Impact of River Bank Erosion on Land Cover in Lower Subansiri River Flood Plain

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Abstract- River banks though being the most fertile region for cultivation, it has become a concern for loss of livelihood as well as settlement during the flood. The inundation of land is reflected with massive river bank erosion thereby causing land loss. The river lower Subansiri exhibit a loads of sediment getting deposited and flooding the flood area leading to massive river bank erosion. The paper explores the impact of land loss due to river flood and substantiate with mapping different study period.

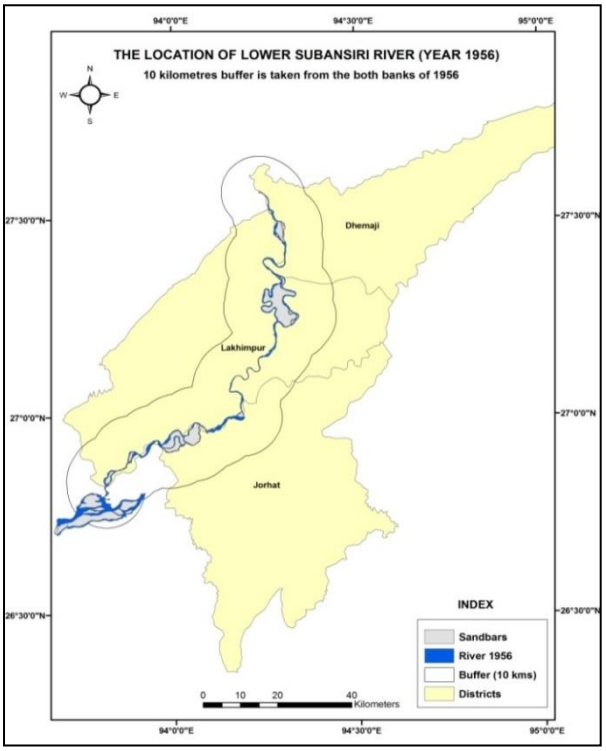
Index Terms- Bank erosion, impact on forest cover, livelihood, inundation, flood plain.

I. INTRODUCTION

River course exhibits dynamic equilibrium adjusting in time and space. The fluctuation in discharge and sediment load results into lateral mobility reflecting flood plains subjected to seasonal and periodical modification. This phenomenon makes the river bank erosion the most common natural calamities in flood plains. Such modifications have direct bearing on human activities along with adjacent land cover. The quantification of land loss due to erosional process of the river is important mostly from the perspective of the people living in the flood plain.

Considering the year 1956 the river lower Subansiri flowed by touching northern boundary of Jorhat distinct, Lakhimpur district and north eastern boundary of Dhemaji district. Massive bank erosion has resulted in unprecedented flooding and changing river course. Moreover the area is not only dominated by Lower Subansiri River.

The river Ranganadi and river Brahmaputra also has their own impact upon the region. Therefore from the perspective of quantifying the land loss caused by lower Subansiri river analysis is carried in the particular area by creating buffer of 10 kilometers from the both banks. The year 1956 is selected as the base year. The total area covered by this buffer zone is about 3021.64 square kilometers. The hydrological characteristics of the river and the geology of the surface indicate that it is an active zone of river bank erosion. The lower Subansiri is an alluvial flood plain and due to this the existing land cover along the river banks is mostly dominated by agriculture because of the highly fertile soil. Thus the present study aims to assess the amount of land loss due to lateral erosion of the river.



