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Improving disaster preparedness and recovery of Bangladesh riverbank erosion areas: Insights from household perceptions and practices

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ABSTRACT

Riverbank erosion significantly affects lives and livelihoods but is still neglected in disaster risk reduction (DRR) research and policy, which tend to focus on rapid-onset events. This research examines how household preparedness affects recovery outcomes in riverbank erosion-prone areas in Bangladesh, addressing an important gap in understanding anticipatory action to slow-onset disasters. Drawing from a mixed-methods approach consisting of household surveys ($n = 280$), focus group discussions, and key informant interviews in Harirampur and Sariakandi Upazilas, the research develops and utilises a multidimensional preparedness index. The index covers behavioural, socio-economic, and institutional aspects of preparedness, providing a new framework for assessing household preparedness in chronic hazard settings. The preparedness index shows that households in the low to somewhat prepared categories are among the most recently impacted. Past-impacted households in Harirampur are marginally better off than Sariakandi. Harirampur households' preparedness was linked with significantly lower asset loss. In both sites, insufficient financial resources and the absence of early warning systems were major barriers, and most households' recovery time exceeds two years. The findings show that local knowledge and informal coping strategies boost resilience, while the lack of early warnings and material support adversely affects preparedness. By linking preparedness to recovery and establishing its role in reducing asset losses, we add new empirical evidence and a practical tool that helps target households in need of support. The findings emphasize how context-specific preparedness should be integrated into national DRR frameworks and inclusive community-based approaches in erosion-prone areas.

1. Introduction

Disaster preparedness and recovery are key concerns of Disaster Risk Reduction (DRR) for minimizing the risk of social, economic, and environmental losses due to natural hazards. Most research on DRR has focused on rapid-onset hazards such as floods, cyclones, and earthquakes. Household preparedness for rapid-onset hazards is driven by the socio-economic conditions, experience, and access to supportive institutions and social networks [1–3]. Preparation is also pertinent in relation to slow-onset events, which involve a gradual risk that needs to be anticipated and addressed through adjustments and protection efforts spread out over extended periods. The understanding of household preparedness in these contexts is important, considering hazards to which long-term exposure will result in the accumulation of risk. Despite its importance, preparedness at the household level for slow-onset disasters is still not well understood.

To further examine these gaps, conceptual frameworks such as those presented in 'At Risk' by Wisner, Blaikie [4] and the vulnerability model by Cutter, Barnes [5] provide an advanced understanding of how vulnerabilities shape disaster outcomes. Nevertheless, such frameworks mainly focus on rapid-onset disasters and offer limited insight into anticipatory household behaviours and strategies in slow-onset hazards. The empirical findings regarding rapid-onset disasters illustrate the significance of knowledge, experiences, and social networks in the mitigation of losses and post-disaster recovery [6,7]. Lessons learned from droughts and similar situations indicate that resilience can be strengthened through early warning systems, diversified livelihoods, and a well-coordinated community [8–10]. Although these mechanisms might also apply to slow-onset hazards, their integration into household preparedness in the context of riverbank erosion is not understood well.

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Riverbank erosion is a slow-onset hazard prevalent in many parts of the world. Riverbank erosion is experienced differently due to geographic and climatic factors for example in the Mississippi-Missouri River System in North America, the rivers of Ganges and Brahmaputra in India and Bangladesh, the Mekong River in Asia, and the River Nile in Africa [11]. In India, riverbank erosion along the major rivers disrupts livelihoods [12], endangers food security [13] and displaces millions of people [14]. It also causes substantial financial losses and damage to agricultural land and infrastructure, exacerbating long-term economic stress. Extreme erosion in Serbia, Croatia, and Egypt has led to the loss of arable land and damage to infrastructure [15,16]. In Cambodia and in Vietnam, serious riverbank erosion has caused displacement and property and livelihood losses [17]. In Bangladesh, riverbank erosion also has serious social, economic, and environmental implications for livelihoods and the displacement of people [18,19].

Despite the adverse impacts of riverbank erosion, little is known about risk anticipation, preparation, and recovery at the household level. Rahman, Crawford [20] and Tha, Piman [17] have recently explored community-based responses and adaptive capacities in communities exposed to riverbank erosion and Mamun [21] examined earlier awareness and informal adjustment strategies in them. Yet there is a need for further research on the topic as empirical evidence gaps remain. This research seeks to address the gaps by examining household-level strategies in erosion-prone areas, with a focus on long-term and cumulative risks.

Preparedness is a guiding principle of the Sendai Framework for Disaster Risk Reduction [22], highlighting anticipatory risk management and fostering resilience. Rapid-onset disaster evidence shows that preparedness works well in combination with other enabling processes such as early warning systems, practical training, and financial means. However, such mechanisms are not common in dealing with slow-onset disasters such as riverbank erosion. This paper fills this existing gap with empirical insights on preparedness, challenges, and relationships with recovery outcomes. Findings from this study can provide valuable inputs to policymakers, local government, and disaster risk reduction experts on planning, budgeting, and community-level interventions for chronic hazards to comply with national disaster management plans.

We investigate how household preparedness shapes recovery outcomes in areas prone to riverbank erosion in Bangladesh. The research explores preparedness practices, challenges, and processes of recovery using a mixed-methods approach that combines household surveys, key informant interviews and focus group discussions. It is among the first empirical studies that examine how household preparedness influences recovery in the context of riverbank erosion. We focus on Harirampur Upazila along the Padma River and Sariakandi Upazila along the Jamuna River based on their different exposure patterns and socio-spatial characteristics.

2. Literature review

2.1. Dimensions of preparedness

The United Nations International Strategy for Disaster Risk Reduction defines preparedness as *'the knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters.'* [23]. Preparedness is not just a set of activities but part of a larger context of developing resilience, through which systems and communities can adapt and recover from disruption [24,25]. Preparedness is also conceptualized as systemic resilience and anticipatory measures to counteract vulnerability before crises occur. Evidence from Pakistan exemplifies this conceptual view. Research by Fahad, Wang [26] shows that household preparedness for floods is strongly influenced by risk perception and socio-economic factors, illustrating how behavioural and structural dimensions interact in shaping preparedness. Ruggiero, Piotrowicz and John [27] and Cavallo [28] placed preparedness within complex adaptive systems where adaptation, connectivity, and co-responsibility are essential in building resilience.

Staupe-Delgado and Kruke [29] conceptualized preparedness as active, forward-looking, and continuous behaviours, distinguishing preparedness from response, recovery and mitigation, while acknowledging their social and facilitative character. Whittaker, Khalfan and UlHaq [30] and Ma, Guo [31] exemplified preparedness at the community level through disaster management networks, social capital and shared learning. Together, these views consider preparedness as tangible actions and a set of flexible capabilities that exist within interconnected social and institutional systems. In contrast, earlier research conceptualized preparedness as either a general system capability or as individuals' discrete actions. For instance, Zamboni and Martin [32] investigated household-level preparedness as tangible behaviours such as emergency food and water storage and family safety planning in relation to socioeconomic and regional inequities. Blackburn, Boyce [33] expanded such an approach to include predictors of individual levels of preparedness, such as experience with disasters and trust in government relief efforts. Ni, Xia [34] emphasized behavioural and psychological aspects in a way that highlights the influences of cognitive appraisal processes, efficacy beliefs, and intrusiveness about household levels of preparatory behaviour.

Contemporary scholarship has sought to redefine preparedness as more dynamic and systematic and by highlighting the role of resilience and foresight in it [35]. This has proved particularly useful considering cumulative vulnerability, since traditional approaches to preparedness tended to overlook systemic constraints [36]. The notions of adaptive capacity and transformational resilience are useful in understanding the impact of learning processes on preparedness [37,38]. The notion of anticipatory governance in turn highlights the need for forward-thinking in preparedness [39]. Research conducted in Pakistan has used the IPCC vulnerability guideline and identified exposure, sensitivity, and adaptive capacity as important elements for household resilience to climate hazards [40]. The household focus in the research sheds light on anticipatory governance mechanisms explored in other research by illustrating how socio-economic conditions and adaptive strategies interact with broader institutional mechanisms to shape systemic resilience.

