

Assessment of Riverbank Erosion and Community Resilience in Banskhali Upazila, Bangladesh: A Mixed-Methods Approach on the Sangu River

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Abstract

Riverbank erosion causes significant loss of agricultural land and homes, profoundly impacting the social, psychological, economic, and environmental well-being of local communities in Bangladesh. This study evaluates the impact of riverbank erosion and communities resilience in Banskhali Upazila, Bangladesh, using mixed methods approaches like field investigations and focus group discussions (FGDs). The study involves 150 questionnaires and six FGDs to explore socio-economic impacts and adaptation strategies. Findings show severe damage like 20% of homesteads, livestock, and crops being completely destroyed, while 51% of homesteads, 45% of livestock, and 61% of crops are partially damaged. Migration patterns show that 64% of displaced individuals relocated to Chattogram, highlighting the necessity for focused assistance in urban areas. The study highlights the urgent need for integrated management strategies, combining structural and non-structural measures, to strengthen community resilience and reduce the impacts of riverbank erosion.

Keywords: Riverbank; erosion; resilience; vulnerability; livelihoods; Bangladesh.

Introduction

Bangladesh has a lot of rivers and is one of the most climate-vulnerable countries in the world because of its (geographic) position^{1,2}. Riverbank erosion is a significant environmental challenge affecting between 10 to 70 million people annually. As a result, many families lose their homes, farmland, livestock, and infrastructure³. This persistent erosion leads to increased poverty and vulnerability, particularly for populations dependent on agriculture⁴. The destruction of homes, crops, livestock, and irrigation systems exacerbates these vulnerabilities, as communities face displacement and economic instability^{5,6}. In southeastern Bangladesh, especially along the Sangu riverbank in Banskhali Upazila, the effects of erosion are particularly severe, significantly impacting the socio-economic well-being of the affected populations⁷. Riverbank erosion reduces employment opportunities, devastates infrastructure, and displaces entire communities, leading to a loss of land and the need for relocation⁸. Recurrent erosion of riverbanks constitutes a serious threat to socioeconomic well-being in these regions; as a result of the degrading land in these fields, the destruction of homes, and the adverse impact of riverbank erosion on the social,

psychological, economic, and environmental situation of the residents⁷. Riverbank erosion significantly reduces employment opportunities, devastates infrastructure, and displaces entire communities from their homes in southeastern Bangladesh⁵. The destruction of homes, livestock, crops, and irrigation systems exacerbates poverty and increases vulnerability⁶. The degradation of agricultural land and the resulting reduced crop yields further intensify food insecurity and poverty. As a result, it is crucial develop a comprehensive understanding of the effects of riverbank erosion and the adaptive strategies employed by affected communities⁹.

Various approaches to the study of the effects of riverbank erosion and the resilience of communities affected by it have been applied in recent studies. An in-depth study from the northern part of Bangladesh (2000) found that function of conventional methods of erosion control such as vegetation on the riverbank enhances the standard of living and the resilience of communities¹⁰. A comprehensive study performed under applied remote sensing (RS), geographic information systems (GIS) field surveys, and focus group discussions (FGDs), erosion, accretion, degradation, and community resilience were

examined as part of one study in southeast Bangladesh^{11,12}. All these studies emphasize the importance of integration of scientific and traditional knowledge in dealing with problems caused by erosion and its associated hazards^{7,13,14}. However, there are significant gaps in understanding the broader impact of riverbank erosion on community resilience. While some studies have focused on specific regions or individual aspects, a more holistic approach is needed one that integrates environmental, socioeconomic, and cognitive factors¹⁵. This paper will discuss the community resilience and riverbank erosion in southeastern Bangladesh. This research was conducted through FGDs and field investigation. The combination of FGDs and field surveys provides a cohesive analysis of the environmental and socio-economic impacts of the riverbank erosion¹⁶. This work explores the social and economic impact of riverbank erosion, along with socio-economic adaptation through field visits as well as FGDs with local people¹⁷. The results of this study show the degree of damage to homesteads, irrigation, agricultural crops, livestock, and infrastructure, as well as the impacts of the geographical and socio-economic conditions of nearby communities. To address these challenges, the study highlights the need for community-based responses and unified management approaches to mitigate the adverse effects of riverbank erosion and enhance resilience. Additionally, the findings provide valuable insights for policymakers, government agencies, and NGOs in developing a long-term regulatory framework for managing riverbank erosion in southeastern Bangladesh and other regions.

