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Rural Risk Assessment Due to River Bank Erosion in Laharighat Area, Morigaon, Assam, India

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ABSTRACT

The spine of Assam's agro-valley is the Brahmaputra River, one of the world's greatest rivers. However, the stability of the riverbank is negatively impacted by the river's temporal shifting, frequent floods, and severe erosion. One of the main natural risks in Laharighat, Morigaon district, is river bank erosion. In the northern area of the Morigaon District, several villages disintegrate completely or partially each year. In many areas of Assam, especially the Morigaon district, bank erosion of the Brahmaputra River has reached worrisome proportions. The study's goals are to assess the Brahmaputra River's bank erosion situation in the Morigaon District of the Laharighat Circle (1986– 2021). Consequently, a study on river bank erosion is conducted in the Morigaon area under the Laharighat circle of the Brahmaputra River (1986-2021). The people of the Northern Side experienced numerous issues annually as a result of bank erosion. There is a serious social and economic crisis in the impacted area as a result of the affected people leaving their home country to migrate elsewhere and the river bank's width growing at a rate of 79.6 meters per year.

Key words: *River morphology, River bank erosion, Morigaon, Lahari ghat Circle.*

Introduction

On the Asian continent, the northeastern part of India is the most hazardous. Different from the rest of the eastern region, this area is more vulnerable to earthquakes, cyclones, floods (Asiedu and Kusimi, 2021), and landslides. Brahmaputra and Barak were the two principal river systems in Northeastern India (Mili, *et al.,* 2013). The Brahmaputra is a major tropical alluvial river (Dekaraja and Mahanta, 2021) that drains 580,000 km^2 in south-east Asia, including parts of Tibet and southern China. Despite having its beginning at the Angsi Glacier, a perpetual glacial source on Tibet's northern Himalayan side, the river gets the majority of its discharge. The catchment area covered Bangladesh (8.1%), Bhutan (7.8%), India (33.6%), and China (50.5%). Assam (36.3%), Meghalaya (6.1%), Nagaland (5.6%), Sikkim (3.8%), Arunachal Pradesh (41.99%), and West Bengal (6.3%) share the basin in India. The basin receives 60–70% of its average yearly rainfall during the monsoon season, which runs from June to September. The river rises to an elevation of 5300 meters at its source in Tibet and flows for around 2900 km before emptying into the Bay of Bengal after passing through South China, Bangladesh, and India.

The river that is known as the "Brahmaputra" originates from the confluence of the three head-

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streams, Dihang, Dibang, and Luhit (Das, 2022) in the Sadia subdivision of the Tinsukia district, east of Kobi. It travels 700 km east to west along the regional gradient until it reaches Assam, Bangladesh, and the town of Dhubri. At this point, the Brahmaputra re-enters Bangladesh, where it is referred to as the Jamuna. It continues under that name all the way to Goalundo, where it meets the Ganga and becomes the Padma. Finally, it descends into the Bay of Bengal. The overall catchment area of the Brahmaputra River is 5,80,00 km^2. This includes 2,93,000 km^2 in India, 2,40,000 km^2 in Bhutan, and 47,00 km^2 in Bangladesh. Brahmaputra is the world's third-largest river; it ranks second in terms of sediment bed behind China's Yellow River. The river flows through the Assam plains for 720 km of its 9–18 km length in India.

Statement of the Problem

Examination of geomorphologists' changing career paths. The study of rivers' changing courses has long piqued the interest of geologists and archaeologists (Saikia, *et al.,* 2023). First, as a result of fluvial processes related to the valley's alluviation, a number of earlier courses in the Brahmaputra River System may be identified in the Alluvial regime (Dekaraja and Mahanta, 2021). Secondly, the alteration of the courses has sculpted several kinds of fluvial landforms throughout the basin. In addition, the research includes an applied component from the perspectives of groundwater exploration and geohazard mitigation associated with the river's shifting path (Mamun, *et al.,* 2022).

