Research Journal of Recent Sciences _____ ISSN 2277-2502
Vol. **7(6),** 7-11, June **(2018)** *Res. J. Recent Sci.*

Assessment of River Bank Erosion in Morigaon District part of Brahmaputra River, Assam (India) using Geospatial tools

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Available online at: www.isca.in, www.isca.me
Received 19th November 2017, revised 16th May 2018, accepted 28th May 2018

Abstract

River bank erosion in the Brahmaputra river of Assam is a serious problem. The bank line of Brahmaputra in Morigaon district is migrated southward through bank erosion. Therefore, a river bank erosion study in Morigaon district part of Brahmaputra River is carried out from 1970 to 2006 at 1:50,000 scale using satellite data. Land loss map of river bank is prepared using Geospatial tools. Land loss map is carried out using available data from government agencies and maximum risk zones of the district are mapped accordingly. It can recognize high risk location and routing development activities away from the area vulnerable to river bank erosion and support planning and development.

Keywords: River morphology, bank line migration, bank erosion, remote sensing and GIS.

Introduction

River bank erosion is a common event in the middle and lower course of large rivers. It is a dynamic fluvial process that occurs rapidly for a short duration during and after floods resulting in meandering of rivers as well as change of channel course. Such type of erosion affects on a range of physical, socio-cultural, ecological management issues in the surroundings. It is recognize that bank erosion is a function of many interrelated factors like-flow characteristics, composition of bank materials, sediment deposit characteristics, channel geometry etc, vegetation cover and man induced factors like human habitation near the river bank, removal of vegetation cover from the river bank area etc. Extraction of river resources likes sand and gravel is a major factor of bank erosion. Erosion may be caused either by undercutting of the upper bank materials by channels water in high flood event or by over steeping of bank due to the movement of channel dippiest point closer to the bank in water declining stages[1]. Large scale slumping of bank material during the declining stage is associated with water movement from formation back into the channel causing a lateral flowage of sand and silt into the channel resulting in subsequent failure[2]. The Brahmaputra is a braided channel. Most of sand bars and river islands are temporary. *They are inundated in summer and severely change their shape, size and location*[3]. *The Brahmaputra River run* over different district boundary of Assam namely Tinsukia, Dhemaji, Dibrugarh, Lakhimpur, Majuli, Jorhat, Sibsagar, Golaghat, Biswanath, Sonitpur, Nagaon, Marigaon, Darrang, Kamrup, Barpeta, Nalbari, Goalpara, Bongaigaon, Dhubri and Mankachar. Some district of them have severe bank erosion problem. Morigaon is such a district located to the south bank of river Brahmaputra toward downstream. The Brahmaputra has been shifting slowly southward[4]. In Morigaon district, the bank line of Brahmaputra is migrated southward through land loss in river bank. Remote sensing with GIS plays an important role in river morphology and river bank erosion studies[5]. Therefore, river bank erosion assessment in Morigaon district part of Brahmaputra River is done at 1:50,000 scale in GIS environment to identify high risk location of river bank erosion and support planning and development.

Geographical background: Geographically the Morigaon district is located on 26°03'39.48" N to 26°31'23.61" N latitudes and 91°57′21.59" E to 92°34'15.48" E longitude (Figure-1), covering an area of 1490.96 km^2. The mighty river Brahmaputra flows to the northern boundary of the district. Physiographic characteristics of the study area are mostly plain with numerous wetlands. It is observed from Figure-2, there are 260 numbers of small and large sizes of wetlands are located in the district. A numbers of isolated hills are found namely Bura Mayang, Gobardhan and Kamarpur in the north-west and Tetelia Baghara and Matiparbat hills in the south-west. The southern boundary of the district is enclosed by Plateau topography politically Hamren part of Karbi Anglong. It falls in subtropical monsoon belt of Brahmaputra plain where fluvial dynamism and soil erosion processes are accelerated by heavy monsoon. The climatic characteristic of the study area is highly seasonal rainfall in the form of heavy showers that leads inundation, soil erosion and river bank erosion during and after the flood period.