II. DATA AND METHODOLOGY

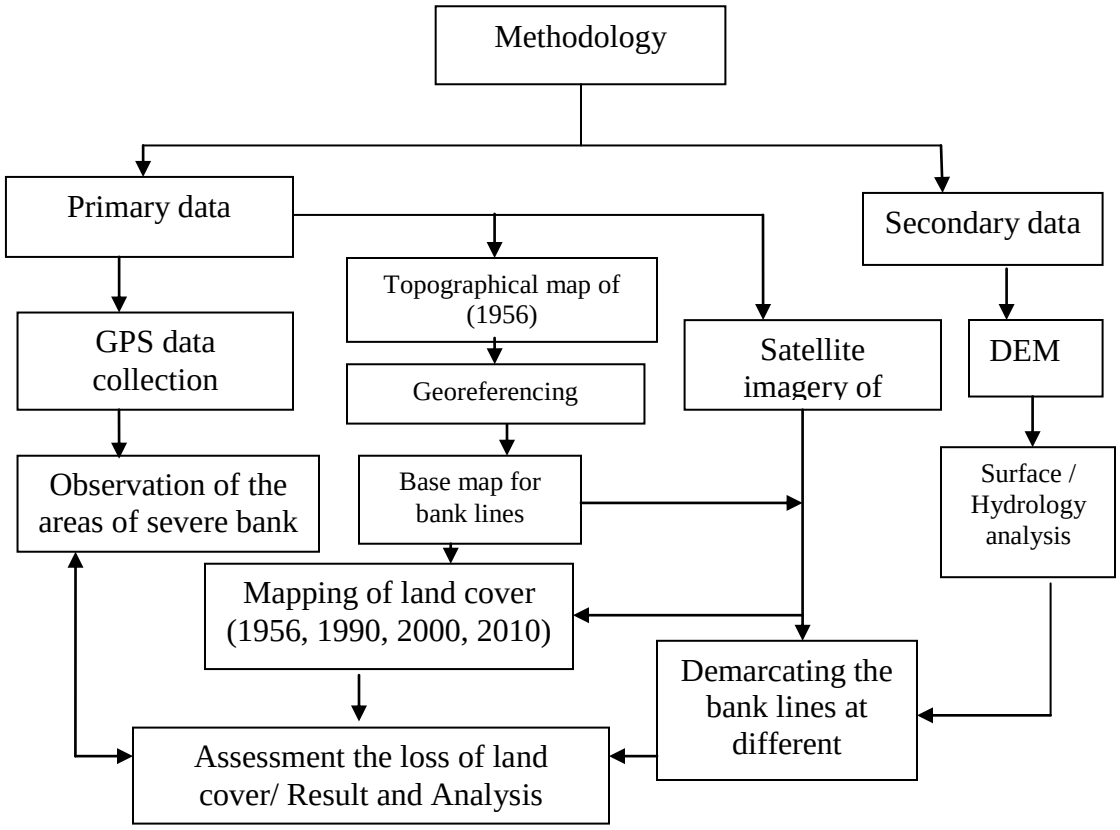
The estimation of river bank erosion and bank line shifting falls into two main categories: on-site measurements and use of remote sensing and GIS technique. This study will be based on application of remote sensing and GIS technique. The data of the study are collected both primary and secondary sources. The primary data are as,

1. Topographical map of the study area at 1:250,000 scale for the year of 1955-56 (NG 46-7 & NG 46-3, source U.S Army) using for base map preparation.
2. There are three satellite imageries of Landsat-7 ETM+ images with 30 meters spatial resolution, for the years of 1990, 2000 and 2010, (source USGS) using for extracting bank lines for three different times and preparation of land use land cove maps.
3. The ground truth verification and collecting GPS points at certain areas of the bank erosions and collecting information from digital photography.

The secondary data are

1. Aster DEM with 30 meters spatial resolution, Source Aster Global digital elevation model,
2. The geological map of Assam, scale 1:200,000 (year 1998), source Geological Survey of India
3. Soil map of North East India, Scale 1: 200,000 (year 1971) source department of science and technology Government of India.

