The International Journal Of Engineering And Science (IJES)
||Volume||2 ||Issue|| 9 ||Pages|| 01-06||2013||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

A STUDY ON BANK EROSION AND BANK LINE MIGRATION PATTERN OF THE SUBANSIRI RIVER IN ASSAM USING REMOTE SENSING AND GIS TECHNOLOGY

[1,]Chinmoyee Gogoi , [2,]Dulal C. Goswami
[1,2,]Department of Environmental Science
Gauhati University, Guwahati – 781014, Assam, India

ABSTRACT

Every year the hazard of flood and erosion causes severe problem to the people living in the floodplain of the river Subansiri. Bank line migration due to erosion is a common feature in the Subansiri river. A study on bank erosion and bankline migration of the present course of the Subansiri river through the Ghagar nala indicates that the area is currently under active erosion. The study was carried out using the satellite imagery of 1995 and 2010 and it shows that shifting of the bankline due to erosion is more pronounced in both the banks compared to shifting due to sedimentation. The study of the width change also indicates that the width of the Subansiri river through Ghagar nala has been increasing from 1995 to 2010 eroding a large portion of land along the both banks of the river.

KEYWORDS: *Subansiri river, flood, floodplain, erosion and sedimentation, bankline migration*

Date of Submission: 24 August, 2013 ⟺ Date of Acceptance: 20, September 2013

I. INTRODUCTION

The Subansiri is one of the largest among the Trans-Himalayan tributaries of the Brahmaputra River in Assam. It flows from the higher Himalayas of Tibet through middle and sub Himalayas of Arunachal Pradesh to the plains of Assam before meeting the river Brahmaputra. The river, after entering the plains of the Brahmaputra valley from the high gradient of Himalayas spreads its enormous discharge forming anastomosing pattern in the channel which, in the downstream direction, takes a meandering course. Flood and drainage congestion is a major problem in the plains of the Lower Subansiri basin. Erosion which is associated with flood is a growing concern in this part of the basin in Assam. The Subansiri river is characterised by heavy flow during flood season, enormous volume of sediment load, continuous change in channel morphology, bankline migration and lateral changes in channels which further causes severe bank erosion leading to a considerable loss of good fertile land every year (Sarker A. et.al, 2012).The main aim of the present paper is to study the channel configuration of the Subansiri river in Assam with special emphasis on erosion and deposition. This study will be useful for devising effective remedial measures to prevent erosion and deposition.

II. STUDY AREA

The Subansiri is one of the principal tributaries of the Brahmaputra river and it forms one of its largest sub-basins covering parts of Tibet (China) and India. It is one of the major tributary of the river Brahmaputra and contributes as much as 11% of the total flow of the river Brahmaputra. On entering the plains of the Brahmaputra valley after flowing down the steep gradient of the Himalayas, the river spreads its enormous discharge and load of sediments forming an anastomosing pattern of its channel which assumes a meandering pattern further downstream. The Subansiri basin covers an area of 35,771 sq.km., of which 4350 sq.km. falls in Assam. . The maximum discharge recorded at Chowldhoaghat is 12,636.43 cumec in the year 1987.The present study is centered around the area lying between the longitude $93^{\circ}50'$ E and $94^{\circ}20'$ E and latitude $27^{\circ}50'$ N and $26^{\circ}35'$ N (Figure 1).

