

Spatio-Temporal Change Detection of Channel Migration Using Geo-Spatial Techniques: A Study on Ranganadi River Basin of Lakhimpur District, Assam

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Abstract

The shifting of channels is one of the natural phenomena on the earth's surface; globally, it is considered one of the unpredictable natural calamities. Floods greatly impact many tropical regions and channel course shifting due to flood among them; state of Assam is one of them. During monsoon season, the state has suffered from high flood and riverbank erosion, leading to severe river and bank erosion, which impacts the environment in several social and physical ways. The present study primarily emphasized the spatiotemporal change detection of the Ranganadi River and how it affected on environment. Satellite data from 1995-2023, SOI topographical map, and Google Earth Pro were used for the study. For the spatio-temporal analysis of the river, GIS has been implemented and calculated the channel shifting by applying the different cross-sections. Ranganadi is one of the perennial rivers of Assam, a tributary of Subansiri. Due to high intensity of flooding and river bank erosion yearly, the local dwellers suffer from problems such as infrastructural damage, land loss, economic disbalance, etc. Land use/cover has also changed due to course shifting the channel. Maximum changes are observed from 2002-2023, mainly in lower part of the basin. The erosion rate will be high in 2023. Deforestation leads to high erosion of river banks, resulting in people facing tremendous problems and issues in various ways. It is essential to study proper watershed management planning for a better understanding of the geomorphological instability of the river basin.

Keywords: River shifting, Remote-sensing & GIS, Environment, Bank erosion, Ranganadi river

1. Introduction

Landscape changes are a spontaneous process of environment from the beginning of the era; with time and space, landscape is changing by naturally or anthropogenically. Geomorphological landforms are changing more rapidly on the earth's surface, and river channels have shifted course and are considering new paths for flowing. Floods, rapid landslides, and earthquakes are the causes of landscape changes. (Leopold, L.B., 1972). Channel changes in terms of short-term added noticeable changes in hydrological geometry of planform, resulting from anthropogenic impact on physical environment or due to variation in climate. Based on historical time, the channel has led to changes due to many vital aspects that are co-related with

channel form. Increasing or decreasing sediment or water discharge leads to channel modification. (Goswami, U., Sarma, J.N. et al., 1999). The morphological study of the channel is a complex part, which includes its shape, size, structure, changing behaviour of the channel, bank erosion, etc. Bank erosion, channel course shifting, and accretion is the natural processes for all types of alluvial rivers. Innumerable factors are accountable for channel shifting. Among them, flow velocity, flow direction, flood, changing climate, erosion of bank are major. Meandering river highly leads to channel changes as the meandering river are the curvy which tend to erode its bends easily due to high-rate erosion. (Thu, A.N., Shwe, K.P., et

al., 2018). Many river floodplains provide habitats for many plants and animals and are suitable for food production. Channels tend to change their course by the process of lateral and vertical erosion, which drives changes in floodplains periodically and seasonally, which changes land use land cover as well. (Hazarika, N., Das, A.K., et.al., 2015). River bank erosion is a common issue country like India, Bangladesh, Pakistan as the regions is highly prone to flood, leading to shifting of courses of channels and environment destructed. Numbers of people become homeless due to bank erosion every year. (Haque, M.A., Shishir, S., et.al., 2022). Although erosion and deposition are natural processes functioning by river channels, erosion hurts human settlement. On the other hand, deposition sedimentation has a positive impact on the human environment. On one hand, humans are becoming homeless due to river erosion, but on the other hand, humans are getting space for their homestead in the sedimentation region, called "Char land" along the riverside. (Haque, M.A., Shishir, S., et.al., 2022). The floodplain regions on the earth surface result from the fluvial process; as the river passes through its dynamic equilibrium, continuous adjustment fluctuates through space and time, leading to channel mobility laterally and vertically. (Das, A.k., Sah, R.K., et.al., 2012). morphological changes are taking place in river channels Due to human intervention, which many researchers' studies, mostly related to the developmental purpose of the region, such as engineering activities and other structural work by the people and resultant vast changes in the river landscape, which is a cause of hazards and disasters such as bank erosion, impact on many aquatic species, environment. In the Himalayas regionals, the fluvial process is active VES carried out by river channels. The region North-east is contemplated as one of the natural hazard-prone zones in the world as the region experiences floods every year, earthquakes, landslides in the mountainous areas, river bank erosion, and channel shifting; maximum river channel of the north-east region are The Ranganadi is situated in the district of Lakhimpur, Assam. District Lakhimpur lies at 26°48' N to 27°53' N latitude to 93°42' E to 94°20' E longitude. The total area covered is 2,977 km² northeast of Assam (India). The Lakhimpur

