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A STUDY ON FOREST LOSS DUE TO RIVER MIGRATION IN SONAI-RUPAI WILDLIFE SANCTUARY OF ASSAM, INDIA USING GEOINFORMATICS

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ABSTRACT

Forests are the natural resources which have been degraded during the last few decades continuously either by natural or through man-made activities. The study is carried out in Sonai-Rupai Wildlife Sanctuary which is located in the foothills of the Eastern Himalayas in Sonitpur district of Assam, India. This study estimates the changes in the forest areas of the sanctuary due to river channel migration using remote sensing and GIS. The data used for the study were Survey of India toposheets for 1959-60 and 1961-62 and satellite images for 1988, 2001 and 2005. Base map of the study area was prepared by using toposheets. The contour lines from the topographical maps were digitized and TIN and DEM maps were prepared. Changes in river channels were detected during 1960-2005 through overlay analysis and their impact on forest cover was assessed. The total area covered by the river in 1960s was 11.67 sq km which increased to 16.12 sq km in 1988 but there was not much change in the river area in 2001 and 2005. It was found that river Belseri is the most meandering river and its channel has bifurcated and shifted toward west. River migration has also resulted in forest fragmentation which has further led to forest degradation and loss.

Key Words : Forest loss, River migration, GIS, DEM, Forest fragmentation

INTRODUCTION

A forest is a natural ecosystem having multi species and multi-age trees as dominant community. Forest cover about one third of the earth's land surface of which about 50 % is occupied by tropical forest. Forest constitutes the largest, complex and most important natural resource, mostly dominated by trees, the diversity and sizes of which vary in different parts of the world.[1] Forests are a major factor of environmental concern. The loss of forest cover and forest fragmentation can adversely affect the forest biodiversity. Rivers are a dynamic environment that changes its course both temporally and spatially. River channel migration, erosion, sedimentation and water table fluctuation constitute the natural disturbance regime.[2] Riverine networks are large scale networks of streams and rivers that occur in all forested regions. Riverbank erosion is a common geomor phological process of alluvial floodplain rivers which corresponds to bank adjustment, bank trampling, changes in bed elevation and topography in reaction to modified flow condition.[3] The complete knowledge and understanding of these mechanisms are very important for conservation implication. Running water has higher capacity of erosion than the other geomorphologic agents. In monsoon, floods and flows of river water erode the bank of the river and during the winter, the water level of the river goes down and sandbanks are deposited alongside the riverbanks.[4] River bank erosion effect the vegetation growth and causes degradation of fertile soil.[4] Remote Sensing (RS), Geographical Information Systems (GIS) and Global Positioning Systems (GPS) facilitate environmental change detection, analysis and monitoring. Remote sensing and Geographical Information Systems (GIS) are powerful tools to derive accurate and timely information on the spatial distribution

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of land use/land cover changes over large areas.[5-7] Change detection and estimation of erosion and deposition of riverbanks are facilitated by application of remote sensing, GIS and GPS.[4,8,9] GIS is a very efficient tool in the process of identification and mapping of river changes and bank erosion. Digital change detection helps in identifying change between two (or more) dates that is uncharacterized of normal variation. Change detection is useful in many applications such as landuse changes, habitat fragmentation, rate of deforestation and other cumulative changes through spatial and temporal analysis techniques such as GIS and Remote Sensing.[7,10,11] Forest and land cover change detection is one of the major applications of satellite-based remote sensing. The present study has been carried out to assess the forest loss by using remote sensing and GIS technologies in Sonai-Rupai wild life sanctuary. The sanctuary is under great threat of forest loss and degradation which is ultimately affecting its rich biodiversity. The rivers within the sanctuary are very meandering and show channel migration which results in erosion and deposition of river banks.

AIMS AND OBJECTIVES

To estimate the eroded and deposited riverbank areas from 1960 to 2005 and to identify the forest loss due to river migration through remote sensing and GIS technologies.

