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Adapting but Not Escaping: Community Adaptation Amid Persistent Vulnerability to Riverbank Erosion in Majuli, India

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Article

Keywords:

Posted Date: November 6th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11619379/v1

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Additional Declarations: No competing interests reported.

Abstract

Purpose: This study examines community adaptation strategies to riverbank erosion and their perceived effectiveness in erosion-prone areas of Majuli Island, Assam, India. Design/methodology/approach: Primary data were collected from 250 households across five erosion-prone sites—Salmara Site-I, Salmara Site-II, Ahataguri, Bhakat Chapori, and Kamalabari—using a structured questionnaire, supplemented by key-informant interviews with village heads. Findings: Riverbank erosion affected 73.2% of households, mainly through agricultural land loss (47.0%), house damage (32.2%), and displacement (20.8%). Households adopted structural measures, including raised plinths, stilt houses, sandbags, bamboo porcupines, and vegetation-based stabilization; livelihood measures, including income diversification, wage labour, fishing, seasonal migration, and crop diversification; and spatial measures, including relocation, land abandonment, and settlement shifting. Structural adaptations were perceived as most effective (44.8%), followed by livelihood (33.3%) and spatial adaptations (21.9%). Adaptation remains largely self-financed and constrained by financial limitations, continued erosion, shortage of relocation land, inadequate institutional support, and limited technical knowledge. Originality: The study provides household-level evidence on the nature, effectiveness, and constraints of community-led adaptation to riverbank erosion in Majuli, highlighting priorities for strengthening long-term resilience. Research limitations/implications: The findings are based on perceptions of affected households and may not capture all adaptation practices across the island. Practical implications: Strengthening durable riverbank protection, financial and rehabilitation support, livelihood diversification, and institutional involvement is essential for enhancing community resilience.

1. Introduction

Riverbank erosion is among the most persistent environmental hazards affecting riverine communities in the Brahmaputra basin of Northeast India. Beyond its immediate geomorphological impacts, recurrent erosion produces cumulative losses of agricultural land, settlements, infrastructure, and livelihood assets, thereby generating prolonged socio-economic vulnerability among exposed households (Bhuyan et al., 2024; Deka et al., 2024). In the context of riverbank erosion, adaptation refers to the adjustments made by individuals, households, and communities to reduce exposure and sensitivity to erosion-induced losses and to strengthen their capacity to cope with recurrent environmental change. Such responses may include structural protection of homesteads, livelihood diversification, and spatial adjustments etc. Community-based adaptation has received increasing attention in disaster risk reduction and climate adaptation research because local and Indigenous knowledge systems often provide context-specific strategies for responding to environmental hazards (Petzold et al., 2020; IPCC, 2023). Majuli Island has experienced recurrent riverbank erosion for several decades, resulting in substantial land loss and repeated displacement of households. Recent research demonstrates that changing land use and land cover, together with persistent flood and erosion processes, have contributed to the progressive relocation of populations toward the northern and eastern parts of the island (Deka et al., 2024). Communities in Majuli, including the Mising, Bodo, Deori, Kachari, and Kaibarta groups, have developed a wide range of adaptation strategies to reduce the impacts of riverbank erosion. Structural and nature-based measures include bamboo porcupines, temporary embankments, raised plinth houses (*chang ghar*), and vegetation-based bank stabilization. Such practices reflect locally embedded knowledge and long-standing experience of living with a dynamic river environment (Borah et al., 2023; Kashif et al., 2023; Deka et al., 2024). Livelihood adaptations, including crop diversification, wage labour, fishing, seasonal migration, and engagement in multiple income-generating activities, have also become increasingly important for reducing dependence on erosion-prone agricultural land (Bhuyan et al., 2024). In addition, house relocation and settlement shifting have emerged as significant spatial responses to recurring land loss and household displacement (Deka et al., 2024). However, the effectiveness and sustainability of these adaptation strategies are shaped by socio-economic, institutional, and environmental factors, including access to financial resources, government assistance, community participation, early warning systems, and the physical stability of riverbanks. Geotechnical assessments of erosion-prone sites around Majuli indicate that low shear strength and moisture ingress contribute to bank instability, highlighting the limitations of household-level adaptation in the absence of durable engineering and institutional interventions (Dutta et al., 2023; Karmakar et al., 2025). Limited institutional support, inadequate financial capacity, and repeated erosion often constrain the adaptive capacity of vulnerable households, consistent with broader evidence that poverty, inequality, and insufficient adaptation finance create soft limits to adaptation (IPCC, 2023). Therefore, assessing existing adaptation practices and evaluating their effectiveness are essential for strengthening community resilience and informing sustainable riverbank management policies in Majuli Island.

