Study on the channel migration pattern of Jia-Bhareli, Puthimari and Pagladiya tributaries of the Brahmaputra river using remote sensing Technology

A.J Desai*, S.D Naik, and R.D Shah***
*Geology Department, M.G Science Institute, Ahmedabad
**Space Application Centre (ISRO), Ahmedabad

key words: Brahmaputra river tributaries, erosion, deposition, channel shifting, geology and geomorphology

COMMISSION: WG-IV/10 , No: WG-410-132

ABSTRACT

Floods of high magnitude are one of the major problems in the north-eastern region of India. Heavy flooding causes abrupt changes in the flow pattern of the rivers. The present paper deals with the study of three northern bank tributaries of the Brahmaputra river, namely Jia-Bhareli, Puthimari and Pagladiya. The river Brahmaputra shows significant amount of erosion and deposition in the basin. Erosion is mainly caused by the rapid flow of water through soft, disintegrated rocks. Sporadic heavy downpours causes flash floods which also contributes towards erosion. Apart from all these, factors such as deforestation also contributes towards erosion. When the river enters the plain region with very gentle slope the velocity of water flow greatly decreases and the suspended load which is carried by the river gets deposited. This phenomena of deposition also contributes towards the change in the flow pattern and meandering of the river channel. Frequent Occurrence of high magnitude earthquakes are also responsible for the sudden and gradual change in the flow pattern of the Brahmaputra river and its tributaries. The main aim of the present study is to understand the problems caused by continuous change in the fluvial patterns of the river channels, amount of bank erosion and rate of sedimentation.

INTRODUCTION

Brahmaputra river is the fourth largest river of the world, and discharges very high rate of sediment load . It originates from the Kailas range of Himalayas at an elevation of about 5300 m above msl and meet Bay of Bengal along with Ganga river. The total catchment area is about 9,24,000 sq.km, with a total length of about 2880 km. This river flows through parts of China, India and Bangladesh. Its total length in India is 880 km, out of which 160 is in the state of Arunachal Pradesh and 720 km is in Assam. The flow direction in Assam is towards south and west. Here the Brahmaputra valley is about 720 km long and 80-90 km wide.

Brahmaputra river shows braided nature and exhibits natural fluvial features such as leeves, point-bars, crevasses, meander-scrolls, ox-bow lakes, channel-bars and flood basins. The Brahmaputra basin consists of sands, silt and clay of Quaternary age. The Brahmaputra basin is seismically very active and shows its effect on the course of Brahmaputra river and its tributaries. Erosion which is associated with floods is also one of the most serious problems in recent years. Thousands of hectares of agricultural land is affected by severe erosion. The Brahmaputra river is Characterized by exceedingly large flow, enormous volume of sediment load, continuous change in the channel morphology, rapid bed aggradation, bankline recession and erosion.

The main aim of the present paper is to study the channel configuration of the three main northern bank tributaries of the Brahmaputra river namely, the Jia-Bhareli, the Puthimari and the pagladiya with a special emphasis on erosion and deposition. This study will be useful for devising effective remedial measures to prevent erosion and deposition.

STUDY AREA

The Brahmaputra river originates in the Tibet Himalayas at an altitude of about 5300 m, about 63 km. Southeast of Mansarovar lake in Tibet. Here the river Brahmaputra is known as Tsangpo. The river Brahmaputra is covered within the following co-ordinates-

Latitudes 25^0 45' and 28^0 N
Longitudes 89^0 45' and 95^0 45' E.

The major tributaries under study are the northern tributaries Jia-Bhareli, Puthimari, and Pagladiya.

Jia-Bhareli river - Jia-Bhareli is one of the main northern bank tributaries originating in Arunachal Pradesh and then enters the plains which are just north of Balukpong. Its course is straight and braided.