METHODOLOGY

Study area

Sonai-rupai wildlife sanctuary is located in Sonitpur district of Assam, India and covers an area of 220 square kilometres as notified in 1998. The sanctuary extends along the foothills of the Himalayan range and offers a splendid view of both the wildlife and the landscape. The altitude ranges from 100 - 300 m from mean sea level. The average rainfall ranges from 2,000 - 2,800 mm and temperature vary from 7 °C to 35 °C. It was declared as a Game Reserve in 1934, because of its rich biodiversity that included the Indian One-horned Rhinoceros (*Rhinoceros unicornis*), and reported populations of Wild Buffalo. The sanctuary was earlier part of Charduar Reserve Forest. In 1998 Sonai-Rupai was declared as a Wildlife Sanctuary. The terrain in Sonai-Rupai is flat and gently sloping towards the south. The sanctuary is very rich in natural vegetation and comprises of various species of plants and trees. The Indian bison and Elephant are the main attractions of the sanctuary. The flora of the sanctuary includes deciduous forest. The most prominent among the natural forest species are *Bombax ceiba. Dalbergia sisoo, Sterculia villosa, Trewia nudiflora, Zizypphus jujube* and *Litsaea polyantha*. The sanctuary is also rich in faunal species. Some of the important faunal species are Elephant, Wild Boar, hog deer, barking deer (mammals), white winged Wood duck, hornbill, pelican (birds), phython, Viper (reptiles) etc. Serepabeel is an important wetland of the sanctuary were different bird species can be seen. The present area of the Serepabeel is 31 hectares which was delineated with the help of GPS (Global Positioning system). The major rivers (tributaries of Brahmaputra) that traverse the sanctuary are Gabru, Gelgeli, Pachnoi, Chapnoi, Sonai Rupai and Belseri. These rivers are the perennial source of water available to wildlife. River Sonai-rupai, Gelgeli and Gabru Nala join to form River Gabru. The sanctuary is under the threat of encroachment which is affecting its biodiversity. Sanctuary forest area around River Pachnoi and Chapnoi have been encroached by peoples. The encroached areas are dominated by tribal peoples and agriculture is their major occupation. Presently the sanctuary is under the threat of deforestation which is causing biodiversity loss. Both the natural and anthropogenic process is affecting the biodiversity of the sanctuary.

Data used

The study is carried out with the help of Remote Sensing data, topographic sheet and the ground truthing data collected from the field survey. Data from Survey of India (SOI) topographic maps (83 B/5 and 83 B/9) scale of 1:50,000 survey on 1959-1960 and 1960-61 and LANDSAT data acquired on monsoon and post monsoon were used for landuse classification. Monsoon and post monsoon data were used to check the hydrological variability. The spatial resolution of Landsat imagery is sufficient to identify and monitor

the dynamics of river systems such as migration of rivers, movement of river channels and eroded and deposited riverbanks. The Landsat images used in this study have been downloaded from GLCF, ESDI and Landsat.org. Landsat TM (30 January 1988 & 24 December 2001) and ETM+ (30 Jan 2005) images of path 136 and row 41 were used in this study. Landsat TM and ETM+ have 30 m spatial resolution. These images are projected and corrected geometrically by GLCF using the UTM projection method. These images are ortho rectified. For this reason, geometrical corrections of landsat images are not needed.[12,13] Layer stacking of the landsat images have been done in Erdas 9.1 software. For convenient we are writing year 1960 as in place of 1959-1960 & 1961-1962 (surveyed date of toposheets).

The base map of the study area was prepared by using survey of India toposheets. The toposheets were geometrically corrected in the Arc GIS 10 software. For georeferencing, Kalianpur 1975 geographic coordinate system was used as survey of India toposheets have been prepared by using Kalianpur 1880 Datum. The geographic transformation of Kalianpur 1880 datum is not available in the software so we are using Kalianpur 1975 which is very close to it. Then the toposheets were transformed to WGS84 Geographic Coordinate system which were than projected in Universal Transverse Mercator projection WGS 1984 UTM Zone 46 N. The preparation of base map of the study area is the first step in the analysis of land use and land cover. Various features like roads, track, location or any other land based features were transferred to the base map. For this Personal Geodatabase were created in Arc GIS 10 in which different feature classes were created. The base map of the study area has been shown in **Fig.1**. Base map is prepared in 1:75,000 scales. Digital Elevation Model (DEM as TIN) was produced from the standard topographic maps with the scale of 1:50.000. DEM was created in ArcGIS10 by using contour line. Contours are polylines that connect points of equal value of elevation. The contour lines were digitised from Survey of India toposheets with an interval of 20 m. The DEM for the study area has been shown in **Fig. 2**. Contour map is a useful surface representation because they enable to simultaneously visualize flat and steep areas, ridges, valleys in the study area.The land-use/vegetation map of 1988, 2001 and 2005 was derived from the visual interpretation of satellite data. Landuse/Landcover categories such as Forest cover; river, oxbow lake, grassland, etc. have been identified and mapped from the SOI topographic sheets. The landuse of 1960 (1959-1960 & 1960-1961) was mapped, classified and calculated accurately from the toposheets and it was compared with those prepared from the satellite imageries. For landuse class also Personal Geodatabase was created. Landuse/Landcover is prepared in 1:75,000 scales. Eroded and deposited landcover formed by the river channel migration was finally estimated in Arc GIS 10. Boundary of river areas in 1960, 1988, 2001 and 2005 are digitized through visual interpretation. The digitized layers were analysed and compared pair wise to identify eroded and deposited areas. Overlay analysis between the year 1960s-1988, 1988-2001 and 2001-2005 has been carried out to find out the eroded and deposited area and eroded and depositional layer was created. In overlay analysis union was used to find out the eroded and deposited layers and landuse/ landcover map of eroded and deposited area was prepared by clipping from the 1960s, 1988, 2001 and 2005 landuse/ landcover map with the eroded and deposited union layer.