As a result, the current research has been conducted on changing courses and fluvial processes, specifically pertaining to the Brahmaputra River System. Various methodologies have been employed to identify and map the altering courses of the rivers, and in addition, an analysis has been conducted on the associated landforms and fluvial processes (Saikia *et al.,* 2023). Geological, geomorphic, and hydrologic elements have all been used to examine the potential origins of these shifts. Following a thorough examination of the migrating courses, an estimation of the expected future shift in the courses has been made.

Since the beginning of time, riverine areas have always drawn the expansion and development of human settlement (Das *et al.,* 2014). River valleys offer towns and agricultural pursuits numerous benefits, but they can also be mixed blessings. In Assam, the majority of people reside in the Brahmaputra valley, where natural occurrences like bank erosion and flooding are growing more frequent (Shetu, *et al.,* 2016). The erosion on the southern bank of the Brahmaputra River has caused it to steadily shift southward (Dekaraja and Mahanta, 2022). Both human settlement areas and significant swaths of priceless agricultural land have been eroded by it. The Brahmaputra River, which has significant erosion, floods the Morigaon district nearly annually, causing incalculable suffering to innumerable people.

Methodology

The research was conducted in the Assam's district of Morigaon. Using satellite photos from two different time periods-1987 and 2000. it was possible to discern the precise bank line movement of the Brahmaputra River in the district as well as the patterns of land development and settlement in the area. This data was overlaid to the base map created by the Survey of India's topographical surveyor to ascertain the temporal variations in river courses. The degree of correctness of the interpreted data was determined by comparing these data with ground truth investigations. Since 1989, when erosion started to become more severe, that year is used as the cutoff year to determine which settlements along the river flow were flooded. The villages that were there before 1989 but were submerged along the river course because of river migration and capture since then were located using the village level maps that were obtained from the circle office. To determine the number of communities lost to river erosion, the relocated (Rana and Nessa, 2017) and temporary settlement locations are determined from the village records dating back before 1989. In the Morigaon district alone, over 93 villages have been reported lost, according to the village revenue data from 2001.

In the Lahari ghat revenue circle, thirty villages were completely devastated in 2001, and over 6,000 people are struggling. Roads, colleges, and a lot of schools have been damaged by bank erosion. Up to 2001, 1010 families were rehabilitated by the government under the resettlement and rehabilitation program (1981). Thirty percent of these families, or 300 families, were randomly chosen as a sample size from eight (8) of the rehabilitated areas of the

Morigaon district to examine their occupational structures, both past and present, and to comprehend the challenges posed by migration and changes in the natural and social environments. An additional 300 (three hundred) samples were gathered from the regions where the individuals relocated independently. In order to examine the occupational structure and economic status of the three hundred and fifty (150) self-rehabilitee families, samples from each of the four rural and four urban villages in the district are once more chosen. In order to ascertain the agricultural land use and cropping pattern (Das and Tamuli, 2024), the past and present occupational structures of the resettled villager population, their limitations and hardships as a result of migration (Rana and Nessa, 2017), and the changes in social and natural ecology, the primary data thus collected was tabulated and statistical analysis was employed (Rezaul, 2021).

Study Area

The Morigaon district is located in the very center of Assam. Its latitude is between 26° 15′N and 26° 50′N, and its longitude is between 92° E and 92°50 E. Located on the southern bank of the Brahmaputra River in the Central region of Assam is the current Morigaon district. Its borders are as follows: the Karbi Anglong and West Khasi Hills district to the south; Nagaon district to the east; and the Kamrup district, Assam, to the west. Including a portion of the Eastern Himalaya Biodiversity Hotspot and covering 1,704 km (658 sq mi) in extent includes a single rhinoceros with horns and a range of species' habitats. The district's only wildlife refuge is situated in the historic Mayong area. Lahari ghat is a region in the Indian state of Assam's Morigaon district that is part of Lahari ghat Tehsil. Lahari ghat, in the Indian state of Assam, is situated at 26 25° 10.3584"N and 92 20° 31.3476"E. From the district headquarters at Morigaon, it is 21 km to the north. It is headquarters for Tehsil. Assam town and subdivision Lahari ghat is located in the Morigaon District. The entire Lahari ghat Subdivision spans 229 km, of which 1.03 km is an urban region and 227.58 km is a rural area. There were approximately 103 settlements within the Lahari ghat circle, but 30 of those have completely eroded as a result of denuded banks. Moreover, several of the villages had partially worn away. This results from the regular flooding that occurs once or more times a year, which causes continual geomorphic land erosion. As of right now, the Lahari ghat circle includes 73 settlements in total.