Materials and Methods

This research is conducted with a combination of field surveys and FGDs to estimate the riverbank erosion and community resilience in southeastern Bangladesh. This research methodology is chosen to gain a comprehensive understanding of the environmental and socio-economic impacts of riverbank erosion and to enhance community resilience. The objective of this study is to assess the impact of riverbank erosion on the socio-economic conditions of local communities and their resilience strategies in southeastern Bangladesh. Specifically, the study aims to evaluate the extent of damage to homes, agriculture, and infrastructure due to riverbank erosion, as well as the adaptive responses of the affected communities. This research is conducted using a mixed-methods approach, combining field surveys and FGDs to provide a

comprehensive understanding of both the environmental and socio-economic impacts of riverbank erosion. Field surveys were carried out from 10th January to 10th April 2025, allowing for real-time data collection on erosion effects and community resilience. FGDs with local residents are also conducted during this period to gather qualitative insights on community adaptation strategies and challenges. This methodology was chosen to ensure a thorough analysis of the issue from both quantitative and qualitative perspectives, thus enhancing the reliability of the findings.

Study Area

The Sangu River is the lifeline for the people of Chattogram district, located in the southern part of Bangladesh, in Banskhali Upazila. It is situated in the southeastern part of Satkania Upazila and flows, in a very beautiful way, through the high hills of the northeastern part of the Upazila. As it winds, it provides water for farming, meets the daily needs of the town people, and supports several business activities. The river is beautiful everywhere and any local or visitor cannot help but stop and look at its greenish water that meanders around the mountains, hills and through the forested landscape, creating a breathtaking view¹⁸. In this rich village, fishing and irrigation are the two main sources of income of the people of Banskhali, who heavily depend on the river for their livelihood and to feed their family and to contribute to the local economy. They rely a lot on the river for those things. It's about the water, which is very important for farming in the nearby areas, and that's very important for urbanization¹⁹. The Sangu, like many other rivers in the neighboring countries, faces problems due to human expansion, including building dams and the effects of industry on the river.. how the river naturally flows, and how many things like different plants and animals. Even in this situation, there are a good chance that Sangu River still constitutes an important and valuable resource for the people that live in Banskhali Upazila.

Field Investigations

Field investigations were conducted to gather the primary data on riverbank erosion and the effects of erosion on local communities in the vicinity of the Sangu River. It was chosen as it was considered highly subject to erosion and suitable for investigation because of historical information. Field surveys are conducted directly at erosion-affected sites and are used to obtain real-time data

concerning erosion extent and its immediate effect on the environment and human life.

Questionnaire Surveys

A total of 150 well-designed questionnaires were distributed among the inhabitants of the riverine areas of the study area. The study focused on three unions such as Pukuria, Khankhanabad, and Banigram within Banskhkhali Upazila. These unions were selected because of their direct exposure to the impacts of riverbank erosion and their relevance to the study's objectives. In each of the three selected unions, 50 respondents were chosen randomly to ensure that the sample was representative of the local population. The sample size of 150 was determined based on the population size of these riverine communities, with consideration for the need to capture both the diversity and commonalities of the socio-economic impacts of riverbank erosion. While a larger sample size would provide greater statistical representation, this number was deemed sufficient to provide reliable data within the time and resource constraints of the study. The questionnaires were purpose-built to gather comprehensive information on household demographics (e.g., age, gender, marital status), economic activities, sources of livelihood, and the extent of damage caused by ongoing erosion. Additionally, the study included questions to assess the community adaptation strategies in response to riverbank erosion. The findings from this research aim to estimate both the current and future socio-economic implications of riverbank erosion and to understand community resilience in the affected areas.

Focus Group Discussions

To explore the community resilience tactics and know the people's perception of riverbank erosion, six (6) FGDs were conducted. In each FGDs group, 8-10 participants from different stakeholder groups in the community were selected to discuss. A structural guideline was used to conduct what was discussed in the FGDs. The topics addressed were those caused by riverbank erosion, the responses of the community, and mitigation recommendations²⁰. The results of the FGDs display those sustainable policies need to be implemented to solve the problematic environmental and socioeconomic conditions of southeastern Bangladesh due to the riverbank erosion.

