Other than that higher sensitivity for water was found in the *chars* as most of them have used hand pump water. In both areas, people have to suffer to get safe drinking water. While conducting the survey, it has been found that percentage of families drinking arsenic-contaminated water is lower in the riparian mainland than in the *chars* as there are some tap water connections. However, most of the respondents from the riparian mainland use hand pump as a source of drinking water because adequate numbers of piped water connections are not available there and these tube wells are mostly Iron and arsenic-contaminated.

Adaptive capacity

Components such as socio-economic profile, livelihood strategies and social network are all included in the adaptive capacity. Findings noted that the river-bank households have higher adaptive capacity than *char* dwellers. There is a significant difference found between the socio-demographic profile of the *char* and riparian mainland households (Table 2). In the *chars*, the dependency ratio is more than that of the riparian mainland households, which means that the percentage of elderly people and children is higher. They are not working and are solely dependent on the earning members of the family. Most of the household heads have never attended school for education. In *chars*, people get less assistance from others. The percentage of people borrowing money from others is more in the riparian mainland than the *chars*. However, they have inadequate access to financial institutions. Social networks among the residents are not well established. The *char* households are mainly dependent on agriculture and allied activities and at times on livestock farming. However, due to the fragmentation of farmland the produced crops are only used for fulfilling their own needs.

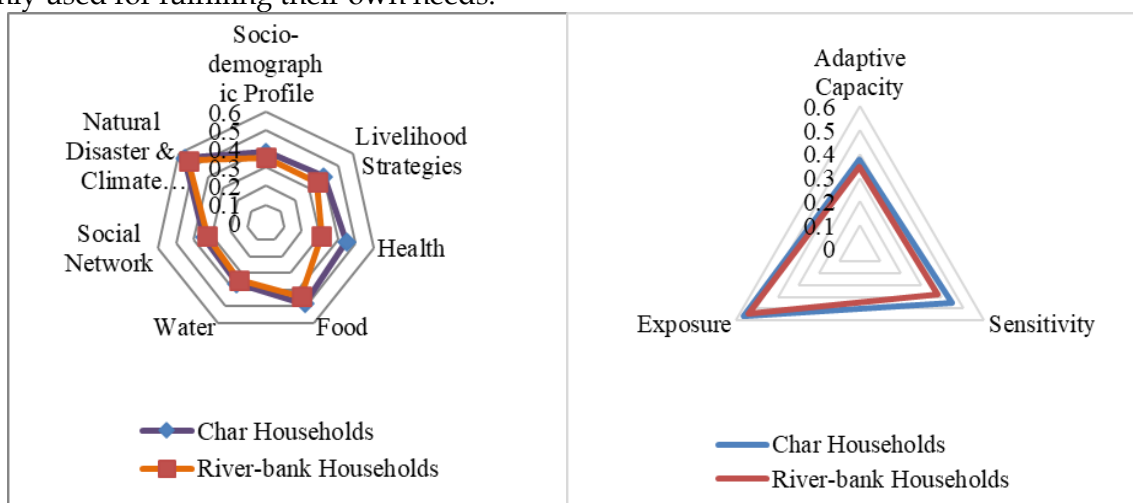


Figure 2: Factors of vulnerability

The livelihood diversification index is almost similar in both areas, as they are engaged in more than one occupation. They have been growing crops, rearing animals, collecting natural resources (such as crop residue, forest fuel), and working as migrant workers. Landless farmers have chosen to migrate to different cities or states to work as wage labourers. Only farmers with large farmlands have retained their occupation. People from the riparian mainland households are mainly wage labourers. In *chars*, most of them are agricultural labourers. In the *chars* (0.74), the percentage of migrant workers is more than that of the riparian mainland area (0.67) because most of the farmers become landless and are left with no choice except migration, making their lives more vulnerable. It is noticed that there are several cases of dispute among the inhabitants regarding reclamation of their lost land after it becomes re-emergent.