Methodology

The assessment of river bank erosion of Morigaon district is carried out using high resolution (IRS LISS IV) satellite imagery and toposheet for identifying land loss area. The details of required data base are mention in Table-1. Location map of Morigaon district is delineated from SOI toposheet, at scale

1:50,000. The Remote Sensing data has the ability to provide spatial-temporal measurement of many hydrological variables. In this paper, it is investigated how the geospatial technology can implement for bank erosion affected area.

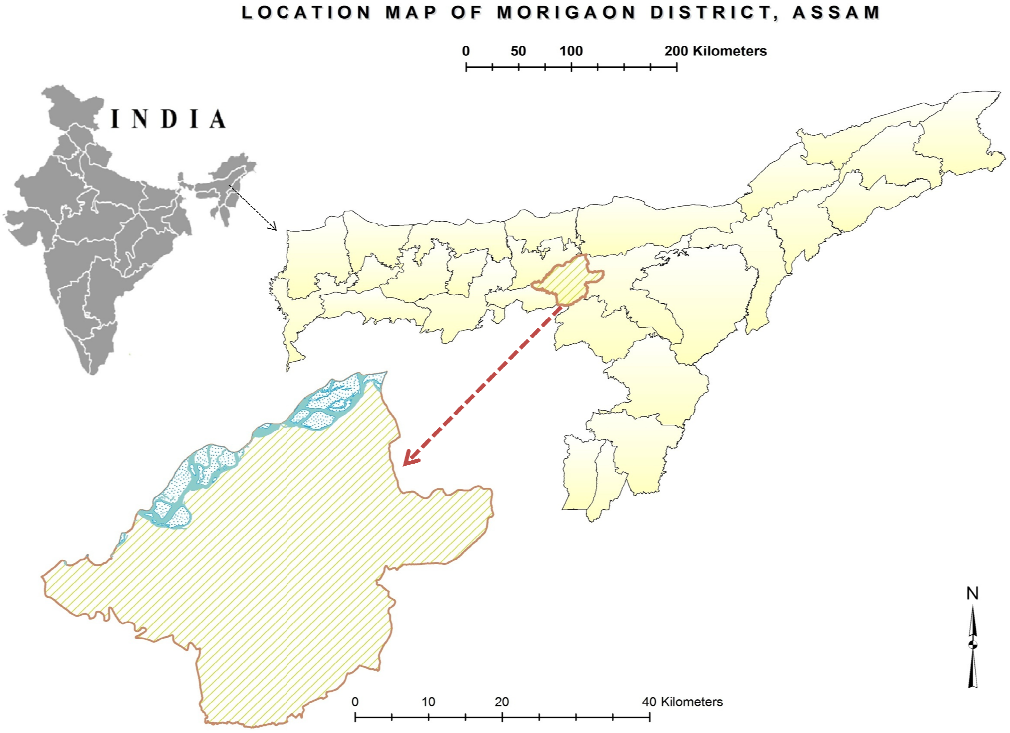

Figure-1: Location map of Morigaon district, Assam.