The above conceptual foundation has guided empirical studies, which have found that preparedness is determined by a series of interlinked factors, such as financial ability and socioeconomic status [5,41,42], awareness and knowledge [43], access to early warning systems [44], social networks and institutional support [3,45]. Financial preparedness, such as savings, asset diversification, or access to electronic means of paying for goods and services, affects the ability of a household to prepare and recover. Recent studies in Bangladesh indicated financial limitations as a key constraint: smallholders prefer non-monetary modes of insurance, such as contributing to the crop due to financial limitations [46]. Other results indicate that risk-averse farmers and those who have experienced flood events are more prone to adopt crop insurance as a financial preparation strategy, emphasizing the role of behavioural factors alongside economic factors [47]. This suggests innovative financial mechanisms can help overcome affordability challenges. Setiadi and Frederika [48] found that many households in flood-prone areas of Indonesia were aware of the importance of financial planning: digital cash was effective for disaster preparation, though only a few adopted it as part of their disaster preparedness effort.

Preparedness at the community level also depends on local knowledge, institutional trust, and effective coordination. Bali [49] emphasized that awareness and training allowed poor communities in India to act as first responders, maximizing disaster responses and self-reliance. Baudoin, Henly-Shepard [44] found that top-down early warning systems all too often fail the most vulnerable, calling for a people-centric approach utilizing local knowledge to improve risk communication. Hossain [50] investigated Bangladeshi governmental and non-

governmental organizational support for flood preparedness and found that although they do assist coordination and resources, their efforts are limited due to communication gaps, limited authority, and lack of public awareness. Nahayo, Mupenzi [51] also found warning delays and insufficient community participation because of poor implementation of National Strategy in Rwanda. Thieken, Bubeck [52] in turn found in a post-flood survey in Germany (July 2021) that a high proportion of residents perceived no warnings, and others were unprepared due to inadequate communication and unclear guidance. On the other hand, the catastrophic DANA floods (October 2024) in Valencia in Spain, exposed institutional lack of vision, late warnings, and planning failure that made even better-defended areas highly vulnerable [53].

Preparedness determines the impact of disasters by reducing economic and physical loss. For instance, retrofitting, property protection, and emergency planning can reduce losses [54]. Preparedness in terms of collective efficacy and informed threat perception can reduce disaster-associated damages and vulnerability [55]. United States government aid related to mitigation and preparation has been found to reduce property damage due to floods and storm damage in coastal areas [56]. Notably, these observations show that communities that prepare are proactive and take preventive measures to counteract the effects of disasters.

Preparedness is, however, often limited by practical constraints. Engineering measures often work only partially due to costs, design limitations, and incomplete implementation [57]. Traditional measures, such as bundling and bank vegetation in northern Bangladesh, highlight that preparedness can be influenced by cultural practices and available resources, particularly in low-current rivers [58]. Social networks and customary governance arrangements can improve community responses [59], highlighting that effective preparedness needs to combine local and scientific knowledge and take local contexts into account.

To assess the level of preparedness, recent research has used composite index techniques. For example, Rahman, Islam [60] assessed flood preparedness for individuals in terms of HIPM criteria but without considering household-level dynamics, practical barriers, or prior experience. Moghadas, Asadzadeh [61] constructed an indicator for flood resilience in urban areas based on expert-driven methods, a solution with limited applicability to riverbank erosion in rural areas. Shah, Ajiang [62] assessed flood risk perception in rural Pakistan but did not link perception and actual preparedness. Much of the existing literature is gender biased and cross-sectional. There is a clear need, considering the foregoing shortcomings, for context-specific, household-focused preparedness assessment.

2.2. Preparedness and recovery in disaster contexts

The recovery process is significant because it affects recovery outcomes [25]. Research on earthquakes, floods, and oil spills has found that better prepared communities recover faster [63]. Following Japan's tsunami and earthquake in 2011, Aldrich and Sawada [64] showed that household preparedness and social capital facilitated recovery of housing through shared resources and collective action. Also, other institutional and policy-based approaches have been effective in building resilience and promoting recovery. There is evidence that government support for the agricultural and green sectors, like environmental patents, significantly enhances adaptive capacity, reduces climate vulnerability, and promotes sustainable recovery in the agri-food sector [65]. While there is limited research on preparedness for riverbank erosion, findings regarding other hazards suggest that preparedness enables not just effective responses but also future anticipation and adaptations to risks, hence minimizing vulnerability and facilitating recovery.

Rokonuzzaman and Hattori [66] found that institutional and community-led measures can reduce vulnerabilities and facilitate recovery. Dube, Wedawatta and Ginige [2] highlighted the importance of local knowledge and communities in improving recovery and preparedness. Similarly, the recent study of Few, Ranjit [67], conducted in India, identified that institutions' interpretations of disasters may shape whose needs are prioritized in the recovery process and generally tend to disadvantage vulnerable groups. He [68] found that it is important to make interventions responsive to local needs to foster resilience, while Mohan [69] found that companies that are better prepared to respond to threats can recover faster. Moatty [70] argued that recovery operations can involve risk reduction interventions, contributing to preparedness against subsequent threats. Further evidence from South Asia by Mukherjee, Wickramasinghe [71] noted that nature-based strategies, with the help of community engagement and institutional planning, can support preparedness and long-term recovery across various hazards. Collectively, these studies indicate that preparedness and recovery processes reinforce each other with community participation and institutional capability.

Social identities and culture are essential for recovery and preparedness processes. Recent research indicates that in contexts of social vulnerability, recovery and preparedness are shaped by gendered, cultural, and psychological factors. Fatema, East [72] illustrated how cultural factors and gender norms prevent women from accessing shelter and processes of preparedness in rural Bangladesh. Enarson, Fothergill and Peek [73] in turn found that gender is essential for capacity and resilience within preparedness processes. Preparedness processes are thus deeply embedded in social and cultural facets rather than merely operational. Socially embedded processes of preparedness and recovery also interact with overarching structures and factors that shape resilience. Roy, Gain [74] suggested an adaptation pathways framework that conceptualises preparedness and recovery as phased, sequential processes, highlighting the emergence of absorptive, adaptive, and transformational capacities over the long term through the implementation of short, medium, and long-term strategies. The framework highlights the role of tangible assets, particularly financial preparedness, in supporting recovery and enhancing future disaster preparedness.

Considering the limited attention to preparedness to and recovery from riverbank erosion in the literature, findings about other hazards, such as droughts, may offer useful theoretical and practical lessons. In drought-prone areas, short-term reliance on relief rather than proactive planning is common, although it weakens long-term resilience [8,75]. The research has also emphasized the importance of early warnings and planning, as many regions lack forecasting tools and comprehensive drought policies. Guo, Sim and Su [76] and Ntali and Lyimo [77] highlighted the importance of indigenous knowledge and place-specific considerations for preparation and planning in places that lack government intervention. Biella, Shyrokaya [78] also emphasized a need to look beyond technical approaches and consider indigenous approaches to planning. That is, drought preparedness and recovery depend on linking institutional capacity and community approaches, and this is relevant for managing riverbank erosion risk as well.

Although current research offers valuable insights, critical gaps remain, particularly in the understanding of the processes by which preparedness influences recovery from future risks.

2.3. Research gaps

Three unique challenges related to riverbank erosion have not been explored in the literature to date. Firstly, the literature has not explored the household-level preparedness for riverbank erosion as a combination of protective activities (such as protecting food, water, valuable items, and livestock), institutional response capacity (such as early warning and preparedness training), and the underlying capacity of the household (such as income levels and literacy). How such elements interact to shape preparedness for riverbank erosion is still to be examined. Secondly, households encounter challenges when preparing for riverbank erosion that have not been investigated: no research has examined how prior experience with gradual land loss, displacement, and economic disruption shapes preparedness decisions for slow-onset disasters. Finally, even though preparedness has been demonstrated to

contribute to loss reduction and to foster recovery in rapid-onset events such as floods, cyclones, and other disasters, there is no evidence about whether the same is true about riverbank erosion. This raises a conceptual issue too: what do individuals prepare for when they are faced with riverbank erosion? We therefore examine household preparedness in terms of food and water storage, taking measures to protect their assets, and arranging space for families and livestock during erosion events. Therefore, we seek to answer the following research questions to address the research gaps:

RQ1. What are the perceived opportunities and barriers to preparedness activities in riverbank erosion-exposed communities, and to what extent do local knowledge and experience influence their preparedness strategies?

RQ2. How does household-level preparedness influence loss reduction and recovery when riverbank erosion occurs?

3. Conceptual framework, study sites, materials and methods

3.1. Conceptual framework

The conceptual framework outlined in Fig. 1 combines the insights of the reviewed literature on how riverbank erosion triggers interconnected processes, building household resilience. The framework outlines how households at risk can prepare for and recover from riverbank erosion. It highlights barriers to action, the importance of risk knowledge and experience, and how preparedness contributes to recovery and loss prevention and reduction. The framework encompasses social vulnerability [79], disaster management cycle [80], FEMA's principle that preparedness accelerates recovery [81], resilience [82] and adaptive capacity [83,84].

