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Analysis of the impact of Brahmaputra riverbank erosion on agricultural productivity and riverine communities in Assam

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ABSTRACT

The complex process of riverbank erosion along the Brahmaputra River's braided course is examined in this study. The research uses a broad technique that includes satellite imagery from Indian Remote Sensing (IRS) to identify the factors influencing erosion processes. The main causes of erosion are liquefaction, sub-aerial weathering, and oversteepening; these processes are exacerbated by the heterogeneous nature of bank materials. Located in the tectonic sedimentary province of Assam, in the Brahmaputra valley, the region is very susceptible to erosion, which has a substantial effect on the socioeconomic structure of the area. The valley, home to more than 15 million people, floods regularly, causing extensive displacement, the loss of agricultural land, disruptions to the educational system, and worsening public health issues.

To address these issues, the government has started anti-erosion campaigns in addition to large-scale infrastructure projects like building embankments and drainage canals. The study highlights the implementation of geo-textile bags as a preemptive strategy to enhance the stability of riverbanks. Additionally, the study offers a number of thorough recommendations for fully mitigating the hazards related to erosion and flooding. These include developing a thorough plan for managing floodplains, implementing bioengineering techniques to stabilise riverbanks, and fostering institutional coordination for efficient river management.

Through the combination of census data, academic articles, and governmental initiatives, this study offers an understanding of the intricate relationships between human activity, natural geomorphologic processes, and

policy responses in endangered riverine ecosystems. The data acquired from this research will be essential for developing plans for sustainable river management in the Brahmaputra basin and other areas of the world facing comparable problems.

Keywords: Brahmaputra River, Bank erosion, Riverbank protection, Socioeconomic impact, Bioengineering, Floodplain management, Assam

INTRODUCTION

Millions of people who live along the banks of the world's largest river, the Brahmaputra, receive food and a means of subsistence as it passes through the northeastern Indian state of Assam. But riverbank erosion is a persistent threat to this beautiful location. The unrelenting power of the Brahmaputra's currents has caused the banks to erode gradually—and occasionally quickly—causing considerable land loss and uprooting of communities.

This study aims to investigate the complex linkages that occur from erosion along the Brahmaputra riverbed between agricultural productivity and the socioeconomic level of Assamese riverine people. Although riverbank erosion is not a recent issue in the region, a thorough analysis is required to comprehend its consequences on livelihoods and agriculture given the shifting environmental dynamics and socioeconomic vulnerabilities. Its primary objective is to comprehend the complex interactions that exist between agricultural systems, environmental processes, and the ability of communities to withstand natural calamities. To provide meaningful insights into the intricate mechanisms of riverbank erosion and its impact on agricultural and community livelihoods, this research will thoroughly examine secondary data sources, such as academic journals, official government publications, and statistical databases.

The Climate Vulnerability Index (2021) ranks Assam as India's most climate-vulnerable state. ***Image Source: Northeast Now, 2019 by Borgohain, Dhruba Jyoti***

We must acknowledge the gravity of the problems caused by the erosion of the Brahmaputra riverbed as we set out on this investigation. Erosion affects the region's food security, employment prospects, and socioeconomic stability in ways that go beyond the immediate loss of agricultural land. Our study project aims to provide evidence for policies and activities that reduce the effects of riverbank erosion and promote sustainable development in Assamese riverine villages. It does this by bringing attention to these challenges.

LITERATURE REVIEW

The Brahmaputra River, which is Assam, India's vital lifeline, is seriously threatened by widespread erosion of its banks. The effect of this erosion on riverine communities and agricultural output is examined in this review.

Impact on Agricultural Productivity

- **Land Loss:** Studies by NDMA (2018): and Saikia et al. (2017): Highlights the substantial loss of agricultural land due to erosion. This directly reduces cultivable area and agricultural output.
- **Soil Degradation:** Erosion can lead to the removal of fertile topsoil, impacting crop yields as documented by Saikia et al. (2017)

Impact on Riverine Communities

- **Displacement:** Erosion displaces communities residing along the riverbanks, as noted in the NDMA report (2018). This disrupts lives and livelihoods.
- **Loss of Infrastructure:** Erosion can damage essential infrastructure like houses, roads, and irrigation canals, further impacting communities (NDMA 2018)
- **Threat to Life and Property:** Riverbank erosion poses a constant threat to the lives and property of riverside communities (NDMA 2018)

Additional Considerations

- **Neo tectonic Activity:** Borah et al. (2010): Discuss how neo tectonic activity (recent earth movements) might influence erosion patterns. Understanding these geological factors is crucial for mitigation strategies.