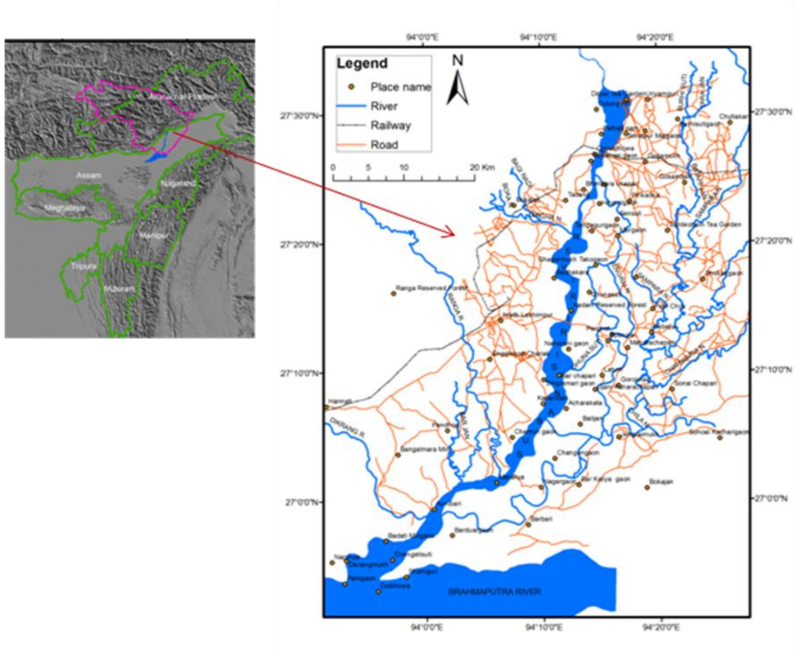


Figure 1: Location map of the Subansiri river in Assam.

III. SIGNIFICANCE OF THE STUDY

The Subansiri is one of the most dynamic and unstable rivers originating in the Eastern Himalayan region. Flood and drainage congestion is a major problem in the plains of the Lower Subansiri basin. Heavy rainfall in the hilly reach as well as in the plains, lack of adequate gradient to drain out the high discharge of the rivers, increasing silt load due to increased deforestation and landslide in the upper catchment, breaching of embankments are the main causes of flood in this part of the basin. Heavy flooding causes abrupt changes in the flow pattern of the rivers (Desai et.al. 2012). Geotectonically fragile and seismically sensitive sub-Himalayan segment of the basin further accentuates the flood and erosion scenario. The map evidence, together with records of flood history indicate that regular large floods have breached the embankments, created areas of bar development and caused bank erosion and aggradation and channel migration in the study area. The river has changed its course several times since the past and the channel migration study shows the shifting of the river towards western side (GSI, 1977 and Goswami et.al, 1999). But in this study, we have selected the present stretch of the Subansiri river in Assam and its bank line change due to erosion from the past. The Great Assam Earthquake of 1950 and the associated floods have changed the entire morphology of the river. According to Schumm and Litchy (1963), floods of very high magnitude may be a contributing factor to channel widening and river bank erosion along with associated changes in the channel pattern. Erosion may be caused either by undercutting of the upper bank materials by channels during the high floods producing an overhanging cantilevered block that eventually fails or by over steepening of bank materials due to migration of the thalweg closer to the bank during the falling stages (Goswami,2002). Large scale slumping of bank during the falling stages of the river was observed in many places which may be associated with water movement from the formation back into the channel causing a lateral flowage of sand and silt into the channel resulting in subaqueous failure (Coleman, 1969). Enormous amount of land degradation in the present Subansiri river in Assam suggests that the area is under active erosion.

IV. METHODOLOGY AND DATABASE

Identification of the channel migration pattern of rivers from satellite images of different years using GIS and Remote Sensing technology is found very much useful for studying the fluvial geomorphology of a river. Many researchers in recent years have used RS and GIS techniques for studying channel changes of different rivers. Among these, the names of Yang et.al, 1999, Bhakal et.al., 2005, Thakur et al. 2011 etc. may be cited. Goswami et.al(1999) has studied the channel changes of the Subansiri river in Assam from 1920 to 1990 using satellite images of three years. However, the bank erosion and bankline migration of the present course of the Subansiri river has not been done yet. To study the changes in the flow pattern of the Subansiri river in Assam, two years of data over a span of sixteen years (1995 – 2010) have been considered.