RESULTS AND DISCUSSION

The land use pattern of an area depicts an idea of overall areal utilisation of resources - natural or cultural. Changes in land use/land cover were evaluated from the differences between 1960s, 1988, 2001 and 2005 status. The most striking change in landuse/l andcover has been the sharp increase in degraded area or bare land. It shows that there is a tremendous decrease in forest cover since 1988 to 2005. River channel migration within the sanctuary was investigated and the changes in channel characteristics during the period 1960s to 2005 have been shown in **Fig.1**. It has been observed from the analysis of Digital Elevation Model (as Triangular Irregular Network, TIN) shown in **Fig.2** that

the channel migration is closely related to slope of the area. As river flows from North to South and also steepness decreases towards the south, it clearly indicates that channel shifting and migration is dependent on steepness of an area. Because of steepness of the area water flows with much higher velocity and increases the chance of erosion. Channel migration is affecting the landcover in the sanctuary. Total area covered by the rivers in 1960 was 11.67 sq km which increased to 16.12 sq km in 1988. During 2001 and 2005 river area was 19.25 and 19.07 sq km respectively.

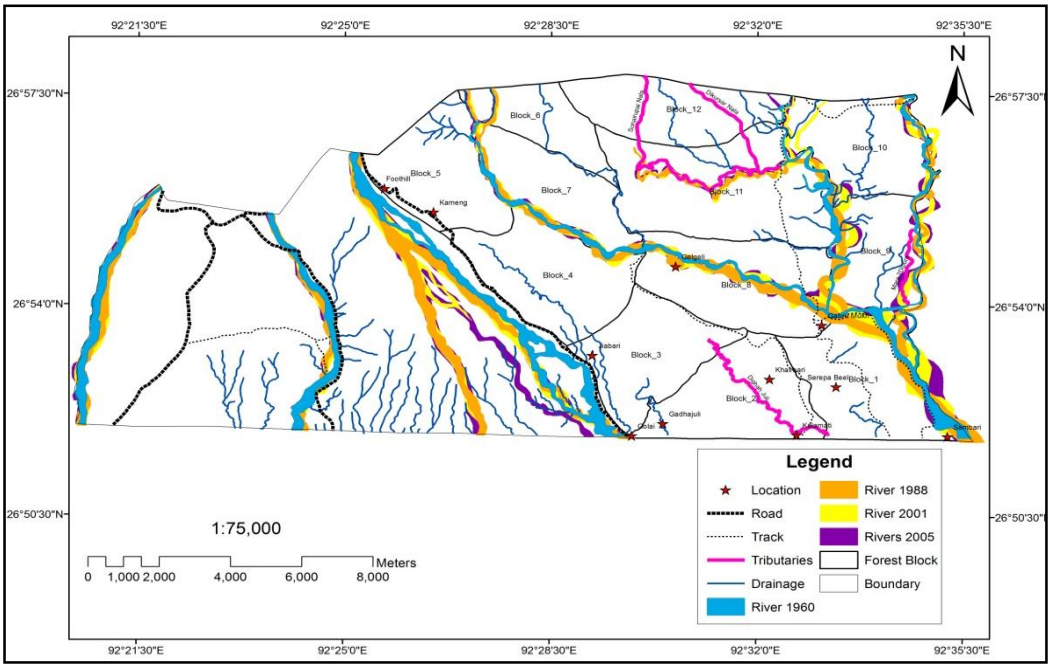

Fig. 1 : Base map of the study area with River migration

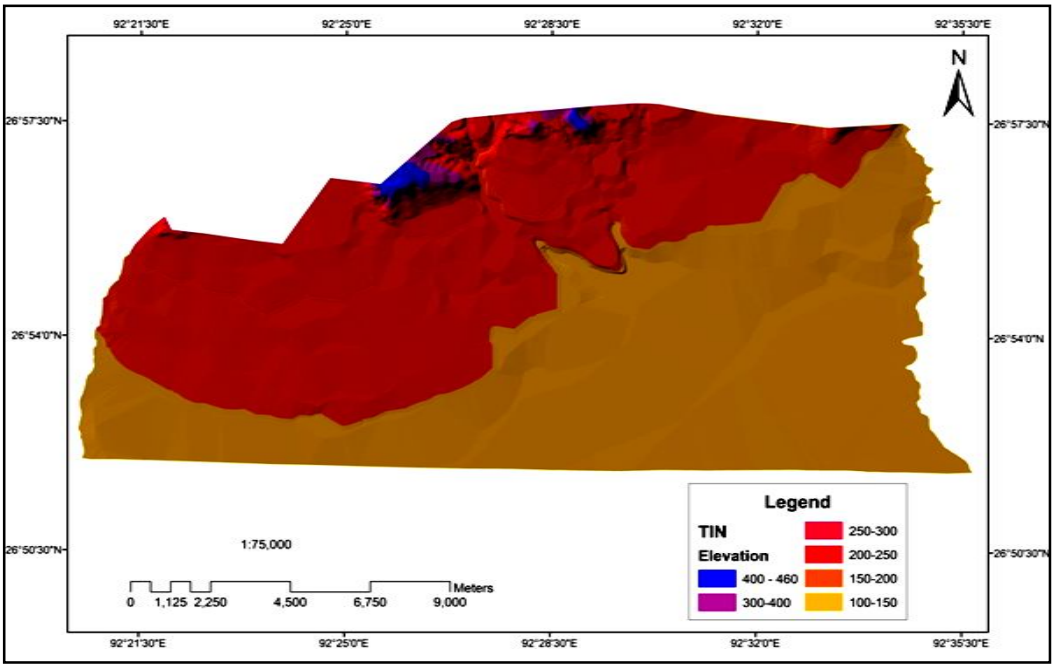

Fig. 2 : DEM (as TIN)

River channels are changing due to erosion and deposition of the river banks. From 1960-1988 estimated erosion was 9.81 sq km and deposition was 5.27 sq km. During this period, rate of erosion was much higher than the rate of deposition. It was also estimated that forest loss due to erosion was 7.61 sq km and deposition of forest cover was found to be 3.3 sq km. There was a net loss of 4.29 sq km of forest cover due to river channel migration during the period 1960 to 1988. From 1988-2001 estimated erosion was 6.16 sq km and deposition was 3.52 sq km. In this period also rate of erosion was higher than the rate of deposition. Forest loss due to erosion was 4.68 sq km and deposition of forest cover 0.91 sq km. There was a net loss of 3.77 sq km of forest cover due to river channel migration. During this period, there was more erosion than deposition which indicates that the rivers are getting wider. From 2001-2005 estimated erosion was 4.3 sq km and deposition was 4.9 sq km. During this period rate of deposition was higher than the rate of erosion and it was found that forest loss due to erosion was 1.01 sq km and deposition of forest cover was 1.09 sq km. **Fig. 3** shows the areal extent of rivers within the sanctuary from 1960 to 2005. Graphical representation of eroded and deposited land cover is shown in **Fig. 4** to **Fig. 6**. The areal statistic is calculated in Km^2.