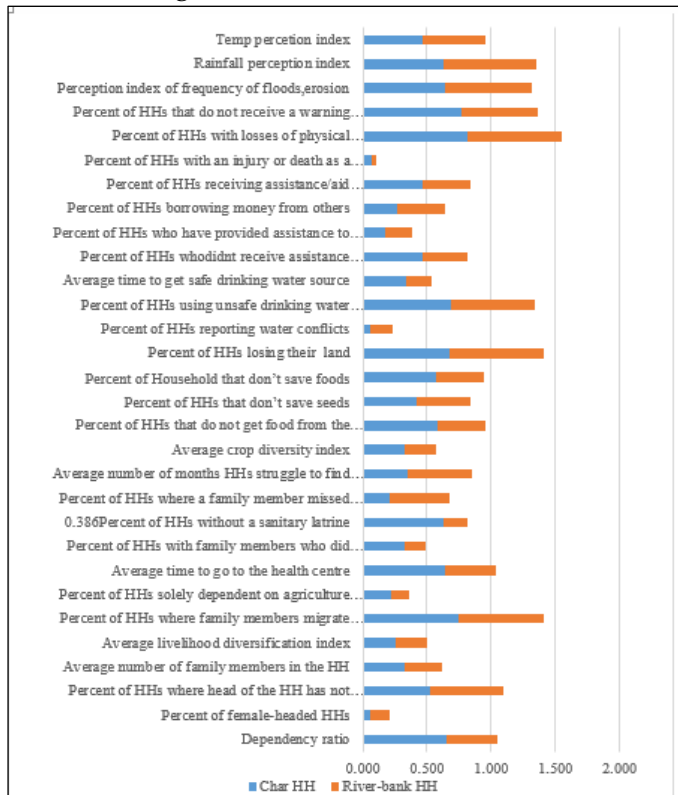


Figure 3. Proportions of the sub-components within IPCC-dimensions

a.



b.



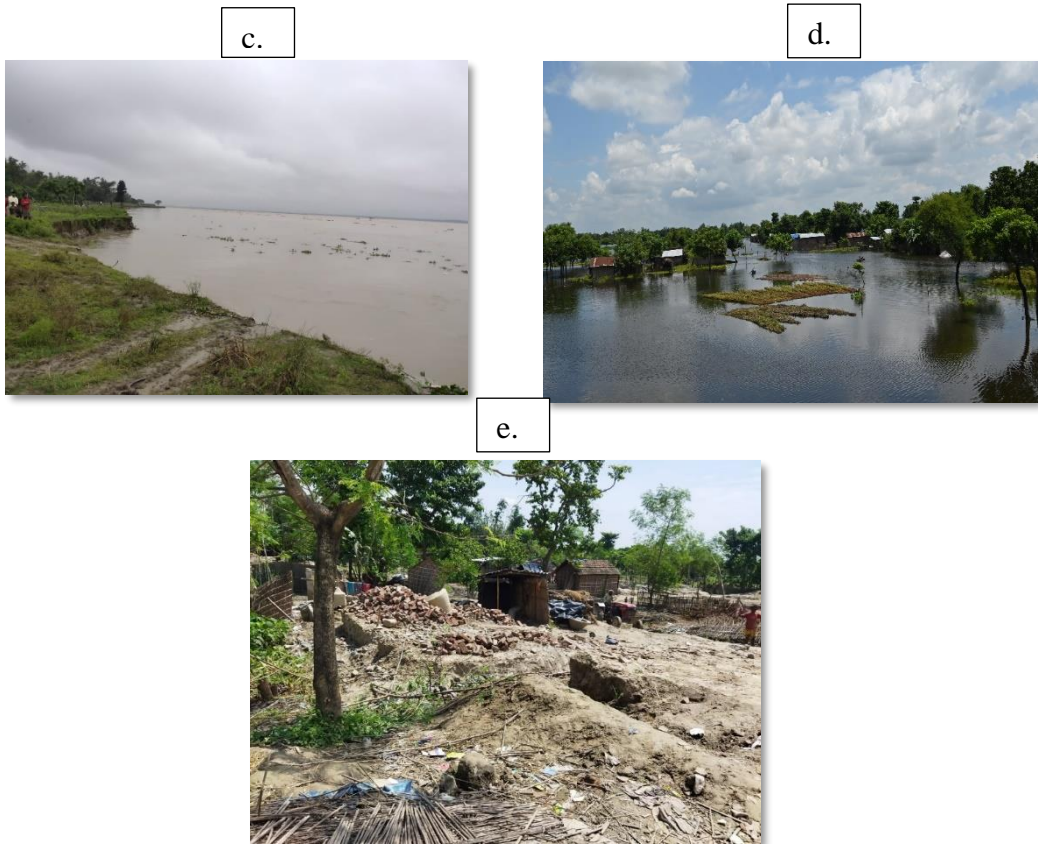


Fig: (a & b) Glimpses of flooding and river-bank erosion in the riparian villages and (c & d) in the char villages; (e) House demolition by their own and take the house building materials to safer place to reduce the vulnerability of erosion

Determining the Role of Different Indicators of the Adaptive Capacity in the Livelihood Vulnerability:

Table 4 provides evidence of livelihood risk among the study families resulting from natural hazards, based on the mean rank of the components of adaptive capacity. Accordingly, there was evidence that families headed by non-schooling persons were more susceptible to threats to their livelihood, as demonstrated by their higher mean rank in both locations (char households, $\chi^2 = 21.37$, p value 0.000), and river-bank households, $\chi^2 = 54.62$, p value 0.001). A greater mean in chars ($\chi^2 = 71.49$, p value 0.01) was also frequently observed in houses with dependent people, indicating considerable livelihood vulnerability. Consequently, the absence of crop-growing households was shown to be associated with a higher mean rank in the chars ($\chi^2 = 38.32$, p value 0.000) and river-bank ($\chi^2 = 17.987$, p value 0.001) areas, suggesting a higher level of livelihood vulnerability. In the same way, households with no primary source of income from agriculture were found to be more vulnerable to changes in their livelihood, with a greater mean in chars ($\chi^2 = 14.37$, p value 0.001). In addition, a higher mean rank in chars ($\chi^2 = 49.23$, p value 0.001) was seen for the households without access to local government services, suggesting a higher risk of livelihood vulnerability. Households who solely depend on wage labour experience greater livelihood vulnerability in regions like riverbank areas ($\chi^2 = 11.42$, p value 0.01) and chars ($\chi^2 = 13.004$, p value 0.001).

Table 2: Result of Krushkal-Wallis test:

Characteristics	Char Households			River-bank Households		
	Mean Rank	χ^2	p value	Mean Rank	χ^2	p value
Age						
<65	87.11	1.82	0.177	87.44	1.098	0.295
>65	78.04			79.65		
Attended school						
Yes	67.1	21.37	0.00	61.37	54.62	0.001
No	97.02			112.56		
Working in a different community						
Yes	73.8	5.982	0.014	66.92	27.49	0.002
No	89.9			101.25		
Dependent Person						
Yes	101.02	71.49	0.01	85.41	0.001	0.977
No	41.42			85.62		
Grow crops						
Yes	62.32	38.32	0.00	71.23	17.98	0.001
No	102.27			99.11	7	
Rear Livestock						
Yes	69.76	18.64	0.02	76.4	24.14	0.002
No	97.57			114.13	5	
Agri. Source main source of income						
Yes	67.06	14.37	0.001	67.85	16.99	0.003
No	92.57			95.49	6	
Wage labour						
Yes	90.94	11.42	0.01	93.35	13.00	0.001
No	66.68			67.65	4	
Access to support from relatives/ friends						
Yes	80.47	0.556	0.456	90.54	1.948	0.163
No	85.4			81.33		
Access to local government services						
Yes	63.32	44.29	0.001	92.86	5.786	0.016
No	106.27	3		77.02		

Discussion:

In order to analyze the livelihood risk of riverine people, this research was conducted among char and river-bank dwellers in the Malda district, which is situated in the lower Gangetic basin. This study also looks for indicators of adaptive capacity that affect households' vulnerability to disasters. The finding shows that both the households are very

much vulnerable to hazards because every year, an extensive amount of river bank cutting and population movement from the villages near the Ganga river occurs due to the high and frequent rate of erosion of river banks (Iqbal, 2010; Thakur et al. 2011;). The majority of the erosion victim area upstream is located in Malda district, primarily in four blocks: Manikchak, Kaliachak-II, Kaliachak-III, and Ratua-I. This river bank erosion hazard has been eroding a significant area since the 1960s (Thakur et al., 2011). According to Majumdar and Pal (2018) and Talukdar et al. (2020), the river generates significant land loss and related vulnerabilities because of its flow dynamics and the fragile thin silt layers it has near its mouth. Every year, they prepare themselves to endure the loss and to relocate their house to a different place. They not only lose their lands and homes, but also their sources of income, which pushes their lives into economic disaster subsequent to natural hazards (Mukherjee, 2011; Rudra, 2010; Mandal et al., 2019). Therefore, river-bank erosion and floods wreak havoc on all aspects of the lives of inhabitants of both areas simultaneously. However, due to the remoteness, physical separation from the mainland, and lack of resources, char inhabitants are thought to be more susceptible. These findings are corroborated by Alam et al. (2017), who state that people living in Char are the most impoverished and vulnerable to natural disasters. Due to inadequate transportation and communication networks, they are also less able to access services and related benefits than people living on mainland (Talukdar et al., 2020). Sarker et al. (2019) also reported that the terrible erosion of river banks has caused the char dwellers to lose a significant quantity of agricultural land annually.