The interaction between the level of exposure to the hazard and vulnerability, shaped by the extent of institutional gaps and lack of knowledge, limits household capacity to prepare. Preparedness, considered as anticipatory actions aiming to lower levels of exposure and loss, plays an important role in influencing the speed and efficacy of recovery [81]. Evidence from other natural hazards such as floods and cyclones indicate that households with greater levels of preparedness suffer smaller losses and recover faster [35]. The importance of adaptability is that preparedness is a dynamic rather than a fixed attribute, varying based on access to resources, knowledge, and institutional engagement [83,84]. The framework suggests that early investments improve both immediate recovery and future resilience.

3.2. Study sites

The research was conducted in Sariakandi Upazila (Bogura district) and in Harirampur Upazila (Manikganj district) in Bangladesh (Figs. 2 & 3). These study sites were selected because of their substantial exposure to riverbank erosion [57,85] and their contrasting geomorphological and socio-economic features that made a comparative analysis of preparedness level and recovery outcomes at the household level possible. Erosion occurs during the monsoon season (June–October), involving sudden ground collapse due to heavy rainfall with upstream discharges.

Sariakandi is located along the Jamuna river, which is braided and dynamic in character, experiencing lateral shifts and recurrent erosion [86]. By 2020, about 50 km^2 of land had been lost in Sariakandi [87]. Harirampur is situated along the meandering Padma River, which is characterized by high sinuosity and lateral erosion [88]. In Harirampur, 144 km^2 of land was lost by 2011 [89]. In Harirampur, the research was conducted on char land that has different topography and socioeconomic aspects than Sariakandi. Chars are often isolated and lack roads, schools, markets and medical facilities. The contrasting contexts help explore how households cope with preparation and recovery under conditions of heightened vulnerability and institutional neglect. Table 1 outlines the key geographic and socioeconomic characteristics of the two study locations.

3.3. Data collection

A mixed methods design combining a Household Survey (HHS), Focus Group Discussions (FGD), and Key Informant Interviews (KIIs) was used. Both qualitative and quantitative approaches were deemed necessary since one method would not provide a comprehensive understanding of preparedness and its challenges. This approach ensured a robust investigation and improved the validity and reliability of the findings. In what followed we first report the overall patterns based on quantitative data and then enrich them based on qualitative data. The data were gathered during fieldwork between December 2023 and February 2024 by the main author with the support of three local enumerators who were trained in each site.

Seven KIIs were first conducted with local NGO representatives, Union Parishad members and older residents in the two study sites. The interviews provided contextual data on historical erosion patterns,

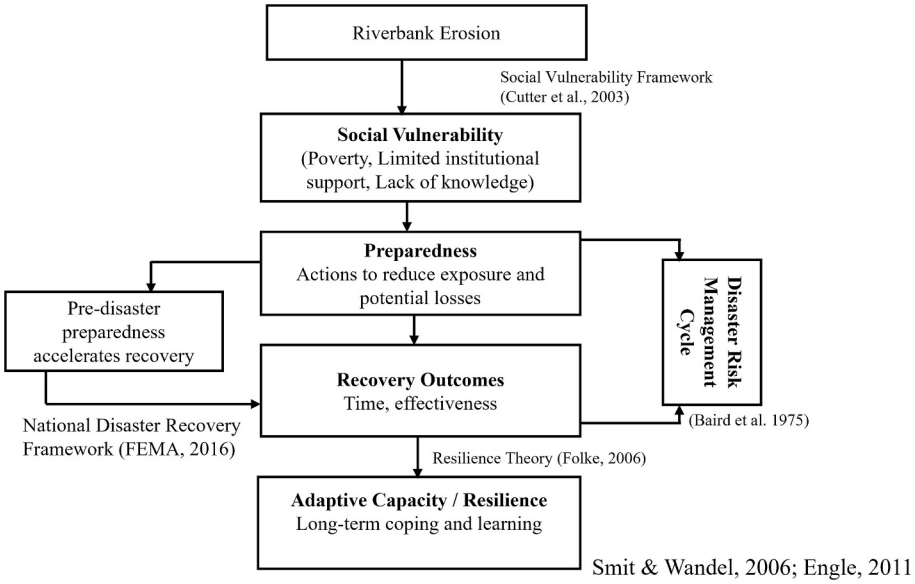

Fig. 1. Conceptual Framework for Preparedness and Recovery of Riverbank Erosion.

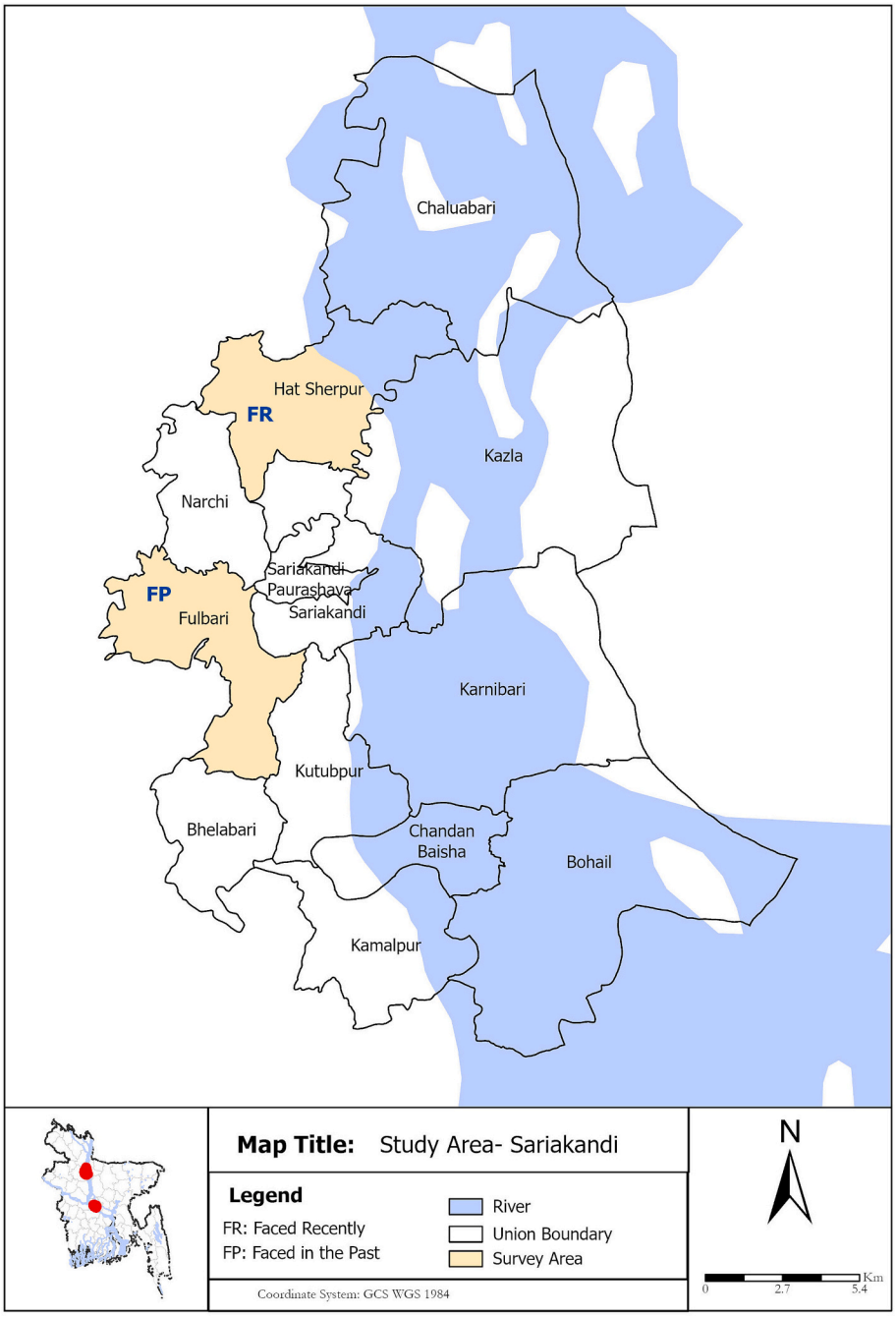

Fig. 2. Study site: Sariakandi prepared by the authors, Source: [91].

preparedness, and recovery challenges. They also enabled the identification of suitable unions and households for the HHS and FGDs. This approach helped cover diverse preparedness behaviours and recovery capacities shaped by different exposure experiences.