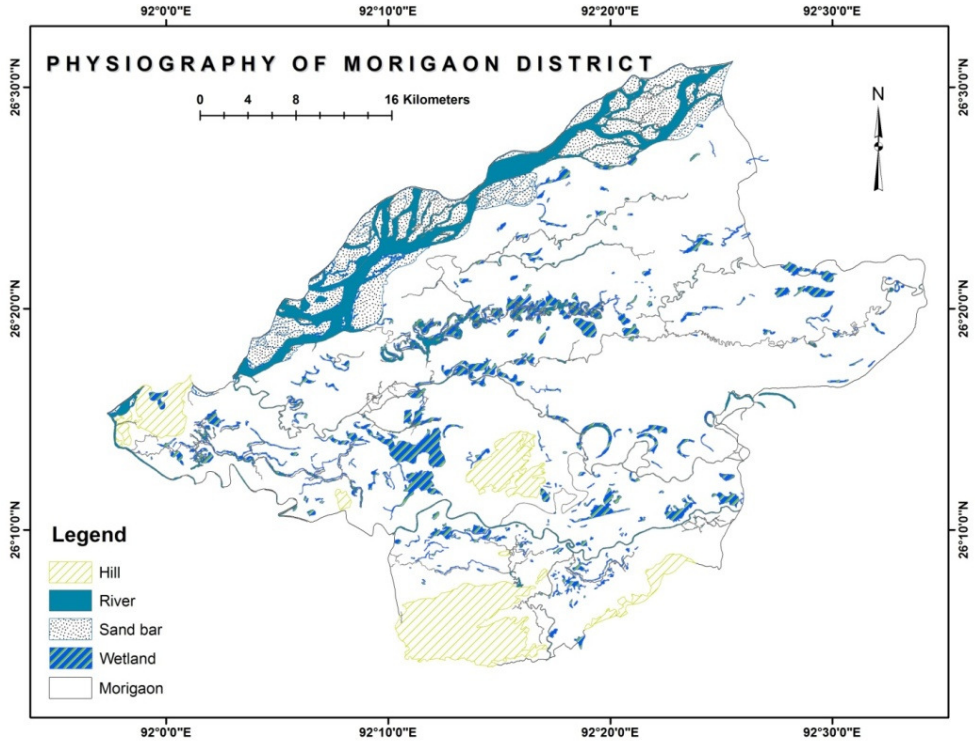

Figure-2: Physical characteristics of landform.

Table-1: Detail of data base.

Data type	Data base
Toposheet[6]	78 (N15, N16); 83 (B03, B04, B06, B07, B08, and B11), scale 1:50,000
Climatic data (rainfall)[7]	Morigaon station
Soil	Soil map[8]
Satellite image[9]	IRS LISS IV, 09/03/2010
Village Map[10]	Revenue village of Morigaon district

Results and discussion

The bank erosion of Brahmaputra River in Morigaon district is a natural phenomenon in summer months. It is a combine effect of high seasonal rainfall, structure and composition of soil, topography and drainage network and land use and land cover etc. These contributing factors of bank erosion of Brahmaputra in Morigaon district are analyzed in details:

Rainfall: North East India is an area of high rainfall[11]. Average annual rainfall of Morigaon town station is 180 cm. High intensity of rainfall in upper catchment area causes flood in downstream and consequent land loss of Brahmaputra river bank in the Morigaon district[12].

Soil: Soil Characteristics is an important constituent factor of bank instability and resultant flood susceptibility[13]. The bank of the Brahmaputra in Morigaon district is composed of highly erodible alluvium soil, coarse-silty and fine-silty soil texture. Therefore, unstable bank material causes bank erosion of each flood period in Brahmaputra River bank of Morigaon district.

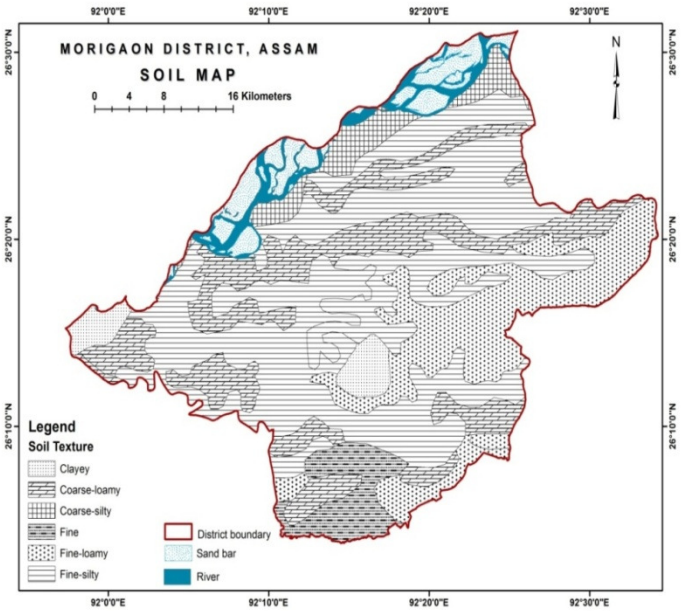

Figure-3: Soil map.