OBJECTIVES

1. Quantify the impact of geomorphic factors and human activities on rate of bank erosion.
2. Assess the efficiency of the current controls on bank erosion are working.
3. Assess the feasibility and economic viability of bioengineering solutions.
4. Construct a framework for a comprehensive flood plain management plan for the Brahmaputra Valley.

METHODOLOGY ADOPTED

The impacts of Brahmaputra riverbank erosion on agricultural productivity and riverine communities in Assam were examined using a secondary data study methodology. The strategy involved systematically compiling, analysing, and integrating previously released research, studies, and datasets regarding the community dynamics, agriculture, and riverbank erosion along the Brahmaputra in the area.

1. Literature Review:

A detailed analysis of the literature was done using scholarly resources like ResearchGate, Google Scholar, and institutional repositories. We used search terms including "riverine communities," "agricultural productivity," and "Brahmaputra riverbank erosion" to locate relevant studies, research articles, reports, and grey literature.

2. Document Analysis:

The National Disaster Management Authority's (NDMA) Final Report on the Brahmaputra River and other relevant official publications were closely analysed to gather information on the patterns, causes, and effects of erosion in Assam. Additionally, pertinent information was taken from research articles about "Erosion-deposition and land use/land cover of the Brahmaputra River in Assam, India" and "Bank erosion of the Brahmaputra River and neo tectonic activity around Rohmoria, Assam, India."

3. Data Synthesis:

Data from the selected sources were merged to provide information on lost agricultural land, erosion hotspots, socioeconomic repercussions, and community responses. Spatial data on land use and cover changes and erosion dynamics were extracted from relevant studies and reports for further research.

4. Database Used:

The primary sources used for this study included the NDMA Final Report on the Brahmaputra River, research articles from websites such as ResearchGate and The International Journal of Engineering Sciences & Research Technology, and additional official reports and publications about riverbank erosion in Assam.

5. Data Analysis:

Employing data analysis techniques like content and topic analysis allowed researchers to identify important findings, recurring themes, and patterns in the literature. When applicable, statistical software was used to analyse quantitative data about the amount of erosion and how it affects agriculture. Using a secondary data research approach and a range of information sources, the aim of this study was to provide a comprehensive analysis of the consequences of Brahmaputra riverbank erosion on agricultural productivity and riverine populations in Assam.

RESEARCH

The main mechanisms causing riverbank erosion were oversteepening and related sub-aerial weathering and weakening processes in relation to soil moisture content, as well as aqueous flow of sediments (liquefaction) enhanced by the inhomogeneity in the bank materials in question, according to a study conducted on a specific segment of the Brahmaputra River channel. The study found that there were differences in the rates of erosion and deposition between the years 1914–1975 and 1975–1998. Processes that cause bank erosion are primarily caused by shear failures of various sizes and kinds.

The Brahmaputra valley is a 720 km long and 80–90 km wide tectonic sedimentary province in Assam. Its heights vary from 120 metres at Kobo in the extreme east to 50.5 metres at Guwahati and 28.45 metres at Dhubri in the far west. About 10% of the valley is in the river's channel, and more over 40% of that area is farmed. In the Assamese Brahmaputra valley, there are an estimated 15 million inhabitants. The river flows in an extremely braided channel with many mid-channel bars and islands in Assam. With an average flow at the mouth of 19,839 m3/s, the Brahmaputra is the second-largest river in the world in terms of sediment transport per unit drainage area. A characteristic that sets it apart is the channel's slow southerly migration over time. Furthermore, the system's location in a seismically active area demands a prompt evaluation of its geomorphologic behaviour while accounting for socioeconomic impacts.

270 km of toposheets from the Survey of India (1914 and 1975) and satellite imagery from Indian Remote Sensing (IRS) (1998) are used to study the erosion phenomenon on the braided Brahmaputra River channel, which runs from Panididihing Reserve Forest to Haloukonda Bil. In addition to the globally significant Kaziranga National Park, which is home to the critically endangered Asian one-horned rhinoceros species, the region is home to Majuli, the largest river island in the world, which is seriously threatened by erosion.