2. Study area

Majuli Island is located in the upper floodplain of the Brahmaputra River in Assam, northeastern India (Fig.1). It was declared a district in 2016, making it the first river island district in the country. The area is lies between of 26°45' North to 27°12' North and longitudes 93°39' East to 94°35' East with 85 to 90 meters of elevation from the mean sea level (MSL), It is bounded by the mighty Brahmaputra in the south and its tributaries i.e. Subansiri in the west, Lohit in the north and Khersuti in the east respectively (Saikia, 2018). Globally recognized as the world's largest inhabited river island and cultural hub of Assam. Majuli is the land of total 167,304 population according to the 2011 census.

3. Research Methodology

The study adopted mixed-based research approach and uses predominantly primary data for assessing community adaptation in Majuli. Data were collected through household visit in five key erosion prone regions of Majuli. A Semi-structured questionnaire has prepared to understand the pattern and ways of adaptation that adopted by the communities. The study was conducted from March 2026 to April 2026. A total of 250 households were surveyed from five erosion-prone sites in the south riverbanks (highly vulnerable) in Majuli Island i.e. i) Salmara site-I, ii) Salmara site-II, iii) Kamalabari, iv) Bhakat Chapori and v) Ahataguri, with 50 households selected from each site. The study sites were purposively selected on the basis of their exposure to recurrent riverbank erosion, whereas households within each site were selected using simple random sampling. The household head or an adult member with adequate knowledge of household livelihoods and erosion-related experiences was considered the primary respondent. To complement the household survey, key-informant interviews were conducted with *Gau Pradhans* (village heads) to obtain additional insights into community-level adaptation practices, local

institutional arrangements, and erosion-related vulnerabilities. To analyse further, the quantitative data collected from the direct field study Microsoft excel were used for tabulation and data visualization and interpretation.

4. Results and Discussion

4.1 Extent and Impacts of Riverbank Erosion on Households

Riverbank erosion has emerged as a recurrent environmental hazard in Majuli Island, affecting both the physical landscape and the socio-economic conditions among the communities. The continuous shifting of river channels and progressive erosion of riverbanks have resulted in the loss of agricultural and homestead land, damage to property, displacement of settlements, and disruption of livelihoods[7,2]. Although the intensity of erosion varies across different parts of the island, its impacts are experienced most severely by households located in close proximity to the riverbanks. Previous studies have similarly reported that erosion-induced land loss in Majuli has contributed to permanent displacement, declining agricultural capacity, and increasing socio-economic marginalization.

4.2 Households Affected by Riverbank Erosion

The extent of household exposure to riverbank erosion was assessed to understand the necessity and intensity of adaptation practices across the five selected study sites. Table 1 presents the site-wise distribution of households affected by riverbank erosion. The results reveal that 73.2% of the surveyed households (183 out of 250) had been directly affected by riverbank erosion. The proportion of affected households varied considerably across the study sites, indicating spatial heterogeneity in erosion exposure. Salmara Site-I recorded the highest proportion of affected households (84.0%), followed closely by Salmara Site-II (80.0%) and Ahataguri (74.0%). In contrast, Bhakat Chapori (68.0%) and Kamalabari (60.0%) reported comparatively lower levels of household exposure (Table 1, Fig. 2). The higher concentration of affected households in the Salmara site I and II reveal the on-ground reality of greater proximity to actively eroding riverbanks and greater exposure to channel migration and seasonal high-flow conditions. By contrast, the relatively lower proportion of affected households in Kamalabari reflect a comparatively greater distance from the active erosion front, more stable bank conditions, and the influence of existing protective measures. The observed spatial variation in erosion exposure indicates that the consequences of riverbank erosion are not uniform across Majuli Island. Therefore, the site-specific assessment of erosion impacts is essential for identifying priority areas for intervention, understanding the magnitude of household vulnerability, and designing context-specific adaptation and riverbank-management strategies.

4.3 Major Impacts of Riverbank Erosion on Households

To assess the severity of riverbank erosion, affected households were asked to identify the single most significant impact experienced by their household. The responses reveal considerable spatial variation in the dominant forms of erosion-induced damage across the five study sites. The major impacts reported by affected households were classified into three categories: agricultural land loss, house damage, and displacement or relocation. The results indicate that agricultural land loss was the most significant impact of riverbank erosion, reported by 47.0% of affected households (Table 1). The highest proportion of households reporting land loss was recorded in Salmara Site-I (52.4%) and Salmara Site-II (50.0%), indicating that erosion in these locations has severely affected cultivable land and, consequently, agriculture-based livelihoods. House damage was the second most frequently reported impact, accounting for 32.2% of responses, while displacement or relocation was reported by 20.8% of affected households.

