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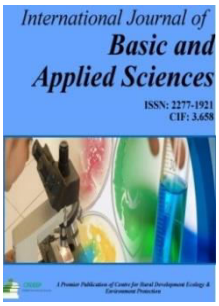

Full Length Research Paper

A GIS Based Study of River Bank Erosion and its impact in Land use and Land cover of Dibru-Saikhowa National Park during 2010-2020.

Dr. Chandra Kumar Dutta [1] , Ankita Mahanta [2] , Daisy Roy [2] , Sikhamoni Devi [2] , Jintu Das [2] , Ijaz Ahmed [2] , Porag Jyoti Borah [2] , Kalyan Nath [2] & ; Ananya Chutia [2]

1-Assistant Professor, Centre for Studies in Geography, Dibrugarh University, Assam, India.
2-M.A/M.Sc Students, Centre for Studies in Geography, Dibrugarh University, Assam, India.

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Corresponding Author:
Chandra K. Dutta

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ABSTRACT

The river island are prone to channel dynamic influencing the physical extension too, as the river is active in its banks throughout the year, mainly affected due to variation in flow perimeters of the river during seasons. The islands in Brahmaputra River are prone to bank erosion, mass deposition due to siltation and deposition elevating the river bed. Dibru-Saikhowa National Park (DSNP) is located in Dibrugarh and Tinsukia districts, Assam, India is a river island in Brahmaputra river. The Park is bounded by river Siang and Dibang in the North and Lohit, and Dibru River in the south. The natural degradation of the national park is triggered to study with help of secondary sources of data, respectively through geographical Information System (GIS) collected from open source platforms like, the Landsat OLI-8 (30 m) data (for 2020) and Landsat 4-5 TM (30 m) data (for 2010) has been downloaded from USGS (earth explorer) and layer stacking with 6 bands with the help of ERDAS software. With delineation of natural region of DSNP of the temporal years, the spatial techniques were curved out from the satellite imageries and change detection was performed. The land use and land cover analysis were carried out for the identification of change in the study area during the period. The study attempt to understand the literal change in the national park due to river dynamic, and focused for the sustainable development of the Dibru-Saikhowa National Park. It is evident from the present study that the Dibru-Saikhowa National Park has faced severe bank erosion. The total area of the park was 271.73 sq. km in 2010 which reduced to 241.12 sq. km in 2020. In conclusion short and long term strategies were suggested for the sustainability of DSNP.

Introduction

The river banks are prone to erosion in seasonal variation in river discharge (Lotsari, 2019). In the flood plains due to low slope gradient the river system attains the stage of equilibrium as well as on some extent to a braided channel bed creating lateral changes in the shoreline (Nelson, 2015). The islands in Brahmaputra River are prone to bank erosion, mass deposition due to siltation and deposition elevating the river bed (Kotoky, Bezbaruah, Baruah and Sarma, 2005). The upper course of the Brahmaputra River are characterized as braided channels with exceedingly large flow, enormous volume of sediment load, continuous change in channel morphology, rapid bed aggradations, bank line erosion and recession (Goswami,1985).

Background of study

Dibru-Saikhowa National Park is located in Dibrugarh and Tinsukia districts, Assam, India. It was designated a biosphere reserve in July 1997 with an area of 765sq km. It is located at about 12 km north of Tinsukia town at an average elevation of 228m ranging from 110 to 126m (meters above mean sea level). Dibru-Saikhowa National Park become an isolated patch of land forming as a river island in 1998, which is 2nd largest river island in India after Majuli river island (Kuldeep P, 2021). The Park is bounded by river Siang and Dibang in the North and Lohit, and Dibru River in the south. The national park areas prone to environmental consequences and thus need to be observed in details in

geographical prospective. The paper triggered to find the changes occurs in the DSNP in temporal range from 2010 to 2020 by compiling natural boundaries and land use land cover of the region during said temporal period.