Bechan and Tenga are the two main sub-tributaries of Jia-Bhareli. Its catchment is very small as compared to the other rivers and has a very narrow floodplain. Enormous amount of land degradation in the catchment suggests that the area is under active erosion. This is well noticed in the Jia-Bhareli catchment area especially at the lower reach in the plains of Sonitpur district. This tributary debouches from the Himalaya through a dissected piedmont plain. The drainage basin covers an area of 12,361 sq km. The catchment covers the outer hills, lesser Himalayas and the Greater Himalayas. Structural features in the Jia-Bhareli river includes a system of faults, dividing the basin into number of different blocks. Major part of the Jia-Bhareli catchment lies in the wet belt, which in turn induces high runoff into the Jia-Bhareli streams.

Puthimari river – Puthimari river is one of the of the main northern bank tributaries of Brahmaputra river. The river Puthimari flows through the Kamrup district of Assam. It shows various geomorphic features such as floodplains, meanders and river islands. In this area the river shows wide floodplains formed by the Brahmaputra river which flows from east to west in the lower portion. The Puthimari river flows from north to south. The region is also characterized by heavy floods due to high rainfall during monsoon. The Puthimari river catchment lies within the the Sub-Himalayas and is bounded by ranges varying in height from 6,000 ft to about 10,000 ft. The catchment is long and linear with high bifurcation ratio and lies in the humid belt. The catchment is small in size and consists of rocks which are easily disintegrated.

Pagladiya river – The river Pagladiya is one of the northern bank tributaries of the Brahmaputra river. Pagladiya is a meandering stream which shows braiding in the upper portion. The channel migration pattern shows that the major shift to the east was due to the 1897 tectonic activity. (reference–G.S.I– 1977). Before this tectonic activity this tributary used to flow in a westerly direction. The relict of the earlier Pagladiya can still be seen in the form of abandoned channel passing through Khagrabari and Barama. Thus it can be clearly said that the Pagladiya basin has been developed by the actively migrating nature of the stream and resulted in a basin consisting of complex channel migration pattern. Apart from tectonic activity, erratic flash floods and heavy sediment load also contribute towards active channel migration. The catchment of Pagladiya is formed by a number of north-south streams.

METHODOLOGY

To study the changes in the flow pattern of the tributaries of the Brahmaputra river, two year data over a span of six years (1998 - 2004) have been considered. Satellite data used for this purpose include IRS-1D LISS III for the year 1998 and RESOURCESAT-1 for the year 2004 respectively. Both the data have a spatial resolution of 23 m.
Collateral data – SOI topographical maps, previous work by G.S.I on geology, geomorphology of the area were also used as references.

Satellite data – The river Brahmaputra is covered in 6 imageries of IRS-1D and IRS-P6 (RESOURCESAT-1). The table covering the list of images of IRS-ID LISS III and IRS-P6 LISS III is given below.

IRS-1D LISS III YEAR 1998

TRIBUTARY	PATH	ROW	DATE
JIA-BHARELI	111	53	18-12-1998
PUTHIMARI	110	53	13-12-1998
PAGLADIYA	110	53	13-12-1998

IRS P6 LISS III YEAR 2004

TRIBUTARY	PATH	ROW	DATE
JIA-BHARELI	111	53	16-12-2004
PUTHIMARI	110	53	5-12-2004
PAGLADIYA	110	53	5-12-2004

Comparative study was carried out using postmonsoon multidate satellite data for both the years. Multidate satellite data prove to be very useful as they provide data on repetitive basis so that the same area can be monitored for different years and the changes can then be detected. This work was carried out using ERDAS image processing software. First of all the image registration was carried out with reference to the ground co-ordinates of SOI topographic maps. Various fluviogeomorphic features such as floodplain, sandbars, agricultural land, water channel, bankline, waterbodies, ox-bow lakes etc. were demarcated from SOI maps as well as from the satellite images. Various linear features such as roads, railway, settlements and embankments were also demarcated using SOI topographical maps. This was followed by the integration of multidate satellite data using ERDAS image

processing software. Interpretation and analysis was carried out by comparing the SOI topographical maps and the satellite images. By comparing these datas the eroded and the aggraded areas between 1998-2004 were identified. The studies also revealed the stable and the unstable river banks. For this purpose both the bankline i.e. 1998 and 2004 were superimposed over one another and the changes were identified.

