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Morphotectonic evolution of the Majuli Island in the Brahmaputra valley of Assam, India inferred from geomorphic and geophysical analysis

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ABSTRACT

The Majuli Island, located in the upper reach of the Brahmaputra valley in Assam (India), has reduced in its areal extent from 787.9 km^2 to 508.2 km^2 during the period 1915–2005 (35.5% reduction). This amounts to severe average erosion of 3.1 km^2/yr. All efforts so far to save the island have failed to achieve the desired redress. The engineering approach of 'Save Majuli' action plans has focused on quarantining the island from the influence of the Brahmaputra River rather than designing long-term process-based solutions anchored on proper understanding of evolution of the relic island. The existing geomorphic model for the evolution of the Majuli Island related its genesis to the great earthquake (M 8.7) in 1750 during which a much smaller palaeo-Brahmaputra developed an anabranch and captured the Burhi Dihing River. The intermediate land-locked area thereby became the Majuli Island that is constituted primarily of the older floodplain deposits. We demonstrate that the evolution of the Majuli Island has been influenced by fluvial morpho-dynamics, as well as basement configuration and tectonic controls. Thus, the landform called the Majuli Island cannot be explained as a simple fluvial geomorphic feature. Rather, it represents an outcome of tectono-geomorphic process having strong subsurface control. We have investigated the influence of geomorphic parameters including channel belt area (CHB), channel belt width (W), braid bar area (BB), channel area (CH), thalweg changes and bankline migration on the trend of erosion of the Majuli Island. Integration of geophysical evidence from seismic data and the surface morphological changes suggest that the Majuli Island and other similar landforms represent structural 'highs'. Morphotectonic evolution of these islands has involved three stages- *pre-bypass uplift*, *Majuli formation* and *abandonment*. The Majuli Island in the Brahmaputra valley is presently passing through the abandonment stage and is gradually being incorporated within the flood plain of the valley.

1. Introduction

The Brahmaputra, considered as one of the top ten large anabranching mega-rivers of the world (Latrubesse, 2008), is the seventh largest tropical river (Hovius, 1998; Latrubesse et al., 2005; Tandon and Sinha, 2007) in terms of mean annual discharge (20,000 m^3/s in Bangladesh). It passes through three populous countries, China, India and Bangladesh. The mega-river acts as a conduit for transporting a very high sediment flux (852.4 t/km^2 year in Bangladesh) (Singh, 2006; Singh et al., 2006; Latrubesse, 2008) from a source representing broadly the active zone of continent-continent collision between the Indian and the Eurasian plates (Brookfield, 1998). The exceptionally high sediment flux of the Brahmaputra has been attributed to erosion of actively uplifting mountains of the Himalayas, slope erosion of the Himalayan foothills and movement of alluvial deposits stored in the Assam valley (Thorne et al., 1993; Garzanti et al., 2004). The influence of the Himalayan orogeny and large influx of the eroded materials from the hinterland on fluvial dynamics of the Brahmaputra River has been studied by several workers (Mathur and Evans, 1964; Coleman, 1969; Bhandari et al., 1973; Das Gupta and Nandy, 1982; Goswami, 1985; Ahmed et al., 1993; Das Gupta and Biswas, 2000; Kent and Das Gupta, 2004; Sarma, 2005). Available data also suggest that the present-day Brahmaputra valley, a NE-SW trending intermountain alluvial relief, was earlier a part of the Assam-Arakan basin, and it constituted mainly the shelf part of the basin (Das Gupta and Biswas, 2000). Although basins undergoing active tectonic adjustments are not considered suitable for hydrocarbon prospects (Fielding, 2000), the Brahmaputra valley, in spite of intense seismic activities, has provided excellent hydrocarbon reservoirs.

The upper reach of the Brahmaputra (Fig. 1) trends northeast-southwest extending from the confluence of three rivers, the Siang, the Dibang and the Lohit, to the stretch adjacent to the Mikir Hills. One of the most diagnostic features of the alluvial reaches of the Brahmaputra is the presence of large alluvial islands and several of them are more than a century old and inhabited as well. One such island, Majuli, located in the upper reach of the Brahmaputra valley is the focus of this paper. Majuli is one of the largest riverine islands in the world and the largest in Asia with a population of 0.16 million