originated from the Himalayas Mountain range. (Das, R., 2021) Ranganadi is a river highly affected by floods and severe course shifting. it is a tributary of river Subansiri, which causes a high rate of bank line shifting and bank erosion and tends to destroy homestead land and cultivation land as region is well populated and more than half of the people are based on their agriculture. Every year in this region, people suffering from this type of natural calamities and suffer from homelessness and loss of property; children are suffering from a disturbance in proper education. (Das, A.k., Sah, R.K., et.al., 2012). Changing the channel course also directly impacts land use and land cover as LULC changes according to time and space, and the channel plays a vital role in bringing changes to the natural environment and the human environment. Therefore, it is necessary to analyse the land use /cover change concerning channel shifting behaviours. LULC changes are common phenomenon due to bank erosion and channel shifting with time. (Maity, A.K., Das, S., 2019). Changes in water level, flow direction, and downcutting of banks are natural processes for any alluvial river and lead to bank erosion. (Thu, A.N., Shwe, K.P., 2018). Climate and land use changes constantly impact river geomorphology. Along the river bank, many anthropogenic activities are concentrated, such as industrialization, cultivation of multiple crops, human residence, etc., leading to river channel disturbance. (Ghani, A.A., Ali, R.,) The study tries to enlighten the pattern of LULC changes in the buffer areas of river Ranganadi, a tributary of river Subansiri. Therefore, the study contributes to the spatiotemporal changes analysis of rivers and provides knowledge about managing bank erosion and floodplain regions, which sometimes lead to very disastrous situations by the river. The study's primary objective is to analyse the spatiotemporal change detection of the Ranganadi River basin and its impact on the physical and human environment

2. Study area

district is situated on the northern bank of river Brahmaputra. Siang and Papumpare districts of Arunachal Pradesh surrounded the district in the north and south, surrounded by the Majuli subdivision of Jorhat district, Dhemaji district on the

eastern side, and Gahpur in the western side. (Figure 1 shows the locational map of study area). River Ranganadi originated from the foothills of the

Himalayan of Arunachal Pradesh at an altitude of around 3,400 m. River Ranganadi is one of the tributaries of Subansiri.

