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Erosion activity on Majuli – the largest river island of the world

P. Kotoky^{†*}, D. Bezbaruah[†], J. Baruah[†] and J. N. Sarma[#]

[†]Regional Research Laboratory (CSIR), Jorhat 785 006, India

[#]Dibrugarh University, Dibrugarh 786 004, India

Majuli, a river island within the two arms of the mighty Brahmaputra river, is a site having extreme historical and cultural importance, and warrants immediate exposure to the scientific community. The island faces an acute erosion problem as no permanent anti-erosion measures based on proper geo-hydrological models have been adopted so far. The land area of the island, as evidenced from the IRS satellite imagery of 1998, is 577.65 km² compared to 1245 km² according to available historical records. The available data indicate an erosion rate of 1.9 km²/yr for the period of 1920–98. If the situation remains unattended, the island will soon be engulfed by the Brahmaputra river and will become extinct from the world map.

MAJULI, the largest river island of the world^{1,2} (26°45'N to 27°15'N lat.; 93°45'E to 94°30'E long.), is covered by

the Survey of India toposheet nos. 83 F/5, F/6, F/9, F/13, I/4, I/8 and J/1 (Figure 1). Majuli Island has a population³ of 134,395 and an area of 900 km². It is now one of the subdivisions of Jorhat District, Assam, India, with Kamalabari as its subdivision headquarter. It includes 155 villages under three revenue circles (Salmora, Kamalabari and Ahatguri). The famous cultural centres – Auniati, Kamalabari, Garamur and Dakhinpat – have made significant contributions to the Vaisnavite Movement of Assam^{4,5}.

Geomorphologically, the Majuli Island forms a part of the flood plains of the Brahmaputra river. The Majuli Island suffers from severe bank erosion on its southern side due to the erosive action of Brahmaputra river, and on its northern side due to the Subansiri river. The river island is subjected to severe annual floods under the influence of the SW monsoon. The erosion is mainly attributed to extreme sediment charge^{6–9} and to the main river traversing through a series of deep and narrow throats, and formation of sand bar in the midst of the river. Along the channel of the Brahmaputra river, bank material is rarely homogeneous in composition and uneven bank-slumping is a characteristic feature. Often, highly saturated clayey silts liquefy and tend to flow towards the channel. Consequently, the overlying less saturated bank material tends to slump along well-defined shear planes. Thus, there appear two prominent types of slumping: (a) undercutting during flood stage and (b) flowage of highly saturated sediments during the

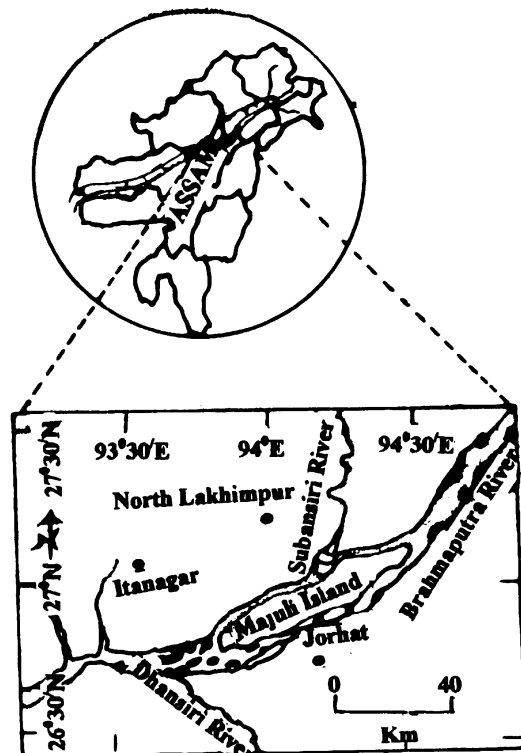


Figure 1. Location map of Majuli Island.

*For correspondence. (e-mail: probhatk@yahoo.com)

falling stage of the river. However, slumping is more severe after the flood stage. Ground observation around Majuli Island and along the channel has indicated severity of erosion just after the flood period in comparison to failure during flood.