Statement of problem

The change in river bank-line causing erosion is taking place during receding stage of floods when excess sediments are deposited as sand bars within the channel resulting into the change of the direction and migration of sandbars thereupon and also due to the flowage failure of the silt materials of the banks**.** The high flowage and perennial nature of bordering rivers stimulate frequent waves of flood and intensive erosion leading to the gradual shrinkage of the Dibru-Saikhowa National Park**.** (Neog, 2016)

Significance of this paper

Keeping in mind the present critical erosion problem of the Dibru-Saikhowa National Park, we took up this study to throw light on the topic. The study is an area of interest for the geomorphologies, environmentalist and wild life conservations as the national park is prone to erosion and for sustainability such studies has higher relevance in present day context. The land use land cover of the national park is prone to denudation due to intense pressure of river bank erosion and siltation in the island in peak flow. The denudation processes active in the region is responsible for the shrinking of the DSNP its sustainability for environmental conservation is a treat (Mili, 2013). The conservation of the DSNP is possible on knowing the problems and its causal analysis, so the paper trigger to highlight the phenomenon of bank line erosion and its affect on ;land use and land cover over the time span on 10 years viz. 2010 to 2020.

Objectives

- To compare the changes of bank erosion in Dibru-Saikhowa National Park in the years 2010 and 2020.
- To evaluate the environmental impact over land use and land cover of Dibru-Saikhowa National Park.

Materials and methods

Database

An analytical method has been adopted for the fulfillment of the present study. The research is mainly based on secondary data and geographical information system (GIS) and remote sensing (RS) technologies. The secondary data has been collected through article, journals, Newspapers, historical and recent satellite data, meteorological data portal etc. We have been used following database for our study purpose-

Table-1: Collected data types, sources and purposes and uses

Type of Data	Survey Year/ Acquisition Data	Scale/Resolution	Sources	Purposes
Landsat 8 OLI and Landsat 4 5 TM	2010, 2020	30 meters	USGS	Bank line delineation/LULC/ References
Rainfall and Temperature	2010 and 2020	monthly	CHRS data portal and World Weather online	Hydro climatic analysis
DEM	2014	30 meters	USGS	Bank line identification/ Slope gradient

Methodology

To explain the methodology adopted, a flow chart has been shown in figure (1) which provides an overview of steps followed to complete this research. These steps are-

(i) Delineation and digitization of Dibru-Saikhowa National Park

The area of DSNP has been identified and delineated for the satellite images of 2010 and 2020.From the Google earth image, we have digitized the physical boundary of DSNP and convert it from KMZ to shape file with the help of QGIS 3.12. After that, the two different vector layers have been overlay in QGIS software to find out the change area between 2010 and 2020.The total area of DSNP and erosion and deposition areas in two different years also have been calculated through overlay analysis using QGIS software.

(ii) Preparation of Study area Map

For this study, the Landsat OLI-8 (30 m) data (for 2020) and Landsat 4-5 TM (30 m) data (for 2010) has been downloaded from USGS (earth explorer) and layer stacking with 6 bands with the help of ERDAS software. After that, the DSNP area has been digitized from Google Earth images and the coordinate transformation has been done in Dibru-Saikhowa National Park area from Geographic Latitude and Longitude to UTM projection using ERDAS IMAGINE 9.1. Also make it a shape file in Q GIS. Using ERDAS software, the shape file of DSNP (2020) added on Landsat satellite image (2020) and subset the study area. Final layout has been done using ArcGIS software.

(iii) Preparation of Land Use and Land Cover (LULC) Map
For the preparation of LULC map, the Landsat-8 OLI and Landsat 4-5 TM data for 2020 and 2010 year respectively has been downloaded from USGS website. Using ERDAS software layer stack with 6 bands and make it an FCC image. After that, the shape file of DSNP (2020 and 2010) has been added on Satellite image and subset the study area and prepares the LULC map for the both (2020 and 2010) years. In ERDAS software, using attribute table the area has been calculated for different classes of the study area. Final layout map has been prepared using Arc GIS 10.3 Software.