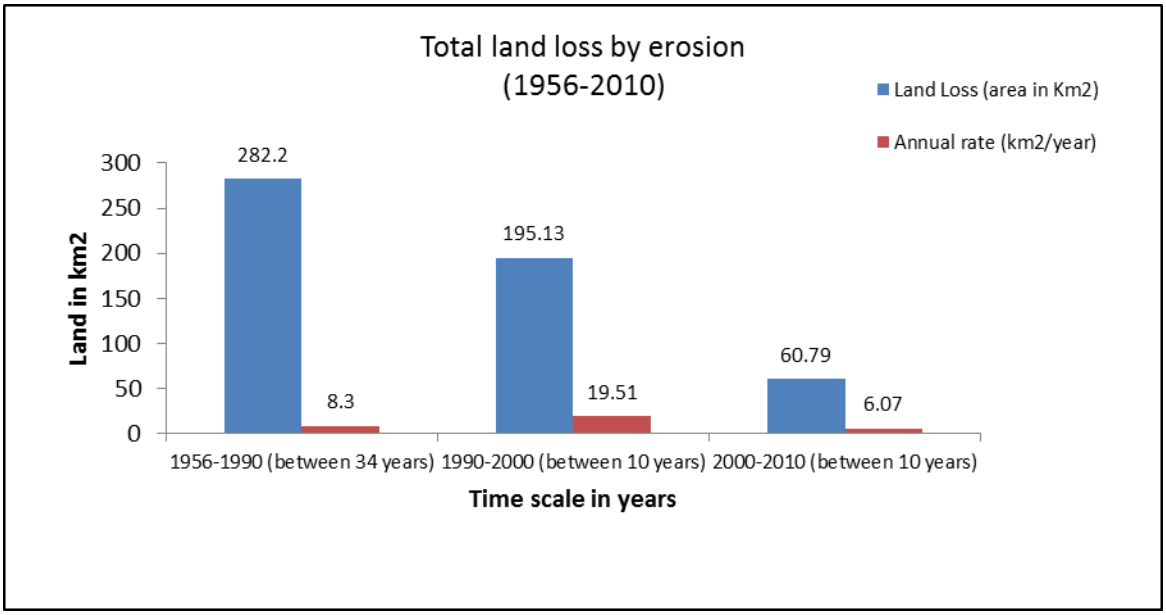
Methodology: The datasets will be processed and analyzed at GIS environment. The processing of satellite images will be done at ERDAS Imagine 9.1 software and mapping and analysis will be done using Arc GIS 9.3 software. The methodology is explained in different steps.



