BANK LINE SHIFT OF RIVER BRAHMAPUTRA IN MORIGAON DISTRICT, ASSAM (1996-2016)

Manash J Nath[a*], HimanshuMedhi[b]
[a] Department of Geography, AryaVidyapeeth College, Guwahati-16
[b] Department of Earth Science, University of Science and Technology, Meghalaya
*corresponding author: manashjnath@gmail.com, +91 97060 23126

Abstract:
The Brahmaputra River, the fifth largest river in the world, serves as a backbone for the Agro-valley region of Assam but sequential shifting of the river, severe erosion and frequent flooding has a major adverse effects on riverbank stability. Bank erosion of river Brahmaputra has attained a menacing proportion in many parts of Assam including Morigaon district. The objectives of the study is to examine the status of the bank line and to study the shifting of the bank line of Brahmaputra river in Morigaon district (1996-2016).The status of bank line and the shifting of Brahmaputra River in the study area were carried out from two sets of satellite imageries retrieved for two different time periods (1996 & 2016) from Landsat-TM and Landsat-OLI images. Along the bank line from Mayong Revenue circle in the west to Laharighat in the east the river has been divided into 43 strips at an equal spacing of approximately 1 km and reference cross sections have been drawn at the boundary of each strip. The result shows that atleast 64 villages got eroded fully or partially along a stretch of 49.19 km from Mayong to Laharighat.The area eroded in between two bank line is about 112.59 sq. km from 1996-2016.
The average banks line shifting from all the segments (in 43 cross sections) is calculated to be 1.79 km. Maximum shift was observed to be of 4.35 km in Mayong Revenue Circle between 1996-2016.The width of the river bank has been increasing at the rate of 89.5meters/yearand the affected people living in that area are compelled to migrate to other places.
Keywords: Erosion, Morigaon, River bank line shift, Remote sensing and GIS

Introduction:

The Brahmaputra also known as Tsangpo-Brahmaputra, (called as "*Burlung-Buthur*" by the Bodo people of Assam) is a trans-boundary river and one of the major rivers of India Sub-continent. The river is 3,848 km (2,391 mile) long, and its drainage area is 712,035 km^2 (274,918 sq mile)[1]The average depth of the river is 124 feet (38 m) and maximum depth is 380 feet (120 m)[2]

The Brahmaputra River, the fifth largest river in the world, serves as a backbone for the Agro-valley region of Assam and also other north-eastern states of India. However, sequential shifting of the river, severe erosion and frequent flooding has major adverse effects on riverbank stability. Erosion and flood undoubtedly displaces a large number of the population often renovating needy and landless as well as change the socio-cultural behaviours which are like change in the demographic profile, income level and standard of life, tradition and custom as well as personal behaviour.

The flow regime of the Brahmaputra possesses the seasonal rhythms of the monsoon and freeze-thaw cycle of the Himalayan snow. Along the channel of the Brahmaputra bank materials are not homogeneous in composition, and result in uneven bank slumping. This causes the flow to take a different path and the orientation of the bank-line to the direction of flow also changes and at some localities older alluvium protruding into the river offers significant resistance to the flow regime and causes changes in hydraulic conditions.[3]

Braided river like Brahmaputra represents a high-energy fluvial environment often characterized by non-cohesive banks lacking vegetation and consequently, high

rates of bank erosion and deposition. The in homogeneity in bank materials and the constant change in flow direction have caused severe undercutting, which enhances the intensity of slumping along the banks.[4]

Bank erosion is a dynamic and natural process as rivers meander across the landscape. However, bank erosion of river Brahmaputra has attained a menacing proportion in many parts of Assam including Morigaon district. Taher and Ahmed (1998) stated that, side by side with floods, bank erosion of some major rivers also causes immense long-term destruction every year.[5]

Morigaon district in Assam is located in the south bank of the River Brahmaputra, which is highly erosion prone and gets flooded almost every year. Large scale bank erosion occurs in the rainy seasons from the month May to August under the influence of the SW monsoon. The river Brahmaputra has been shifting slowly towards southward and is a perennial problem of Morigaon district. According to Circle office of District Revenue Department of Morigaon, more than 10256.93 hectare land eroded in between1969 and 2001. Erosion has been regular occurrence in some areas of Bhuragaon, Laharighat and Mayong subdivision. The erosion is mainly attributed to extreme sediment charge to the braided river and formation of sand bars in the midst of the river.[6,7] The district faces an acute erosion problem as no permanent anti-erosion measures based on proper geo-hydrological models have been adopted so far. Geomorphologically, most part of the plains of Morigaon district falls under the flood plains of the Brahmaputra River.