Results and Discussion

Intensity of Bank Erosion

District Morigaon has a serious erosion issue because there are insufficient anti-erosion measures.

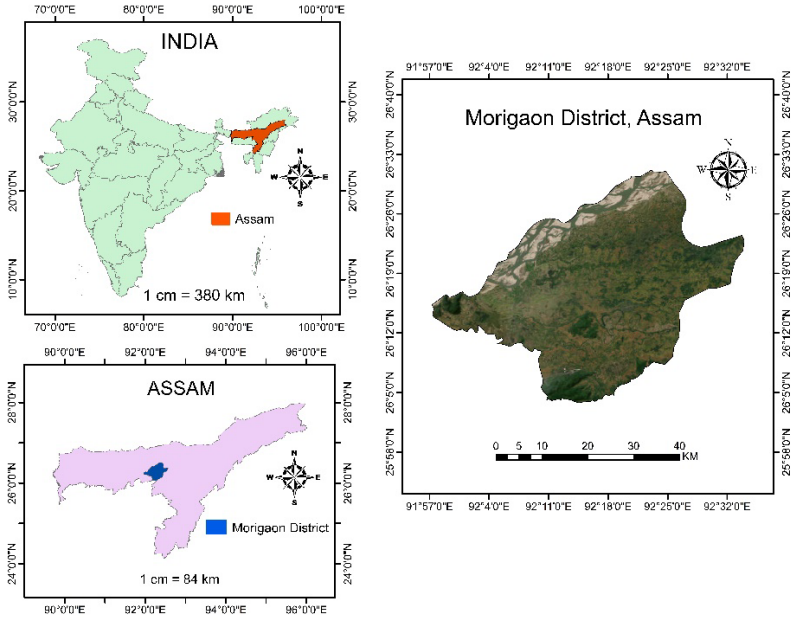

Fig. 1. Morigaon District, Assam, India.

Thus far, geo-hydrological models have been adopted with support. The Brahmaputra River's flood plains cover the majority of the district's plains. Over the course of the last forty years, the River Brahmaputra has caused erosion in 94 revenue villages. Many of these villages have totally disappeared, while others have just partially disappeared. In the middle section of the river Brahmaputra, substantial siltation is a major contributing factor to erosion and deposition. It is believed that deforestation is the root cause of the siltation. The siltation is thought to be caused by the deforestation in the higher catchment area as well as the aftermath of the Assamese earthquake in 1950, which loosened the debris and left barren slopes behind. As a result, the river system received 45 billion m^3 of sediment, which finally choked the riverbed. The plains' predominantly fine sand and silt soil is of a type that makes it susceptible to erosion.

Table 2 indicates that a few of the villages in the study area, namely Savagery, Lechari Borl, Balipara, Bardobatoop, Tengaguri, Gumolu, Molohu, Kacharigaon, Chenimari, etc. After displacement, people choose embankments, roads, nearby rural areas, and towns for shelter, education, and livelihood. The displaced people suffered from sanitation facilities, drinking fresh water, being homeless, unemployment, health care services, etc. Again, from the table, it is clear that 60.67 percent of people are sheltered in embankments or roads, 28.09 percent are sheltered in nearby rural areas, and 11.24 percent have shifted to town or other places.

Table 2. Displacement Scenario of the flood river bank erosion affected people in the study area

Displaced Households	Number of displaced households	Percentage of displaced households
Shifted to embankments	54	60.67
Shifted to nearby rural areas	25	28.09
Shifted to another place	10	11.24

Table 3. Number of eroded villages of the study area (1982-2019).