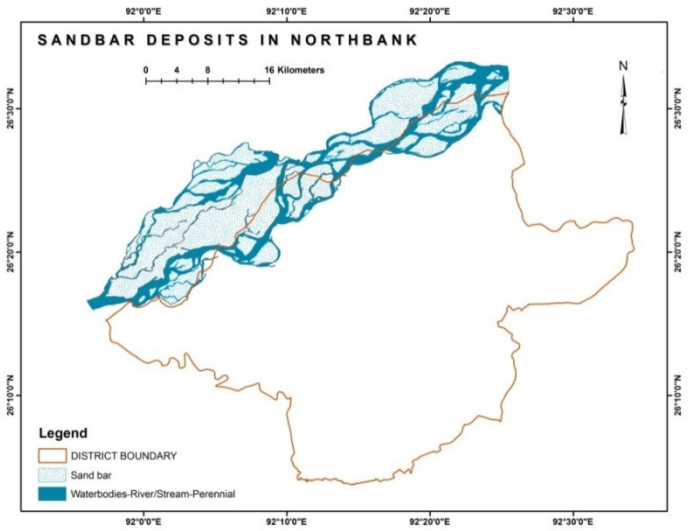

Figure-4: Sand deposits in north bank and river bed.

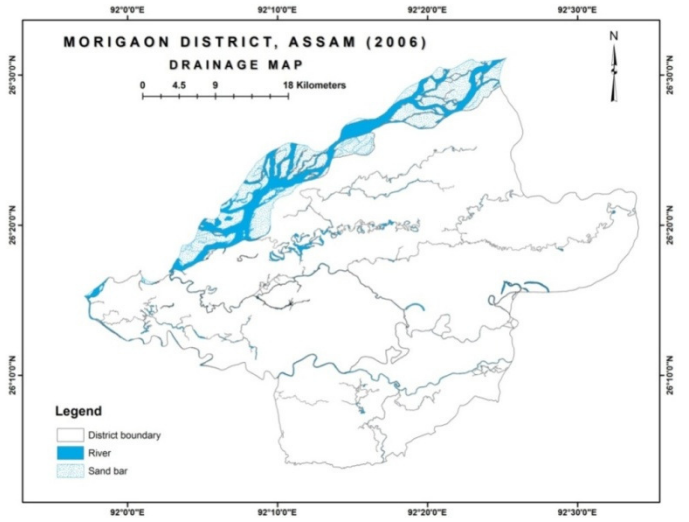

Figure-5: Drainage map.

Drainage: Tributaries and their connected distributaries are also main reason for flood risk as well as river bank erosion[14]. Drainage network is another important contributing factor of bank erosion of Morigaon district part of Brahmaputra River. The important tributaries of Brahmaputra in Morigaon district are Kolong-Kapili, Sonai, Morasunai, Lalijan, and Son Doba. The general slope of landscape is east to west. There are numbers of wetlands are form in the district. It is observed from the toposheet that about 260 numbers small and large sizes of wetlands are found in the district.

Land use: Land use map is prepared from satellite data and digital image interpretation (DIP) is processed in GIS environment. Supervised interpretation technique has been adopted in ERDAS 9.1 for preparing the map. Field verification is done before interpretation and necessary information about the ground truth are collected. There are six land use types are identified. They are cropland, forest, Grassland, settlement with

household plantation, sand bar and water bodies specially wetland, pond, river etc. Erosion affected area of Morigaon district is covered by crop land, settlement, wetland and tributary stream of Brahmaputra.