Despite enormous efforts and enormous spending (more than Rs 15,000 million) to construct 431 km2 of area for drainage channels, 599 km of embankments, and 3647 km of embankments, the Brahmaputra River still causes yearly severe floods that are out of control. Records show that there were multiple catastrophic floods between 1954 and 1998. Every year, floods cause damage to up to 9600 km2 of land, or 12.21% of Assam's total geographic area. In 1998, a devastating four-wave flood submerged 38,200 km , or 48.65%, of the state, endangering the lives and property of fifteen million people. The monsoon and the freeze-thaw cycle of the Himalayan snow are the two seasonal rhythms to which the Brahmaputra flow regime reacts.

Spatial changes of the area during 1983-1996:

With a ground resolution of 36.25 metres, IRS IB LISS III data from December 1996 was used to evaluate the spatial changes that occurred after 1983. In the short time span of 13 years, the Brahmaputra moved north of Oakland-Nagaghuli, Balijan, Rohmoriagaons, and Garhparagaon by 5.5 km, 4.5 km, 1.8 km, and 0.2 km, respectively. This resulted in the Dibru River's mouth being moved 8 km eastward from its original location in 1983 to Balijan, and the Brahmaputra being 16.20 km wider.

Subsequently, the Brahmaputra engulfed the Okland-Guijan scarp, encompassing sixteen small towns, transforming the scarp into the riverbank. The Brahmaputra continued to flow beside the scarp in the meantime. Furthermore, in 1996 the Lohit River erupted and altered its course, passing through the Dangari and Dibru rivers before reaching the Brahmaputra River at Balijan. The average yearly discharge of this watercourse was 1447.66 m^3/sec.

Spatial changes in the area after 1996:

The IRS ID LISS III data from December 2001, which has a ground resolution of 23.6 metres, depicts the alterations that occurred between 1996 and 2001. The regions of Garhparagaon, Rohmoriagaons, and the northern edge of Oakland TG have disappeared by 2001. Beyond the Rohmoriagaons, the Brahmaputra River continued east to Bagaritoli and west to Kachuanigaon. During this period, the Brahmaputra's incursion stretched between 200 and 750 metres.

During the six years between 2001 and 2007, the south bank of the Brahmaputra moved southward unabatedly up to 200 metres around Rohmoriagaons, according to IRS P6 LISS III data acquired in December 2007 with 23.5 metres of ground resolution. The continuous bank erosion has been verified by Cartosat 1 data, which was obtained in November 2009 and has a 2.5 m ground resolution. The largest incursion, measuring almost 107 metres, occurred between 2007 and 2009. In 2009, the Brahmaputra River's breadth was recorded at 17.02 kilometres. On January 10, 2011, a field assessment verified that the erosion had persisted; in 2010, the maximum quantity was measured at 20 metres.

Amount of bank erosion in different periods:

The banklines of the Brahmaputra River around certain localities, such as the Rohmoria locality, are brought to the same scale and superimposed along a length of approximately 17 km for the years 1916, 1963, 1983, 1996, 2001, 2007, and 2009 in order to quantify the regions being eroded over time. Considering the similarity between the banklines in 2007 and 2009. Between 1916 and 1963, the average annual rate of bank erosion was roughly 1.093 km2, and between 1963 and 1983, it was roughly 0.926 km2. Even if the two annual rates of bank erosion are similar, there may have been a decline in the average rate of erosion. It is more likely that the annual rate increased after the 1950 Assam earthquake and was much lower before. Between 1983 and 1996, the rate of erosion increased to a level that was more than 2.5 times that of the two rates that came before it. The primary reason for the higher rate of erosion by 1996 is probably this greater sinking north of the neotectonic fault scarp. Annual rates of bank erosion were significantly lower in the following periods.