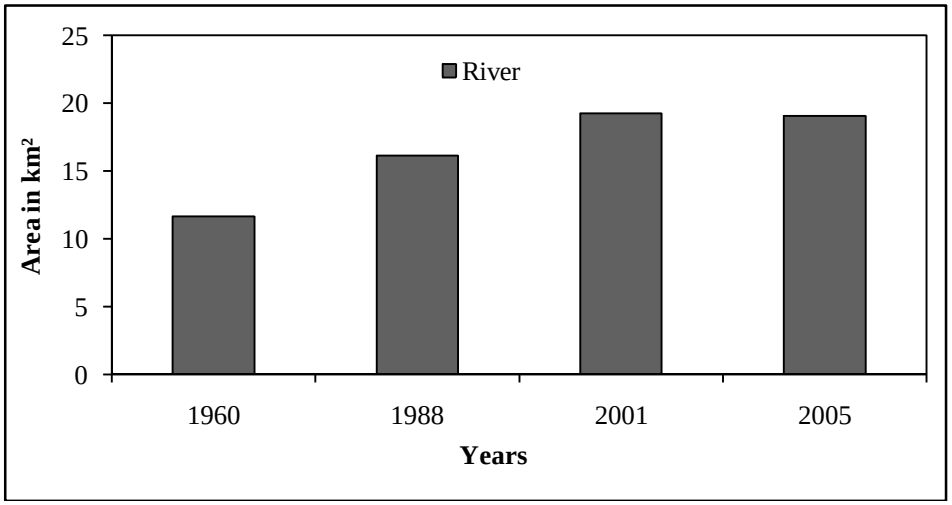

Fig. 3 : Area extent of river within the sanctuary

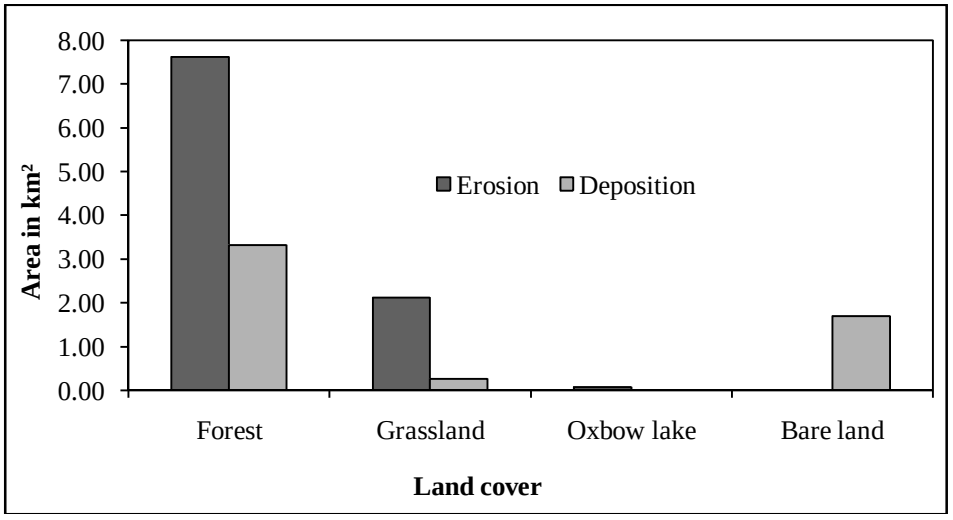

Fig. 4 : Eroded and deposited landcover during 1960-1988

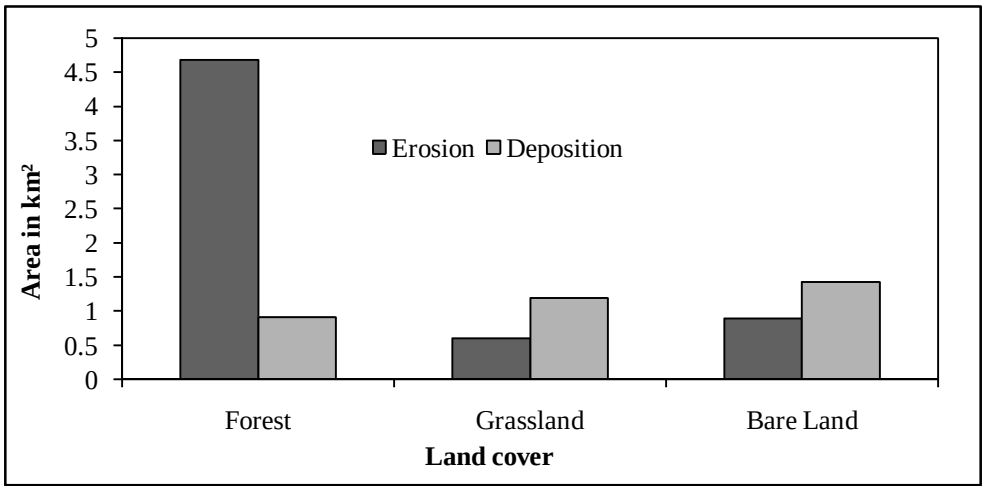

Fig. 5 : Eroded and deposited landcover during 1988-2001

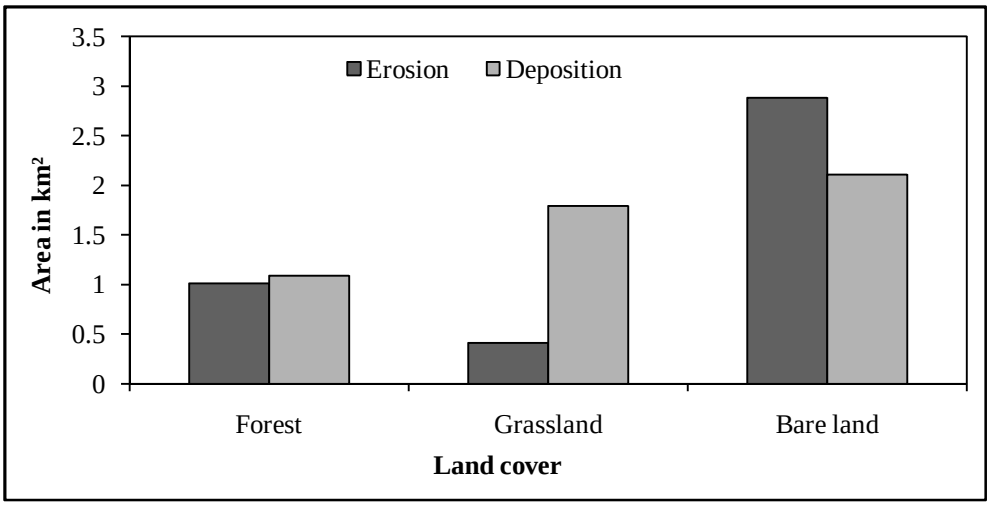

Fig. 6 : Eroded and deposited landcover during 2001-2005

The eroded and deposited landcover map for the year 1960-1988, 1988-2001 and 2001-2005 is shown in **Fig.7** to **Fig. 9**. Net change in landuse/landcover due to river migration is shown in **Table 1**. River channels are shifted by erosion and deposition following their direction.