The study employed stratified referral sampling [92] to capture variation in household experiences of riverbank erosion. Households had been pre-stratified into two groups based on the length of time since they experienced the last major erosion event: (1) recently affected (within 1–5 years) and (2) impacted in the past (10 or more years ago). The stratification allowed the exploration of differences among the groups exposed to riverbank erosion over different lengths of time, rather than helping generate statistically representative estimates. A fixed sample size was required due to the lack of population data on households exposed to erosion over different time intervals. A sample size of 280 households was selected, 140 at each site, and about 70 households per stratum at each site. This strategy helped facilitate analysis of strategies and processes of recovery conditioned by varying vulnerabilities.

The questionnaire was framed to reflect the slow-onset and recurrent nature of riverbank erosion. It emphasized household preparedness measures, recovery challenges, barriers to action, and access to institutional support. This erosion-specific and household-level focus is a novel contribution of the research which extends preparedness research to a hazard that has received limited attention in the literature to date. The structure of the questionnaire was identical for both household strata. The questionnaire was translated into the local language. It was pre-tested with 10 respondents in each site to check clarity and relevance. The pre-test did not lead to any changes in questions, but minor

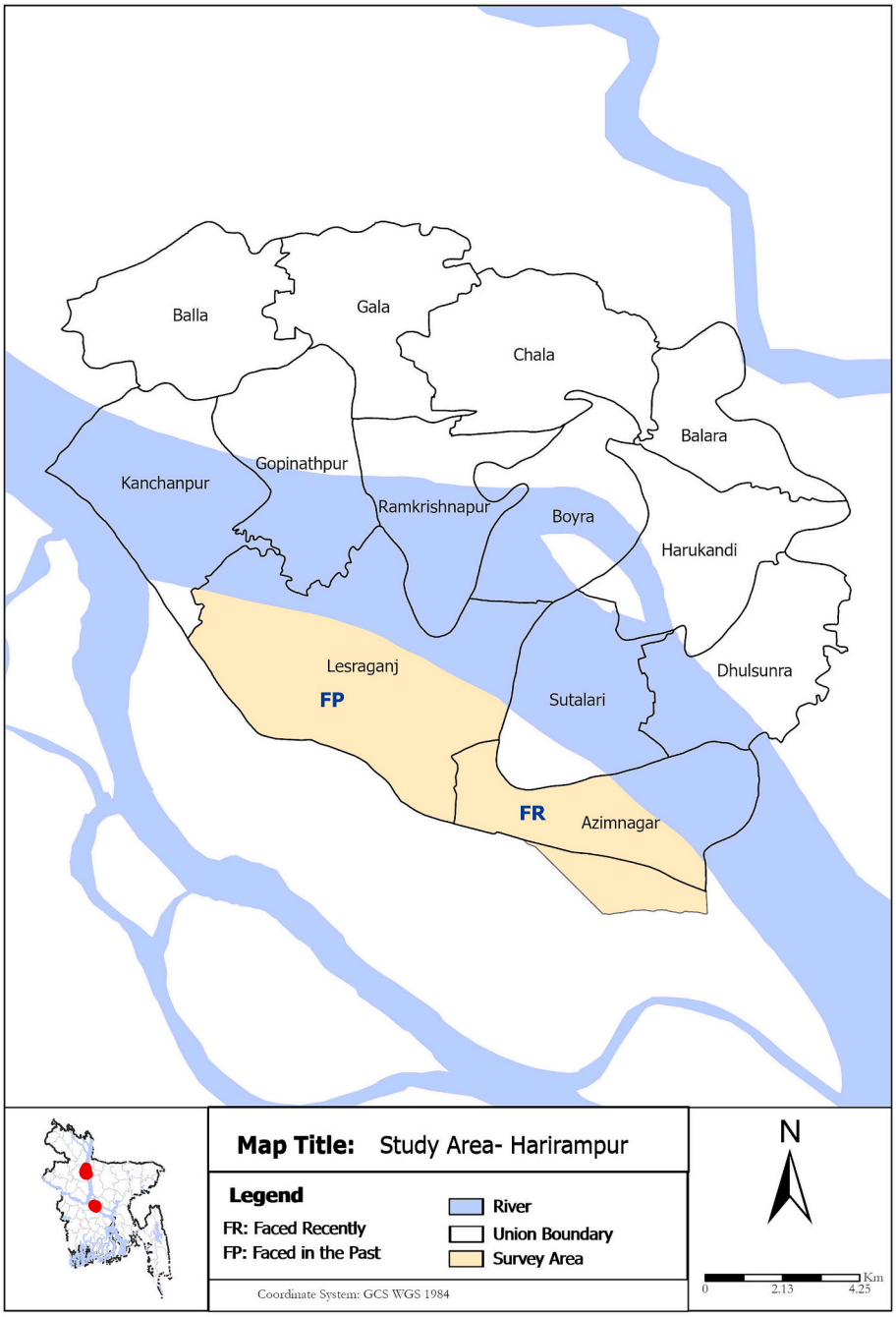

Fig. 3. Study site: Harirampur prepared by the authors, Source: [91].

adjustments were made in wording and phrasing to make sure that participants could comprehend them very well in the local language. The survey was targeted to household heads because they are usually in the best position to offer information regarding household-level decisions and experiences. If the household head was not present, a survey with another adult household member was conducted.

FGD participants were recruited with help from key informants, community members, and local institutions based on their experience with riverbank erosion. Four FGDs were completed with 44 people. In each study site, one FGD was conducted with participants who had recently been affected by riverbank erosion, and another one with participants affected in the more distant past. Each FGD comprised 8–12 men and women aged 20–60 years, and the participants were from diverse occupations. The FGD questions focused on the level of preparedness, barriers to perceived preparedness, the role of prior experience and recovery strategies at the community level. Sessions lasted about 90 min and allowed for open discussion.

All FGDs were audio recorded and then transcribed to ensure uniformity and comparability across sites and exposure groups. The same predetermined set of open-ended questions was used in all FGDs to ensure comparability with, and relevance to, the research questions. NVivo software (version 14) was used to review, organise, and qualitatively code the data. A thematic coding approach was applied, using inductive codes and themes developed directly from the FGD transcript data rather than a pre-defined coding framework. This helped find patterns regarding preparedness and experiences during recovery at the household level. These qualitative findings were used for the interpretation of survey results, and selected quotes of participants were used for

Table 1
Key socioeconomic and geographic characteristics of the study areas.

Feature	Harirampur Upazila	Sariakandi Upazila
Location	90 km west of Dhaka	200 km north of Dhaka
Distance from district (km)	35	23
Area (km^2)	245.42	432.55
Population (in 2022)	1,39,318	2,40,083
Population density (per km^2)	698	104.85
Population growth rate (%)	0.40	0.45
Literacy rate (%)	48.8	42
Economy	Over 50% agriculture; trade, govt services, remittances	Nearly 2/3 agriculture
Rivers (number)	3	2

Source: [90].

the validation of key findings. Fig. 4 summarises the overall research process utilized in the study.

3.4. Ethical consideration

Ethical approval was sought from and granted by the Faculty Research Ethics Committee (FREC) for the Faculties of Business, Environment, and Social Sciences of the University of Leeds, before the fieldwork. The research followed the ethical principles of informed consent in written or verbal form, confidentiality, and safeguarding of participants. The recordings took place through KIIs and FGDs, with the verbal consent given by all participants being explicit. Before the recordings, all participants were informed about the purpose, confidentiality, and how the recordings would be stored and anonymized during transcription.

No financial compensation was offered to participants, but they were given light refreshments during the FGD session in line with local custom. The participants were made aware that they could opt out of or pass any question or withdraw from the study at any point. This intended to foster psychological comfort when exploring possibly sensitive or erosion-related issues.

3.5. Data analysis

In this research, preparedness is defined as the proactive actions undertaken by households in anticipation of riverbank erosion events. The survey asked households to report the protective actions that households undertook before riverbank erosion. Actions reported by the respondents included storing food and water, relocating valuables and livestock, and arranging alternate shelter. Based on these responses, households were grouped into (1) those with no plan or any preparation measures at all (no preparedness); (2) those who were aware of steps that could be taken (e.g., where to move or how much to save) but who failed to carry them out (awareness only); and (3) those who had made preparations and carried them out (prepared for disaster, e.g. built a shelter, arranged boats for transfer). Regarding food and water, households were considered fully prepared if they had taken all important steps (such as food, drinking water, and medication); partially prepared if they had adopted some but not all measures; and not prepared if they had done none of them.