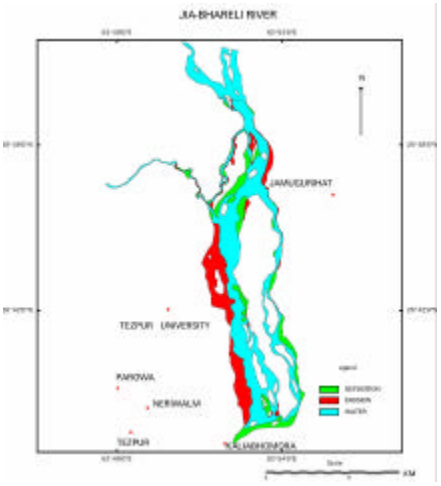
The present work provides a very useful database on the tributaries of the Brahmaputra river regarding the channel changes, and the rate of erosion and deposition.

RESULTS AND DISCUSSION

JIA-BHARELI RIVER

Jia-Bhareli is a northern bank tributary which originates in Arunachal Pradesh and then enters the plains in the north of Balukpong. The satellite data (FCC'S) shows the braided nature. The channel configuration is interpreted using IRS-1D (1998) and RESOURCESAT-1 (2004) data. The river course is mainly straight and shows broad width in the middle-lower reach. Delineation of various geomorphic features and bankline indicate that both the banks of Jia-Bhareli have experienced severe erosion and deposition. It is shown in Fig (1) below. The erosion and deposition amount were also calculated from the interpretation and analysis. The amount of erosion and deposition is 9 sq km and 7 sq km. respectively. Refer bar chart fig. (7).

Fig: 1 erosion/deposition in Jia-Bhareli river



Also, the river has shown a distinct channel shifting from east to west which is shown in the following fig. (2).

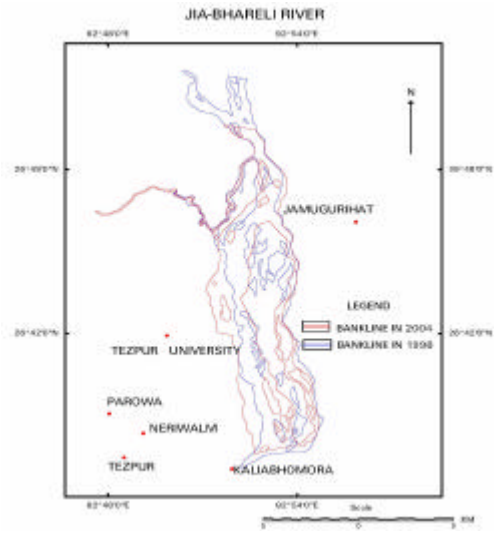


Fig: 2 channel shifting in 1998/2004

PUTHIMARI RIVER

Postmonsoon data of the years 1998 and 2004 were studied. Various geomorphic features were delineated from FCC's. The channel configuration was demarcated using the 1998 and 2004 data. FCC's showed variation in the fluvial features. From this data it was very clear that both the banks have simultaneously undergone erosion and deposition which is shown in the following fig. (3).

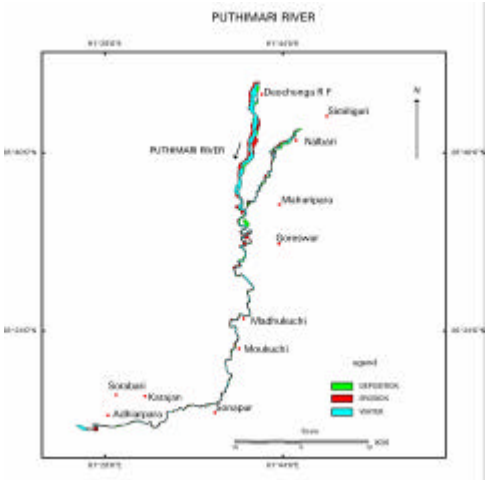


Fig: 3 erosion/deposition in puthimari

The flow of the river is from north to south and meet the Brahmaputra river in the south. The river shows meandering nature. The river bankline changes were mainly observed in the

upper-middle reaches of the river which is shown in the fig. (4).