(iv) Preparation of monthly rainfall and temperature variability graph of Tinsukia and Dibrugarh district
For the hydro climatic analysis, monthly average rainfall and temperature data of two districts viz. Tinsukia and Dibrugarh is used because, the study area (Dibru-Saikhowa National Park) covered a part of both of the districts. Therefore, the monthly average rainfall data and temperature data for 2010 and 2020 years, has been collected through CHRS data portal and World Weather Online website.

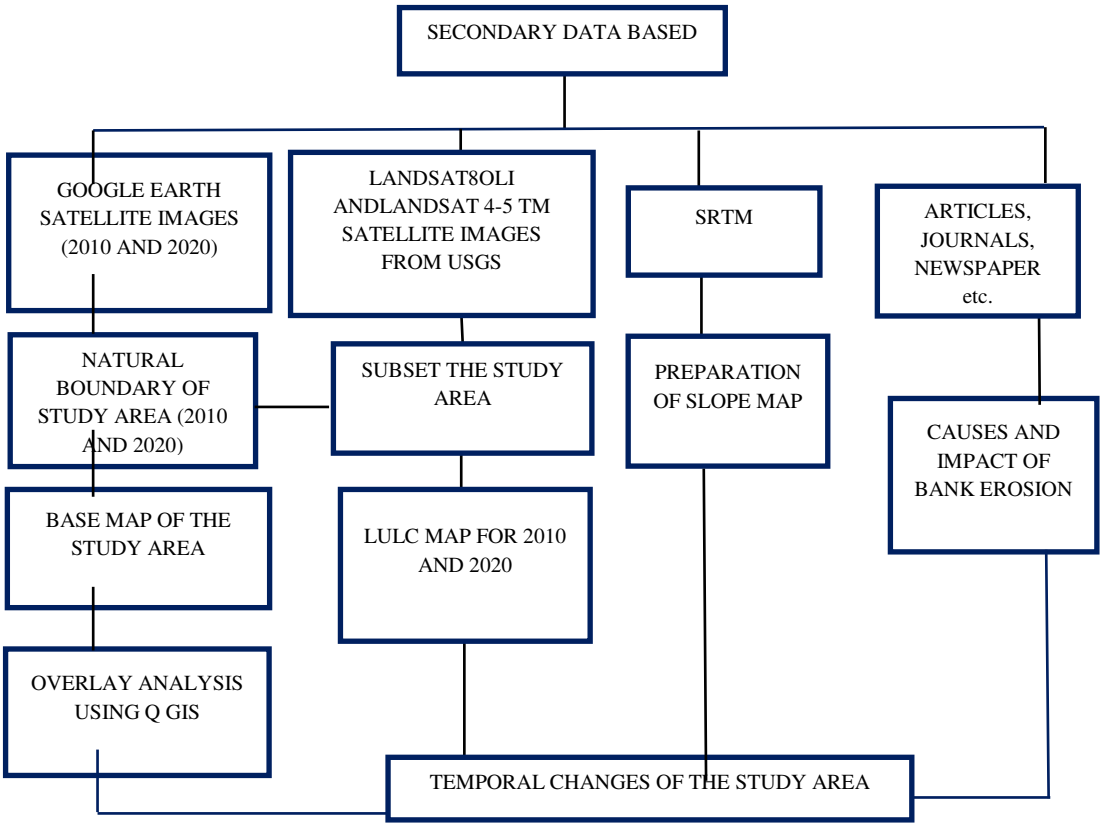

Fig-1: Flowchart of the Study

(v) Preparation of monthly rainfall and temperature variability graph of Tinsukia and Dibrugarh district
For the hydro climatic analysis, monthly average rainfall and temperature data of two districts viz. Tinsukia and Dibrugarh is used because, the study area (Dibru-Saikhowa National Park) covered a part of both of the districts. Therefore, the monthly average rainfall data and temperature data for 2010 and 2020 years, has been collected through CHRS data portal and World Weather Online website.