To measure household preparedness, a Composite Preparedness Index was developed, as no standardized framework exists for the riverbank erosion hazard. Inspiration was drawn from the Holistic Individual Preparedness Model of Rahman, Islam [60] which proposed an individual flood preparation scale comprised of 21 indicators. Compared to this flood preparedness index, our index is optimized for a household scale and allows for a systematic evaluation of preparedness for cumulative hazards. Maintaining the conceptual alignment, the index enables a comparison along preparedness factors for general and context-specific measures related to riverbank erosion hazard. This index included nine variables that capture institutional support, household knowledge, socio-economic status, and preparedness behaviours. Indicators were chosen based on a comprehensive literature review and the specific context of riverbank erosion. It included two context-specific indicators: arrangements for family and livestock, and protective measures for belongings. These capture socio-material realities of erosion-

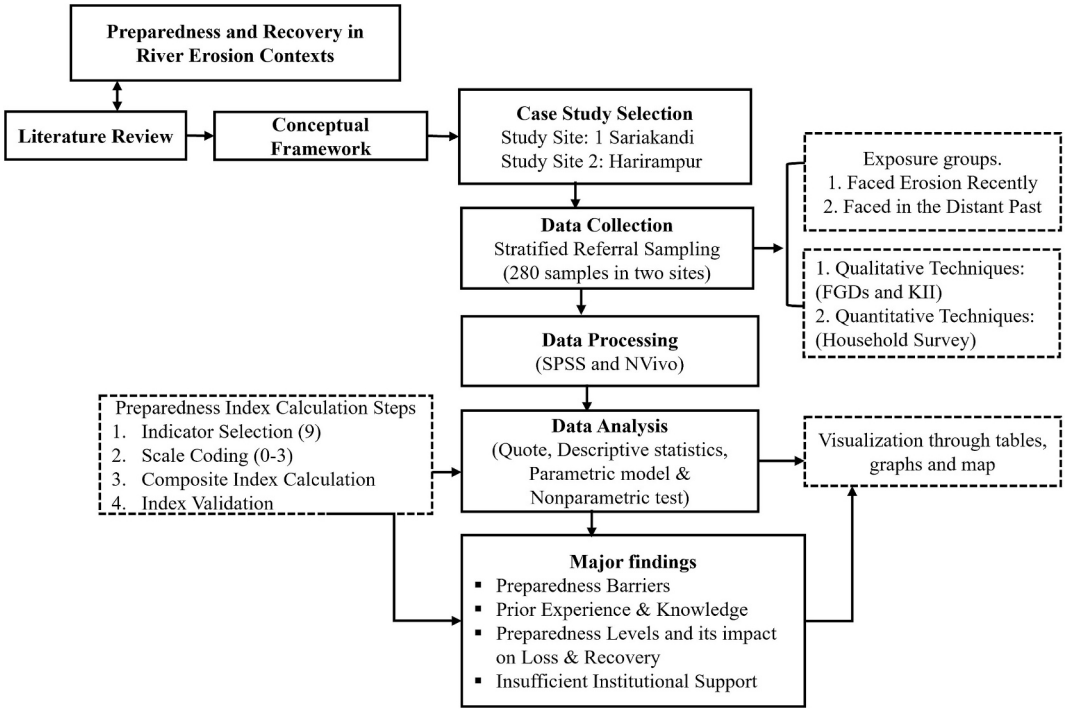

Fig. 4. Flowchart of research design.

affected communities, as evacuation and securing assets are important but often overlooked concerns.

Psychological and behavioural aspects of household-level preparedness, such as risk perception and self-efficacy, have been explored by many researchers [34]. For example, Rezabeigi Davarani, Nekoei-Moghadam [93] discussed the importance of cognitive and social processes in earthquake preparedness but did not consider activities for protecting property or preparing for livestock evacuation. A scale of 0 to 3 was used to score every indicator. This simplified scale, advocated by Osman and Altıntaş [94], is easy to understand in communities with limited literacy. Details of variables are provided in the supplementary material. Table 2 below explains the included indicators and the survey questions that were used to quantify them.

Each indicator was scored, and the scores were tallied to create an overall preparedness score ranging from 0 (least prepared) to 27 (better prepared). To facilitate comparison between the households, the range was divided into four bands: Low (0–6), Somewhat Prepared (7–13), Moderately Prepared (14–20), and Better Prepared (21–27).

Internal consistency was assessed using Cronbach's alpha, with justification for acceptable thresholds provided in prior research [95,96]. Values above 0.60 are generally considered acceptable for exploratory studies [97,98]. Similar index-based approaches have been used in flood preparedness and risk research and extended to other hazards such as landslides [99–101]. Validation through reliability testing is well established in prior studies across hazards, confirming the appropriateness and credibility of this approach [60,101].

The magnitude of losses was estimated for seven asset categories: land, residential buildings, livestock, crops, farm equipment, basic services, and other. The participants were asked whether they experienced losses in these asset categories (coded 1 for yes, 0 for no) or if the asset was not relevant (coded 2). A loss score was then calculated for each household using the following formula:

$$\text{Loss score} = \frac{\text{Number of loss assets}}{\text{Number of applicable assets}} \times 100$$

A Composite Preparedness Index and severity of loss were computed for comparison across sites and households. Descriptive statistics were used to characterise household preparedness and recovery outcomes. Inferential tests were conducted to investigate correlations between key variables: Kruskal-Wallis test compared whether the extent of preparedness influenced the extent of losses; binary logistic regression was used (for Harirampur only due to not enough variation in Sariakandi data) to determine whether past exposure improved household preparedness; and a Chi-square test investigated the association between perceived knowledge significance on erosion and measured recovery time. The input and analysis of HHS data were done using the SPSS software (IBM SPSS Statistics 30). In addition, study area maps were prepared utilizing ArcGIS Pro 3.4.3 to depict the spatial distribution of the surveyed unions. The audio-recorded FGD and KII sessions were transcribed and then translated into English. Important quotes related to preparedness steps, coping, and recovery strategies taken by households were selected to emphasize the key results from the survey data.

Table 2
Indicators and related survey questions.

Indicator	Survey Question
Prior preparedness training	Have you or your community received any training or information on disaster preparedness related to riverbank erosion?
Arrangement for family and livestock	Have you or your community made arrangements for family and livestock safety during riverbank erosion?
Protective measures for belongings	Have you or your community taken measures to protect your belongings during riverbank erosion?
Food and water preparedness	Have you arranged food and drinking water for emergencies?
Preparedness level	HH's /community's disaster preparation
Early warning systems	Is there an early warning system for riverbank erosion in your community?
Household head literacy	Household head literacy status (literate/illiterate)
Household (HH) income	What is your approximate monthly household income? (Based on that, categorized: Low / Middle / High)
Perceived government assistance	Do you think the government provides sufficient support for riverbank erosion preparedness?

4. Results

4.1. Perceptions and practices of household preparedness

Proactive preparedness was limited (Table 3), especially among the recently affected. In Harirampur, 83% of the recently affected households reported no preparedness, while 17% demonstrated awareness only. None were "prepared for a disaster," including not having planned for relocation or shelter. In Sariakandi, no recently affected household was "prepared for disaster," but 74.3% were "partially prepared for food and water," having taken some but not all the relevant steps.

Yet there were instances of reactive measures in the recent exposure group in Sariakandi. About 98.6% of HHs relocated members and livestock in response to initial erosion indicators, and 97.1% of HHs identified safe places or relied on informal strategies. These actions were triggered by indicators such as cracks in riverbanks reported in FGDs. KIIs in Harirampur revealed that there is no early warning system, which makes household decisions on when to act dependent on local observations of water levels. One participant explained:

'*They just come once with the loudspeaker (miking in the area), but by then the river is already breaking—there's no time to do anything*'—FGD, Harirampur.

Table 4 indicates collective preparedness mechanisms. In Harirampur, 31% of the recently affected households mentioned infrequent awareness activities led by NGOs. In Sariakandi, no one recalled any community-level campaigns. KIIs indicate that although BWDB issues regular flood forecasts, no forecasts warn about riverbank erosion. FGDs demonstrate that in the absence of such warnings and initiatives at the community level, households rely on local observations such as riverbank cracks or unusual river behaviours to anticipate erosion events.

4.1.1. Household preparedness level through composite index

The Composite Preparedness Index, based on nine indicators

Table 3
Household-level preparedness actions.