Data Analysis

The structural questionnaire surveys demonstrate quantitative data, which can be evaluated through statistical software, for example, SPSS, with careful consideration to clarification. Expressive statistics were consistently applied to explore the patterns and correlations among the negative impact of riverbank erosion and numerous socio-economic factors that could affect the community. On the other hand, the qualitative data from the FGDs were transcribed and analyzed carefully to distinguish significant issues and patterns, in line with the community responders to the riverbank erosion threat. This novel multidisciplinary approach, combining field surveys, structural questionnaire surveys, and elaborate FGDs, displayed an in-depth understanding of the environmental and human issues heavily influence the riverbank erosion and community resilience^{12,21}.

Results and Discussion

Impacts on Livelihoods and Assets

The results from the FGDs and field surveys display that the damage from riverbank erosion in southeastern Bangladesh was enormous. The field investigation showed a strong indication that the riverbank erosion severely damaged agricultural land, crops, residential areas, livestock, as well as the socio-economic well-being of its inhabitants⁴. Questionnaire survey data clearly showed that around 20% of the homesteads, livestock, and agricultural crops were fully damaged, whereas 51% of the homesteads, 45% of the cattle, and 61% of the crops were partially damaged. These results establish the wide, severe effects of riverbank erosion on the riverine community's socio-economic condition²². Some responders reported a decrease in household income and an increase in financial instability as a result of damage to the productive land and assets. These findings display the quantity to which the community in the southeastern region was severely damaged through the impact of riverbank erosion, including damage to homesteads, livestock, and agricultural crops. These representations are required to capture the impact of erosion and determine community resilience.

Damage to Homestead, Livestock, and Crops

The damage to homesteads was classified as partial and total devastation. Figure 1 shows the extent of homestead damage due to riverbank erosion. The data indicates that 51% of homesteads were partially damaged, 20% completely destroyed, and 29% remained unaffected. This

distribution shows that although the majority of the families experienced some degree of destruction, a sizable portion were unscathed, demonstrating the community's varied levels of resilience. Figure 1 presents the damage to livestock. According to the analysis, 45% of livestock partially affected, 20% completely lost, and 35% remained unaffected. The substantial percentage of livestock that were partially damaged shows the delicate nature of animal

husbandry is in the area. However, the resilience is also evident as 35% of livestock remained unscathed. In the case of agricultural crops, this figure 1 presents that 61% of crops partially damaged, 22% completely destroyed, and 17% unaffected. The rapid proportion of partially damaged crops indicates that while erosion caused significant losses, some degree of crop resilience measures may have mitigated the total loss¹².

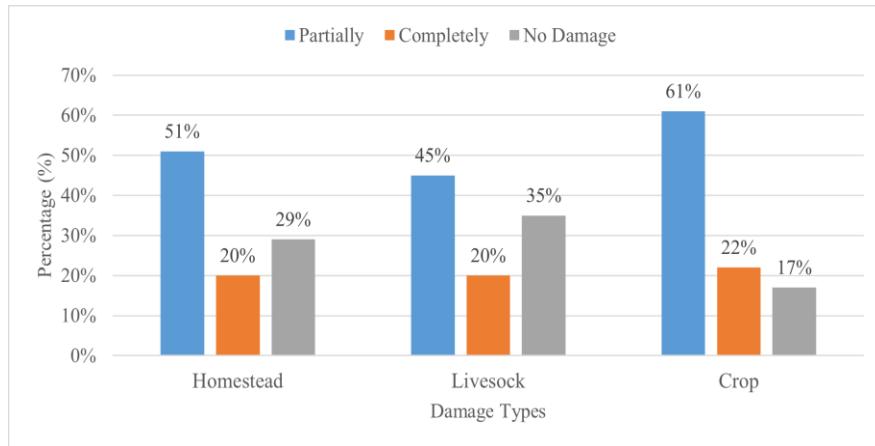


Figure 1. Damage to homesteads, livestock, and agricultural crops due to riverbank erosion.
(Source: Field survey, 2025).

Past Occupation and Income Source

Figure 2 depicts the previous occupations of the respondents. Most respondents (90%) were unemployed prior to the erosion, followed by farming (10%) and day labor (5%). A minority of the population was engaged in other occupations, including business, private employment, factory work, fishing, security services, retail, and government positions. Similarly, Figure 2 illustrates the income sources of the respondents prior to

the onset of erosion. Farming constituted the primary source of income for the majority of respondents (90%). Additional notable sources comprised day labor (5%) and private employment (3%). The residual occupations, including business, fishing, teaching, factory labor, retail, public service, rickshaw/van driving, and carpentry, constituted a negligible percentage of the respondents' revenue sources.