Besides exposure, sensitivity (food, water, and health) and adaptive capability (socio-demographic profile, livelihood strategies, and social networks), are elements that impact a household's susceptibility (IPCC, 2007). Even in the same place, a household's ability to restart their livelihood follows a different path depending on its own capacity, even while exposure is similar (Cardona and Barbat, 2000). The study findings identified that the households who have more capacity to adjust, are less vulnerable to the severe impacts of hazards. Most of the people have adopted different strategies depending on their income status, educational level, farm category, occupation and available information. Although the poor people have adopted several strategies, they have reported that some barriers such as lack of public provisioning of services and support prohibit them from adjusting effectively. Results also demonstrated that The riparian mainland households have comparatively better adaptive capacity owing to various reasons, such as more opportunities to diversify their income, relatively less reliance on agriculture, small dependency ratio, higher education level, and improved connection to transportation and other services than *char* households. These help them to lessen their level of vulnerability. Madhuri et al. (2015) also acknowledged that there are differences amongst the families' absorptive capacities to withstand or mitigate the distress produced by disasters, as well as how they employ their adaptive capacities to modify and sustain their way of life. The most susceptible households in terms of their means of subsistence were those with the lowest adaptive capacity as well as the most sensitivity and exposure, according to further studies (Tashmin et al., 2018; Azam et al., 2019; Hoq et al., 2021; Khan et al., 2022).

Results also indicated that char households have less access to food, health and social network which make them more sensitive. In *chars*, people get less assistance from others. The percentage of people borrowing money from others is more in the riparian mainland

than the *chars*. Social networks among the residents are not well established. Financial institutional facilities such as Bandhan Bank, Samitis, and Self Help Groups are absent in the Godai *char*. So they are unable to borrow money for their immediate needs. In Godai *char*, there are no health centres or hospitals. The inhabitants of the Godai *char* get medical facilities from either Bhutni hospital or Sahebganj. For any health emergency, they have to travel a long distance to arrive at the health centres. Moreover, most of them prefer the traditional systems of treatment over going to local doctors. Therefore, this situation makes the lives of the inhabitants truly heartrending. In the Bhutni *char*, there is one rural hospital and some sub-health centres where primary treatments are done. In the riparian mainland, villages such as Gopalpur and Dharampur have nearby health centres where primary treatments are done. Since most families in *chars* fail to save food or grains for the future because they practice subsistence agriculture. During the rainy season these households often move to a safer place, less at risk from flooding and bank erosion. The role of livestock in food is also negligible overall. The char people asserted that insufficient access to money, property, and resources for both agriculture and non-agricultural uses, as well as poor access to food, water, and health care, are the main causes of livelihood vulnerability in the char region (Singha et al., 2020; Hossain et al., 2020). Other studies also reported that lack of health, education, food and transport facilities hinder the development of the char dwellers.

However, the significant findings of this research are relevant to the government's active involvement in flood and bank erosion control programmes. Using LVI analysis, the government can identify the most vulnerable areas and supply basic amenities following their needs as an improvement plan to strengthen the households' capacity to respond to flooding and bank erosion. Moreover, by addressing the basic needs of the households and providing improved health and sanitation facilities, the government can reduce their vulnerability and improve their revival rate. A broad LVI assessment thus can be helpful to identify and assess the vulnerability of all the households and to provide essential services and infrastructure to reinforce the ability of the households to conquer challenges posed by these hazards. The severe vulnerability of river-bank and *char* communities to natural hazards requires site-specific adaptation in order to safeguard the lives and means of subsistence of the vulnerable people.

Conclusion:

This research study attempted to assess the livelihood vulnerability of *char* and river-bank residents using an indicator-based livelihood vulnerability index. After this comprehensive analysis, it can be concluded that the *char* households are more vulnerable than the river-bank households, because the riparian people benefit from diversified income options, better health facilities and infrastructure accessibility, and have low dependency on agriculture. However, riparian people are also vulnerable because of their relatively low livelihood status. These are the consequences of natural hazards such as floods and river-bank erosion, which make the poor people increasingly vulnerable. Generation after generation, people are engaged in shifting their homes and finding suitable conditions for sustenance. Thus, it can be said that this creates a vicious cycle of poverty. Despite the severe impact of flood and bank erosion, the poor people sustain and enhance their livelihoods through various coping and adjustment strategies. Therefore, substantial assistance from the government would be needed to improve their situation. The new state

policy should focus on enhancing the accessibility of water, transport, medical facilities, and livelihood diversification. These would help to improve adaptive capacity and make their lives less distressed.

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