Several studies¹⁰⁻¹² have indicated that the Brahmaputra river changed its course abnormally after the Great Assam Earthquake of 1950 with a magnitude of 8.6, and the attendant historic flood. There was a balance between sediment supply and transport up to 1950 AD, and this balance was disrupted by the great earthquake which produced severe landslides within hilly tracts, and suddenly provided a large quantum of additional sediment. Descending into the plains, the extra sediment choked the river channel gradually and initiated bank erosion causing channel-widening. Moreover, there has been a gradual increase in channel slope since 1920 (ref. 13). The riverbed of Brahmaputra has also shoaled following heavy siltation due to the construction of flood embankments, deforestation, etc. Many other towns besides Majuli, on the banks of the Brahmaputra river, are also under threat due to abnormal changes in the river course.

The regional geomorphological transformations, which ultimately led to the development of Majuli, are not yet clearly known. The available historical reports suggest its formation nearly two and a half centuries ago. In 1188 AD, Sri Gauri Narayana of the Great Bodo Tribes founded a dynasty with Ratanpur as its capital. Ratanpur was situated near Kherkatia Suti on the southern bank of the Lohit river. As two branches of the river flowed on either side of Ratanpur, it was known as 'Majali'⁵. The word 'Majuli' is derived from 'Majali' through a

sequence of lingua-phonetic transformations with time. During 1622 AD, the Brahmaputra river was flowing along the present channel of Lohit in the northern part of Majuli, while the Dihing was flowing along the present channel of the Brahmaputra, south of the island⁴. In 1671 AD, the Dihing changed its course and had a confluence with the upper Lohit, and in 1735 AD, the Brahmaputra, after abandoning its course due to a heavy flood, followed the abandoned course of Dihing⁴. Thus, the Majuli was formed due to headward erosion and channel migration of the Brahmaputra river. Majuli then was formed with 13 'chaporis' or small islands intersected by channels of communication between Dihing and Lohit⁵.

Two sets of Survey of India toposheets (1920 and 1975) and a set of Indian Remote Sensing Satellite imageries (IRS-1B LISS II B/W geocoded data) covering the cloud-free period of 1996 to 1998 were used for the present study. In order to assess the rate of erosion, maps and imagery were registered and geo-referenced with respect to Survey of India toposheets. The bankline of the Brahmaputra river with Majuli Island was demarcated from each set of maps and the area of the island was determined with the help of a digital planimeter. The data thus derived, coupled with available historical data, were used for the present study.

When the river floods the state every year, the entire population of Majuli Island fears that it may be engulfed by the mighty Brahmaputra river. The present study indicates that a considerable portion of the Majuli Island was eroded away by floods every year (Figure 2). Available records indicate that the original area of Majuli Island

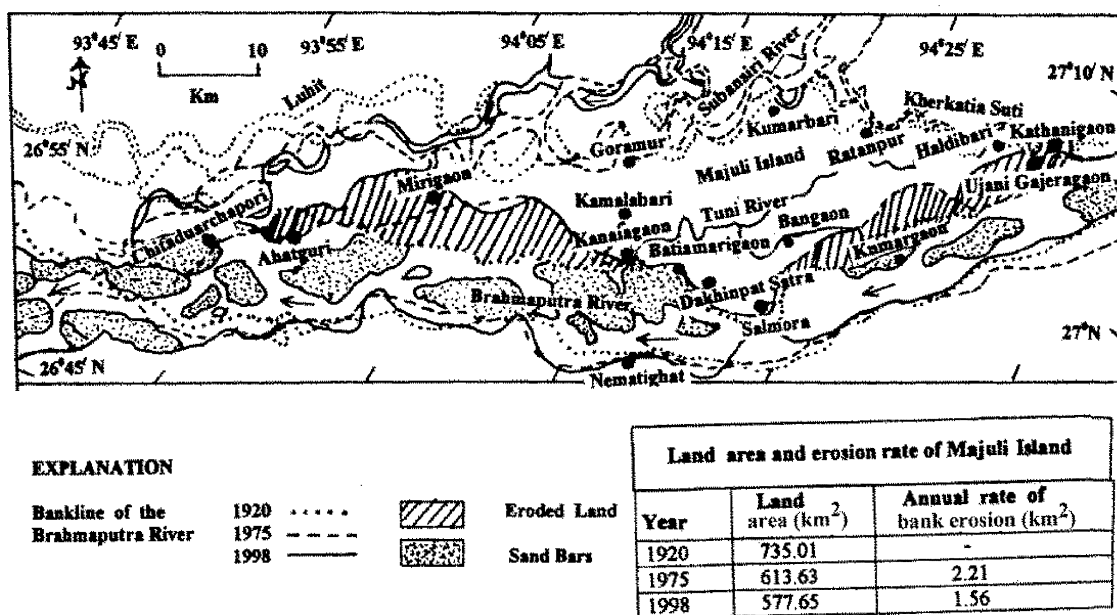


Figure 2. Sequential Banklines of Majuli Island.