Since the last three decades 56 revenue villages have been affected by erosion by the river Brahmaputra out of which 41 revenue villages have been completely wiped out. The rest 15 revenue villages are partially eroded. More than 80% of the lost land once produces some of the finest variety of jute in Assam. Incidentally, the entire Bhuragaon, Laharighat belt was once considered the granary of middle Assam.[8]

Objectives of the study:

a) To study the status of the Bank line in Morigaon district (1996-2016).

b) To study the shifting of the Brahmaputra river bank from 1996 to 2016.

Materials and methods

Study area:

The Morigaon District is located between 26°15′& 26°5′ North latitude and between 92° and 95°5′ degrees East longitude (Figure 1). The district covers a geographical area of approximately 1450.02 Sq. km inhabited by a population of 9,578,53 as per census 2011.There are 632 villages and sub-division in the district.

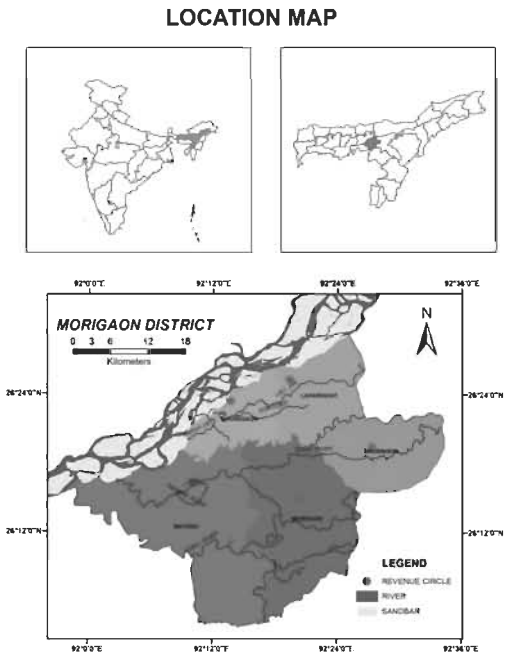


Figure 1: Locational map of Morigaon district

Physiographically the district Morigan can be divided in to three regions viz.

1. The north-eastern low lying plain.
2. The central and the eastern built-up plain and
3. The south-western plain interspersed with hillocks.

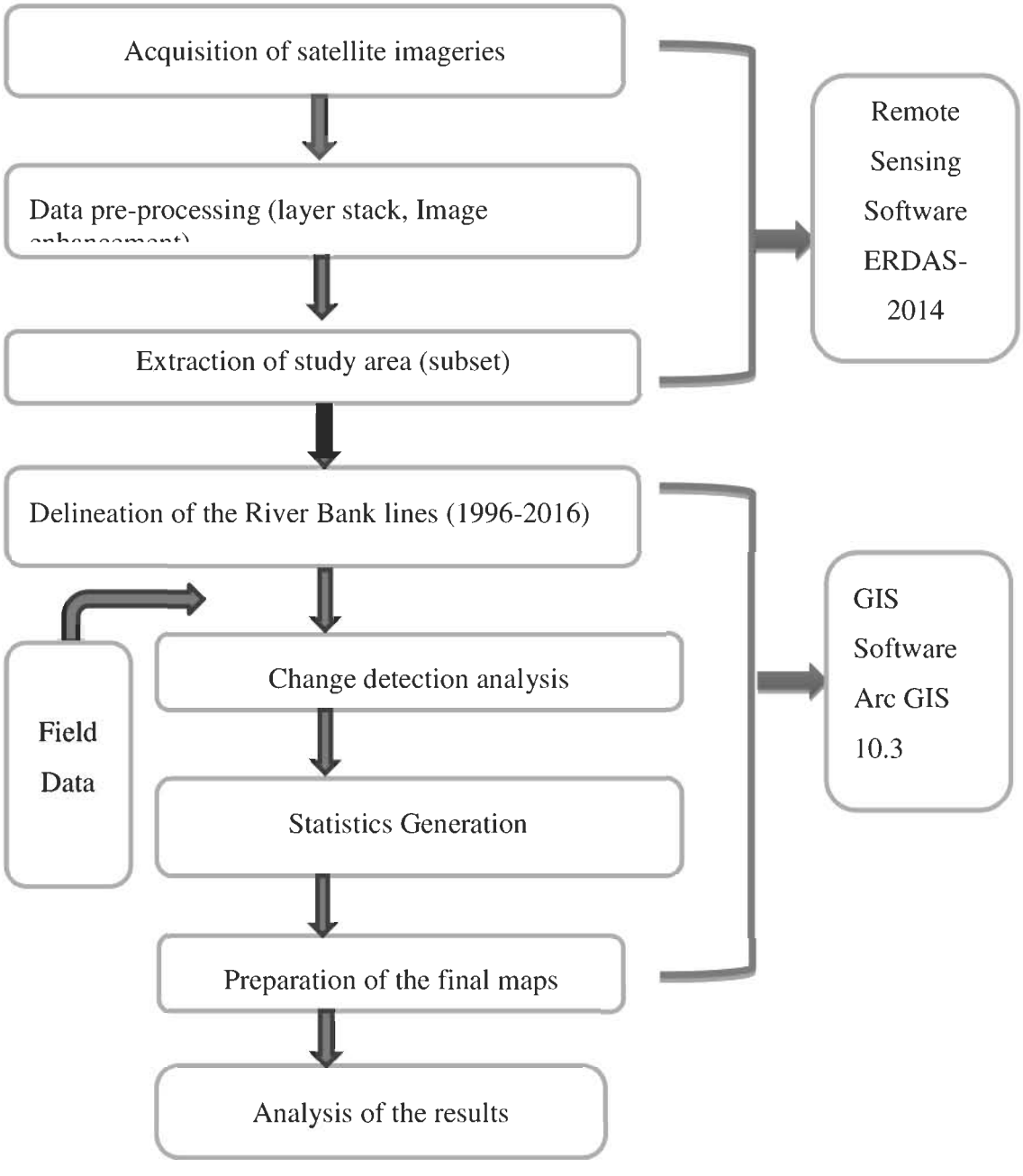
The north-eastern low lying plain covers the northern part of the mouzas of Bhuragaon, Bokani, Pakria to the north-western part of the Mayong. As there is no embankment on the south bank of Brahmaputra, this area is inundated by thefloodsofthe river chronically during summer. The plain possesses a number of swamps and water logged area here and there.