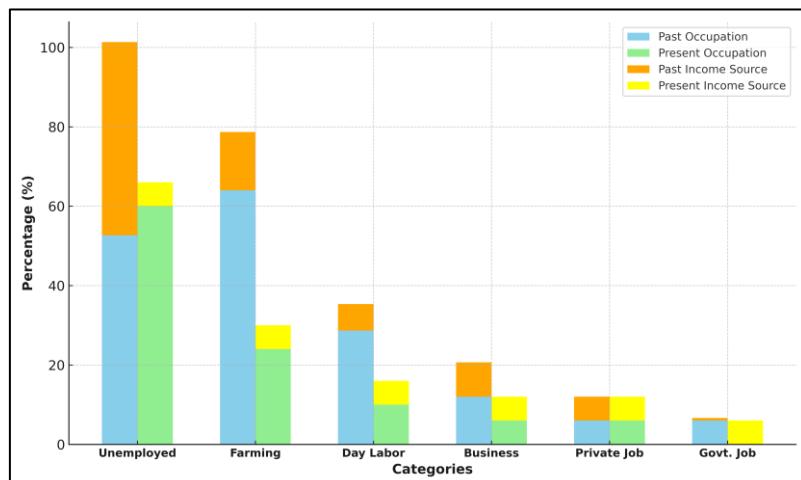


Figure 2. Occupation and income source before and after riverbank erosion. (Source: Field survey, 2025).

Present Occupation and Income Source

The respondents' present occupations are depicted in Figure 2. A large proportion of respondents (70%) are currently unemployed, which represents a substantial increase in comparison to previous occupation data. Farming continues to be the second most prevalent occupation; however, its prevalence has declined to approximately 15%. The representation of other occupations, including day labor, business, private jobs, factory work, fishing, security officer, shopkeeper, and government employee, is minimal. In the same vein, Figure 2 illustrates the respondents present sources of income. Although farming remains the primary supply, it has declined to approximately 60%. The percentage of day laborers has risen to approximately 20%, suggesting a transition to more transient employment practices. Shopkeeping (10%) and instruction (5%) are additional substantial sources. The remaining occupations, including fishing, commerce, private employment, auto rickshaw driving, factory work, rickshaw/van driving, and carpentry, have minimal representation.

Community Resilience and Adaptation Strategies

FGDs provided deeper insights into the community resilience and adaptation strategies. Several adaptive measures were identified, including relocating homesteads, diversifying income sources, and implementing community-based erosion control practices^{9,12,23}. Figure 3 shows the frequency of displacement. Most respondents (56%) displaced 1-2 times, fewer (30%) displaced 3-4 times, and even fewer (8%) 5-6 times. The results show how riverbank erosion has a big and ongoing effect on the communities who are affected. The high number of initial displacements shows how quickly erosion can become a problem. The fact that repeated displacements are going down shows that families have a hard time managing multiple relocations and that there may be fewer places to live after multiple erosion events. This pattern shows how important it is to quickly come up with effective ways to help these vulnerable areas and stop more people from having to move.