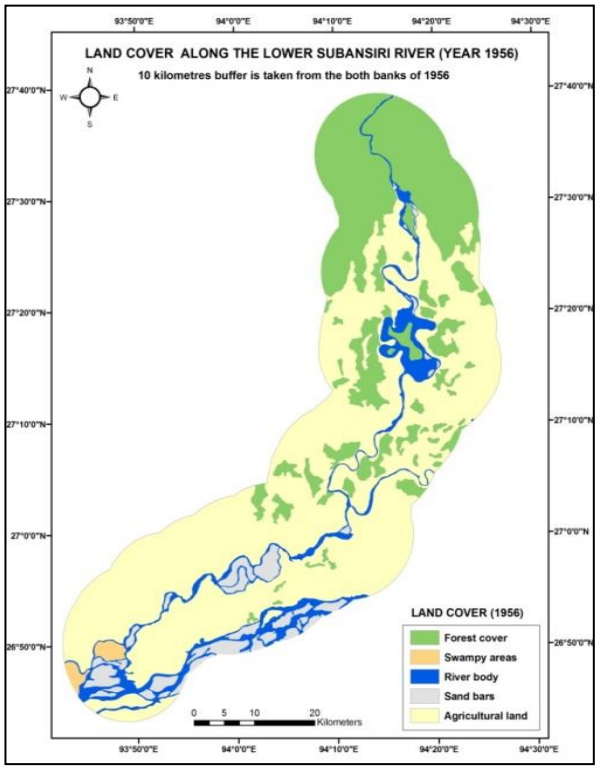
III. RESULTS AND DISCUSSION

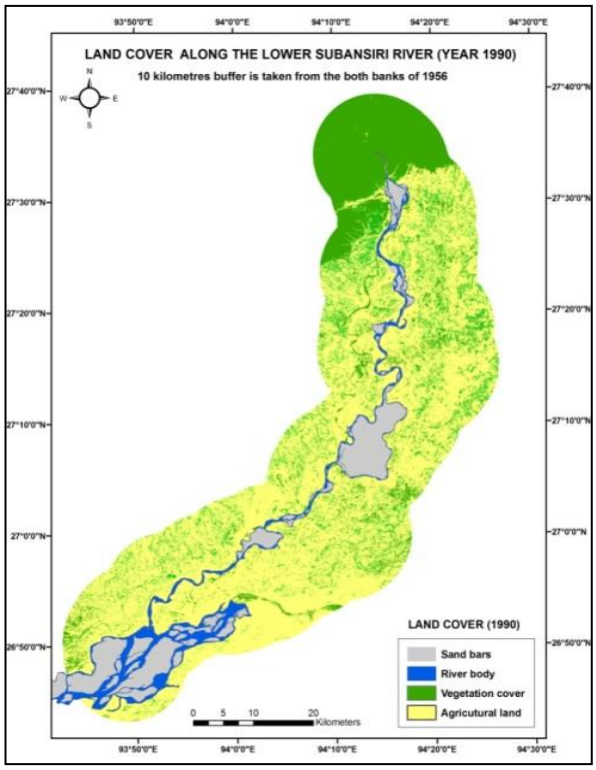
The flood plain of river lower Subansiri is the worst affected region. The flood plain is mainly use for agricultural purpose. Thus small amount of land loss accounts for a significant loss of livelihood for the marginal farmers. A progressive migration of the backlines of the river toward the *Doab* and continuous channel widening has resulted in obvious land loss in the region. Quantifying the land loss due to erosion process of the river it is found that between the years 1956 to 1990 the total land loss due to lateral erosion of the river is about 282.20 square kilometers considering both the banks. Between the years of 1990 to 2000 the total land loss was about 195.13 square kilometers and during the last decadal year of 2000 to 2010 a total 60.79 square kilometers of land were lost due to the process of river taking both the banks into consideration. On the other hand analyzing the land cover change of the study region there are some important changes in forest and agricultural areas.

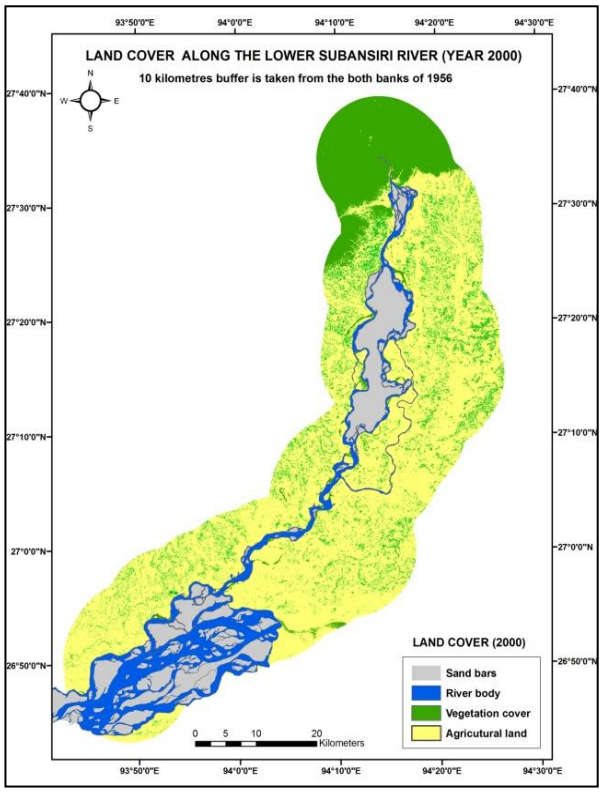
The land cover of the area is divided into two categories as; agricultural land and the forest cover. The study shows that between the year 1956 to2010 due to high mobility of the river banks, increasing amount of erosion has influenced the amount of agricultural land. There is a change in the land use which is related to the land loss of the area. According to the past record in 1976 there are some patches of permanent forest cover along the banks of the river Lower Subansiri (NIC, Dhemaji District, and Govt. of Assam) which reduced to about135.52 square kilometers along the river banks that were caused by both natural and anthropogenic factors.