The central and the eastern built up plain is an extensive alluvial plain covering the southern part of Bhuragaon, Laharighat, Moirabari, Mikirbhata, Silpukhuri, Dandua, Charaibahi, NizGhagua, part of Manaha, Tetelia and the Uttarkholamouzas. This built up plain is drained by several river channels and dotted with heels and marshes. Between the· Brahmaputra in the north and foothills of the Meghalaya plateau in the south-west, this plain is the extension of the broad plain of the Morigaon district, built up partly by the Kollong and Kopilee which flows from east to west. This plain is extremely flat with an imperceptible gradient from east to west. There are several drainage water channels between the Brahmaputra and the Kollong namely Leteri, Sonduba, Lalipara, Sonai and Pakaria flowing more or less parallel with the Kollong. These channels dry up during winter leaving a series of heels, while water flow through them during summer due to heavy rainfall in the catchments area.

The geographic unit making the south-western plain interspersed with hillocks of the district bordering the Meghalaya plateau covers the southern parts of Mayong, Monoha, Tetelia, Uttarkhola and the whole of the Gobhamouza. Being the extension of the Meghalaya plateau, it has many isolated hillocks surrounded by fragmented plains interspersed by numerous swamps and heels. The important isolated hillocks include the Teteliaparbat and the Hatiuthaparbat with the average height of 272 metres and 219 meters respectively. The general gradient of the area is comparatively high (1 meter in 1.5 km). The surrounding plains are aggradation of the Kopilee and the Kollong and partly by degradation of the hillocks. This area is less important than the built up region from the view point of agricultural land use, because this area is covered with swamps, heels, hillocks and reserve forests.

The mighty Brahmaputra flows along the northern boundary of the district. Killing, Kollong and Kopilee River flows through the southern part of the district. The Kollong takes off from the river Brahmaputra and flows towards south west to meet the river Kopilee near Jagichaki. This river rejoins the parent river at Kajalimukh about 24 km from Guwahati. The region between the Kollong and the Brahmaputra is drained by a large number of water courses forming a network of intricate channels which widens out here and there into heels or swamps, the largest ones of which are known as the Sonduba and the Leteri.

Flow chart of the Study



Data Source:

The status of bank line and the shifting of Brahmaputra River in the study area were carried out from two sets of satellite imageries retrieved for two different time periods (1996 & 2016) fromLandsat-TM and Landsat-OLI images from the web portal www.earthexplorer.usgs.gov (Table 1).