The satellite image of IRS LISS-III of 1995 and Landsat 5 TM of 2010 are used for this purpose. In the first step, the satellite images of these two years were georeferenced using GIS software ARCGIS 9.3. Bank lines of these two years were digitised from the georeferenced satellite imageries using the same software and then the bank lines are overlaid. The overlaid bank lines give us the overall channel migration pattern of the Subansiri river from 1995 to 2010 and the rate of erosion and deposition. Bank line migration was measured taking 17 cross-sections along the present river. Erosion and deposition areas have been estimated through area estimation using GIS software tools for polygon areas with the shifting bank lines in the study period.

V. RESULT AND DISCUSSION

The channel pattern of the Subansiri river in Assam changes continuously; large channels being abandoned and new channels developing in a few years only are common features (GSI, 1977). It is seen from the figure 2, that during 1995 the Subansiri river was flowing through Ghunasuti and the Ghagar nala was present as a small channel in the right side of the river. But after 1995, it starts capturing the Ghagar nala abandoning the channel through Ghunasuti and straightened its course through this nala, which has become the main channel of the Subansiri river at present. The Channel through Ghunasuti was blocked by many channel bars locally known as 'chars'. This channel usually disappears during winter and gets activated by water flow only during flood season. The shifting of the channel from 1995 to 2010 along both the banks was measured in 17 cross- sections along the river and the results are presented in table1. The highest erosion that took place in the right bank was along the section G (1954.01m) and in the left bank along the section K (1823.05m). The line diagram in Figure 3 indicates that erosion is more pronounced in both banks in comparision to sedimentation. The negative values (-) indicate the shifting due to erosion and the positive values (+) indicate the shifting due to deposition. Because the river Subansiri is flowing from North to South from the high Himalayas of Tibet through Arunachal Pradesh to the plains of Assam where it meets the river Brahmaputra, the shifting of the river means shifting of the bankline towards eastern or western side. Except the sections A and B, erosion is more dominant along the right bank of the river which indicates shifting of the channel towards western side. In the section A and B small amount of sedimentation indicate the shifting of the right bank towards eastern side. Along the left bank, except the sections G, H, L and N erosion is more dominant than sedimentation which indicates shifting of the channel towards eastern side. In the section G, H, L and N, due to sedimentation, the left bank shifted towards the western side.

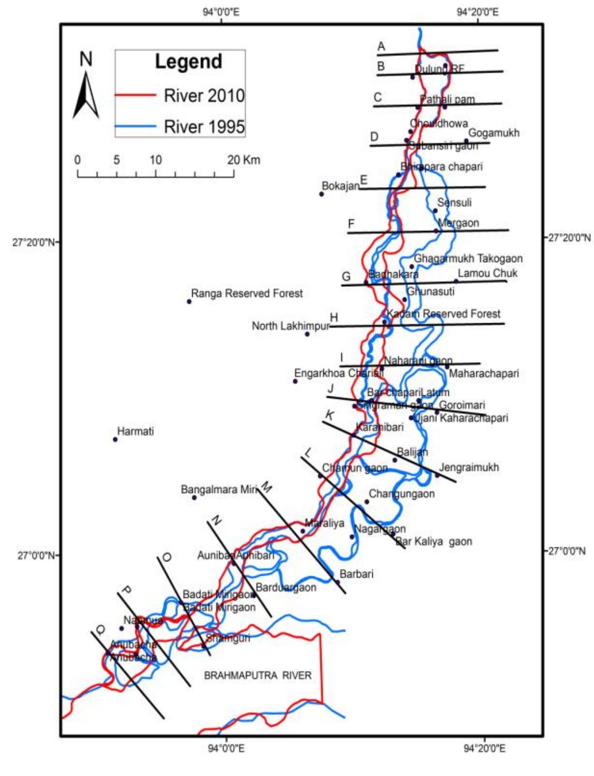
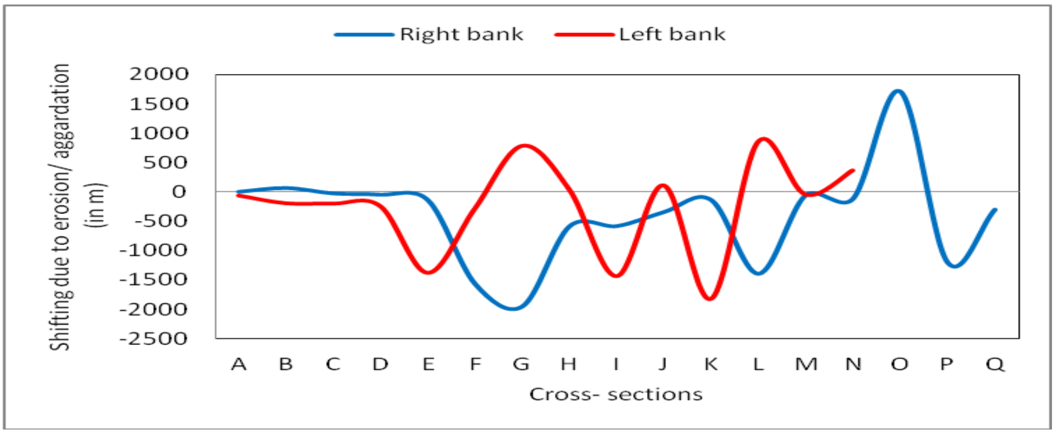