Table 1: Site-wise distribution of erosion-affected households and major impacts of riverbank erosion in Majuli Island

Study site	Affected households (n)	Unaffected households (n)	Total respondents (n)	Households affected (%)	Agricultural land loss n (%)	House damage n (%)	Displacement/relocation n (%)
Salmara Site-I	42	8	50	84.0	22 (52.4)	13 (31.0)	7 (16.6)
Salmara Site-II	40	10	50	80.0	20 (50.0)	12 (30.0)	8 (20.0)
Ahataguri	37	13	50	74.0	17 (45.9)	12 (32.4)	8 (21.7)
Bhakat Chapori	34	16	50	68.0	15 (44.1)	11 (32.4)	8 (23.5)
Kamalabari	30	20	50	60.0	12 (40.0)	11 (36.7)	7 (23.3)
Total	183	67	250	73.2	86 (47.0)	59 (32.2)	38 (20.8)

Data Source: Primary survey, 2026 (n=183)

The field survey further revealed that erosion-related losses were often cumulative rather than isolated events. Several respondents reported losing substantial areas of agricultural land and relocating their households six to seven times during the preceding 10–15 years. Respondents from the Salmara and Ahataguri area stated that approximately 150–200 houses had been shifted to alternative locations over the past 20–25 years because of recurrent riverbank erosion. These accounts highlight the prolonged and repeated nature of erosion-induced displacement in the study area. Photographic evidence of active riverbank erosion and its impacts on settlements and agricultural land is presented in Plate 1. The findings indicate that the loss of cultivable land remains the primary concern among erosion-affected communities in Majuli. Because agriculture constitutes an important source of income and food

security for many households, the loss of productive land increases economic insecurity and often compels households to diversify their livelihoods through wage labour, fishing, migration, or non-farm activities. Similarly, recurrent house damage and displacement increase household expenditure and reduce the capacity of families to invest in long-term adaptation. These impacts therefore influence the adoption of adaptation measures, particularly livelihood diversification, structural protection of homesteads, and relocation to comparatively safer locations.

4.4 Community Adaptation Strategies

In Majuli, different communities have developed a range of adaptation measures to minimize the adverse impacts of riverbank erosion. These practices have evolved through prolonged local experience and repeated exposure to erosion and flood hazards, reflecting the importance of Indigenous and local knowledge in shaping context-specific responses to environmental change (Dey, 2012; Petzold et al., 2020; Kashif et al., 2023). The adaptation strategies adopted by households and communities can be broadly categorized into structural and non-structural measures, livelihood-based measures, and spatial measures. The selection of a particular strategy generally depends on the type, severity, and recurrence of erosion impacts experienced by the household, as well as on the availability of local materials, labour, and financial resources (Bhuyan et al., 2024; Deka et al., 2024). Similar patterns have been observed among riverine communities in Majuli, where recurrent flooding, erosion, and declining agricultural productivity have encouraged livelihood diversification, temporary mobility, and relocation as important coping responses (Pegu, 2018; Saikia, 2016; Baruah, 2024).

4.4.1 Structural and Non-Structural Adaptation Measures

Structural and non-structural adaptation measures refer to the physical and non-physical interventions undertaken by communities to reduce the impacts of riverbank erosion and protect settlements, agricultural land, and household assets. In Majuli, communities largely depend on locally available materials, traditional knowledge, and collective labour to implement such measures (Dey, 2012; Kashif et al., 2023). According to the local communities, these practices are low-cost and locally feasible, although their effectiveness may be limited in the context of severe or recurrent bank retreat (Dutta et al., 2023; Karmakar et al., 2025). As shown in Table 2 and Fig. 3, raised plinth or stilt houses were the most widely adopted structural adaptation measure, reported by 41.5% of affected households. The prevalence of elevated housing reflects the combined threat of riverbank erosion and seasonal flooding, which frequently damages low-lying settlements. By raising the dwelling platform above the surrounding ground level, households seek to reduce the risk of structural damage, protect household assets, and maintain safety during flood events. This practice is closely associated with the traditional *chang ghar* of the Mising community (Sarma, 2026), which is constructed on bamboo or timber stilts using locally available materials and represents an important Indigenous flood-adaptation strategy (Dey, 2012; Pegu, 2018; Kashif et al., 2023). Sandbags and temporary bunds were reported by 26.8% of households, making them the second most common protective measure. These interventions are generally used as short-term responses to reduce localized bank erosion and safeguard homesteads during periods of high river discharge. Although such measures provide immediate protection, their temporary nature and vulnerability to strong currents limit their long-term effectiveness, particularly where bank materials have low shear strength and are susceptible to moisture-induced instability (Dutta et al., 2023; Karmakar et al., 2025). Bamboo porcupines were reported by 16.9% of households and are mainly installed at sites experiencing active bank retreat. These locally constructed structures are intended to dissipate flow energy, trap sediment, and reduce the direct impact of river currents on the bank. Vegetation-based stabilization was reported by 9.8% of affected households. This non-structural measure involves planting locally available species, including *Simalu*, *Kanchan*, *Kalmou*, and *Hibiscus tiliaceus*, along vulnerable riverbanks. The root systems of such vegetation help bind bank sediments, while the above-ground biomass reduces flow velocity and promotes sediment deposition, thereby contributing to gradual bank stabilization. A small proportion of households (4.9%) reported not adopting any structural or non-structural adaptation measure. The major reasons for non-adoption included financial constraints, limited technical knowledge, lack of access to suitable materials, and uncertainty regarding the effectiveness of protective interventions. Overall, the findings indicate that households in Majuli primarily rely on practical, low-cost, and locally feasible measures to reduce erosion impacts and protect their settlements. However, continued dependence on temporary measures highlights the need for integrated riverbank-management strategies that combine community-based and Indigenous practices with technically robust and sustainable engineering interventions (Dutta et al., 2023; Karmakar et al., 2025; Petzold et al., 2020). Selected structural and non-structural measures observed during the field survey are presented in Plate 2.