Table 1: Data source

Image	Year	Path/Row	Spatial Resolution	Source
Landsat- TM	2-2-1996	136/42	30m	USGS
Landsat- OLI	8-1-2016	136/42	30m	USGS

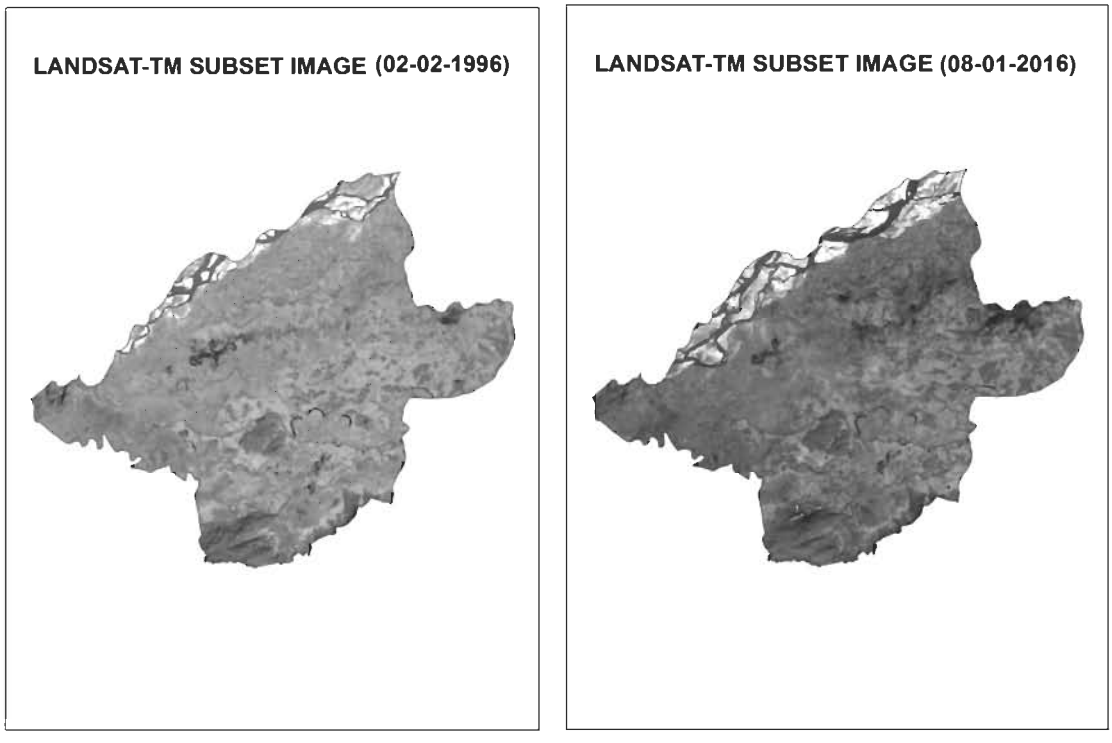


Figure 2: Subset Satellite images of Morigaon district (1996 & 2016)

Software and Platforms:

- ERDAS IMAGINE-14
- ARC GIS 10.3
- GRAMIN MAP SOURCE

Digital image processing was adopted for Band composition (layer stack), the Geometric Correction,Radiometric Correction, Noise Removal, andImage Enhancement which is done by Remote sensing software ERDAS Imagine-14. Images were projected to a common Universal Transverse Mercator (UTM) project system in zone 26 North and datum is define by WGS-84. After that the satellite imageries were clipped with the administrative boundary of Morigaon district by the GIS software ArcGIS 10.3. (Figure 2). False Color Composite (FCC) of Morigaon for different periods was prepared thereafter.

Delineation/Digitization of River Bank Line:

The Brahmaputra River in Morigaon district from Mayong Revenue circle in the west to Laharighat in the east has been divided into 43 strips at an equal spacing of approximately 1 km, reference cross sections have been drawn at the boundary of each strip. Base line has been taken as permanent reference line, on the basis of 2016 channel flow direction so that they maintain their identity when the morphology is changed. The river bank-line has been identified and delineated from the mosaics satellite images of 1996 and 2016 (Figure 3).

While the shallow water channels have been considered the part of river, old and new soil/sand deposits at the river banks posed some ambiguity of interpretation as the river. A few of these soil/sand patches are at considerable distance from active water channel, but have dark tone on satellite image, indicating higher moisture. On the other hand, several soil patches very close to the active water channel bear bright signature, an indication of low moisture. It has been observed that the areas with recent soil deposits have higher moisture in comparison to other areas adjacent to river bank, due to the river related activities associated with them. Either the river was flowing through that area in the recent past, or that area was submerged in water, when there was high flow in the river. These areas have been marked as a part of river. The identified river bank lines for the south banks of the river have been digitized using GIS software ArcGIS-10.3. Two river bank lines have been prepared for the years 1996 and 2016. The length of banks both the1996 & 2016 have been calculated using GIS software. Erosion and deposition area has been estimated through area estimation using GIS software tools for polygon areas with the shifting bank-lines in study period.