(vi) Preparation of Slope Map using Digital Elevation Model (DEM)
To create a slope map, we have visited in USGS Earth Explorer and downloaded SRTM, DEM of the year 2014 (only available) with approximately 30 meters resolution. After that, using Arc GIS software we extract the study area with the help of Shapefile, created earlier and prepared the slope map of DSNP.

Study Area
The Dibru-Saikhowa National Park is situated in the upper part of the Brahmaputra valley, which covers part of two districts - Tinsukia and Dibrugarh, Assam. The National Park is bounded by Siang River in North East and Lohit, and Dibru river in the South. (Neog, 2017) It lies between 27°30′N to 27°48′North latitude and 95°08′E to 95°35′East longitude at an average altitude of about 118m above sea level. The Park was designated a Biosphere reserve in July 1997 with an area of 765sq. km., including core area of 340sq. km. and a buffer zone of 425sq. km.

Sampling Methods
The physical boundary of the Dibru-Saikhowa National Park was taken into consideration for the natural delineation of the national park region. The natural boundary of the park constantly changes due to river dynamics, associated with

huge amount of sediment lose and deposits too, either bank of the park. Affecting the environmental concern along with land use and land cover of the park. Random sampling method is considered for sampling land use and land cover under a supervised classification on geospatial software Arc- GIS 10.1 and an open source tool QGIS-3.22.6 respectively.

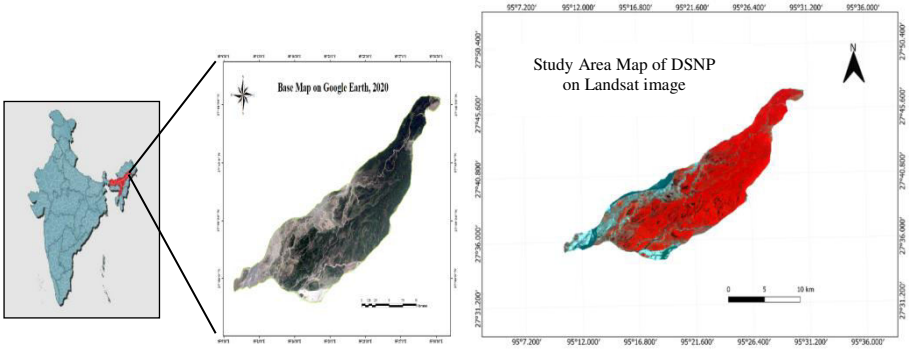

Fig-2: Location Map of the Study Area

Results and discussion

The Brahmaputra is an extremely dynamic and predominantly braided river in the world (Gilfellon, Sarma & Gohain, 2003). The river is unique due to its peculiar drainage pattern, diverse geological setting, high sediment load and critical bank erosion problem (Desai, Naik and Shah, 2014). Degradation of river islands due to erosion is a common factor due to instability in the Brahmaputra due to the very large amount of discharge with tremendous sediment intrusion from bank erosion (Saikia, Mahanta, Mukharjee and Borah, 2019). This sedimentation in river course causes further instability downstream triggers more bank erosion, and apart from the loss of land and flood hazards, it hampers navigation (ADB, 2009). The process results to rise the elevation of the river bed to sallower depth, influencing the over flow in peak discharge to adjacent lowland and flood plain of the national park. Both erosion and deposition of the river has link to land use and land cover (LULC) since the land cover is under constant change in a dynamic landscape constantly shaped by continuous erosion and deposition (Saikia, L, et al, 2019). The Dibru-Saikhowa National Park has been witnessing the problem of bank erosion since ages. The total geographical area of Dibru-Saikhowa National Park was about 337.96 sq. km. in the year 1967, which degraded to 302.45 sq. km. in 1988, and further 279.38 sq. km. in 2001 and finally to 241.82 sq km in the year 2016 (Neog, 2018). The continuous severe erosion is threat to the national park, as the net result is loss of 30.61 sq km of land within 10 years. By observing the Land Use& Land Cover Map and Google Earth Satellite Imagery, we have seen that the total area of the park has been degraded and reduced to 241.12 sq. km. in 2020. We have also observed changes in the area of some major geographical features of the Dibru-Saikhowa National Park.