4.4.2 Livelihood Adaptation Measures Adopted by Households

Households have adopted various livelihood adaptation measures to reduce economic vulnerability and enhance resilience against future erosion-related losses. The results presented in Table 2 and Fig. 3 reveal that the adoption of multiple income sources are the most common livelihood adaptation strategy, reported by 33.3% of affected households. Many respondents reported supplementing their primary occupation with small businesses, including traditional pottery making, boat making (Plate 3), handicraft production, and weaving, along with daily wage work, livestock rearing, or other income-generating activities to compensate for losses caused by riverbank erosion. Wage labour emerged as the second most important adaptation measure, adopted by 26.8% of households. The increasing engagement in wage-based employment, such as daily labouring and construction work, reflects the declining availability of productive agricultural land and the growing need for alternative income opportunities. Fishing and allied activities accounted for 18.6% of responses and continue to provide supplementary income for a section of the erosion-affected population. However, the declining productivity of wetlands and the disruption of riverine resource systems have reduced the reliability of fishing as a primary livelihood for many households in Majuli (Baruah, 2022). Seasonal migration was reported by 13.1% of respondents, which indicate that temporary movement in search of employment has become an important coping mechanism for some households. Respondents reported that many young people migrate to nearby districts, including Jorhat, Lakhimpur, Dhemaji, and Sivasagar, as well as to more distant urban centres such as Hyderabad and Bengaluru, in search of employment opportunities. Crop diversification represented the least adopted strategy (8.2%). The findings reveal that livelihood adaptation in Majuli is primarily driven by the need to secure stable income sources in the face of recurring erosion and land loss. Households increasingly rely on diversified economic activities to reduce their vulnerability and sustain their livelihoods under changing environmental conditions. However, the predominance of wage labour and migration also indicates that many adaptation responses are reactive and may provide only short-term economic relief rather than durable livelihood security.

4.4.3 Spatial Adaptation Measures Adopted by Households

In addition to structural and livelihood-based adaptations, many households have adopted spatial adaptation measures in response to recurring riverbank erosion. These measures include house relocation, land abandonment, and settlement shifting, all of which involve the reorganization of household space to reduce exposure to erosion hazards (Bhuyan et al., 2024; Deka et al., 2024). As shown in Table 2 and Fig. 3, house relocation is the most widely adopted spatial adaptation measure, reported by 42.6% of affected households. Repeated erosion and the increasing threat to residential structures have compelled many families to shift their houses to comparatively safer locations. This finding is consistent with evidence that recurrent erosion in Majuli has produced repeated displacement and settlement relocation, particularly among households located near actively eroding riverbanks (Bhuyan et al., 2024; Deka et al., 2024). Land abandonment emerged as the second most common spatial adaptation measure, accounting for 29.5% of responses. Continuous riverbank erosion and declining land stability have forced many households to abandon highly vulnerable agricultural plots and homestead land. Settlement shifting was reported by 19.7% of respondents. A relatively small proportion of households (8.2%) reported that they had not adopted any spatial adaptation measure. Spatial adaptation has therefore become an important component of community resilience in Majuli Island.

The predominance of house relocation and land abandonment highlights the extent to which erosion influences settlement decisions and land-use practices. These measures represent long-term responses aimed at reducing exposure to recurring erosion hazards and securing household livelihoods, although they may also result in loss of productive assets and increased socio-economic marginalization if not supported by planned rehabilitation (Bhuyan et al., 2024; Baruah, 2022).