was 1245 km², with a population of 134,395 (refs 3–5, 10, 14). The area has reduced from 735.01 to 613.63 km² in a matter of 50 years (Figure 2).

Ground observations on the overall erosion activity around Majuli Island exhibited two types of features. The bowl-shaped shear failure activated by the flow of sediments is more common around Gajera gaon, the eastern-most corner of the island. During the high stage of the river, water forced into the massive sand bodies, providing additional support to the bank materials and acting as a continuous system. However, with the fall in water level, the pressure diminishes rapidly and water from the pore spaces of sand bodies tends to flow to the main channel. This flow of water from the sand bodies has caused liquefaction of sediments and the bank materials have been subjected to different degrees of flow. This type of failure is more common around Kumargaon, Batiamarinagar and Bechamara. However, around Salmora where the bank material comprises mainly cohesive clay material, the slope is almost 90° and causes significant oversteepening towards initiation of bank failure. Moreover, the cohesive clay material, on the other hand, produces a comparatively stable land mass that is not prone to erosion and thereby helps to generate a node point there. The node point, in turn, also offers significant resistance to the connected flow regime. As the bank materials are relatively stable in this area, the river scours deeper to accommodate the flood discharge, thereby increasing the wash load of the river temporarily. Therefore, below the node point, the river tends to be wide and shoaled. Here the current velocities diminish when large quantities of sediments are deposited and mid-channel bars or chars are formed. Once formed, the chars locally decrease the cross-sectional area and they must cut the bank laterally to maintain a proper cross-sectional area that is in equilibrium with discharge. This might be the most possible explanation about the enhanced rate of erosion activity around Nematighat, Kamalabari and Kaziranga, which has already taken a devastating proportion of land area. Moreover, a comparison of the data of 1975 topographic base map, with the Indian Remote Sensing satellite imageries of 1998 shows that the area has decreased by 35.97 km². The present land area of the Majuli Island within the two arms of the Brahmaputra river, as revealed from the 1998 data, is 577.65 km². Recent studies^{10,15} indicate that the erosion near Batiamarinagar appears to

be alarming as the river Brahmaputra is flowing at a distance of less than 1 km from the Tuni river, thus threatening a great disaster to the main township of Kamalabari on Majuli Island. Comparing the satellite imageries of 1998 with the topographic base map of the year 1920, it is evidenced that on an average, the Brahmaputra channel has increased its width from 7.00 to 9.25 km, with significant expansion on the southern side of the island. The increase in amount of sediment load in excess of competency of the river initiated the development of new mid-channel bars, which offer enormous obstruction to mid-channel flow. The flow was then diverted sideways and caused extensive rate of bank erosion. Erosion along the northern side of the island is comparatively less than the southern side of the island. It is observed that the bankline between Pohardia and Kanaiajan villages has receded more than 7 km. The study of multi-temporal satellite data¹ acquired for the period from 1987 to 1994 indicates that the Brahmaputra river has undergone a significant change in its northern bank. The data pertaining to 1993 evidenced extreme erosion effect around Kanaia-gaon, causing removal of additional land area of about 0.95 km² to the extent of breaching the embankment for its 2 km stretch¹. Compared to the loss of land during the period (Table 1), the loss of land occurring at a single site during the year 2002 is quite alarming. The downstream translatory movement of the stream west of Kanaia-gaon caused maximum erosion and exhibited severe erosion activity in the westerly direction. The continuous scouring of the river poses significant threat to this area. Due to shifting of the bankline, the Brahmaputra dyke from Dakhinpat to Kamalabari was breached in 1993 (ref. 16). The worst affected breach was reported between Haldibari to Bechamara. The breached opening is now increased to about 3 km (ref. 16). The flood water inundates large areas through this breached dyke and allows deposition of recent sediments on the extremely fertile cultivating land, making the areas unproductive. This not only affects the fertility of land, but also imparts remarkable imprints on the existing rich bio-diversity of the Majuli Island.