Figure 2: Bank lines of the Subansiri river in different years along with the cross- sections

Table 1: Shifting along both banks of the river from 1995 to 2010 (in metre)

Sections	**Right bank**	**Left bank**
A	+3.94	-59.67
B	+69.02	-191.02
C	-23.73	-195.31
D	-45.7	-242.39
E	-136.92	-1378.63
F	-1566.77	-279.73
G	-1954.01	+790.28
H	-584.4	+42.34
I	-582.15	-1435.24
J	-341.45	115.06
K	-137.82	-1823.05
L	-1394.55	+859.9
M	-50.94	-42.01
N	-113.65	+371.3
O	+1713.77	
P	-1202.28	
Q	-299.33	

Minus sign (-) means shifting due to erosion and plus sign (+) means shifting due to aggradation



Minus sign (-) indicates shifting due to erosion and plus sign (+) indicates shifting due to aggradation

Figure 3: Shifting along both banks of the Subansiri river from 1995 to 2010 due to erosion and aggradation

Table 2: Variation of width of the channel in different cross sections (in m)

Sections	**1995**	**2010**	**Total width change**
A	723.02	779.25	- 56.23
B	3892.17	4010.43	- 118.26
C	2348.27	2570.33	- 222.06
D	1253.7	1541.21	- 287.51
E	1300.04	1708.47	- 408.43
F	228.26	2080.15	- 1851.89
G	218.65	2094.48	- 1875.83
H	220.02	1489.99	- 1269.97
I	162.32	2186.28	- 2023.96

J	2228.29	2453.19	- 224.9
K	1366.85	3317.12	- 1950.27
L	1501.25	2048.66	- 547.41
M	2260.7	2352.57	- 91.87
N	2567.12	2318.3	+ 248.82
O		1797.86	

(Minus sign (-) means width increases due to erosion and plus sign (+) means width decreases due to aggradation)