4.4.4 Perceived Effectiveness of Adaptation Measures

The effectiveness of adaptation measures influences their acceptance and continued use among local communities. Respondents were asked to identify the adaptation strategy they considered most effective in reducing the impacts of riverbank erosion. The results reveal that structural adaptation measures were perceived as the most effective strategy by 44.8% of respondents (Table 3). Raised plinth houses, sandbags, bamboo porcupines, and vegetation-based stabilization provide immediate protection against erosion and flood-related damage, particularly at the household scale (Dutta et al., 2023; Karmakar et al., 2025). Livelihood adaptation measures were considered most effective by 33.3% of households, highlighting the importance of income diversification in reducing economic vulnerability when land-based livelihoods become insecure (Bhuyan et al., 2024; Barman et al., 2025). Spatial adaptation measures accounted for 21.9% of responses, indicating that relocation and land abandonment are generally viewed as last-resort options because of their financial, social, and emotional implications (Deka et al., 2024; Baruah, 2022).

Table 2: Structural, livelihood and spatial adaptation measures adopted by erosion-affected households and their perceived effectiveness in Majuli Island

Adaptation category	Adaptation measure / strategy	Frequency (n)	Percentage (%)
Structural adaptation	Raised plinth/stilt houses	76	41.5
	Sandbags/temporary bunds	49	26.8
	Bamboo porcupines	31	16.9
	Vegetation-based stabilization	18	9.8
	No structural measure	9	4.9
Livelihood adaptation	Multiple income sources	61	33.3
	Wage labour	49	26.8
	Fishing and allied activities	34	18.6
	Seasonal migration	24	13.1
	Crop diversification	15	8.2
Spatial adaptation	House relocation	78	42.6
	Land abandonment	54	29.5
	Settlement shifting	36	19.7
	No spatial adaptation	15	8.2
Perceived effectiveness	Structural adaptation	82	44.8
	Livelihood adaptation	61	33.3
	Spatial adaptation	40	21.9

Data Source: Primary survey, 2026

4.5 Sources of Support for Adaptation

The successful implementation of adaptation measures often depends on the availability of financial, institutional, and community support. In the erosion-prone areas of Majuli Island, households rely on various sources of assistance to undertake structural improvements, livelihood diversification, and

relocation activities. The findings indicate that self-financing was the primary source of support for adaptation measures, accounting for 50.3% of affected households (Table 3). Which indicates that most of the households depend on their own financial resources to implement measures such as house elevation, relocation, and livelihood diversification. Government assistance was reported by 22.4% of respondents and mainly consisted of relief support, financial assistance, and rehabilitation-related interventions. Community support accounted for 15.8% of responses, reflecting the importance of collective action and social networks in helping households cope with erosion-related challenges. Support from non-governmental organizations (NGOs), self-help groups (SHGs), and village organizations (VOs) was reported by 11.5% of respondents and was generally associated with awareness programmes, livelihood assistance, and limited rehabilitation support. These findings indicate that adaptation in Majuli remains largely household-driven, with relatively limited institutional involvement. This pattern is consistent with broader evidence that financial constraints and inadequate institutional support constrain the adaptive capacity of erosion-affected households in the Middle Brahmaputra floodplains (Bhuyan et al., 2024; Asian Development Bank, 2023).

4.6 Constraints to Adaptation Measures

Despite adopting various structural, non-structural, livelihood, and spatial adaptation measures, households in Majuli continue to face several challenges that limit their adaptive capacity. Understanding these constraints is essential for improving the effectiveness of community-based adaptation and enhancing long-term resilience to riverbank erosion. The results presented in Table 3 reveal that the lack of financial resources was the most significant constraint affecting adaptation efforts, reported by 36.6% of respondents. Many households are unable to invest in durable structural measures, house relocation, or livelihood diversification because of limited economic capacity. Continuous erosion and land loss emerged as the second major constraint (25.1%), as repeated erosion often undermines previously adopted adaptation measures and increases household vulnerability. The lack of alternative land for relocation was reported by 16.9% of respondents, highlighting the difficulties faced by households seeking safer locations. Inadequate government support accounted for 13.1% of responses, indicate that existing assistance programmes are insufficient to meet local adaptation needs. A smaller proportion of respondents (8.2%) identified a lack of technical knowledge as a constraint, particularly regarding effective erosion control and livelihood adaptation practices. These findings indicate that financial limitations and recurring erosion remain the primary barriers to successful adaptation in Majuli Island. Addressing these challenges through improved institutional support, access to financial assistance, planned rehabilitation, and sustainable riverbank-management initiatives could significantly strengthen community resilience and adaptive capacity (Bhuyan et al., 2024; Asian Development Bank, 2023; IPCC, 2023).