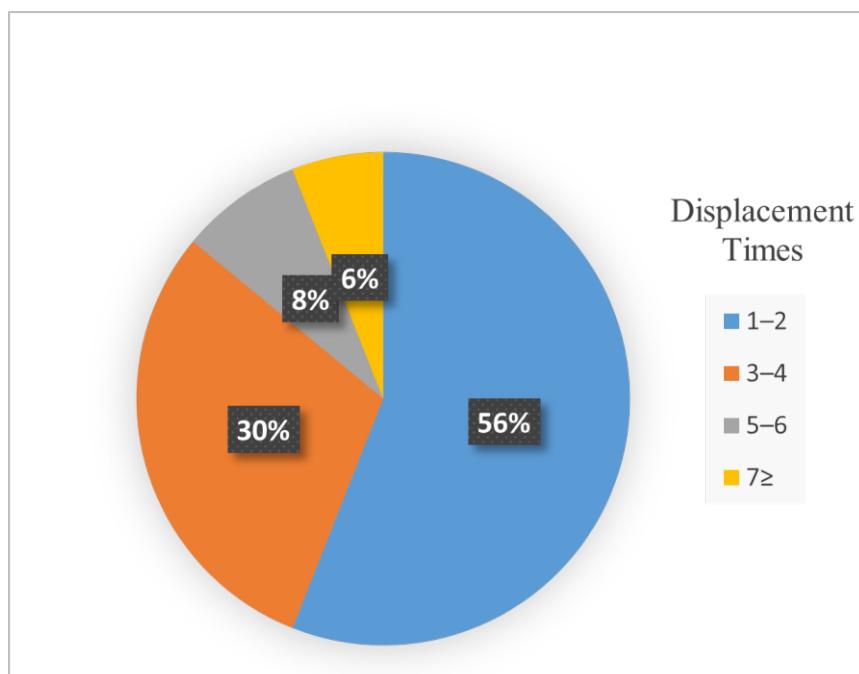


Figure 3. Frequency of displacement time due to riverbank erosion. (Source: Field survey, 2025).

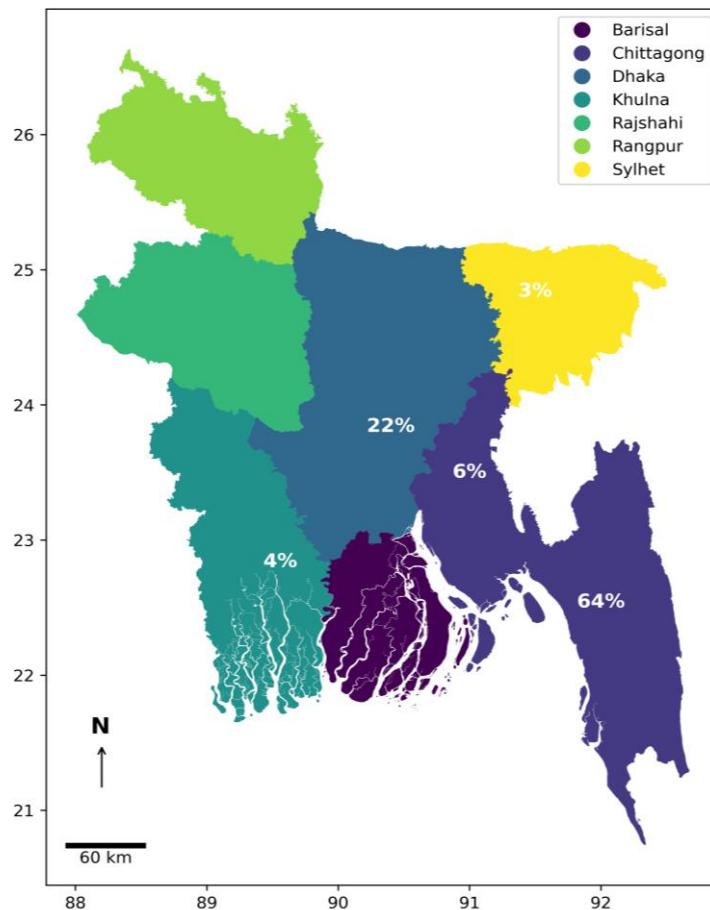


Figure 4. Migration destinations due to riverbank erosion. (Source: Field survey, 2025).

Figure 4 shows that most displaced family members moved to Chattogram (64%), followed by Dhaka (22%). A minority relocated to Khulna (4%), and an even smaller fraction to Sylhet (3%). Dhaka serves as the principal destination for migration. It underscores Chattogram as the principal destination for displaced families from southern Bangladesh. The preference for Chattogram highlights the city's significance as a prominent economic center, drawing individuals in pursuit of work and improved living standards. The movement pattern signifies the necessity for focused

assistance and resource distribution in major urban regions to aid the surge of displaced families. However, Figure 5 shows a weak negative correlation between migration and agricultural land occupation, suggesting that the displacement does not significantly affect agricultural activities in terms of land ownership. However, the effectiveness of these strategies was often limited by a lack of resources and technical knowledge. The community's adaptive capacity is further strained by recurrent erosion events, which undermine long-term resilience efforts.