Results

In 1996, a major channel of the Brahmaputra River was flowing about 4.18 km north of Kacharigaon (GPS point- N 26^0 18.701′ and E $92^0$08.527′) and 3.78 km north of Gagolmari (GPS point –N 26^0 17.823′ and E $92^0$07.722′) in MayongRevenueCircle, 0.57 km north of Baralimari (N 26^0 20.926′ and E $92^0$09.651′), 0.55 km north of Bhuragaon (GPS point-N 26^0 24.456′ and E $92^0$14.018′) and 1.39 km north of Kapurpara (GPS point-N 26^0 26.020′ and E $92^0$16.852′) in BhuragaonRevenue Circle and 1.98 km north of Rawmari (GPS point-N 26^0 26.508′ and E $92^0$20.507′) in LaharighatRevenue Circle (Table 2).

By the year 2016, the Brahmaputra River has erodedmany revenue villages of which 24 villages were fromLaharighatRevenue Circle, 27 villages fromBhuragaonRevenue Circle and 13 villages fromMayongRevenue Circle.The length of the eroded land in Morigaon district is estimated to be 49.19 km from MayongRevenue Circle in the west to LahorighatRevenue Circle in the east.

Table 2: Near Bank line villages with GPS point.

Sl. No	Location	GPS Points
1	Katahguri	N-$26^0$16.945′ E-$92^0$4.345′
2	Gagolmari	N-$26^0$17.823′ E-$92^0$07.722′
3	Kacharigaon	N-$26^0$18.701′ E-$92^0$08.527′
4	Baralimari (Purana bazar)	N-$26^0$20.926′ E-$92^0$09.651′
5	Bhuragaon	N-$26^0$24.456′ E-$92^0$14.018′
6	Kapurpara	N-$26^0$26.020′ E-$92^0$16.852′
7	Rawmari	N-$26^0$26.508′ E-$92^0$20.507′
8	GaraimariPathar	N-$26^0$28.236′ E-$92^0$24.345′

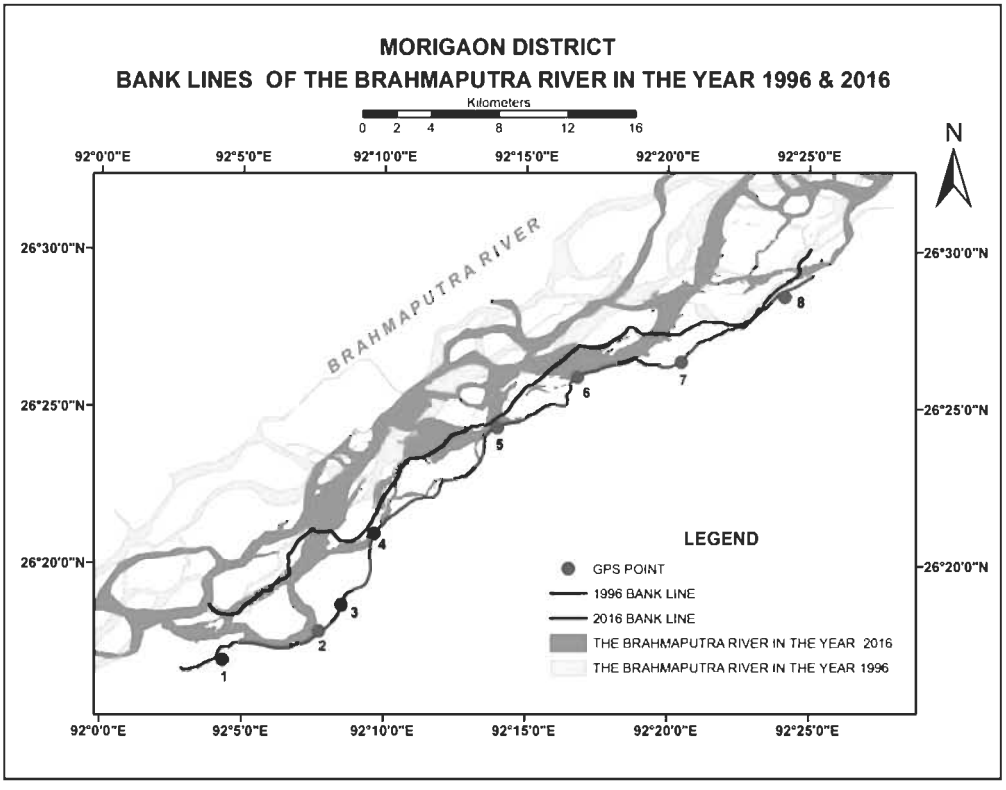


Figure 3: Delineation of river bank line of Brahmaputra (1996-2016)