4.7 Existing and Ongoing Government Initiatives

In Majuli, several existing and ongoing government initiatives aim to mitigate riverbank erosion and protect vulnerable settlements. The Brahmaputra Board has implemented the *Protection of Majuli Island from Flood and Erosion* programme in multiple phases since 2004. Major interventions have included the strengthening of embankments, construction of boulder and geo-bag spurs, installation of RCC porcupine screens, construction of bank revetments, and implementation of pro-siltation measures (Brahmaputra Board, 2017; Press Information Bureau, 2018). The programme has also included the construction of 27 km of geo-bag bank revetments at vulnerable reaches and RCC porcupine screens at 41 locations (Press Information Bureau, 2018; Brahmaputra Board, 2017). More recently, Phase V of the programme has focused on bank-protection measures using porcupines at multiple vulnerable locations across Majuli (Assam Tribune, 2025). In addition, the Government of Assam has recognized riverbank erosion as a state disaster and is implementing broader flood- and erosion-risk-management programmes, including the Climate Resilient Brahmaputra Integrated Flood and Erosion Risk Management Project and the Assam Integrated River Basin Management Programme (Assam State Disaster Management Authority, 2026). Selected government initiatives observed during the field survey are presented in Plate 4.

Table 3: Sources of support and major constraints influencing adaptation measures among erosion-affected households in Majuli Island

Dimension	Source of support / Major constraint	Frequency (n)	Percentage (%)
Sources of support	Self-financed	92	50.3
	Government assistance	41	22.4
	Community support	29	15.8
	NGO support	21	11.5
Constraints to adaptation	Lack of financial resources	67	36.6
	Continuous erosion and land loss	46	25.1
	Lack of alternative land for relocation	31	16.9
	Inadequate government support	24	13.1
	Lack of technical knowledge	15	8.2

Data Source: Primary survey, 2026

4.8 Community Priorities for Strengthening Adaptation

Based on household responses, five priority areas were identified for strengthening adaptation to riverbank erosion in Majuli Island:

- **Strengthening riverbank protection:** Respondents emphasized the need for durable protective structures, as household-level measures are often inadequate against severe and recurrent erosion.

- **Financial assistance:** Financial support, compensation schemes, and low-interest loans were suggested to help households adopt more effective adaptation measures.
- **Land and rehabilitation support:** Displaced households highlighted the need for planned rehabilitation and secure land allocation to ensure long-term settlement security.
- **Livelihood development:** Respondents prioritized skill development, employment generation, and income-diversification programmes to reduce dependence on erosion-prone agricultural land.
- **Awareness and capacity building:** Awareness campaigns and training were considered important for improving preparedness and informed adaptation decisions.

5. Conclusion

This study assessed community adaptation strategies to riverbank erosion in Majuli Island through a household survey across five erosion-prone sites. About 73.2% of surveyed households reported direct erosion impacts, with agricultural land loss being the most significant, followed by house damage and displacement. Impacts were more severe in the Salmara sites, indicating greater exposure to erosion hazards. Households adopted structural measures such as raised plinth or stilt houses, sandbags, bamboo porcupines, and vegetation-based stabilization; livelihood measures including multiple income sources, wage labour, fishing, seasonal migration, and crop diversification; and spatial measures such as house relocation, land abandonment, and settlement shifting. Adaptation was largely household-driven, with self-financing as the main source of support, while government, community, and NGO assistance remained comparatively limited. Although respondents generally perceived their adaptation measures as effective, financial constraints, continued erosion, shortage of relocation land, inadequate institutional support, and limited technical knowledge restricted long-term adaptation. Strengthening riverbank protection, financial and rehabilitation support, alternative livelihoods, and institutional involvement were identified as key priorities. Overall, communities in Majuli have developed diverse adaptation strategies, but persistent erosion and socio-economic constraints continue to limit their effectiveness. Long-term resilience requires an integrated approach combining community-based and Indigenous adaptation, sustainable riverbank management, livelihood development, planned rehabilitation, and stronger institutional support. Such measures are essential for reducing vulnerability and supporting sustainable development in erosion-affected communities of Majuli Island.

Declarations

Acknowledgement

The Author would like to thank the district administration for providing base maps and granting permission to collect essential data. The author is also extending gratitude to Gau Pradhan's of every selected area and the all the respondents who contributed and participated in the data collection procedure.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement

The datasets generated and/or analysed during the current study are not publicly available due to confidentiality related to household survey and interview data, but are available from the corresponding author, Rahul Sarkar, on reasonable request.