The Brahmaputra River continued to flow along the footwall component of the fault scarp after 1996, presumably having devoured the whole low lying or subsided portion (hanging wall of the neotectonic fault) north of the scarp by then, based on the decline in erosion rates in the seasons following that year.Between 1916 and 2009, the Brahmaputra is estimated to have destroyed 109.479 km^2 of bank area across a 17-mile span in the Rohmoria district. The rate of erosion in this reach is 1.177 km^2/year when the total is divided by the 93 years that this reach spans (1916-2009). The amount of bank erosion per unit length of the Brahmaputra river at Rohmoria is around 0.069 km²/km per year, which is the greatest for the entire south bank of the Brahmaputra when divided by the segment's length (17 km). When divided by the length of the segment (17 km), the rate of bank erosion at Rohmoria is around 0.069 km²/km per year, the highest for the entire south bank of the Brahmaputra.

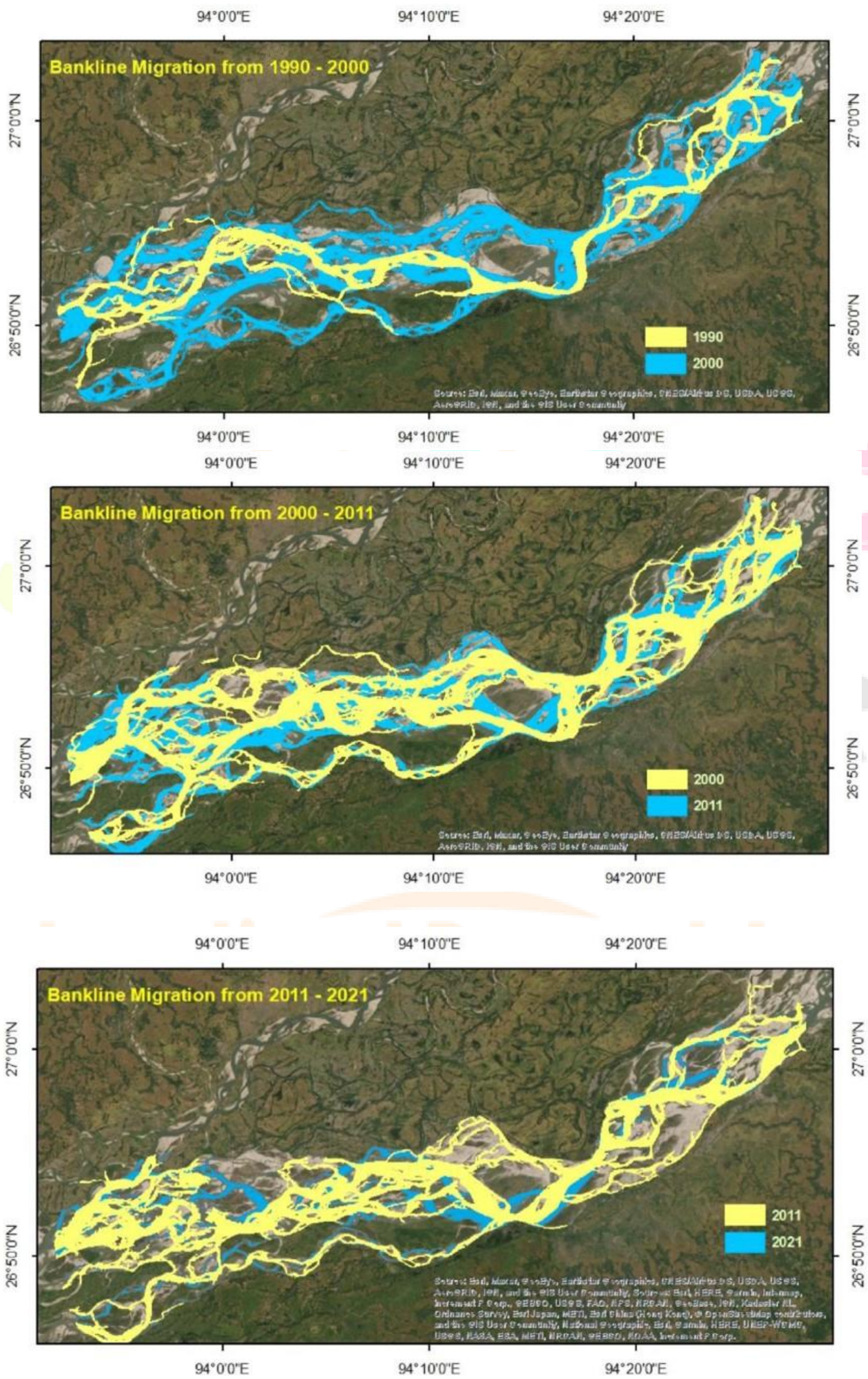

Image: Change of the course of river (1990-2021)