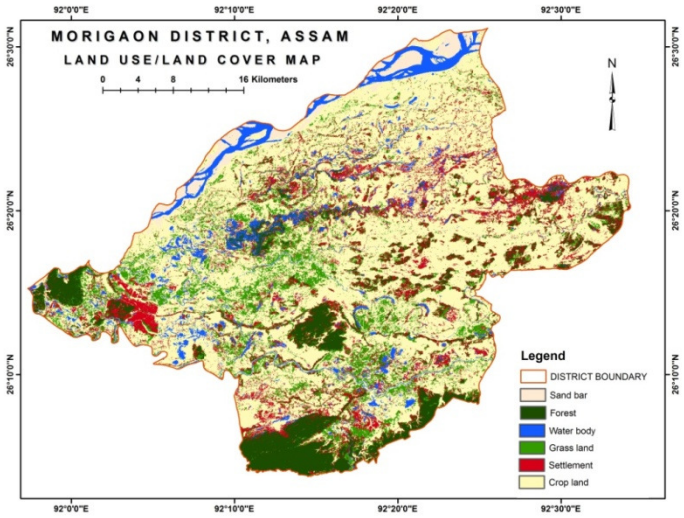

Figure-6: Land use map, 1987.

Area assessment: The district boundary map is prepared from SOI toposheet with 1:50,000 in Arc GIS software. The district map of Morigaon of Assam with Brahmaputra part is delineating from toposheets, surveyed in 1970-71 and satellite Imagery, March 2006 (IRS LISS IV) separately in Figure-7 and 8. From these figures, the bank erosion prone areas are identified properly. It is observed from the table 2 that 12.38 km^2 area covered by Brahmaputra river and riverine landform developed by the river especially sand bars locally known as char, chaporis and River Island etc during the survey, 1970-71 by SOI (Survey of India). These areas occupy 9 revenue village of the district which is shown in Figure-7. After forty years, these areas are increased up to 122.31 km^2 and covered 73 revenue village of the district (Figure-8). During these periods, 64 revenue villages in south bank of Brahmaputra in Morigaon district was loss through bank erosion in flood period and form new sand bars in dry season through deposition of sediment in river bed and bank of Brahmaputra River.

Table-2: Brahmaputra land cover change detection (1970-2006).

Level-I	Level-II	Area (in km^2)	
		1970-71	2006
Brahmaputra River	Water body	6.69	48.11
	Sand bar	5.68	74.20
Other	Other land use	1478.59	1368.65
	Total	1490.96	1490.96

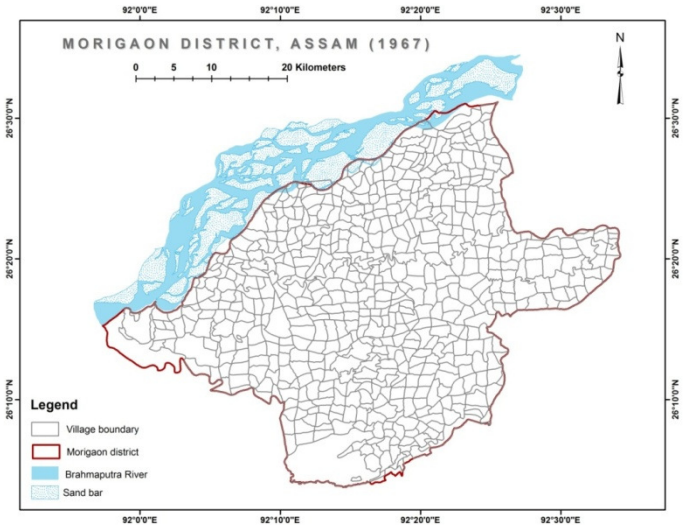

Figure-7: Village boundary of Morigaon district in Brahmaputra River, 1967.