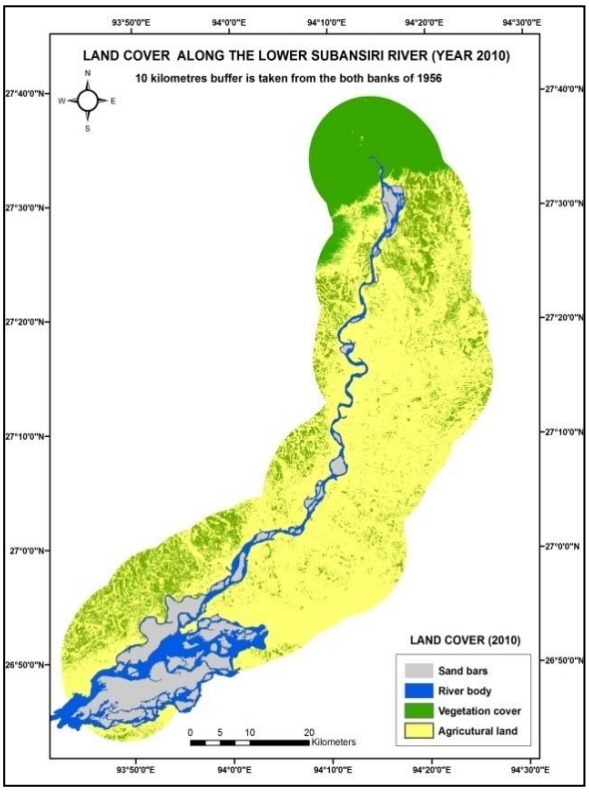


Between the years 1956 to 1990 (within54years), the total land loss by the erosion was 282.20square kilometers. The annual rate was 8.3square kilometers. It has been found out that during the year 1956 there are about 611.62 square kilometers of forest cover in this area among which 236.93square kilometers found along the both banks of the river. During this particular period of time about 67.12 square kilometers of forest cover that are along the river banks were directly hit by the river. 215.08 square kilometers of land was agricultural land with bushes of bamboo. 24.09square kilometers of swampy area (towards the mouth of the river) were also capture by river. Between the years 1990 to 2000 was the most effective period for this particular region. The total land loss during this period was about 195.13 square kilometers. The annual rate was 19.51 square kilometers. A patch of 12.47 square kilometers forest cover between the segment (G) and (H) was captured by the river. Another patch of forest covers of 9.93 square kilometers at the segment (I) also eroded by the river. In this particular period total 57.64 square kilometers of forest cover has lost due to erosion. 137.49 square kilometers of agricultural land with bushes of bamboo and other common trees also have lost.





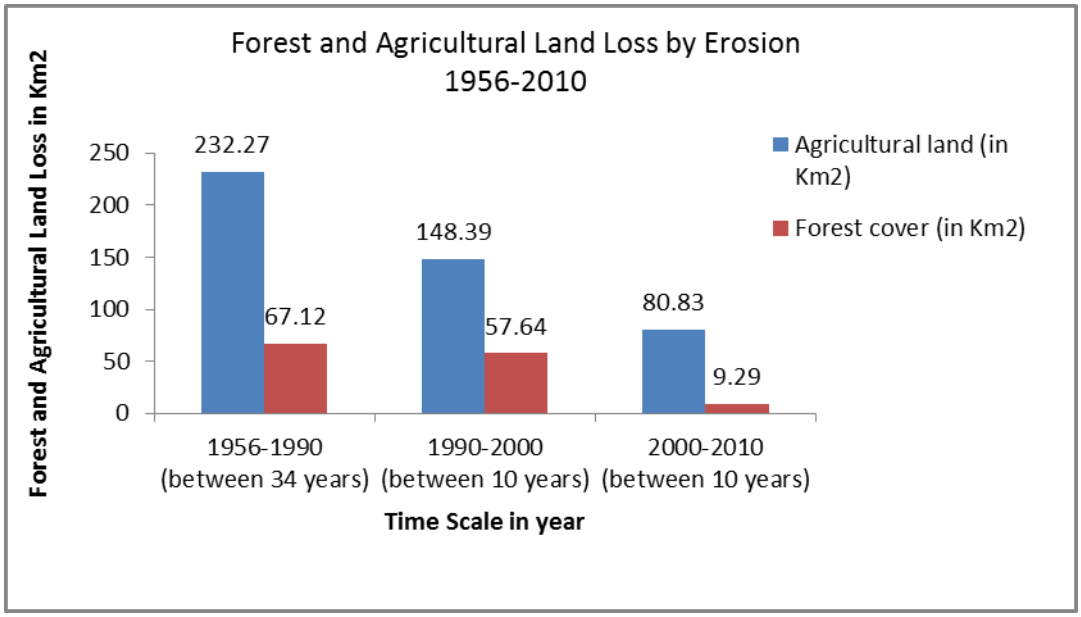




Source: Topographical map, Year1955-56(NG46-7&NG46-3(U.S Army) and Landsat-7ETM+, Years 1990, 2000 and2010, (USGS)