The river begins and ends in the states of Nagaland and Assam, where it flows through for the most of its journey. The upper basin of the Nagaland River has a precipitous slope, and the only areas that flood are the foothills of the Kohima district, which are near the town of Dimapur. Even so, the water only persists for a day or two. Normally, when passing through Assam, major flooding does not occur until Bokajan. At the lower reach, the flooding issue gets more complicated. The Brahmaputra River flood has affected the circles of Sarupatha, Golaghat, Khoomtai, and Bokakhat.

The major contributors of flood in the sub-basin are:

1. Steep slopes of river in the hill
2. High level of intensity with 1.158 mm of annual monsoon rainfall on average. The basin experiences intense rainfall throughout the monsoon season due to its location in the monsoonal regime.
3. Highly meandering nature of the river in the plain.
4. Landslip risk and deforestation in the upper catchment.

The primary factors contributing to bank erosion in the Brahmaputra River are its meandering nature, flooding, flow direction, and rapid flow velocity. Increased erosion of riverbanks has also been connected to changes in river shape and human activity. One of the river basins in India that erodes the fastest is the Brahmaputra basin. One could argue that following the 1950 earthquake, the Brahmaputra valley in Assam saw a dramatic shift in the severity and intensity of its bank erosion issue. The Brahmaputra channel's bank materials are rarely consistent, and there is erratic bank slumping. The flow changes direction as a result, and the bank-line's orientation to the flow direction also changes. Additionally, ground observations along the entire examined stretch demonstrated that older alluvium that occasionally protrudes into the river dramatically affects the hydraulic conditions and poses a flow regime challenge. Because of the finely divided bank material and the frequent changes in flow direction, severe bank caving happens along the channel.

The processes of deposition and erosion that took place between 1974 and 1975 and between 1975 and 1998 could not be compared. There were indications of considerable erosion on both riverbanks in the study area between 1914 and 1975. The greatest deposition, however, was discovered across a 30-kilometer stretch along the river's southern bank; it covered 28.15 km2 of soil near Sikarighat and peaked at 38.75 km2 close to Bhomoraguri Hills. The areas known as Jorhat-Majuli are the most noticeable along the 50 km of erosive activity that precede Kumargaon. A total of 49.5 km2 of land had been lost in this area. Furthermore, there was significant erosion in the region from Sohola Bil to Dipholumukh that surrounded Kaziranga National Park. Up to 1975, 83.23 km2 of this region were lost to erosion from the main mass. It is interesting to note that the banks of the Brahmaputra have severe erosion from Orang Reserve Forest to Haloukonda Bil. But between 1914 and 1975, there was a discernible increase in erosion on the northern bank of the river compared to the southern side. There is a minor variation in the circumstances from 1975–98 compared to the previous investigative era (1914–75). A change in location has resulted in a small decrease in the amount of erosion in the Majuli area. Along its southern bank, the river showed signs of a depositional phase close to Kaziranga National Park and Neemati-Jorhat. An additional 17.65 km2 was added to the southern bank of the Brahmaputra in Kaziranga, close to the confluence of the Burai River.

Sediment slumping occurs when the flow approaches the bank at an angle and produces a large amount of under-cutting. In banks with clayey and silty clay compositions, ditches are more prevalent. The extremely saturated clayey silt frequently melts and moves in the direction of the channel. Less saturated bank sediments on top of the materials tend to collapse along well-defined shear lines as they flow. Therefore, the two primary types of slumping that cause the bank-line to recede are undercutting during the flood stage and the flow of highly saturated sediments during the falling stage. But after the flood threshold, the slumping worsens. The rising water level during the flood stage provides additional support for the bank material because water fills the pore spaces of the loosely coupled bank materials and creates a continuous structure. When the water level falls, the support quickly diminishes and the bank materials undergo different kinds and degrees of erosion. Fine sand, silts, and massive channel sands are piled in some places within the silty clay of the natural levee deposits. The high level of the river pushes water into the strata, increasing the pore pressure there. Water rushes back into the river from the formation when the river's water level drops quickly and the force pushing on the channel wall decreases. Subaqueous failure results from sand and silt flooding the channel laterally. This typically results in a bowl-shaped shear in the naturally occurring levee deposit above. This kind of bank failure occurs close to Majuli, Nematighat, and Kaziranga National Park.