Year	Number of eroded villages	Percentage
1982-1990	20	21.5
1990-2000	29	31.18
2000-2010	22	23.65
2010-2019	22	23.65
Total	93	100

Table 1. Showing loss of lands by the bank erosion in the study area

Sl. No.	Village Name	No. of affected family	Year of erosion	Sl. No.	Village Name	No. of affected family	Year of erosion
1	Sitalmari	305	1982	20	Madharguri	201	1989
2	Kaurihagi	141	1982	21	Gorolmari Patar	211	1989
3	Goroimarigaon	250	1983	22	Sialmari	136	1990
4	Groomers	197	1983	23	Borigaon	116	2002
5	1 No. Rangrai Chapori	267	1983	24	Harangtoli	121	2003
6	2 No. Rangrai Chapori	81	1983	25	Chutiagaon	322	2004
7	Sonarigaon	216	1984	26	Roumari Bill	104	2004
8	Bhajakhaitygaon	140	1984	27	Garakhiakhuti	135	1999-2017
9	Kisamguri	84	1984	28	Pambori	129	2006-2017
10	Kasipur	109	1984	29	Mikirgaon	550	2013-2018
11	Tengaguri NC	125	1984	30	Leruamukh	205	1989
12	Tengaguri Gaon	140	1984	31	Solmari	146	2001
13	1 No. Tengaguri	116	1984	32	Barthal Doloigaon	74	2002
14	2 No. Tengaguri	147	1984	33	Bhajaikhaty Pathar	226	2002
15	Sialmari Kacharigaon	235	1985	34	Chenimari	104	2006
16	Dhumkura	345	1986	35	Ulubari	117	2002-2007
17	Dhekeramari	225	1986	36	Dakhin Chenimari	145	2012
18	3 No. Rangrai Chapori	73	1986	37	Kathani	186	2018-2020
19	Sitalmari Pathar	220	1987	38	Bagalipara gaon	188	2020-2021

Source: Laharighat Circle Office, Assam

According to the circle office of the Morigaon district revenue department, more than 10256.93 hector of land in the district was degraded between 1969 and 2001. In several areas of Lahari ghat, erosion has been a common occurrence. This erosion is mostly caused by significant sediment changes to the braided river and formation.

Over the past thirty years, the Brahmaputra River's erosion has impacted fifty-six revenue villages, wiping out forty-one of them entirely. Nearly thirty villages have been completely devastated and more than 80% of the land has been lost in the Lahari ghat Circle area. As of 2016, 24 villages under the Laharighat revenue circle had been affected by the erosion of numerous revenue villages caused by the Brahmaputra River. The water level in Laharighat subdivision villages, such as Kathani, Chutiagaon, South Salmara, Palasani, and Bogalipara Gaon, rose above three to four meters during the flood. Villagers move into the closest camp and school at this time. In the Laharighat circular in 2022, 27 villages and 376 hectors of cropland would be impacted.

Table 3 reveals that total 93 numbers of villages from the year 1982-2019 have been fully affected by erosion and local village people migrated from their own place. And it is clear that, whole number of villages has been under the river Brahmaputra during the year 1990-2000 about 29 villages have been eroded. A large number of villages have been particularly eroded due to bank erosion in Bhuragaon northern side of the district Morigaon.

Impact of Bank Erosion

The physical environment, like the spatial economy, is a reflection of three types of economic activity (Baki, 2014; Rahim *et al.,* 2024) related to production, distribution, and consumption. Material life depends heavily on resource bases, particularly natural resource bases, particularly in rural areas. Agriculture forms the study area's economic foundation (Islam, *et al.,* 2017). In an agrarian economy, the three most important physical components for agricultural output are land, soil, and climate. For the purposes of this investigation, all three of those physical factors are very common in the Morigaon district. Because of this, the study area's rural economy has few restrictions for promoting life and livelihood; nevertheless, because of severe land erosion

Due to bank erosion, a large number of agricultural areas are lost every year. The economy of the Laharíghat area has thus experienced a continuous decline, at least for the last ten to twenty years, due to severe land loss. According to the field survey, people ever had 30-40 bighas (5.396 ha) of agricultural land, respectively. These people cultivated 6-8 crops per year (jute, rice, mustard, corn, potato, etc.), and these products obtained the highest value or demand in the international markets. The losses of agricultural land result in a reduction in the total production of crops. The resource base, i.e., land, is not able to support sufficient production for the survival of the household economy, causing a severe crisis in livelihood.