Channel shifting measure by Cross section

The whole study area has been divided in to two segments A and B.Segment 'A' is the boundary or bank line of the Brahmaputra river channel in the year 1996 and segment 'B' is the bank line of the river in the year 2016(Table 3). The area in between two bank line is about 112.59sq. km including channel and sand bars.

Table 3: Variation of width of the channel in different cross sections (in km)

Cross section (Per/Sq. Km)	Eroded land (in Km)	Cross section (Per/Sq. Km)	Eroded land (in Km)	Cross section (Per/Sq. Km)	Eroded land (in Km)	Cross section (Per/Sq. Km)	Eroded land (in Km)
1	1.99 Km	12	0.73 Km	23	1.18 Km	34	1.98 Km
2	2.55 Km	13	1.11 Km	24	1.43 Km	35	1.19 Km
3	3.47 Km	14	1.41 Km	25	1.54 Km	36	1.09 Km
4	3.73 Km	15	2.14 Km	26	2.07 Km	37	0.82 Km
5	3.78 Km	16	2.45 Km	27	1.44 Km	38	0.15 Km
6	4.22 Km	17	2.01 Km	28	1.39 Km	39	0.21 Km
7	4.18 Km	18	2.24 Km	29	1.68 Km	40	0.32 Km
8	4.35 Km	19	2.24 Km	30	1.19 Km	41	0.39 Km
9	3.56 Km	20	1.46 Km	31	1.57 Km	42	0.62 Km
10	1.26 Km	21	0.54 Km	32	2.30 Km	43	0.19 Km
11	0.55 Km	22	0.51 Km	33	2.25 Km		

The most significant shifting of river bank line from 1996 to 2016 is found in the cross section No- 2 (2.55 km), 3 (3.47 km), 4 (3.73 km), 5 (3.78), 6 (4.22 km), 7 (4.18 km), 8 (4.35 km) and 9 (3.56 km) in Mayong Revenue Circle, 15 (2.14 km), 16 (2.45 km), 17 (2.01 km), 18 (2.24 km),19 (2.24 km) and 26 (2.07 km) in Bhuragaon Revenue Circle and 32 (2.30 km) and 33 (2.25 km) in Laharighat Revenue Circle. The average banks line shifting from all the segments (in 43 cross sections) is calculated to be 1.79 km (1996-2016). The high rate of south ward shift in this section is due to materials composed of non-cohesive river banks silt.

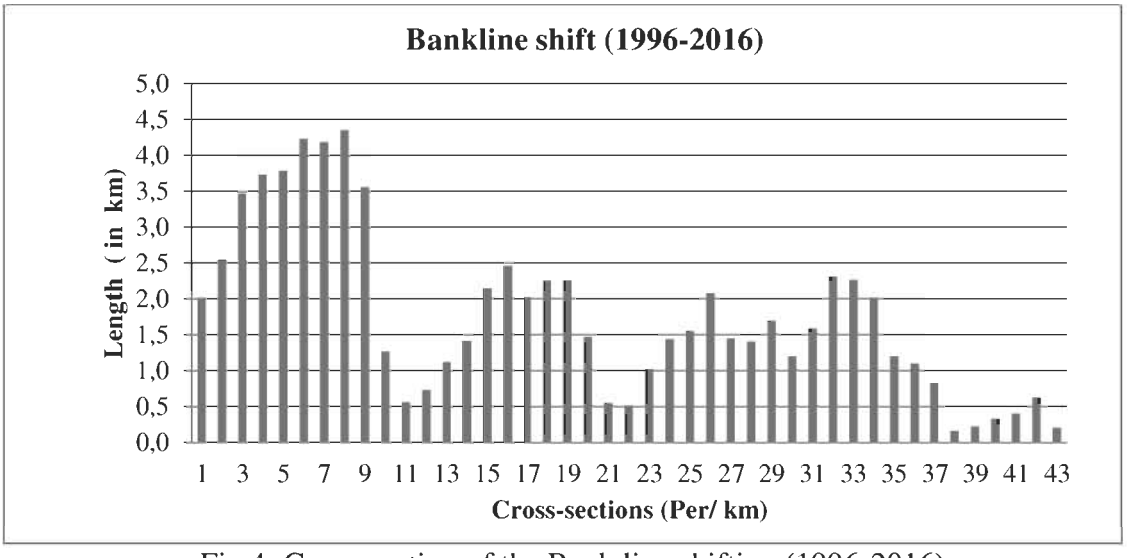


Fig 4: Cross-section of the Bank line shifting (1996-2016).