Rainfall and Temperature

During the monsoonal season the area receives high amount of rain. The average annual rainfall of the study area is 3034 mm, about 90% of the rainfall takes place during monsoon period June to September, only 5.5% of annual rainfall happens during winter and about4.5 % of rainfall occurs during the summer months (Pareta, K., 2021). The Mean Monthly Rainfall of Tinsukia and Dibrugarh for 2010 and 2020, where we see that the amount of rainfall is high during the month of June, July, August and September, which are 52.5mm, 199 mm, 187mm and 234mm (2010) and 90.5mm, 106mm, 133mm and 176.5mm (2020) respectively So, we can say that within a short duration, high amount of rainfall with high intensity occurs, which encourages bank erosion in DSNP (Figure-3). In summer season high temperature leads to melting of ice. Figure-4 shows that Mean Monthly Temperature of Tinsukia and Dibrugarh for 2010 and 2020, where we found that from the month of April to June temperature was increasing, which are 28.5°C, 28.5°C, 30.5°C (2010) and 27°C, 26°C, 28°C (2020) respectively. It indicates that continuous increases in temperature can help to melt glacier. Due to the high amount of rainfall and temperature, the amount of runoff increases which result in severe bank erosion in the study area.

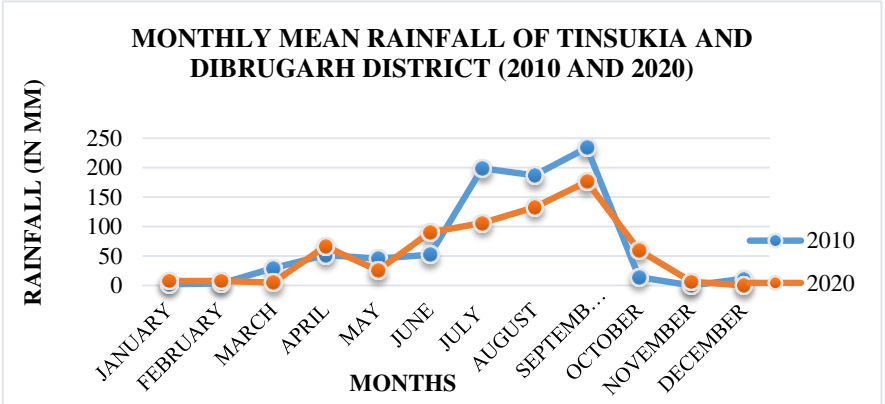

Fig-3: Monthly mean rainfall of Tinsukia and Dibrugarh Districts (2010& 2020)

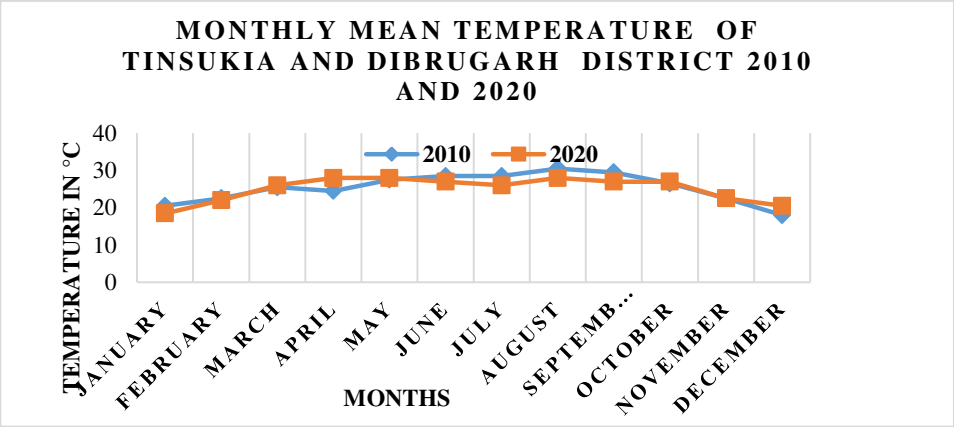

Fig-4: Monthly Mean Temperature of Tinsukia and Dibrugarh districts (2010-2020)