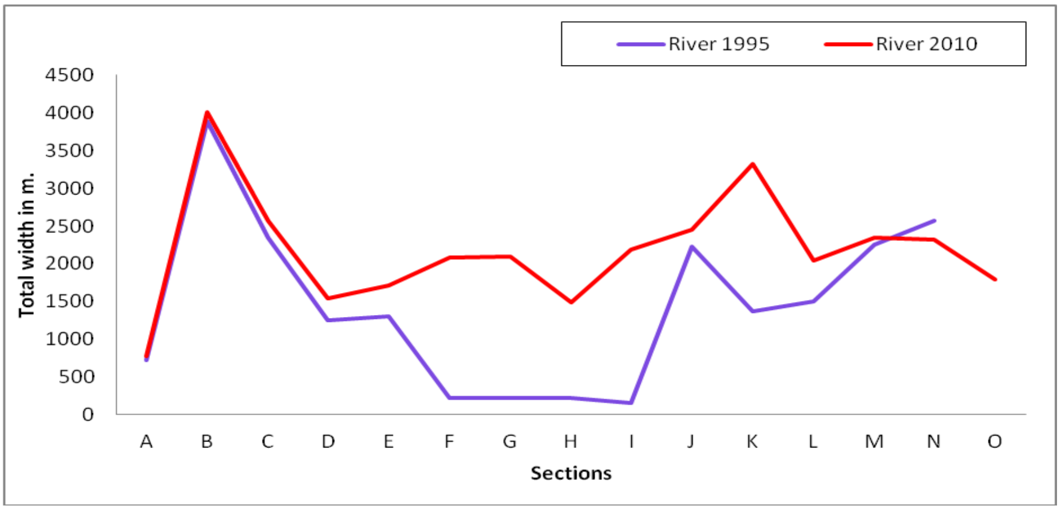


Figure 4: Changing pattern of width of the Subansiri River from 1995 to 2010

The Table 2 shows the variation of width of the channel in different cross-sections along with the total width change. From Figure 4, we can see the overall pattern of width change of the channel in different sections from 1995 to 2010. It is seen that except the position N, in all other sections width has increased significantly due to erosion in both banks. The width change is highest in the middle part of the river along section I (2023.96 m) and it is lowest in the upper part along section A (56.23m). Basically width of a river increases due to lateral erosion along both the banks and decreases due to sedimentation. In the present study, the width of the Subansiri river through Ghagar nala has increased from 1995 to 2010 eroding a large part of land along the both banks of the river.

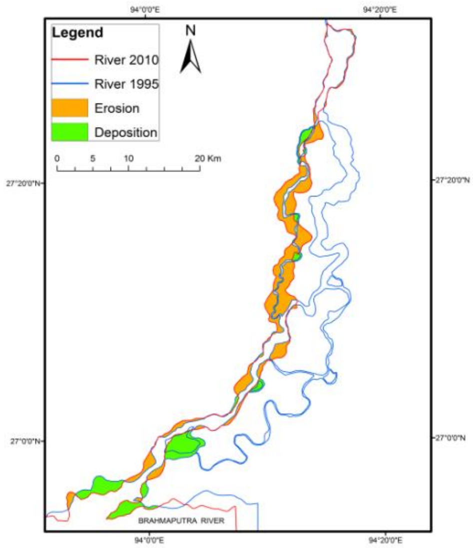


Figure 5: Erosion and deposition along both banks of the Subansiri river (1995 to 2010)

The figure 5 represents the bank line migration of the Subansiri river from 1995 to 2010 due to erosion and sedimentation along with the total area of erosion and deposition. Except the lower part, erosion is more dominant in the upper and middle part of the river because of which the width of the river has increased significantly. Figure 6 shows the total amount of erosion and deposition along both banks of the Subansiri river and these are 82.089 sq.km. and 43.231 sq.km. respectively.

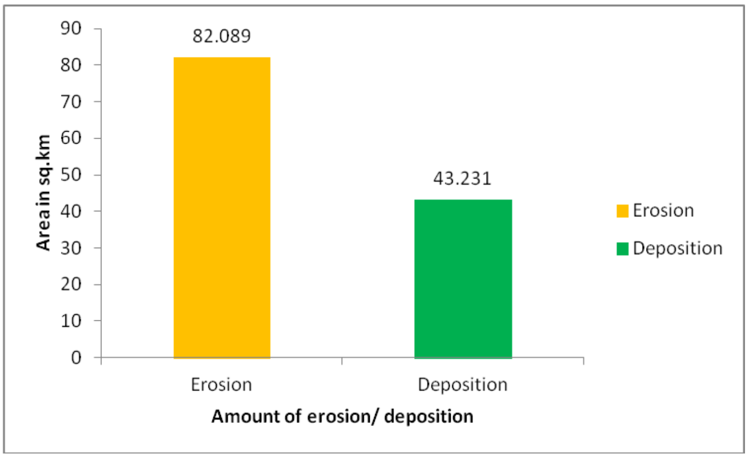


Figure 6: Total erosion/ deposition along the banks of the Subansiri river from 1995 to 2010