Table 1 : Change in landuse due to river channel migration during 1960s-2005

Class	1960-1988 (Km^2)	1988-2001 (Km^2)	2001-2005 (Km^2)
Forest	-4.29	-3.77	0.08
Grassland	-1.86	0.59	1.38
Oxbow lake	-0.08	_	_
Bare Land	_	0.54	-0.77

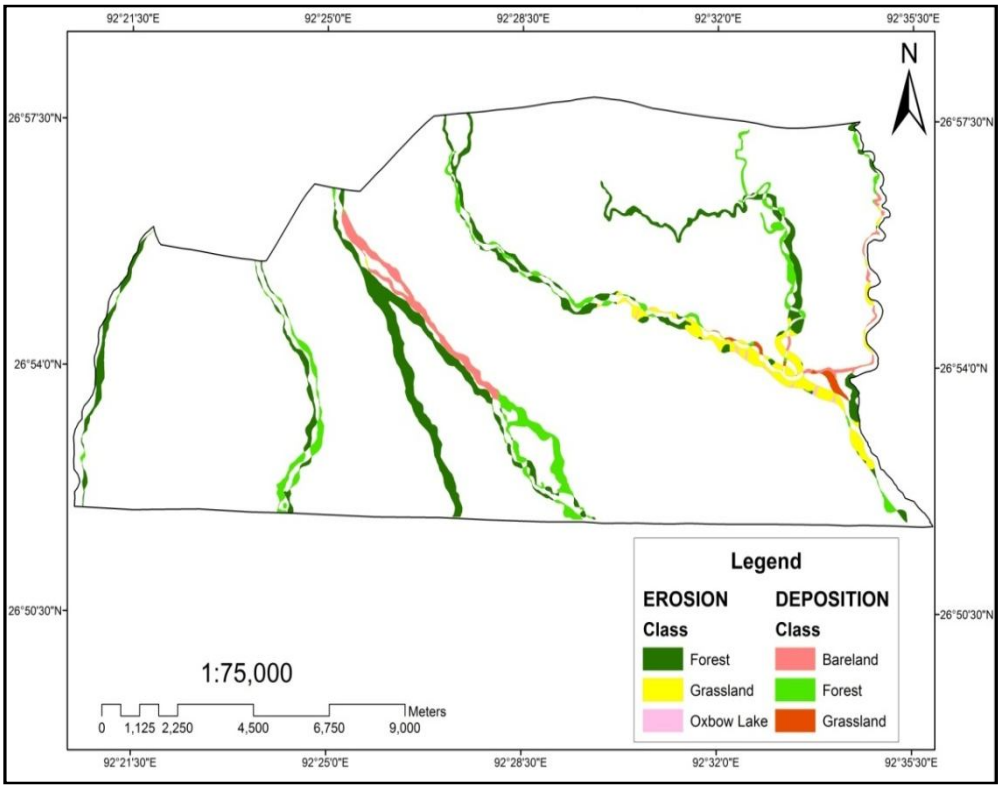

Fig. 7 : Erosion –deposition map for 1960-1988

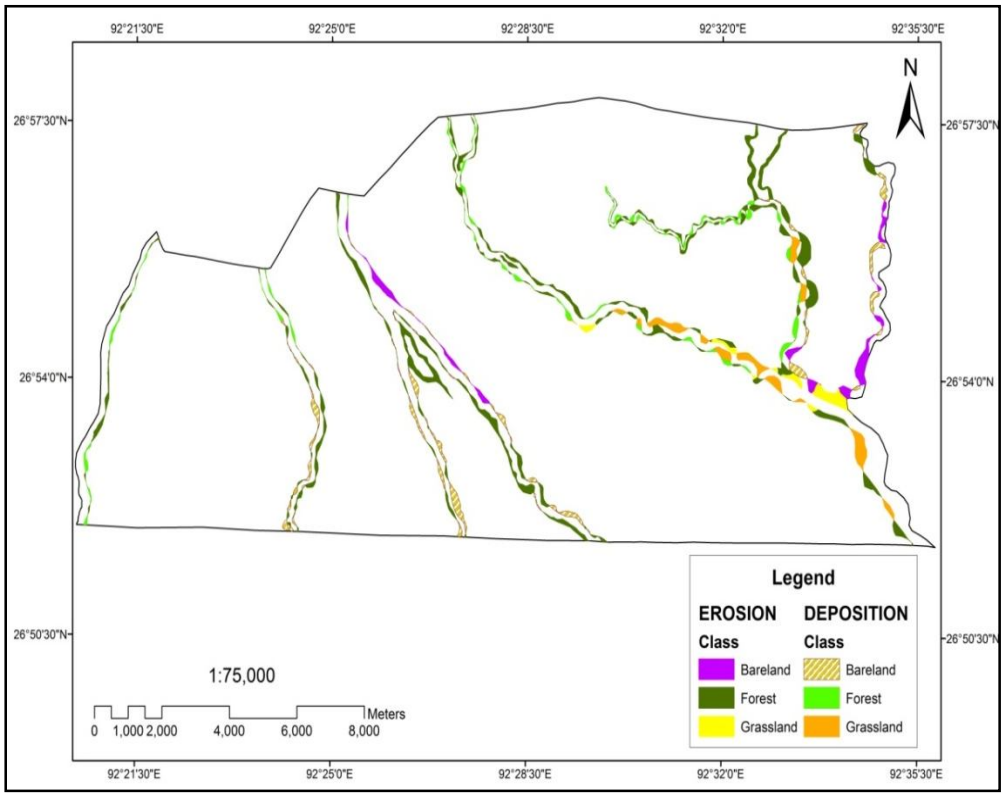

Fig. 8 : Erosion-deposition map for 1988-2001

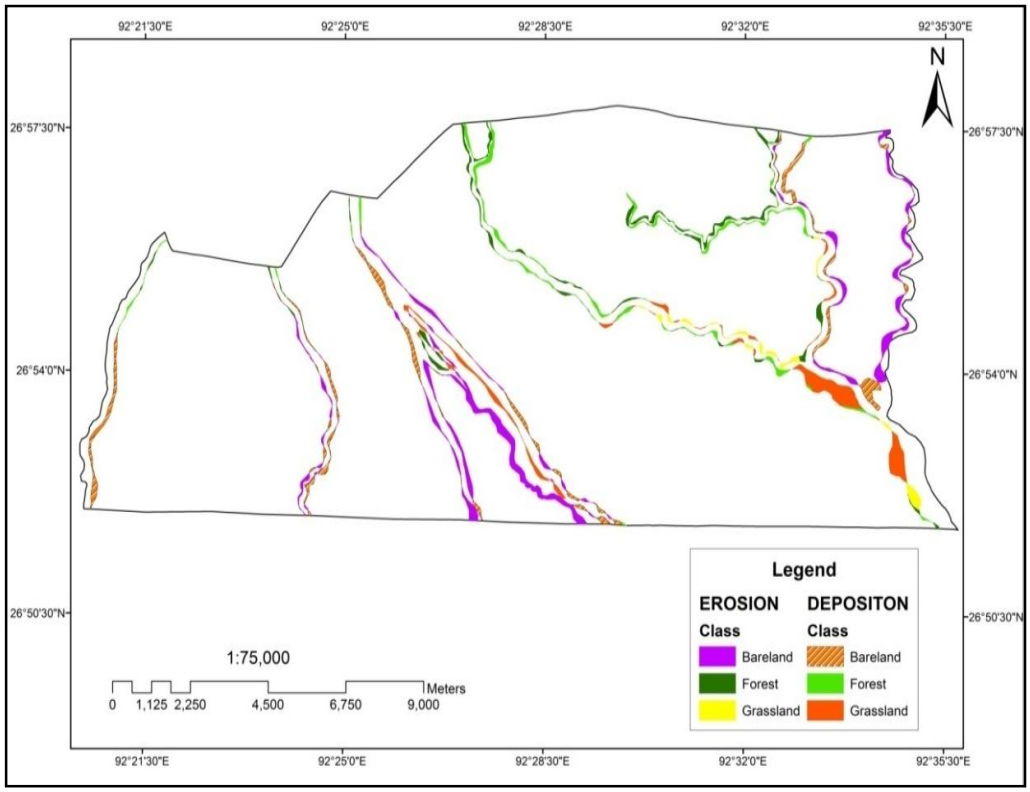

Fig. 9 : Erosion-deposition map for 2001-2005

The general trend of channel movement of the River Belseri is towards the west. Anthropogenic factors are also responsible for bifurcation of river Belseri. Local villagers have made embankment in the bank of river to protect their agriculture field from flood which results floods, erosion and sedimentation on the other side of the river bank. In 1988, it was found that 10.01 sq km of forest land was fragmented by river Belseri and in 2001 this 10.01 sq km of forest land has been converted to deforested land. This has resulted in habitat loss which has affected the biodiversity of the sanctuary. In 2005 also, it has been seen that new channels are opening up and the river Belseri is shifting towards its west. It has also been found that erosion due to river Belseri is higher in lower part of the sanctuary which is a flat terrain. It also shows that river Chapnoi and Pachnoi are very stable rivers as compared to Belseri and Gabru. The study also shows that Belseri is the most meandering river which opens up new channel which is causing forest fragmentation and which ultimately lead forest degradation. There is no recognizable trend observed for the river Chapnoi and Pachnoi. river Gabru is also meandering river which doesn't show any trend of channel shifting but it erodes both the side of the bank.