Fig: 4 channel shifting in 1998/2004

The amount of erosion and deposition is 12 sq km and 12.00 sq km respectively. (Refer bar chart 7).

PAGLADIYA RIVER

The comparison of the postmonsoon data of the years 1998 and 2004 shows distinct bankline changes especially in the upper reaches as shown in fig. (5) below

Fig: 5 channel shifting in 1998/2004

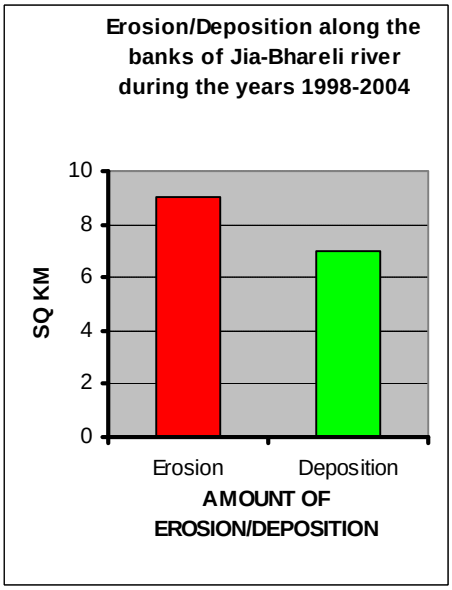
The upper reach of the river has broad width compared to the lower reach. Catchment of Pagladiya is within the Sub-Himalayas bounded by different ranges. It is comprised of alluvium which in turn yields sediment load. It has been observed that the erosion and deposition ratio of Pagladiya is much higher then the other two tributaries.

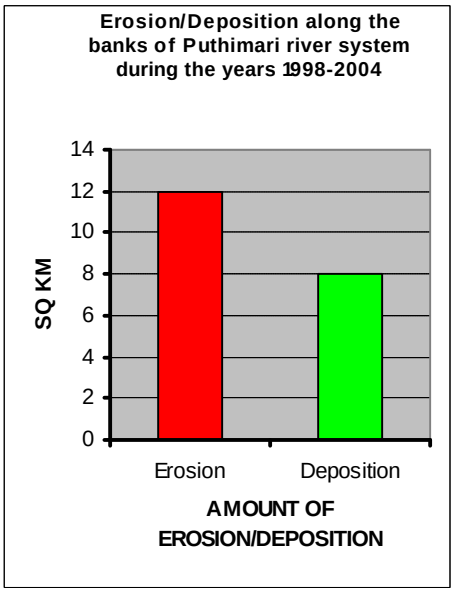
It has been observed that the erosion and deposition ratio of Pagladiya. The erosion and deposition was also interpreted from the FCC data as shown in the following fig (6)

Fig: 6 erosion/deposition in Pagladiya

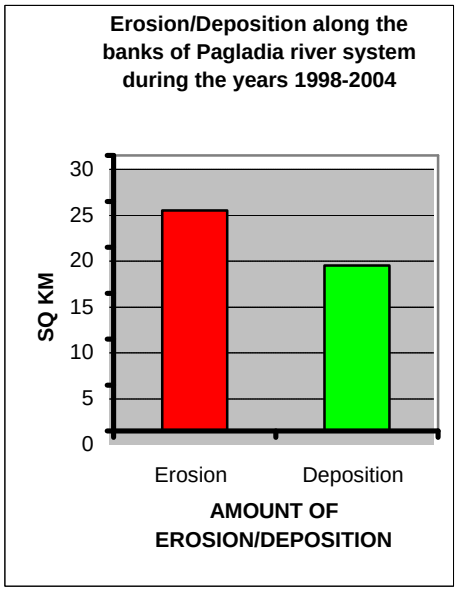
The amount of erosion and deposition is 24 sq km and 18 sq km. respectively as shown in the bar chart (7).
The bar chart of all the three tributaries is as under

JIA-BHARELI RIVER
EROSION/DEPOSITION BAR CHART (7)





PUTHIMARI RIVER
EROSION/DEPOSITION BAR CHART(7)



PAGLADIYA RIVER
EROSION/DEPOSITION BAR CHART(7)

CONCLUSIONS

The thematic maps like river courses in the past and present, prepared using multidate satellite data are highly useful in locating the areas under changes due to floods, and channel migration.