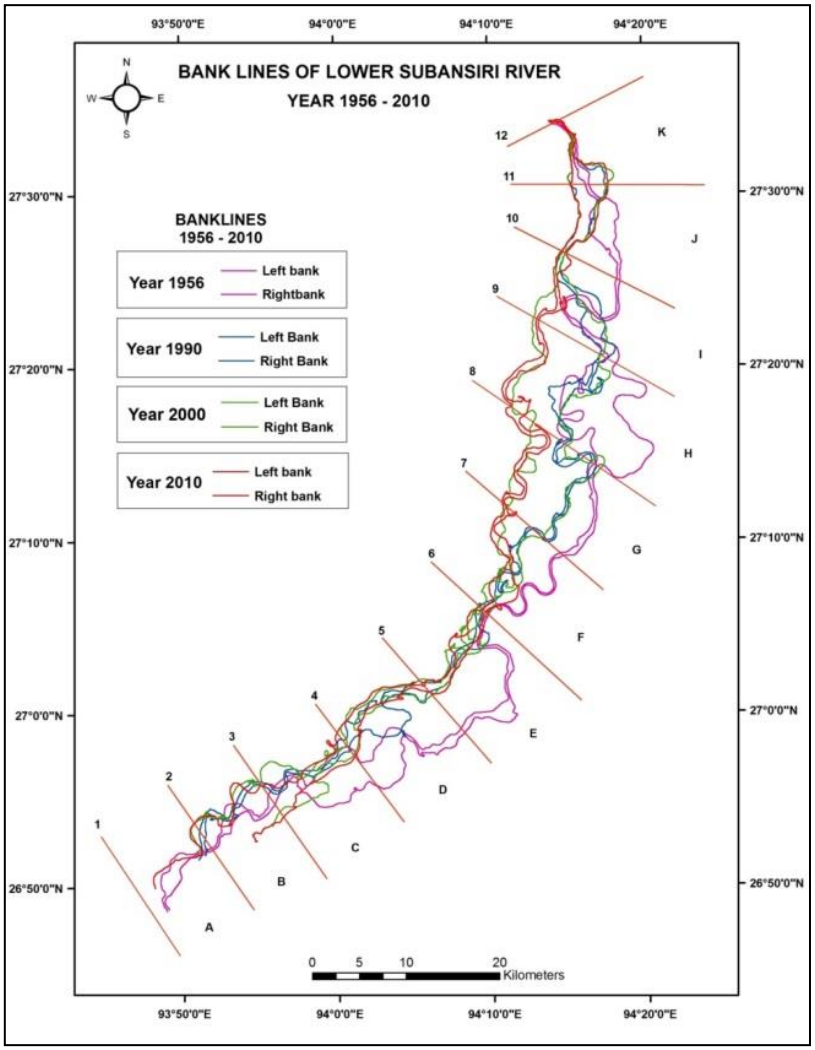
During the 2000 to 2010 the total land loss was 60.79 square kilometers. The annual rate was 6.07 square kilometers. Among the total land loss about 9.29 square kilometers were forest cover and another 54.72 square kilometers were agricultural land with bushes of bamboo and other common tress. The present study shows that within the entire period from the year 1956 to 2010 the magnitude of erosive activates of the river Lower Subansiri was highest in the period between the years 1990 to 2000 considering the annual rate

of land loss. After the year 2000 the forest cover within this year became very much minimum. To re-examine the forest cover that has left after the year 2000, the forest cover boundaries of the year 2003 for the state of Assam (FSI) was superimposed. It is found that there are no well-defined patches of forest cover existing in governmental records. According to the FSI forest boundary there are only brushes of bamboo and other planted trees can be found that are associated with the agricultural land and settlement.