CONCLUSION

Forests are the natural resources which have been degraded during the last few decades continuously either by natural or through man-made activities. The present study was carried out in Sonai-rupai Wildlife Sanctuary located in the foothills of the Eastern Himalayas in Sonitpur district of Assam, India. The study has been done to understand the changes and estimate the forest loss caused by river migration in the forest areas of the sanctuary using remote sensing and GIS. It has been found that remote sensing and GIS techniques are important tools for detecting the changes, location of the changes and quantifying the changes taking places in the sanctuary. The rivers in the sanctuary are characterized by frequent bank erosion leading to channel pattern changes and shifting of bank line. Forest areas in the bank of river have been

reduced considerably during the period of 1960 to 2005. It was found that river Belseri flowing across the sanctuary is the most meandering river which opens up new channel leading to bifurcation and which is shifting towards west. It was also observed that erosion rate is higher in lower part of the sanctuary which is generally a flat terrain. This resulted river migration has subsequently cause fragmentation, which has cause degradation and loss of forest. Channel migration is responsible for changing physical characteristic of river and its surrounded environment. The conservation and management of biodiversity along a river depends on the maintenance of essential ecological processes, such as periodic floods, water flows and specific rates of sediment transport. So, proper management practices should be adopted for conservation of forest and biodiversity in the sanctuary.

REFERENCES

1. Todkari G. U. and Patil B. D., Geographical study of a natural forest in Solapur district of Maharashtra, India, *J. Environ. Res. Develop.*, **5**(1), 233-239, **(2010)**.
2. Midha N., Land use, forest fragmentation and river dynamics in dudhwa landscape and their conservation implication, Thesis Ph. D., *Saurashtra University*, **(2005)**.
3. Nath B., Naznin N. S. and Paul A., Trends analysis of river bank erosion at Chandpur, Bangladesh: A remote sensing and GIS approach, *Int. J. Geomat. Geosci.*, **3**(3), 454-463, **(2013)**
4. Aher S. P., Bairagi I. S., Deshmukh P. P. and Gaikwad R. D., River change detection and bank erosion identification using topographical and Remote Sensing Data, *Inter. J. App. Infor. Sys*, **2**(3), 1-7, **(2012)**
5. Manjula K. R., Jyorhi S., Varma A. K. and Kumar S. V., Construction of spatial dataset from remote sensing using GIS for deforestation study, *Int. J. Com. Appl.*, **31**(10), 26-32, **(2011)**
6. Phukan P., Thakuriah G. and Saikia R., Land use land cover change detection using remote sensing and GIS techniques : A case study of Golaghat district of Assam, *India, Int. Res. J. Ear. Sci*, **1**(1), 11-15, **(2013)**
7. Selçuk R., Analyzing land use/land cover changes using remote sensing and GIS in Rize, North-East Turkey, Aksaray University, Faculty of Engineering, Department of Geodesy and Photogrammetry, *Sens.*, **8**(1),6188-6202, ***(*2008)**
8. Sarma J. N., Borah D. and Goswami U., Change of river channel and bank erosion of the Burhi Dihing river (Assam), assessed using Remote sensing data and GIS, *J. Ind. Rem. Sens.*, **35**(1), 93-100, **(2007)**.
9. Joshi V. U. and Nagare V., Land use change detection along the Pravara river basin in Maharashtra, using remote sensing and GIS techniques, *AGD Lands. Environ.*, **3** (2), 71-86, **(2009)**.
10. Wijitkosum S., Evaluation of impacts of spatial land use changes on soil loss using remote sensing and GIS in Huay Sai Royal Development Center, Thailand, *J. Environ. Res. Develop.*, **6**(3), 487-493, **(2012)**.
11. Mundia C. N. and Murayama Y., Analysis of land use/cover change and animal population dynamics in a Wildlife sanctuary in East Afri., *Remot Sens.*, **1**(2), 952-970, **(2009)**.
12. Sarkar A., Garg R. D. and Sarma N., RS-GIS Based assessment of river dynamics of Brahmaputra river in India, *J. Water Res. Prot.*, **4**(1), 63-72, **(2012)**.
13. Salehipour Milani Alireza and Jafar Beglu Mansour, Satellite based assessment of the area and changes in the Mangrove ecosystem of the QESHM island, Iran, *J. Environ. Res. Develop.*, **7**(2A), 1052-1060, **(2012)**.