Aspect	Type of household response	Harirampur		Sariakandi	
		Faced Recently % (*n* = 70)	Past % (n = 70)	Faced Recently % (n = 70)	Past % (n = 70)
Self-reported household-level disaster preparation	No preparedness	82.9(58)	50.0 (35)	100.0 (70)	97.1 (68)
	Awareness only	17.1(12)	50.0 (35)	0	0
	Prepared for disaster	0	0	0	2.9 (2)
Prepared for food and water	Fully prepared	1.4(1)	5.7 (4)	0	1.4 (1)
	Partially prepared	47.1(33)	78.6 (55)	74.3 (52)	80.0 (56)
	Not prepared	51.4(36)	15.7 (11)	25.7(18)	18.6 (13)
Belongings protection measures	Yes	65.7(46)	84.3 (59)	97.1(68)	80.0 (56)
	No	34.3(24)	15.7 (11)	2.9(2)	20.0 (14)
Family and livestock safety arrangements	Yes	65.7(46)	85.7 (60)	98.6(69)	88.6 (62)
	No	34.3(24)	14.3 (10)	1.4(1)	11.4 (8)

Table 4
Community preparedness activities.

Aspect	Response category	Harirampur		Sariakandi	
		Faced Recently % (*n* = 70)	Past % (n = 70)	Faced Recently % (n = 70)	Past % (n = 70)
Early warning	Yes	1.4(1)	7.1 (5)	0	1.4 (2)
	No	98.6(69)	92.9 (65)	100	98.6 (68)
Preparedness activity	Community awareness	31.4(22)	27.1 (19)	2.9(2)	1.4 (1)
	No activity	68.6(48)	70 (49)	97.1(68)	98.6 (69)
Frequency of preparedness activity	Rarely	15.8(11)	28.6 (20)	0	1.4 (1)
	Never	67.1(47)	68.6 (48)	41.4(29)	58.6 (41)
	Don't know	17.1(12)	2.9 (2)	58.6(41)	40.0 (28)

(Table 2 subsection 3.5) helps generate a broader view of preparedness. Cronbach's alpha value for Harirampur was 0.716, which is well within the threshold value of 0.70, justifying acceptable internal consistency [95,96]. The alpha value for the Sariakandi region was 0.358, indicating low internal consistency due to a lack of response variance, as is often the case with relatively homogeneous populations [102]. The findings indicate the reliability of the index in more diverse settings and highlight the need for contextual interpretation of psychometric measures.

Preparedness levels differed notably between sites and exposure groups (Table 5). In Sariakandi, households were "somewhat prepared", with 81% of the recently exposed group and 66% of the past exposure group in the same category. Only 16% of the past exposure group were moderately prepared. KIIs corroborated these findings: no preparedness plans for riverbank erosion existed; people relied on the government embankment protection initiatives and limited local resources.

In Harirampur, the level of preparedness was better. While the recently exposed group was limitedly or somewhat prepared, 56% of the past exposure group was "moderately prepared". KIIs in Harirampur highlighted that better preparedness scores were because of presence of active disaster management committees and more organized protective measures, such as quick deployment of geo-bags and district-level support.

In both sites, FGDs and KIIs highlighted barriers like poverty, unpredictability, and lack of space for relocation, aligning with the survey findings that indicate households depend on reactive responses despite varying preparedness levels.

4.1.2. Preparedness and its impact on loss severity

Loss severity was estimated as the percentage of affected asset categories. This produced a loss score that ranges from 0 to 100%. Preparedness was measured using the self-reported perception and the Composite Preparedness Index as explained earlier. Due to the non-normal distribution of the data, the Kruskal-Wallis test was used to examine the relationship between preparedness level (both self-reported and composite index) and loss scores. In Harirampur, the Composite Preparedness Index indicates a statistically significant relationship with loss score (χ^2 (3) = 9.715, p = .021, ε^2 = 0.0494), meaning that lower preparedness was associated with greater loss. In Sariakandi there was no significant association (χ^2 (2) = 0.262, p = .877, ε^2 = −0.0127), meaning that preparedness level did not explain variation in loss scores. In Sariakandi, the data were more uniform, with most participants falling into similar preparedness categories, limiting the ability to detect meaningful differences.

In both sites, self-reported preparedness had no significant association with loss score. This suggests that subjective perceptions of preparedness do not reliably reflect actual vulnerability, whereas indicator-based measures, such as composite index-based preparedness level, provide a more valid assessment.

Table 5
Preparedness level based on composite index results among exposure groups.

Composite Preparedness Index (scores)	Faced Recently % (*N* = 70)		Faced in the Past% (N = 70)	
	Sariakandi	Harirampur	Sariakandi	Harirampur
Low (0–6)	17.14 (12)	35.7 (25)	18.6 (13)	8.57 (6)
Somewhat prepared (7–13)	81.43 (57)	45.7 (32)	65.7 (46)	34.29 (24)
Moderate (14–20)	1.43 (1)	18.6 (13)	15.7 (11)	55.71 (39)
Better prepared (21–27)	0	0	0	1.43 (1)

4.1.3. Barriers to preparedness

Fig. 5 presents the barriers to preparedness across sites. The most frequently reported barrier was financial constraints, affecting 60% of recently affected households in Harirampur and all the households from Sariakandi. FGDs explained the result with extreme poverty and land unavailability for relocation in Harirampur, while participants in Sariakandi mentioned health issues, lack of awareness, and absence of shelter.

Time constraints were also a major barrier in Harirampur, particularly among households exposed in the past (78.6%). In Sariakandi, time constraints were not mentioned as a barrier. KIIs in both sites indicated that funding constraints restrict protection and relocation options, making vulnerable households reliant on government support. Lack of knowledge and limited community support were mentioned seldom as barriers but were part of the preparedness gap.

4.1.4. Influence of past experience and local knowledge

Survey data indicate that few households shared erosion-related knowledge. To assess if past exposure affects preparedness, binary logistic regression was used for data from Harirampur only (N = 140, Table 6), as the sample in Sariakandi does not contain enough variance. The dependent variable was a binary indicator of household preparedness constructed based on the perceptual and behavioural indicators of the affected households.

Results indicate that households with past erosion experience were less likely to be prepared. This may mean that repeated exposure leads to asset and income losses, which constrain households' capacity to prepare. Perceived lack of government support and reliance on local authority information also hampered preparedness, highlighting the role of institutional trust and communication in preparedness.

Fig. 6 indicates measures perceived to be available for households to adapt to riverbank erosion. Most households preferred engineering solutions such as embankments (86.4% in Sariakandi; 75.7% in Harirampur). KIIs helped explain the results, noting that local measures such

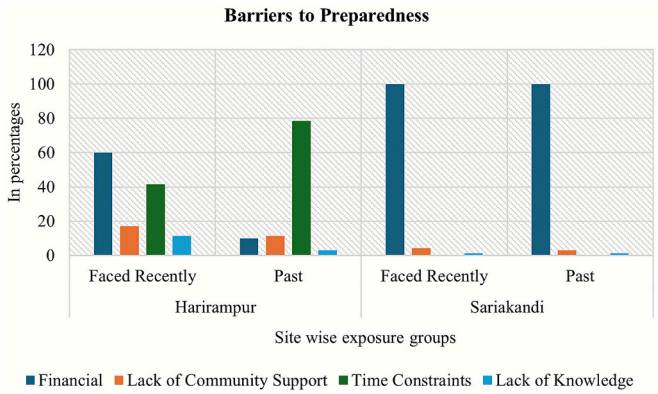

Fig. 5. Barriers to preparedness.

Table 6
Logistic regression results on predictors of household preparedness in Harirampur.

Variable	B	Sig.	Exp(B)	95% CI for OR
Past exposure (vs recent)	−1.81	<0.001	0.16	[0.059, 0.457]
Perceived Govt. support	−2.35	<0.001	0.10	[0.030, 0.297]
Info from local authorities	−2.29	0.036	0.10	[0.012, 0.864]

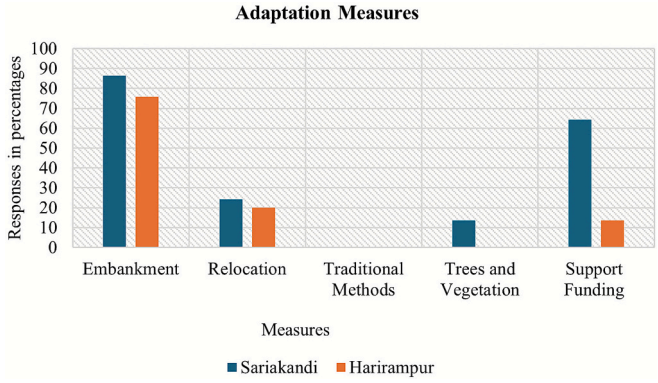

Fig. 6. Perceived adaptation measures.

as bamboo piling and tree planting are ineffective against the strong currents and sandy bed of the Jamuna and Padma rivers. Relocation was mentioned by 24.3% of households in Sariakandi (24.3%) and 20% in Harirampur, while local solutions were not mentioned at all.