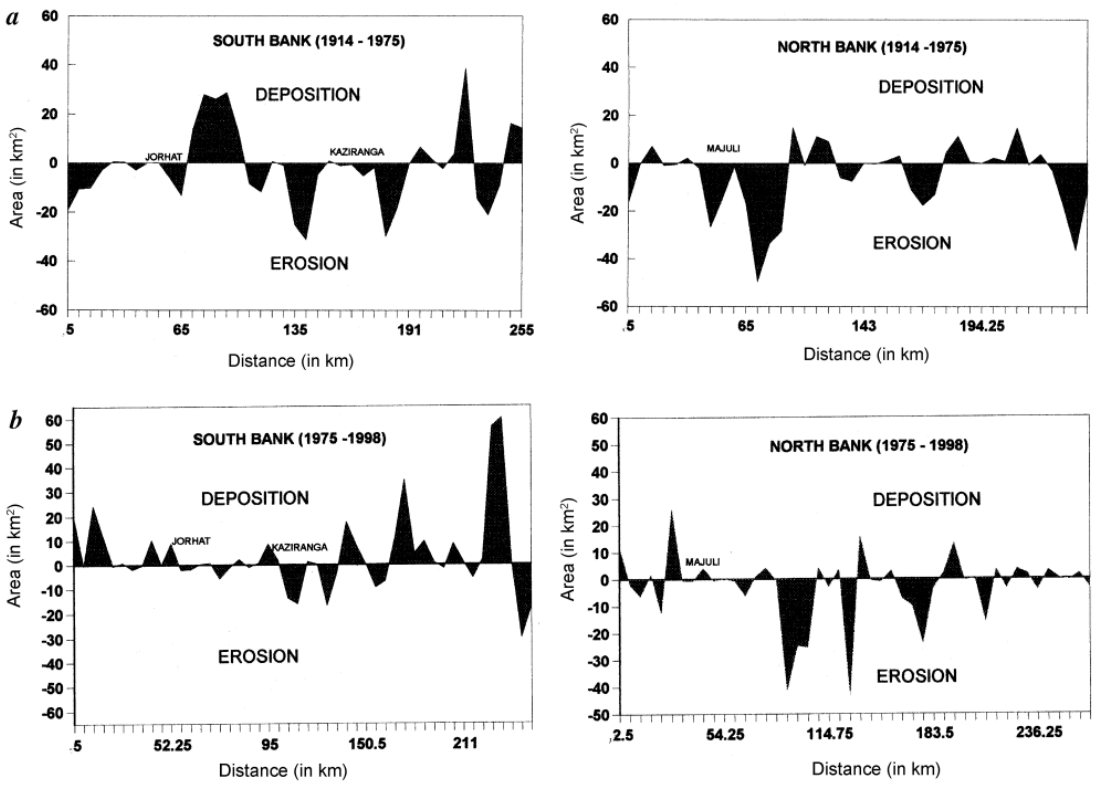

Image: Erosion and deposition in the studied reach of the Brahmaputra River channel during (a) 1914–75 and (b) 1975–98. ***Source: Current Science · February 2005***

Socio Economic Impact of Bank Erosion

1. Displacement - The destruction of homesteads due to erosion and flooding has a profound impact on people's ability to lead fulfilling lives. The displaced people typically relocated to neighbouring communities in search of better prospects, but migration to far-off locations is also frequent. The direct result of erosion and flooding is displacement. Most of them had to relocate their households using only their personal salaries after the tragedy. According to field research, bank erosion has forced the residents of Mainapara village's Rangdoi Chuk to relocate to Tenpur.
2. Loss of arable land and residence - One of the most frequent effects of erosion and flooding is the loss of homes and farms. A large tract of land drains into the river due to bank erosion. The analysis clearly shows that the analysed site has little potential for agriculture. A farmer can only plant two or three crops in a calendar year and must homestead garden for livelihood.
   The intermittent flooding and ensuing bank erosion are the primary causes of this restricted farming. Table 1 demonstrates that over 418 bighas of land were lost to erosion by the Dhanasiri river alone in the Golaghat revenue circle between 2002 and 2011. Large-scale agricultural land loss, particularly in the last ten years, has left about 100 households without a place to live.