Ethics Statement for Methods Section

All methods were carried out in accordance with relevant guidelines and regulations for research involving human participants. As the study involved voluntary, non-invasive household surveys and key-informant interviews using anonymized data, formal ethical approval was not required. Informed verbal consent was obtained from all participants prior to data collection, and participation was voluntary, with respondents informed of their right to withdraw at any time. Confidentiality and anonymity were maintained throughout the study.

The authors used Grammarly and ChatGPT (OpenAI) only for grammar correction, sentence refinement, and language formatting of their original manuscript. All ideas, data, analysis, and conclusions are the authors' own.

I confirm that informed verbal consent was obtained from all participants before their inclusion in the study. Participation was entirely voluntary, and respondents were informed about the purpose of the research, the voluntary nature of participation, and their right to withdraw at any time. Confidentiality and anonymity of all participants have been maintained.

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Plates

Plates 1 to 4 are available in the Supplementary Files section.

Figures

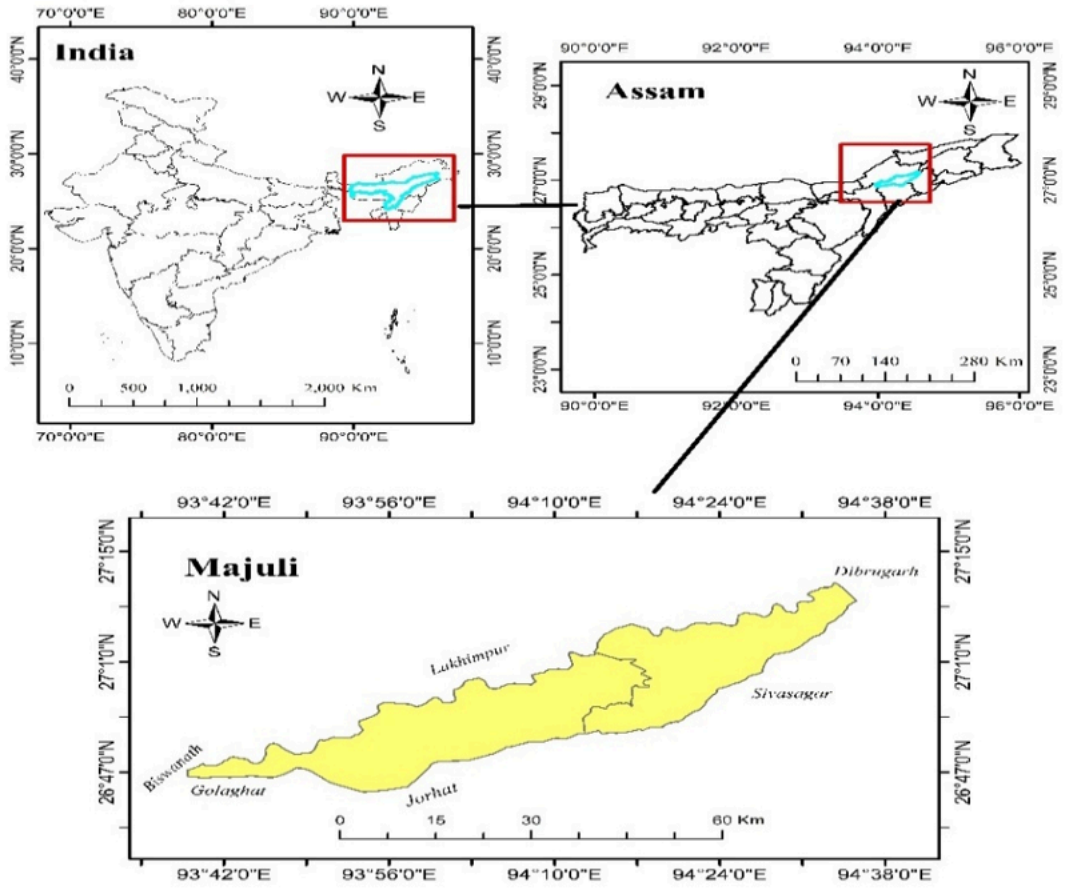


Figure 1

Study area map

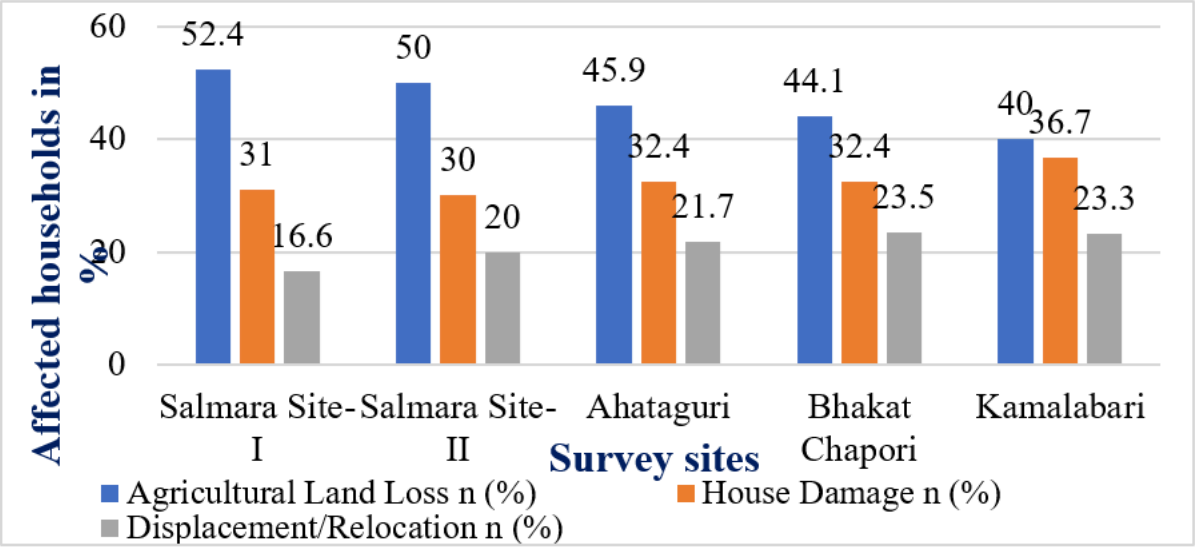


Figure 2

Impacts experienced by affected households

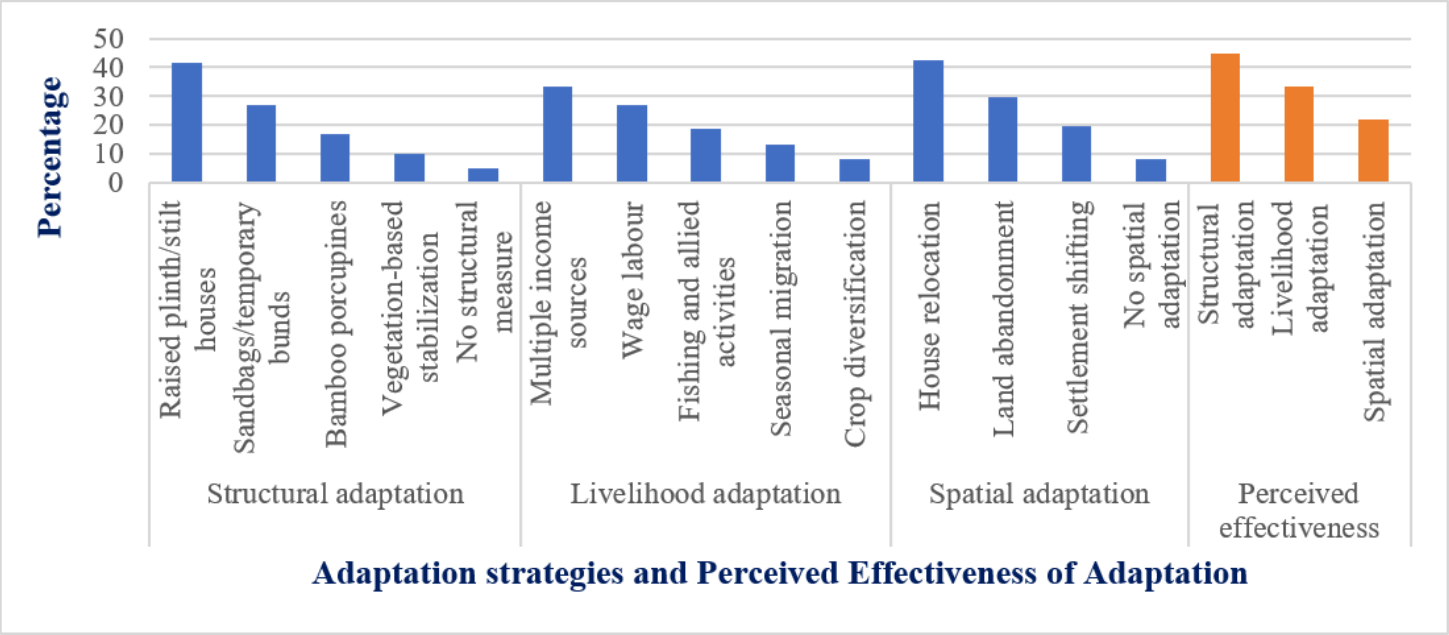


Figure 3

Community adaptation strategies and their effectiveness

Supplementary Files

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