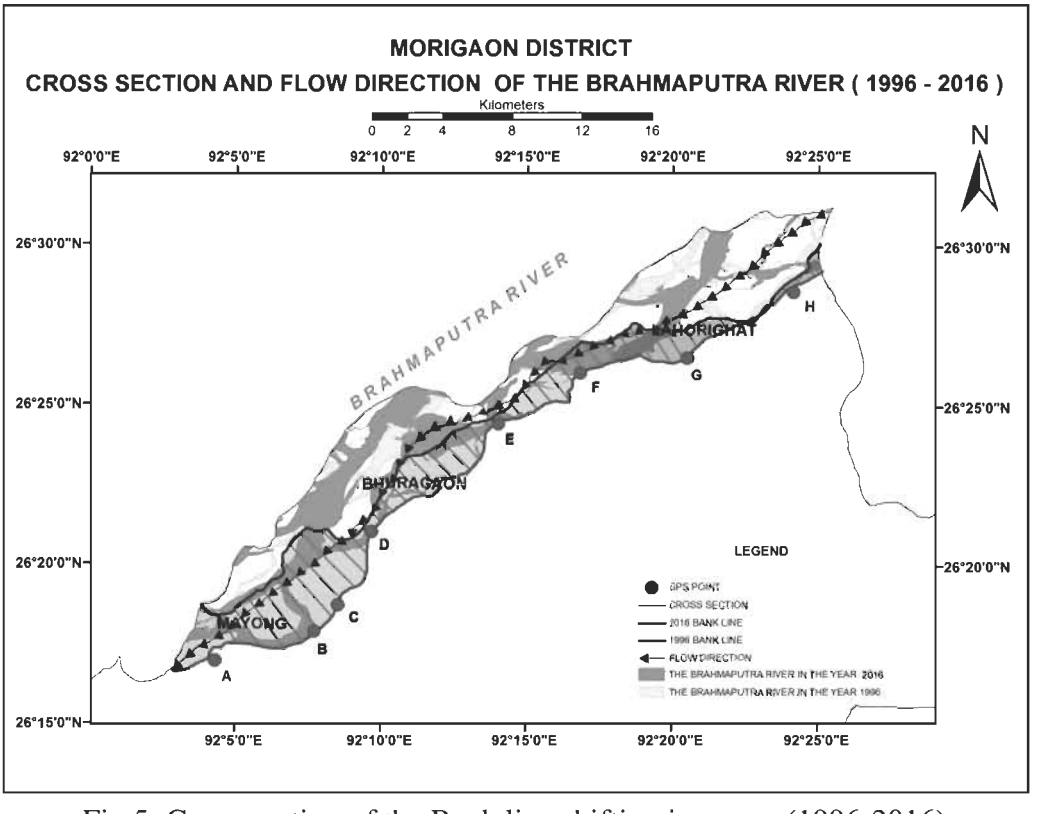


Fig 5: Cross-section of the Bank line shifting in a map (1996-2016).

Discussion

Channel migration of the Brahmaputra River in the study area is drastic. Riverbank erosion and Sandbar deposition is a common scenario in the study area. The most important reason responsible for heavy erosion in the study area is that the soil forming the bank of the river is mostly fine sand and silt that cannot resist erosion. Thedata reveal that amount of bank line erosion and fill up by the alluvial Brahmaputra River in different cross sections are not uniform. The river frequently changes its course through bank erosion and channel migration. These changes are dependent on river discharge, sediment load, bank and bed materials, level difference between river bed and its surroundings resulting from unplanned embankments and longitudinal profile of the river.