Perceptions of support funding (economic support to enable migration, rebuilding, or other adjustment actions) also differed: 64.3% valued it in Sariakandi, compared to 13.6% in Harirampur. Local authorities considered structural measures, such as geo-bags, concrete blocks, and government-sponsored embankment programs, which are only effective for bank protection. The qualitative findings support the survey findings, showing that individuals are likely to associate preparedness with protecting themselves mainly against high-impact events rather than against usual erosion.

4.2. *Preparedness and its role in recovery outcomes*

4.2.1. *Perceived link between preparedness and recovery*

In the survey questionnaire, the households were asked: "*Have you seen any correlations between the level of preparedness in your area and the implications of recovery following incidents of riverbank erosion?*" The responses to this question are shown in Table 7, which takes household perceptions into account but not statistical correlations.

Table 7
Correlation between self-reported preparedness and recovery.

Aspect	Dimension	Harirampur		Sariakandi	
		Faced Recently % (n = 70)	Past % (n = 70)	Faced Recently % (n = 70)	Past % (n = 70)
Correlation between self-reported preparedness and recovery	Strong positive correlation	11.43(8)	57.14 (40)	2.85(2)	30.0 (21)
	Moderate positive correlation	27.14 (19)	4.29 (3)	94.3(66)	64.3 (45)
	No significant correlation	20.0(14)	21.43 (15)	0	4.3 (3)
	Don't know	41.43 (29)	17.14 (12)	2.85(2)	1.4 (1)

More households in Harirampur (57%) than in Sariakandi (30%) from the past exposure group considered that preparation improves recovery outcomes. This perception was corroborated in FGDs. A participant from Harirampur noted:

"*If we had knowledge and money, we could relocate early and protect assets. Without land or resources, recovery takes years.*"-Recent group, Harirampur. This view corroborates the survey finding that while people see preparedness as important, practical barriers, particularly financial, limit its effectiveness.

The following Fig. 7 shows participants' experience regarding the time needed for recovery. The recovery is still ongoing for the recently impacted households in Harirampur (78.6%) and Sariakandi (70.0%). Among those affected in the past, 60.0% in Harirampur and 57.1% in Sariakandi reported it took more than two years to recover.

A Chi-square test was conducted ($N = 280$) to examine the association between perceived importance of knowledge and recovery time. In Harirampur, a statistically significant association ($p < .05$), suggested that those who believe knowledge improves preparedness report shorter recovery times. In Sariakandi, no significant association was found. This may reflect differences in preparedness infrastructure or social support between the two locations.

4.2.2. *Factors enabling or constraining recovery*

Respondents were asked to identify factors that facilitated their household's recovery following the experience of riverbank erosion. The results are indicated in Table 8.

Financial resources were the strongest predictor of recovery, reported by 55.7% of recently affected and 67.1% of households affected in the past in Harirampur, and 84.3% and 91.4%, respectively, in Sariakandi. FGDs corroborated the results, participants indicating that access to credit and loans is required for generating livelihoods. One FGD participant explained:

> *"Loans for cattle or tools would help us restart. With one earner, recovery is slow." —Past group, Harirampur*

FGDs with the recently affected group in Sariakandi suggested that coping by borrowing, renting land, or selling cattle was common after riverbank erosion. Migration and day labour were also mentioned as strategies for coping with riverbank erosion in the Sariakandi FGD group, involving those who had been exposed in the past. Though financial ability was a dominant theme in the discussion of recovery, participants recognized that community support and government aid are also important. However, they acknowledged that this may not be sufficient, leaving households to rely primarily on credit and informal coping strategies.

5. Discussion

To address the first research question, '*What are the perceived*

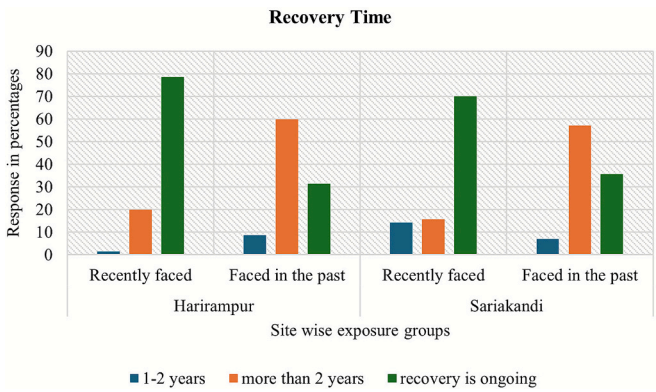

Fig. 7. Perceived recovery timeline among exposure groups.

Table 8
Perceived factors supporting household recovery.

Aspect	Dimension	Harirampur		Sariakandi	
		Faced Recently % (n = 70)	Past % (n = 70)	Faced Recently % (n = 70)	Past % (n = 70)
Key in facilitating household's recovery	Timely assistance from government/ NGOs	32.9(23)	18.6 (13)	8.6(6)	5.7 (4)
	Community support and cooperation	41.4(29)	35.7 (25)	10(7)	42.9 (30)
	Financial resources	55.7(39)	67.1 (47)	84.3(59)	91.4 (64)
	Access to alternative housing	5.7(4)	27.1 (19)	15.7(11)	2.9 (2)
	Disaster preparedness measures	7.1(5)	1.4 (1)	31.4(22)	25.7 (18)

opportunities and barriers in the preparation activities of riverbank erosion-exposed communities, and to what extent do local knowledge and experience influence their preparedness strategies?' —This research examined household preparedness behaviours in Harirampur and Sariakandi.

While preparedness is generally considered an anticipatory, system-level process [103,104], riverbank erosion preparedness was found to be more reactive in nature. Although there was some awareness among the surveyed households regarding the risk involved, owing to a lack of resources and the unpredictability of erosion, there was little scope for proactive planning. These results highlight that preparedness remains dependent on structural conditions. This is consistent with approaches to social vulnerability and adaptive capacity, examining systemic limitations that affect decisions at a household level for risk [79,82]. These findings challenge assumptions drawn from rapid-onset hazards and point to the dynamics of preparedness in the case of slow-onset hazards such as riverbank erosion, with proactive planning being constricted by uncertainty and resource limitation.

Lack of early warning systems for erosion reinforces institutional weaknesses. Unlike floods, which are anticipated with well-organized infrastructure systems, riverbank erosion remains inadequately addressed. Harirampur households with access to institutional disaster bodies and interaction with NGOs were relatively better prepared. Conversely, the frequent occurrence of erosion events in Sariakandi meant that households there were unprepared in the absence of institutional encouragement and support. These differences highlight the significance of institutionalization for preparedness and that experiencing a disaster does not guarantee preparedness [105]. It also corroborates the social learning perspective [106] by highlighting that experience is insufficient in itself without supporting institutional mechanisms, adequate resources, and working channels of communication [107–109]. The results indicate that there is an important gap in governance for slow-onset disasters: lack of institutional presence and early warning systems in comparison to flood disasters.

The Composite Preparedness Index used in this research offers a more comprehensive understanding of household preparedness, considering behavioural, socioeconomic and institutional aspects of it. Empirical evidence suggests that indicators such as income level, literacy rate, and tangible activities like storing food or locking documents influence preparedness. The findings corroborate that resilience not only hinges upon material resources but also serves to enable other systems [81]. Through the operationalization of preparedness using a composite index, this research offers a method to measure preparedness at a household level in erosion-prone areas that can inform future research and practice.

Economic hardship was identified as the most common barrier to preparedness. The participants not only face difficulties in terms of economic burdens but also experience asset losses due to exposure to hazards. In contrast to the rapid-onset hazard scenario, where previous exposure leads to increased preparedness [110], in riverbank erosion situations, previous exposure may erode resilience going forward. This further supports the importance of having distinct emergency preparation measures for slow-onset disasters, such that repeated exposure undermines rather than strengthens resilience.

There was local knowledge about riverbank erosion risk in terms of observations made of the cracking of riverbanks or changes in water flow. But it is not transformed into collective action. Rather, there is reliance on engineering solutions like embankments and geo-bags to mitigate impacts. Household preferences evidence a move away from local knowledge-based community adaptation to externally driven interventions that challenge the assumptions of the resilience model and social learning [111,112]. Integrating local knowledge into formal preparedness planning could reduce reliance on external interventions and foster community resilience.