River erosion is always associated with deposition, where materials brought down from upstream by river are deposited in downstream. Deposition occurs when a river loses energy when it enters a shallow area or when it lost the pressure gradient due to flat terrain. The amount of silt gets deposited resulting into shallowing of river bed. Due to this action, the amount of water flowing in the river overflows thereby causing flooding and bank erosion. The impact of flooding and bank erosion are observed with widening of river, loss of agricultural land, crop failure etc. River Subansiri experience flood every year where the changing course of the river is influential. The flood plain of lower Subansiri river is inhabited by agricultural based rural communities. Due to deposition of silt and sandy deposits the cultivated land lost the quality and quantity of the agricultural crops.

On the other hand because of sand casting the agricultural land usually loss its fertility. The process of regain the original fertility takes longer time. Thus the inhabitants are mostly seasonal as well as marginal farmers. The diversity and productivity of crops mostly at the downstream is found to be considerable low. As the soil is more or less sandy the ground water level goes down during winter season. Therefore cultivation without any provision of irrigation is unable to give the expected result.



IV. CONCLUSION

The effect of bank erosion is felt mostly on land while overbank inundation destroy standing crops, besides disrupting human habitat. As the flood region is extensively used for cultivation the bank erosion or bank line shift results in loss of agricultural land. The affect is also seen with families in the village where their farmland and homestead are destroyed and have taken shelter on the embankment. There are areas in other places along the right bank of the river where bank erosion has left the occupants land less and homeless. Similarly, overbank sand deposition in the flood of 1972, 1988, 1998 and 2004 have done extensive damage to a sizable area. The effect of overbank flooding is mostly felt on crops. Winter paddy is the principal crop grown in the region. The cultivating season of this crop coincides with the flood season. The damage of flood in the study region shows an increasing trend, especially the area affected. This may be due to improvement in reporting or more and more areas have been brought under cultivation. The floods of 1987 and 1988 have surpassed all the estimation regarding flood. During the flood people have suffered either they are not economically viable or ecologically conflicting.

The most important factor that controls the behavior of the river is its geological and topological settings. The surface material of the region made up of new alluvium combine with rocks and silt. It is earthquake prone and the river has tendency to meander and create flood problem due channel congestion. The bed topography of the river is also not same at every cross section. Due to variation in slope aspect of the bed of the river the change in the river with also vary in every cross section. It can be seen the impact of these two physical factors mostly at cross section no 6, 10 and 12, where geology and slope aspect of the bed highly influence the water velocity. The present works also signifies considerable changes that had taken place in terms of agricultural land and forest cover. In 1956 the total agricultural land was 1373.08 square kilometers, in the year 1990 it is rising up to 1713 square kilometers. In the year 2000 agricultural land become 1664 square kilometers where as in the year 2010 the agricultural area decreased to 1392 square kilometers.

The vital behavior of river Lower Subansiri is mostly controlled by the physical settings of the river rather that anthropogenic cause. The analysis off all sizeable factors revels that the geology and slope aspect of the region has immense impact on the river's

hydro dynamics. The possible human induced causes are not as active as the natural. On the contrary bank erosion has notable upon the existing land cover.

Bank erosion often leads to breaches in the embankments and triggers inundation in the region. In fact the most devastating flood of this region is triggered by erosion and breaches. Embankments, constructed to confine the water of a river within channel, are commonly used measured of flood protection in Assam. In the Subansiri *doab* embankments were constructed during 1950s along the banks of the river. However, these artificial walls cannot confine the water within the channel beyond a certain limit. It is often breached due to erosion or overtopping. The consequent sudden inundations not only destroy standing crops but also contribute to the land degradation process. The river carry huge amount of sediments at the monsoon season.