Period	Average Annual Area Flooded (in Mha)		Flooded Crop	Average Annu Population Af	Average Annu Damage (Rs in lakh)	Value of Crop lost as % of Total Damage
	Total	Cropped				
1953 – 59	1.13	0.1	8.85	8,60,000	586	66%
1960 – 69	0.75	0.16	21.33	15,20,000	757	92%
1970 – 79	0.87	0.18	20.69	20,00,000	1,518	89%
1980 – 88	1.43	0.4	28.05	45,50,000	14,552	96%
1999 – 05	1.07	0.38	5.65	45,86,000	71,717	34%

Source: Water resources, Govt. of Assam

3. Hinderance in education - Almost every village has primary and high schools. However, erosion and water cause school buildings to collapse every year. Running the school system is difficult due to issues with missing infrastructure, disruptions in the classroom, and other issues.

Year	Area Eroded in Ha	Nos. of Villages affected in Nos.	Family affected in Nos.	Value of property (including land loss) Rs in Lakh
Year	Area Eroded in Ha	Nos. of Villages affected in Nos.	Family affected in Nos.	Value of property (including land loss) Rs in Lakh
2001	5348	227	7395	377.72
2002	6803	625	17985	2748.34
2003	12589.6	424	18202	9885.83
2004	20724	1245	62258	8337.97
2005	1984.27	274	10531	1534
2006	821.83	44	2832	106.93

Table 1: The extent of damage due to bank erosion ***Source: Water Resources, Govt. of Assam***

4. Medical problems - Because of the concentrated population in a limited location, people typically moved to less hygienic areas during the risks. Floods can provide the perfect environment for

mosquito reproduction, which can lead to the spread of a wide variety of diseases. People who experience erosion and flooding are frequently at a higher risk of contracting various water-borne infections, such as malaria and dengue. Once more, there are not enough medical facilities in the impacted area. Medical facilities are occasionally impacted by these natural disasters as well.

Circle name	No. of flood affected villages
Khoomtai circle	17
Golaghat circle	27
Sorupathar circle	44
Bokakhat circle	25

Table 2: Number of floods affected villages in the flood plain of the Brahmaputra basin. ***Source: Brahmaputra Board***

(a)

(b)

Image (a): Bowl shaped erosion by the river in Murkata village

Image (b): Village temple and homes being washed ***Source: Al Jazeera, 7 Nov 2022***

Impact on livelihood –

People who are uprooted due to riverbank erosion have been noted to live in poverty (GOA, 2011; Rana and Nessa, 2017). Among the unapproved locations where the displaced residents of the districts endangered by riverbank erosion are currently staying are roadside ditches and reserve forest lands. Even though it's possible that there will be further erosion, some of the displaced individuals have been living near the river. Their primary sources of income include farming on rich soils near rivers, small-scale enterprise, and home production.

During the Rabi season, the displaced people who were relocated to the bank lands temporarily cultivate there. In addition, a few of the Dhubri district evacuees relocated to the char areas. The bulk of the displaced people living in the study locations are dependent on agriculture, and these char lands are the most productive when compared to other types of land (FGD). Conversely, those who relocated nearer to markets or cities began working in vending, rickshaw pulling, van driving, etc. The erosion-affected individuals' occupations and other coping mechanisms are insufficient to sustain them.

Environment Degradation –

In addition to the disadvantages already discussed, riverbank erosion has a negative impact on the environment. This covers aesthetic appeal, soil fertility, and the amount of forest cover. Focus group discussions with erosion-affected families have shown that these households have lost both homestead and forest trees. In the homestead grounds of the households under investigation, betel nuts and leaf trees were prevalent prior to erosion; however, these plants vanish following erosion.

A variety of tree species that had established themselves on their homestead are also lost. Elements that experienced erosion also experienced siltation. Siltation or sand deposition decreased the agricultural areas' soil productivity. The Dhubri district's Char regions and the Dhemaji district are where this phenomenon is most prevalent. Large sand deposits cover a portion of the Dhemaji district's agricultural land, making it impractical to conduct farming activities (FGD). Furthermore, erosion reduces the visual appeal of the affected areas. Participants in the focus groups stated that the Brahmaputra River and its tributaries had flooded most of the attractive villages, and that the paddy fields were now becoming sandy. The breathtaking vista and indigenous vegetation vanished into the river. As a result of the river's platform shifting, the attractiveness of the riverfront regions was significantly reduced.