The physical environment is a gift of nature, whereas the economic environment is the outcome of human activity. All the different forms of economic activity (Mondal and Tripathy, 2021; Sarif, 2022), like gathering and hunting. Agriculture, mining, industry, transport and storage, trade and commerce, communication, etc. have evolved in different stages of civilization. In the study area, agriculture is the backbone of the rural economy. But threatened by bank erosion hazards, the agricultural of the study villages is at stake.

According to the survey, both farmers and laborers' uprooting from agriculture has now shifted to the non-agricultural economy wherever available, like casual workers in urban and semi-urban settings, construction workers, and even migrants outside the state. River bank erosion has an enormous impact on livelihood patterns. Due to the risk, there is no developmental or industrial setup in this area. The livelihood of the people is mostly dependent on agriculture or agricultural labor (Das and Tamuli, 2024). Among them, agro-farming is the dominant sector among the occupations. The number of cultivable land proprietors decreased with time due to erosion; consequently, the number of shared cultivations increased. However, the number of labor engagements in the agriculture sector was also reduced. The reasons behind this scenario are that the agriculture sector is the most vulnerable sector affected by erosion.

Findings and Suggestions

The following are the study's main conclusions:
1. People living in the research area have been facing a variety of river-related hazards, such as bank erosion and flooding.

The agricultural land use pattern in the

Laharighat circles and Bhuragaon has been significantly impacted by river erosion as compared to other regions of the Morigaon district.

3. Many study areas cover the floodplain.
4. The Brahmaputra River provides essential resources for the majority of the Laharighat region's population, including agriculture and fishing.
5. Poor cleanliness, hygienic practices, and other factors affect the majority of people and result in poor health.
6. The movement pattern of the population from the erosion-affected areas adequately demonstrates that the inhabitants are mostly drawn to locations with a high demand for unskilled labor.

The following recommendations in the hopes that they may address previous flaws and restrictions and, as a result, result in an improved erosion mitigation plan for the study area.

1. Developing an integrated flood control and erosion mitigation strategy for Assam requires the use of risk assessment, which is crucial to the planning and design of disaster mitigation measures.
2. Strict land use regulations must be created and put into effect in order to reduce runoff, erosion, and water pollution as well as the loss of soil fertility brought on by regular flooding.
3. The relevant authorities and specialists should take the lead in developing a comprehensive, affordable, and practical flood mitigation management plan.
4. Since erosion and floods are common natural calamities in Assam, it is preferable to implement scientific measurements or anti-erosion programs like the porcupine system.
5. Organizing campaigns to educate people upstream about the value of trees, afforestation, and reforestation. This will lessen bank erosion and the effects of flooding by reducing soil erosion.
6. Another recommendation is that individuals impacted by erosion be recognized as Internally Displaced People (IDPs) and should get certificates from the relevant authorities verifying their status as IDPs. This will assist all persons who have been displaced due to erosions in partially resolving their identity dilemma.
9. The Brahmaputra River can be dug up to allow a massive amount of water to flow down a single main channel, which is the most practical way to prevent flooding and bank erosion.

Conclusion

Examining the different kinds and extent of damage caused by erosion and flooding over the prominent features of the Brahmaputra River in the Laharighat is the goal of the current study. The district's numerous agricultural issues can be attributed to the regular flooding. Here, we examined the effects they had on one another. Assam and other northeastern states rely on the Brahmaputra River, the fifth largest in the world, for their survival. Given its inherent advantages and resources, Assam has the potential to achieve high levels of agricultural production and productivity. However, the flood issue, which manifests as sand casting and soil erosion, has put the sustainable growth of rice and other crops in jeopardy. For the district's ecological security, livelihood security, and flood security, Assam's flood problem, particularly in Laharighat of the Morigaon district, must be controlled. The greatest amount of flood control is implemented in a short amount of time. Furthermore, the district's annual flood damage indicates that the flood control board's efforts are insufficient. Although certain flood control methods exist, their effectiveness is quite low. In the Morigaon district, it has been demonstrated that the government's anti-erosion methods are ineffective.

Conflict of Interest

Authors declare there is no conflict of interest.

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