The findings suggest that preparedness for riverbank erosion is significantly affected by the interaction between institutional support, poverty, and the perceived reliability of mitigation options rather than experience with the hazard and local knowledge. This highlights the need for a context-specific preparedness policy. The interventions at the local level must overcome material barriers, expand early warning coverage to riverbank erosion and combine engineered measures with capacity building. At the national level, the integration of riverbank erosion into disaster risk reduction frameworks and livelihood diversification with resources could reduce vulnerability. This research contributes to the larger discourse of disaster risk management related to slow-onset hazards by situating preparedness within its socio-economic and institutional context, an area where empirical evidence is still scant.

By answering the second research question, *how does household-level preparedness influence loss reduction and recovery when riverbank erosion occurs*, the research offers empirical evidence on the implications of preparedness for recovery. Households that made efforts to prepare such as asset protection, inventory maintenance, or relocation planning suffered less losses and recovered faster. The adaptation capability approach to preparedness argues that a dynamic attribute based on resource exposure, knowledge, or institutional assistance shapes preparedness [83,84].

The difference between study sites shows how preparedness functions as a relational capability rather than an autonomous action. In Harirampur, households with higher composite preparedness scores experienced smaller asset losses due to erosion and were able to recover more rapidly. In Sariakandi, preparedness was insignificant for both asset losses and recovery speed, indicating how scattered efforts are not protective when resources or institutional support are absent. The differences between behaviourally assessed preparedness scores and self-reported perceptions indicate how assessment accuracy can function in complex cognitive-empirical terms [113]. Composite preparedness assessment is a more insightful approach concerning protective capability compared to perception-based assessment methods. These findings resonate with those reported by earlier research on rapid-onset hazards [63,114], which suggests that concrete, behaviour-oriented preparedness is a better predictor of reduced losses. Unlike rapid onset disasters, riverbank erosions' slow progression makes it difficult to prepare for because of the gradual nature of displacement and loss of assets.

Past erosion experience played into how preparedness and recovery were perceived by households. Households affected in the past often mentioned that they are prepared to recover quickly, whereas recently affected ones were less certain, suggesting that experience alone does not ensure adaptive action. FGDs indicated that savings and information enabled early relocation and protection of assets, but recovery was

hindered without land and necessary resources. Preparedness is based on social and financial capital. Recently affected households suffered heavy losses and displacement; they often returned to the same exposed area with reduced capacity for preparedness. In contrast, those who had experienced riverbank erosion in the past could rebuild their homes and have time for preparedness. The finding helps explain how the time of the hazard exposure and socioeconomic status determine the degree to which experience can be turned into adaptive action [115]. It suggests that experience alone cannot be translated into adaptive action in the absence of supportive institutional and financial mechanisms.

Recovery trajectories were influenced by institutional and community support. In areas that had functioning local disaster committees and coordination with NGOs, households had less complicated rebuilding processes. In contrast, lack of institutional presence and low trust in authorities adversely affected recovery, leaving people dependent on informal networks. These findings demonstrate that recovery depends not only on the household capacity but also on the strength of local governance and community structures. This is supported by evidence that a well-coordinated governance process between government and society improves resilience and post-disaster outcomes [116]. Strengthening local disaster committees and building confidence in the authorities could enhance the positive influence of institutional support that was seen here.

Economic capacity was a determining variable that transformed preparedness into recovery. Households with economic capacity were able to relocate, rebuild, and safeguard assets, whereas poverty constrained poorer households from acting on knowledge of preparedness. Access to finance emerged as a key enabling factor for recovery, followed by external aid and social support. This also resonates with earlier findings that social and financial capital facilitate better recovery processes [117,118]. In contrast, the unprepared were generally those who lacked financial capacity, while a lack of knowledge and social engagement played a minor role. These results demonstrate how structural poverty devalues preparedness knowledge in practice, reaffirming findings on the bind in which vulnerable populations exist [66]. Such observations illustrate that financial inclusion initiatives, like microcredit or disaster relief funds, are needed to translate disaster preparedness knowledge into recovery action.

To conclude, being prepared reduces immediate losses and fosters longer-term recovery, and it is influenced by the socio-economic and institutional environment around it. Data evidence the conceptual pathway linking preparedness, recovery, and resilience, showing that preparedness can be a buffer as well as a catalyst when supported by enabling systems. This research advances the state of knowledge on disaster preparation by proving its relevance in relation to slow-onset disasters such as riverbank erosion. The findings also highlight the need to incorporate preparedness into national strategies for disaster risk management, enhance local governance structures, and ensure that funding support is in place for vulnerable households. These can turn preparedness from an individual activity into a systemic strategy for resilience.

The research is not without limitations. The cross-sectional nature of the research limits the ability to consider how preparedness and household recovery measures unfold over time following successive erosion events. Since the stratified referral sample was selected neither from a known population nor by any probabilistic technique, this study does not have statistical representativeness. Therefore, the results should be considered context specific. Any inference related to external validity could be extended at most to a similar context. Although the literature emphasizes the significance of gender, cultural factors in shaping disaster preparedness and recovery, this research did not consider this due to the limitations mentioned. The household-level survey design focused on socio-economic and structural indicators. It did not capture the nuanced intra-household gender dynamics, cultural beliefs, or psychological experiences that often influence disaster responses.

6. Conclusion

This research explored the level of preparedness and how that influences the recovery outcome of areas where riverbank erosion is prevalent in Bangladesh, with emphasis on barriers and opportunities, as well as experience and knowledge. Focusing on households with varied experiences of riverbank erosion, it allows the exploration of how experience, institutional engagement, and socioeconomic characteristics influence preparedness and recovery. The research makes several contributions to the literature on disaster risk reduction. First, it offers a novel approach based on a preparedness index covering behavioural, socioeconomic, and institutional aspects of preparedness. Second, it bridges the gaps in empirical and concept development by offering new insights for preparedness in relation to riverbank erosion, which has been unexplored until now. This insight creates opportunities for concept development on disaster management of slow-progress disasters.

This research highlights the need for being prepared in the face of riverbank erosion in Bangladesh. Although awareness of riverbank erosion exists, people are still unprepared owing to financial and institutional constraints. Current informal methods, such as local notices by "miking," remain insufficient. Relevant authorities should incorporate erosion monitoring into national early warning frameworks. This should include prioritization of risk mapping and warning systems, as well as adequate communication systems. Community-based preparedness initiatives also need to be strengthened. NGOs and local authorities should combine awareness raising with material support, such as disaster kits, micro-credit for preparedness investments, and training for evacuations. Evidence indicates that those who have prior experience of erosion and those who have local knowledge took proactive measures to prepare, such as early relocation, warning dissemination, etc. The initiatives should also promote collective learning, including the dissemination of local knowledge and experience.

The Composite Preparedness Index developed in the research helps assess preparedness across households. Such an index could help to identify which households are most vulnerable in terms of preparedness so they can be targeted for support in terms of both preparedness and recovery. Although the research is context-specific, its methodological contribution fills an important gap in riverbank erosion literature as it provides a clear linkage between recovery and preparedness. This offers a foundation for further research in erosion-prone areas where preparedness and recovery processes have been less understood.

Future research should focus on the current knowledge gaps that exist regarding riverbank erosion. Using more inclusive methods of sampling would possibly improve both representativeness and depth of analysis. An exploration of gender, cultural, and psychological variables would help better understand preparedness for erosion events based upon social norms and beliefs. Future research should translate indices of household preparedness and findings into concrete approaches for disaster risk reduction at the local level. Comparative studies across hazards and geographic contexts could refine the indices and test their applicability. Longitudinal studies that assess how preparedness develops when subject to repeated exposure would help build evidence for policy interventions that concentrate on resilience. Combining methods of probabilistic hazard modelling and simulation or machine learning could in turn enhance analytical depth. When combined with social vulnerability analysis, these techniques would further lead to more comprehensive and context-specific strategies of disaster risk reduction and recovery planning.

CRediT authorship contribution statement

Rokshana Binta Samad: Writing – review & editing, Visualization, Validation, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jouni Paavola:** Writing – review & editing, Supervision. **James D. Ford:** Writing –

review & editing, Supervision. **Paula Novo:** Writing – review & editing, Supervision.

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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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pdisas.2026.100526.

Data availability

Data is not freely available because of signed data confidentiality.

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