Measures Taken by the Government

1. Geo Textile bags - The Water Resources Department created the plan to safeguard the river's bank and bed. A key component of the suggested system was the incorporation of adequate bank and toe protection works. The bank slope that was well-dressed followed, reaching a height of around 5.5 metres. Layers of geotextile filter material were topped with geotextile bags that protected the bed and the bank. To improve the stability of the scour prevention strategy, layers of geotextile bags were piled inside PP rope gabions and the perimeter strips of Steel Gabions at regular intervals. Under the geotextile bag revetments, the bank slope is protected by high-quality non-woven geotextile materials that serve as a filter and separator. Two layers of Geotextile bags filled with PP rope gabions were built at the foot of the slope excavation. Because the bank revetment was at a slope of 1:3, the bank slopes were trimmed at the same slopes. Then, premium non-woven geotextile filters were laminated in three layers, and geotextile bags were placed on the incline. The use of rib-shaped gabions with double twisted wire mesh coated in PVC and filled with geotextile bags was implemented on the slopes. The bags had a minimum weight of 126 kg when loaded with dry sand and had lie flat dimensions of 1.03 x 0.7 m.

2. The government frequently initiates a number of anti-erosive programmes in order to offer protection in the erosion-affected areas. Golaghat Township is one of the 9612 hectares of land that are shielded from erosion by several methods.

3. Building embankments on both banks of the Dhanasiri River to reduce flooding. The right bank embankment is 18 km long, whereas the left bank embankment is 5.05 km long. Only 23.05 km is the total length of the embankments built in the Dhanasiri subbasin.

Suggestions

1. Bioengineering for Riverbank Stabilization:
   Examine whether vetiver grass (khus), bamboo bioengineering, and coir geotextiles may be used to strengthen the Brahmaputra riverbanks and encourage the establishment of vegetation. It would contrast these bioengineering techniques' long-term viability and affordability with those of conventional, rigid constructions. To find the best ways to apply these bioengineering solutions, field testing would be carried out in areas of Assam that are susceptible to erosion.
2. Institutional Coordination and Stakeholder Engagement:
   Examine the current institutional structure for managing the Brahmaputra River and identify potential areas of improved cooperation between the federal, state, and local administrations. The construction would be done using a participatory approach, actively including the local community in the choice of erosion control techniques. Building stakeholder capacity and exchanging information will be encouraged by the article to ensure the efficient implementation of erosion management techniques.
3. Comprehensive Flood Plain Management Plan:
   An analysis of historical flood data, projections of climate change, and river morphology would be necessary to create Assam's flood danger map. To identify settlements and vital infrastructure that are susceptible to erosion and flooding, land-use patterns would be studied. Land-use restrictions and zoning laws are recommended to deter development in high-risk locations. Additionally, to relieve the strain on riverbanks, locations for managed floodplain flooding would be identified.

CONCLUSION

The complicated phenomenon of riverbank erosion along the Brahmaputra River in Assam, India, was examined in this study. According to the study, the main causes of erosion include sub-aerial weathering, liquefaction, and oversteepening, which are made worse by the different composition of materials present along riverbanks. In addition to tectonic activity and the river's braided channel, these elements endanger the lives of millions of valley residents and play a major role in land loss.

The paper focused on the disastrous social effects of erosion, such as health issues, disruptions to education, loss of agricultural land, and forced displacement. The government has taken steps, such as building embankments and geotextile bags, but more long-term solutions are still required, the report concludes. The study suggests looking at bioengineering methods for fortifying riverbanks using geotextiles made of vetiver grass, bamboo, and coir. Better institutional cooperation between levels of government and stakeholder involvement with the community are also recommended. As a last resort, the development of an extensive floodplain management plan with controlled flooding zones, land-use restrictions, and flood risk maps is advised. By putting these suggestions into practise, the Brahmaputra Valley may reduce the likelihood of erosion and flooding, safeguard the ecosystem, and preserve the residents' means of subsistence. This will be a step towards a more sustainable future.

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