Bank line of River Subansiri in the study area during the decades of 1990s and 2000 has led to frequent breaches in the embankments. During 1996 flood, when the Brahmaputra was breached at Kareng Caporiarea, the lower reach of the Subansiri causing as many as 24 numbers of breaches. The erosion control measures taken by the water resources department of Assam is not enough to protect the banks against heavy flood and erosion in most of the segments. No permanent measures have been taken against the erosion by the Water resource department of Assam. It is very much transparent that if the erosion of the river cannot be prevented huge damages to properties including cultivated land and imminent. Repairing of breaches at different parts of the embankments of Subansiri River near Tikirai, Temera, Nunibari, Bordeurigaon, Padi, Sonai, Borbil, Jamuguri, Mazghat, Arimora, Tetelibheti are remained incomplete. Regarding Lower Subansiri Hydroelectric Power ProjecttheNHPC (Indian Hydro Power Generation company) is committed to take up erosion control measures on both banks of the Subansiri river for a stretch of 30 km in accordance with recommendations of two panels set up for the Subansiri Lower Hydro Electric Project. NHPC in a release said that a survey of 30 km area downstream of the dam has been carried out jointly by the PSU (Public sector unit) and Assam Water Resource Department and stretches have been identified on both the banks of the river requiring erosion control measures.

REFERENCES

[1] Aher. S. P, Bairagi. S. I, Deshmukh. P.P, Gail wad. R. D (2012), "River Change Detection and Bank Erosion Identification Using Topographical and Remote Sensing Data." International Journal of Applied Information System, Vol:2, No:3.

[2] Dutta.M.K, Barman.S, Aggarwal.S.P (2010), "A Study of Erosion-Deposition Processes Around Majuli Island, Assam." Journal Earth-Science India: Vol:3 (iv) pp-206-216.

[3] Deb . M, Das. D, Uddin. M (2012), "Evaluation of Meandering Characteristics Using RS and GIS of Manu River: Journal Water Resource and Protection: Vol:4, pp-163-177.

[4] Gogoi.C ,Goswami. D. C (2013) "A Study On River Bank Erosion and Bank Line Migration Pattern of Subansiri River in Assam using Remote Sensing and GIS Technology." International journal of Engineering and Science: (IJES), Vol: 2 No: 9, pp-01-06.

[5] Islam M. Z, Qkubo. K, Muramoto. Y (1994) "Embankment Failure and Sedimentation over Flood Plain in Bangladesh: Field Investigation and Model Experiments" Journal of Natural Disaster Science, Vol: 16, No: 1 pp-27-53.

[6] Keya. M. K, Harun.S.M.R, (2007) "Bank Erosion Induced Stress and Coping of Displaced Women in Bangladesh." Empowerment,Vol: 14, pp-17-30.

[7] Kotoky. P. Dutta. M. K , Borah G. C (2012) "Changes in Land use and Land cover along the Dhansiri River Channel, Assam – A Remote Sensing and GIS Approach"Journal Geological Society Of INDIA: Vol.79, January 2012, pp.61-68

[8] Lawler.D. M, (1992), "The Measurement of River Bank Erosion and Lateral Channel Change: A Review."Earth Surface Process and Land Forms,Vol: 18, pp-777-821.

[9] Lanicke. S (2002), "Stream Channel And Flood Plain Erosion." Water and Rivers Commission, Western Australia and Natural Heritage Trust, Australia, Report No:RR18

[10] Nath .B, Sultana.N, Alka.P, (2013), "Trends Analysis of Bank Erosion at Chadpur, Bangladesh: A Remote Sensing and GIS Approach." International Journal of Geometrics and Geosciences, Vol:3 No:3.

[11] 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, Vol: 4 ,pp-67-72.

[12] Shrestha.P, Tamrakar N.K, (2007), "Bank Erosion Process and Bank Material Loss Potential in Manahara River, Kathmandu, Napel." Bulletin of the Department of Geology, Tribuhuvan University, Kathmandu, Napel, Vol:10 pp-33-44.

[13] Sarma.J.N, Borah.D, Goswami. U (2007), "Change of River Channel and Bank Erosion of the BurhiDihing River, (Assam): Assessed using Remote Sensing and GIS."Journal of the Indian Society of Remote Sensing: Vol: 35 No: 1

[14] Thorne.C.R, (1991), "Bank Erosion and Meander Migration of the Red and Mississippi Rivers."Hydrology for the Water Management of Large River Basins,IAHS Publ. No: 201.

[15] Thorne.C.R, (1981),"Field Measurements of Rates of Bank Erosion, and Bank Material Strength". Erosion and Sediment Transport Measurement, IAHS Publ. No:133

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