Land use and land cover pattern of dibru-saikhowa national park

We have used Landsat 8 OLI (2020) and Landsat 4-5 TM (2010) satellite images for the preparation of LULC map of DSNP. Using ERDAS Imagine 9.1 software, we have done supervised classification of both the year and found out the total area covered by the variables. Following are the LULC maps of Dibru-Saikhowa National Park of the year 2010 and 2020.

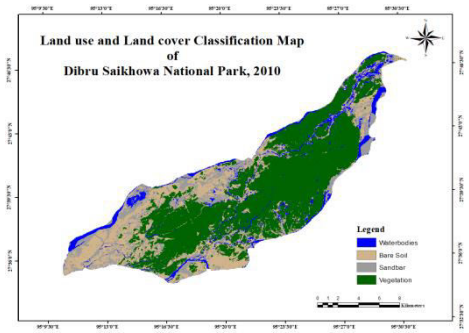

Fig-5: Showing the Land Use Land Cover map of DSNP (2010)

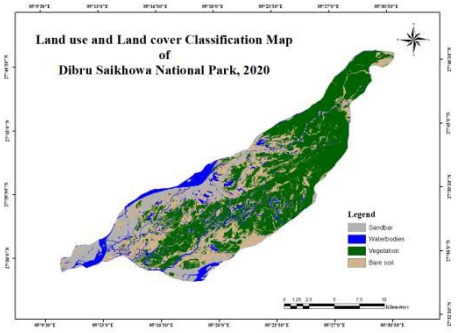

Fig-6: Showing the Land Use Land Cover Map of DSNP (2020)

Table-2: Showing the area covered by different variables of DSNP in the year 2010 and 2020

SL NO	Variable	No. of Pixels (2010)	No. of Pixels (2020)	Area in Sq.km (2010)	Area in Sq.km (2020)
1	Water Body	22407	24376	21.53	21.94
2	Sandbar	41590	38614	39.96	34.76
3	Vegetation	155583	134202	149.51	120.78
4	Bare Soil	65225	72759	62.71	65.48
	TOTAL			273.71	242.96

Table -3: Table Showing the Land Use and Land Cover trend of DSNP during 2010-2020 Based on LULC classification Map

Categories	Area in Sq. km		Change	Change rate in % (2010-2020)	Trend
	2010	2020			
Vegetation	149.51	120.78	-28.73	0.287	Negative
Sandbar	39.96	34.76	-5.2	0.052	Negative
Bare Soil	62.71	65.48	2.77	0.027	Positive
Water bodies	21.53	21.94	0.41	0.004	Positive
Total	273.71	242.96	-30.75	0.3075	Negative

Impact on Water Bodies

By comparing the attribute tables of the Land Use & Land Cover maps of the Year 2010 and 2020, we can say that the area occupied by water bodies has increased over 10 years. In the year 2010, the area was 273.71sq.km. where as in 2020 it degraded to 242.96sq.km. This implies that there is an approximate net degradation of 30.75sq.km of the total area of

DSNP. On the other hand the water bodies are observed in positive trend with 0.41 sq.km increase. There are many factors behind the increase in the area of the water bodies. Due to shifting of the channel by the river Brahmaputra during 10 years heavy bank erosion took place which added many new river channels in Dibru-Saikhowa National Park. As a result, it led to the increase in the water level over 10 years.