Presence of hilly protruding rocks in the middle part of the Brahmaputra valley where the Kalia-Bhumura Road Bridge is located in Silghat area, the river flow maintains a hypercritical velocity and thus do not deposit its heavy silt load. Afterwards, the River enters in to the alluvial plain and the velocity drops in to sub-critical state and the river deposits its silt load. Kar in 1994 in his study found that the embankments has also contributed to increased suspended loads especially during the summer months which are deposited in the riverbed contributing to the braided nature of the river. This, in turn, contributes to direct the finer flow towards the banks accelerating the bank erosion.[9]

Kotoky*et al.,* 2005 in their study strongly stated that there are large numbers of variables involvement in the process of riverbank erosion. The intensity of bank erosion varies widely from river to river as it depends on such characteristics as bank material, water level variations, near bank flow velocities, plan form of the river and the supply of water and sediment into the river. Loosely packed, recently deposited bank materials, consisting of silt and fine sand are highly susceptible to erosion and rapid recession of floods accelerates the rates of bank erosion in such materials. The erosion and the bank line shift in Morigaon district is the outcome of this processes.[10]

The erosion of river Brahmaputra has washed away 64 villages either partially or completely under the three Revenue circles of Bhuragaon, Laharighat and Mayong in the district since till 2016. The width of the river bank has been increasing at the rate of 89.5meters/yeardue to devastating bank erosion and the affected people living in that area are compelled to migrate to other places. The people whose houses and agricultural land were washed away by the bank erosion are either staying in the makeshift huts on the river bank or on the embankments with great hardship. Resettlement and rehabilitation of these persons are the major problem of the district. More than 80% of the lost land was agricultural land where jute and paddy was cultivated in large quantities. The dislocated cultivators had to engage themselves as petty traders, rickshaw/thela pullers in the nearby urban centers or as casual labour in agricultural sectors for their livelihood.

Conclusion

Erosion in Morigaon district is quite intensive and thousands of people are rendered homeless. Bank line migration of the Brahmaputra River has created an acute socio-economic problem in the study area. Anti-erosion measures adopted by the government are proved to be not truly effective. Some suggestions may therefore be forwarded along with the concluding remarks. The first and foremost strategy is developing strong awareness programmers about importance of trees, afforestation and reforestation. Afforestation reduces soil erosion and as a result accumulation of sediment on the river bed reduce, which lessen the effects of flood and bank erosion. Adequate attention must be paid while taking up developmental activities so that natural catchments areas and drainage systems, including wetlands, are not disturbed. Approximate soil conservation measures to check bank erosion need to be intensified.Involvement of the community will help in achieving success in such measures. Although embankments/bunds have led to more problems than solutions, yet it would be helpful if embankments are made stronger. The most plausible measure for control of floods and bank erosion stated to be the construction of dams and taming of rivers. Studies are needed on the rivers and the tributary systems in the state for taking up such projects. A rational co-operation among general people, N.G.Os and the Government is very much needful for a cohesive as well as integrated development of the study area. Relief and rehabilitation works during and

after bank erosion and flood is an emergency service for the affected people. But this is not a permanent solution. An effective disaster management programmed as per the Disaster Management Act, using the latest technologies, is an emergent need.

REFERENCES

1. Gopal, M. (**1990**), Gautam, K. S. edited. *India through the ages*. Publication Division, Ministry of Information and broadcasting, government of India, pp.80
2. Goswami, D. C. (**1998**) "Floods and their impact on the agriculture of Assam Agriculture in Assam". Led P. Goswami, P.C. Inst. Of Development studies. - pp.191.
3. Kotoky, *et.al.* (**2003**), Erosion activity on Majuli- the largest river island of the World , Assam ,India current Science pp. 84.
4. Mamun, M. Z. and Amin (**1999**). Densification, The University Press Limited, Dhaka.
5. Taher, M. and Ahmed, P. (**1998**), Geography of North East India, El-Dorado Publication, Guwahati. Pp. 56.
6. Baker, V. R., *et,al* (**1988**). Flood Geomorphology, John Wiley, New York, p. 503.
7. Goswami, D. C. (**1985**), Brahmaputra river, Assam, India: Physiography, basin denudation and channel aggradation; *Water Resources 21*, pp. 959.
8. Alam, F. (**1993**). "Flood and Erosion facts - A report - Bhuragaon revenue circle" Morigaon, Assam, pp. 1.
9. Kar, M. (**1994**): Flood hazard in Nagaon and Morigaon districts of Assam, a geographical perspective; Unpublished Ph.D. Thesis, Gauhati University.
10. Kotoky,et.al. (**2005**): Nature of bank erosion along the Brahmaputra river channel, Assam, India Current Science, *88*, No. 4, 25 February.

PLATES

Image: Bank erosion Boralimari.

PLATES

Image: Properties of Bank line.

PLATES

Field survey with GPS points. Preventive Measure at Bhuragaon Revenue Circle.