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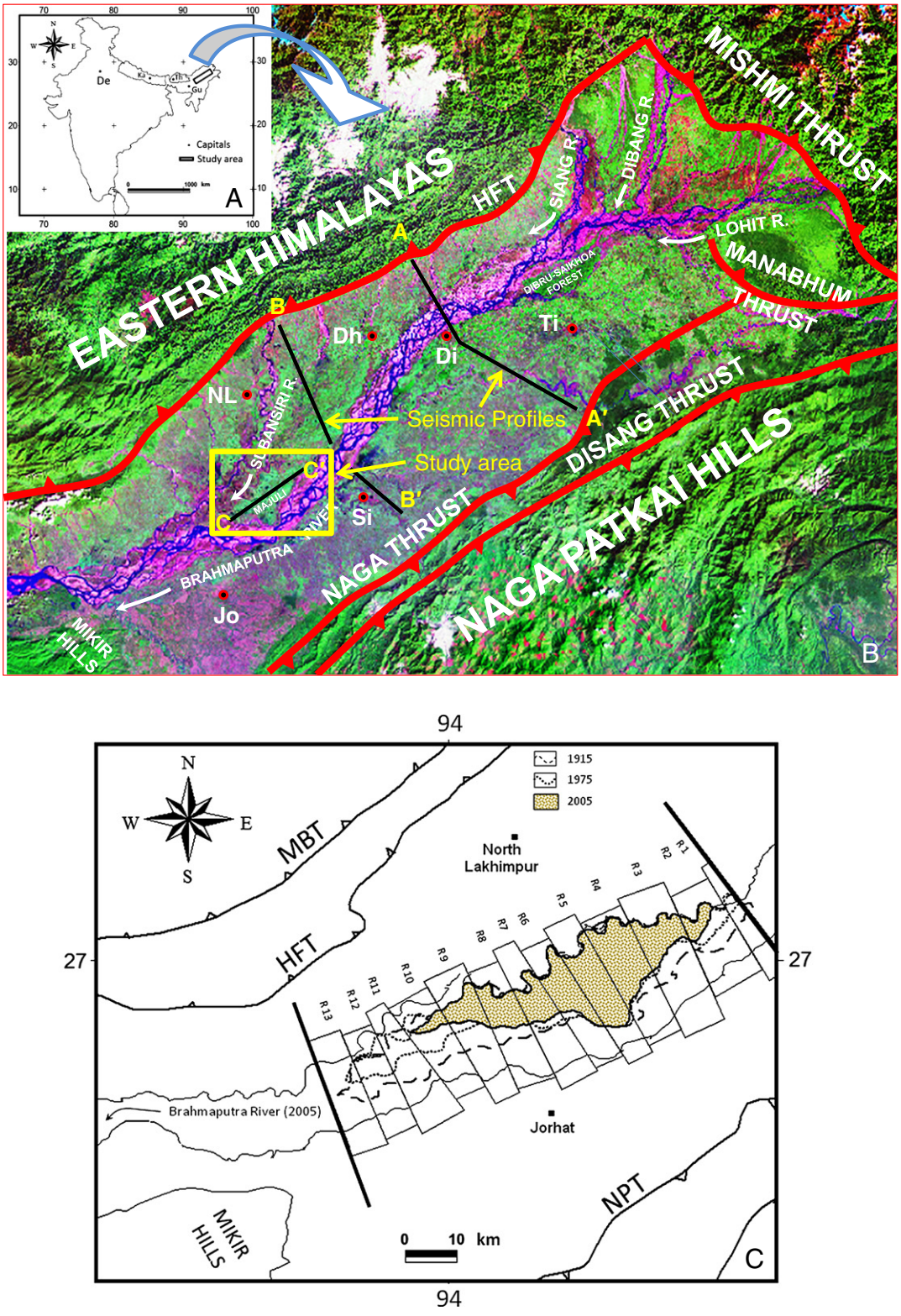

Fig. 1. Location map of the study area. (A) The upper reach of the Brahmaputra valley, situated in Assam, India, is a 280 × 80 sq.km area. (B) Three rivers, Siang, Dibang and Lohit meet to form the Brahmaputra River. Box shows the Majuli Island in the downstream reaches of the river. Important geological features and tectonic elements are shown to describe the study area. The area is sandwiched between the thrust belts of the Eastern Himalayas and the Naga Patkai Hills. The locations of three seismic profiles AA′, BB′ and CC′ are shown. (C) Thirteen reaches covering the Majuli Island where geomorphic measurements were done. (HFT- Himalayan Frontal Thrust; Jo-Jorhat; NL: North Lakhimpur; Si: Sibsagar; Di: Dibrugarh; Ti: Tinsukia; Dh: Dhemaji).

people and the site of ~64 Vaishnavite spiritual centres called 'Satras' (Fig. 1B-C). The literal meaning of 'Majuli' is the land locked between two rivers. The present length of the Majuli Island is ~64 km and the maximum width is ~20 km. This place, considered as a world heritage site that needs preservation, is under the threat of total extinction due to massive land erosion. The Majuli Island differs from other sandbars in the sense that the latter develop directly as the consequence of the sediment load redistribution whereas the former represents the