Impact on Sandbar

The total area occupied by sandbars in the Dibru-Saikhowa National Park has decreased from 39.96 sq. km in 2010 to 34.76 sq. km in 2020. It implies that the net result is 5.2 sq. km has reduction. The DSNP experience flood almost every year and the intensity of flood has increased over 10 years as a result it adversely affects the sandbars. The peak season flooding inputs siltation in the DSNP and the southern part of the park was eroded extensively reducing the sandbars.

Impact on Vegetation

From the Land Use & Land Cover map, its reveals that the area covered by vegetation has reduced over the 10 years. In the year 2010, the area was 149.51 sq. km approximately which reduced to 120.78 sq. km in the year 2020 which there is a reduction of 28.73 sq. km. As a result of flood, the river faced heavy bank erosion and the sediments got deposited in the land surface. As a result, the area covered by vegetation was filled up with sand deposits hence leaving the land infertile.

Impact on Bare Soil

The Dibru-Saikhowa National Park is a river island surrounded by Siang and Dibang River in the north and the Lohit and Dibru River in the south. It has been observed that the area covered by bare soil has increased from 62.71 sq. km in 2010 to 65.48 sq. km in 2020. Bank-line erosion takes place generally during the receding stage of flood when excess sediments are deposited and thus leave the soil unproductive which can also be termed as bare soil.

Measures found applicable for environmental conservation

As river bank erosion and flood are natural processes therefore it is not possible to provide complete protection from these hazards. Besides, using the following various structural measures, we can minimize the adverse effect of erosion and flood.

1. Afforestation: Plantation of trees is planted near to the river. The roots of the vegetation generally increase the soil's strength around the river bank; deep rooted plants may help in reducing the rate of erosion (Dutta, 2020).
2. Soil Erosion Mats: Soil erosion mat (geo-netting) should be used for erosion control over the bank areas. The soil erosion mat help to slow down the flow velocity of water along the surface. It is triggered to retain the soil and prevent from shifting away.
3. Structural Measures: Heavy Guard walls (retaining walls, spurs) on both sides of the river should be created so that the effects of erosion could be minimized. The engineering design will reduce the impact of stream velocity over the river bank to erode, also increase the resistance to flood impact.
4. Short term Management**:** Piled sand bag and zero soil bag (geo-bags) should be use as a loss protection and reduction techniques
5**.** Some long- and short-term protection measures should be taken for minimize the effect of bank erosion. These are like- Land spurs, bull head, porcupine, bank revetment, dampeners with using steel drill- pipes normal apron. Geo textile bags have also been used as revetment to build structural erosion protection measures (Dutta, 2020).
6. To reduce the amount of flood in Dibru-Saikhowa National Park, sustainable embankment construction and its proper maintenance is necessary.
7. Flood forecasting, erosion prediction, quality data acquisition, regional and international co-operation, research to understand the river systems etc. come under immediate actions to be done. In-depth research on hydrology, channel behaviors, geomorphology and environmental impact assessment should be suggested before implementation, long term strategies (Mili, Acharjee & Konwar, 2013).

Conclusion

It is evident from the present study that the Dibru-Saikhowa National Park has faced severe bank erosion particularly after the 1990 s flood. The total area of the park was 271.73 sq. km in 2010 which reduced to 241.12 sq. km in 2020.The elevation of the area, flood, rainfall and the morphological pattern of the river has been the major contributing factors of bank erosion in Dibru-Saikhowa National Park. The north western and south eastern part of the park has been mainly affected. We have found that bank erosion has adversely affected the land use & land cover pattern of the Dibru-Saikhowa National Park. Bank erosion and flood possess serious threat to the Dibru-Saikhowa National Park because it can cause habitat destruction and land use change. After reviewing literature, we came to know that no proper measure has been taken to mitigate the problem of bank erosion in the Dibru-Saikhowa National Park. In view of the alarming rate of degradation, it is very necessary to take proper and accurate measure to protect the biodiversity hotspot region.

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