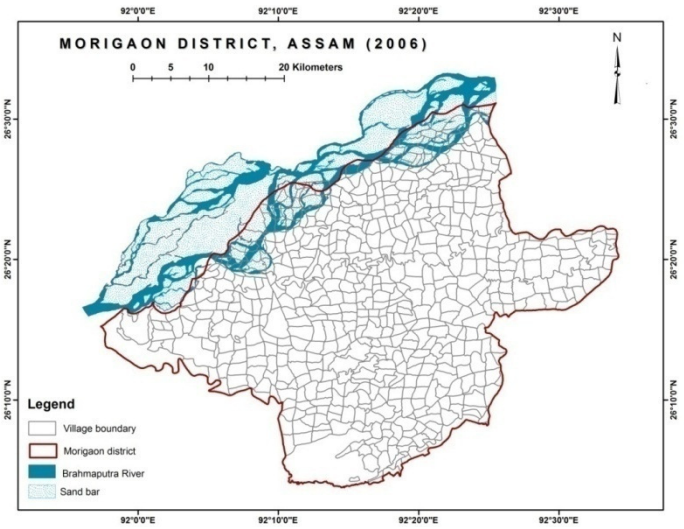

Figure-8: Village boundary of Morigaon district in Brahmaputra River, 2006.

Bank line migration: The bank line of Brahmaputra in Morigaon district is migrated gradually toward south through south bank erosion. It is observed from SOI, toposheet that the south bank line of Brahmaputra River in Morigaon part is flow from 58 m to 53m BM at the distance of about 48.33 km. The general slope of south bank is 10.34 cm/km. The general slope of landscape is towards west from east and south of the district. In 2006, the bank line is shifted 5 - 10 km toward south of line in 1970-71. Due to Sediment deposits mostly in the north bank towards Darrang district and middle and right bed of Brahmaputra River and mainstream is migrated towards south every year through the bank erosion. There are 260 numbers of wetlands are form in the district. In summer, these wetlands are linked with streams and Brahmaputra River. Therefore, the bank line of river Brahmaputra tends towards south after each flood inundation and bank erosion.

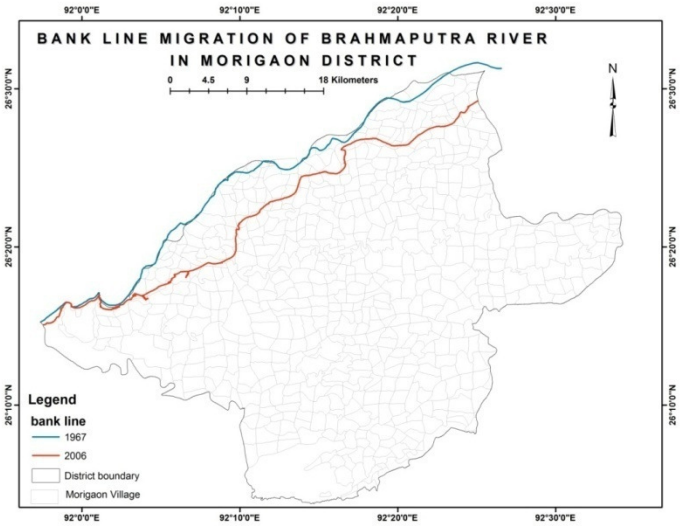

Figure-9: Brahmaputra river bank line migration in Morigaon district.

Conclusion

It may be concluded that the bank erosion is a severe problem in Morigaon district. During the forty years 64 revenue village is vanished in Brahmaputra River. Highly erodible bank materials, high seasonal rainfall and resultant flood event, formation of sand bars in north bank and channel bed, slope, and land use are considered as important causative factors to river bank erosion of the study area. Maps of erosion affected areas are identified and prepared in GIS environment. It will help in appropriate planning for stabilize of bank line and protect from river bank erosion.

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