The IRS-1D WiFS image showing Assam taken in March 1998, clearly indicates the dying-out of Kherkatia Suti and an active significant geomorphic transformation within the area (Figure 3). Probably, because of anthropogenic effects (anti-erosion and anti-flood measures) once the major flow of Subansiri river through Kherkatia

Table 1. Classes of bank erosion response (after Naik and Singh¹)

Class	Type of erosion response	Area loss (km ²)	Location
A	Major erosion changes affecting large area	> 10	Kathonigaon, Ujani Gajeragaon and Sonoal Kacharigaon
B	Moderate to considerable erosion affecting certain areas along bankline	1–10	Lachangaon, Kumargaon, Barmari, Kanaigaon, Batiamarigaon, Khoraparagaon and Kumarbari
C	Minimum erosion with response only at isolated sites	< 1	Salmara, Bechamara, Mirigaon, Chitaduarchapori, Borbari and Kaibortagaon

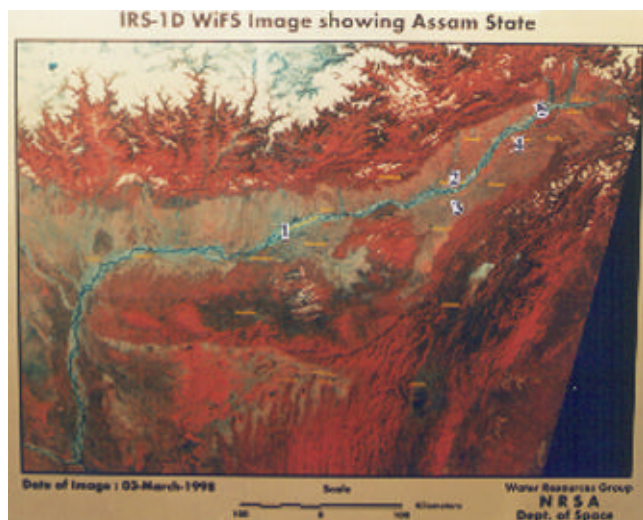


Figure 3. IRS-1D WiFS image showing Assam. 1, Brahmaputra river; 2, Majuli Island; 3, Jorhat; 4, Dibrugarh, and 5, Newly developing island.

Suti has almost been left to a state of abandonment. Geomorphic investigation along with neo-tectonics involved in the area warrant an in-depth scientific evaluation before drawing any conclusion on the conversion of Majuli Island to a stable land mass to the northern bank of the mighty Brahmaputra river. Moreover, a remarkable development near Dibrugarh city, where a significant change in the course of the Lohit river occurs after diverting its flow through the Dangari and the Dhola river courses, from the west of Saikhowaghat to Oakland, leading to development of another prominent island like Majuli is also observed. The island comprises of Dibru-Saikhowa reserve forest with a length of 50 km and width 4 km (ref. 17). From this, it can clearly be attributed that similar phenomena might have been triggered in the region resulting in the diversion of flow of the Brahmaputra river during the recent past, and formed the world's largest river island, Majuli, about two centuries ago^{4,5}.

Majuli suffers from significant erosion to its southern and northern sides due to Subansiri and Brahmaputra rivers respectively. Compared with available historical reports, a reduction of 667.35 km² with an average rate of erosion about 2 km²/yr till 1998 is observed. Subaqueous flow of sediments and oversteepening of soft alluvial bank with low threshold of erosion resistance are observed as the dominant erosion characteristics. The increase in sediment load in excess of competency of the river causes significant channel-widening, with resul-

tant increase in differential rate of bank erosion on both the sides of the island. Available information indicates that active geomorphic transformations of the area, initiated by head erosion and channel migration, triggered the diversion of original flow of the Brahmaputra river to its present form, and formed within its two arms, the world's largest river island, Majuli.

Frequent floods and the consequent erosion have shattered the Majuli Island, which was once a seat of the Vaisnavite Movement in India. The people of this island, with historic, cultural and religious importance, fear that the island may be further fragmented, if erosion is not checked through proper scientific planning and management.

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