Jia-Bhareli river - It has shown distinct channel migration pattern. A prominent shifting of the channel from east to west is observed. The amount of erosion and deposition is 9 sq km and 7 sq km respectively.

Puthimari river – The river Puthimari shows a distinct bankline fluctuation. The erosion and deposition was found to be 12 sq km and 8 sq km respectively.

Pagladiya river – Pagladiya river is perennial, very shallow and is characteristically known for flash floods and high discharge rates. It shows a distinct channel shift towards east and south east. It is clearly observed that the left bank areas are usually inundated during floods. The erosion and deposition was found to be 24 sq km and 18 sq km respectively.

ACKNOWLEDGEMENT

We sincerely acknowledge Dr. R.R Navalgund, Director, SAC(ISRO), for showing his keen interest in carrying out this work. We acknowledge Shri. J.N Chaudhary the then General Manager of the Brahmaputra board, Guwahati and Dr. M.L Goyal Chairman, Brahmaputra Board for showing their keen interest. We acknowledge Dr. K.L Majumdar, Dy. Director, RESIPA, SAC(ISRO), Dr. Shailesh Nayak, the then G.D, MWRG, SAC(ISRO), Dr. T.J Majumdar, Head, ESHD, SAC(ISRO), and Dr. A.P Shah, Principal, M.G Science Institute, Ahmedabad for their immense help and support in carrying out this work.

REFERENCES

Balasundaram, M.S., Murthy, M.V.N., and Dhoundiyal, D.P., 1977. Contribution to Geomorphology and Geohydrology of the Brahmaputra valley. *Geological survey of India*, publ. 2, pp. 1-7.

Bradshaw, E.J., 1944. Manas floods. Basin, Denudation and Channel aggradation. Unpublished report, Vol. 21, No. 7, pp. 959-97.

Chakrabarti, C., 1977. Geomorphology, Geology and Fluvial process. Contributions to Geomorphology and Geohydrology of the Brahmaputra valley. *Geological Survey of India*, Misc Publ. No. 32, pp. 73-96.

Chakrabarti, D.K., et al. 1987. Geomorphological map of North-eastern part of India – A Landsat overview. *Geological Survey of India* , Rec. 115, pts 3 and 4, pp. 65-74.

Desai, J., Naik, S.D., Islam, I., Singh, G.P., and Shah, R.D., 2005. Study of the channel migration pattern of the Jia-Dhol river, a tributary of the Brahmaputra river, using remote sensing.

Goswami, D.C., 1985. the pattern of sediment yield from river basin of the brahmaputra system, North East India. *The Northern Geographer*, Vol. XVII, no. 1 and 2.

Hussain, I., Chaudhary, J.N., Ghani, M.U., and Naik, S.D., 1993. river bank erosion of Majuli Island as deciphered from the IRS imagery. Procd. Nat. Symp. Rem. Sen. Appl. For Resource Management with spl reference to NE region. ARSAC Guwahati. pp. 31-35.

Kalita, N., Saikia, P.J., Sikia, B., and Patra, S.C., 2005. Bank erosion of Jia-Bhareli and its influence on local environment – A case study of affected area near tezpur. Procd. National seminar Envn. Pp. 235-240.

Naik, S.D., Islam, I., Singh, G.P., Shah, R.D., Desai, Janki., and Desai, Ami., 2005. River Channel Changes of Brahmaputra river – A study based on multidate satellite data. PP. 1-62.

Poddar, B.C., Sanyal, S.P., and Paul, P.S., 1977. Geomorphology, geology and fluvial processes. Contribution to geomorphology and geohydrology of the Brahmaputra valley. *Geological Survey of India*, Publ. No.2.

Surendranath, M., and Sharma, G.C., 1991. quarternary geology and geomorphology of Brahmaputra valley in parts of Nagaon and Golaghat districts, Assam. *Geological Survey of India*, Rec. 124, pt. 4.