VI. CONCLUSION

Flood and erosion lead to channel migration of the Subansiri river in Assam. Erosion is more pronounced in both banks than the sedimentation. From 1995 to 2010 the bank line of the river changes significantly. Erosion is more dominant in both the upper and middle part than the lower part of the channel. Width increases most in the middle part due to erosion than in the upper and lower part of the Subansiri river. A large part of agricultural land as well as homestead plantation and rural settlements are affected by erosion every year. Various flood and erosion protection measures such as earthen embankments, spurs, porcupines etc. are used to protect the area. But they are not enough as a long term measure. A comprehensive scientific study of the bank materials as well as morphology of the river is needed to protect the area using eco-friendly materials and techniques such as Geotextile bags (or Geobags) for construction of embankments to protect river banks from severe scouring and erosion. They are also good for vegetative growth and provide habitat for species that are living around water and vegetation.

REFERENCES

[1] Coleman, J.M., 1969: Brahmaputra river: channel process and sedimentation. Sediment. Geol. 3, pp. 129- 239

[2] Desai A.J, Naik S.D, Shah R.D, 2012: Study on the channel migration pattern of Jia-Bhareli, Puthimari and Pagladiya tributaries of the Brahmaputra river using Remote Sensing Technology. http://www.isprs.org/proceedings/XXXVI/part4/Pages from RS-GEO-14.pdf

[3] Goswami, U., Sarma J.N., Patgiri A.D., 1999: River channel changes of the Subansiri in Assam, India: Geomorphology 30 (1999) 227 – 244

GSI., 1977: Contributions to Geomorphology and Geohydrology of the Brahmaputra Valley. Geological Survey of India, Miscellaneous Publication No.32, 291p

[4] Goswami, D. C., 2002: Channel pattern, Sediment transport and Bed regime of the Brahmaputra river, Assam. In: *Recent Advances in Geomorphology, Quaternary geology and Environmental Geosciences: Indian Case Studies* (eds. S.K. Tandon and B. Thakur), Manisha Publications, New Delhi, pp. 143-156.

[5] Sarkar A., Garg R.D., Sharma N., 2012: RS-GIS based assessment of river dynamics of Brahmaputra river in India. Journal of Water Resource and Protection, 2012, 4, 63-72

[6] Schumm SA. And Lichty RW (1963) Channel widening and floodplain construction along Cimarron river in southwestern Kansas. US Geol Surv. Prof Paper 352-D:71–88

[7] X. Yang, M. C. J. Damen and R. A. van Zuidam,1999 “Satellite Remote Sensing and GIS for the Analysis of Channel Migration Changes in the Active Yellow River Delta, China,” International Journal of Applied Earth Observation and Geoinformation, Vol. 1, No. 2, pp. 146- 157. doi:10.1016/S0303-2434(99)85007-7

[8] L. Bhakal, B. Dubey and A. K. Sarma, “Estimation of Bank Erosion in the River Brahmaputra near Agyathuri by Using Geographic Information System,” Journal of Indian Society of Remote Sensing, Vol. 33, No. 1, 2005, pp. 81-84. doi:10.1007/BF02989994

[9] Thakur PK, Laha C, Aggarwal SP (2011) River bank erosion hazard study of river Ganga, upstream of Farakka barrage using remote sensing and GIS. Nat Hazards. oi:10.1007/s11069-011-9944-z