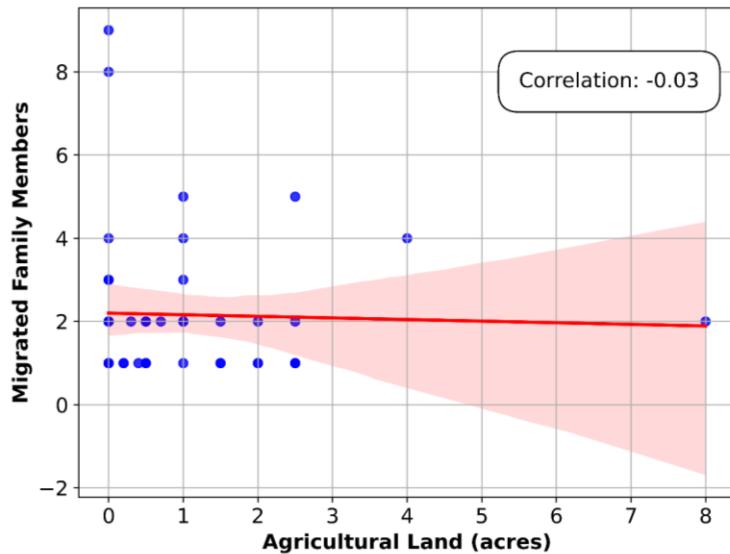


Figure 5. Correlation between agricultural land and displacement. (Source: Field survey, 2025).

The data highlight the diverse effects of riverbank erosion on the livelihoods of the affected communities in Banskhali Upazila. A significant change from farming to unemployment coupled with an increasing dependence on day labor, illustrate the socio-economic challenges faced by these communities. The dependence on agriculture decreased from 90% to 60% while the number of unemployed increased 0% to 70%. These shifts in employment patterns reflect the direct impact of riverbank erosion on local livelihoods. To further understand the erosion dynamics, it is essential to integrate spatio-temporal data on the Sangu River's erosion patterns. By tracking both the spatial extent and temporal changes in the riverbank over time, we can gain a more nuanced understanding of the progression of erosion and its impact on the local population. Historical data, such as erosion rates, seasonal variations, and changes in river flow, are crucial for predicting future trends and identifying areas most vulnerable to erosion. This data can provide insights into the frequency and severity of erosion events, which is vital for developing effective mitigation strategies and interventions.

Studies emphasize the vulnerability of agricultural communities to environmental shocks, particularly those dependent on riverine resources. Expanding income sources to improve resilience is a critical recommendation, as livelihood modification can enhance resilience to both environmental and socio-economic conditions^{12,24}. Similarly, research highlights the need for diversification of

income sources to reduce the vulnerability of communities affected by frequent erosion events²⁵. The inadequate representation of alternate income sources further exacerbates these vulnerabilities and prevents communities from recovering quickly after each erosion event¹⁰. Frequent erosion events undermine community resilience by preventing families from achieving stability, particularly when the erosion leads to the loss of homesteads, farmland, and livestock^{4,12,22}. Therefore, it is essential to encourage programs that target skills development, promote sustainable development practices, and reduce disaster risks to decrease dependence on agriculture.

To design interventions that address both immediate needs and long-term recovery, it is important to assess community-level historical patterns of employment and income, along with the adaptability of these communities to the changing environment. Understanding how communities have coped with past erosion events and their ability to adapt will provide valuable insights for future resilience-building efforts¹⁶. These findings suggest that policies should be context-sensitive and specifically tailored to address the needs of communities in southeastern Bangladesh affected by riverbank erosion²⁶.

Conclusion

This research provides a comprehensive evaluation of riverbank erosion and community resilience in southeast Bangladesh, combining field investigation and FGDs. The incorporation of these approaches revealed significant environmental and socio-economic effects. These findings

are the great interest to policymakers, organizations, and stakeholders working on interventions to increase community resilience and mitigate the impacts of riverbank erosion. The study sounds for the implementation of integrated management tactics and community-driven solutions. Policymakers should focus on sustainability, incorporating both structural and non-structural designs. Structural measures could include embankment construction and riverbank adaptation strategies, while non-structural approaches might include community education, land-use planning, and promoting sustainable agriculture. Collaboration between government and non-governmental organizations is essential to providing technical and financial support to affected communities. Additionally, ongoing monitoring and research are necessary to understand the evolving nature of riverbank erosion and develop creative, targeted solutions.

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