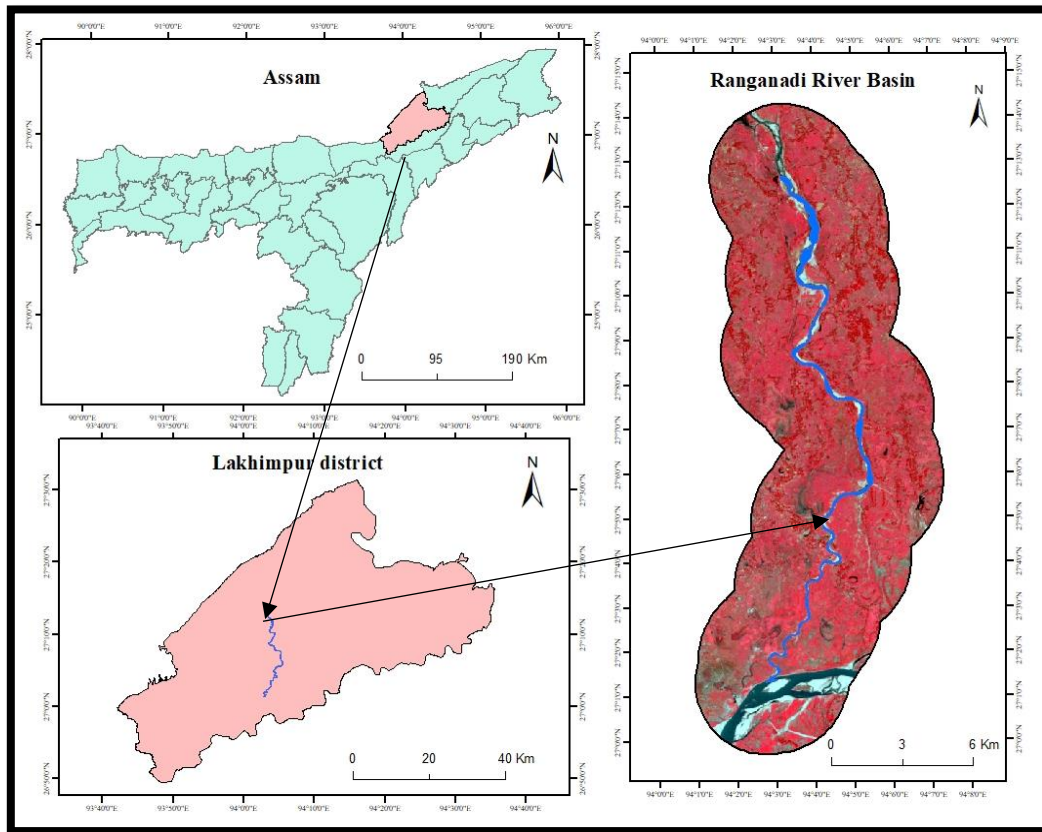


Figure 1: Location map

3. Methodology and database

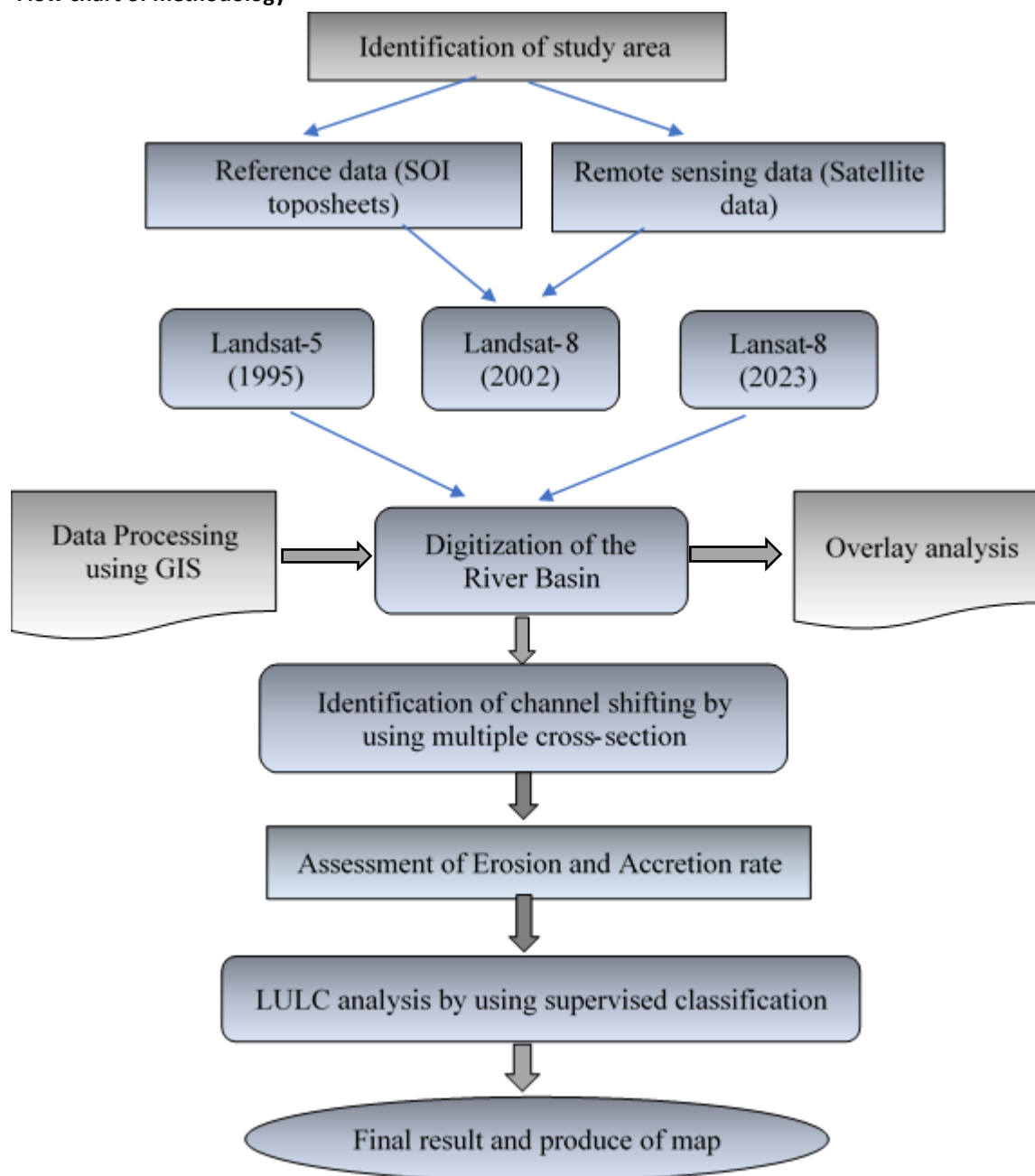
The study is based on both primary and secondary data. LANDSAT imagery was used for the study. The SOI (Survey of India) topographical map (83 I/3, 83 I/4, 83 I/7, 83 I/8) and Google Earth Pro software were used for the reference and

identification of study area. For analysis of River course shifting, different years of data from 1995-2023 were considered in this study. All the analysis was done with the help of GIS tools. Table 1 shows the data which are applied for the study.

Satellite	Sensor	Acquisition date	Resolution	Path/Row
Landsat-5	TM	7-11-1995	30 m	135/41
Landsat-8	TM	21-11-2002	30 m	135/41
Landsat-8	TM	22-12-2023	30 m	135/41

Table 1: Data applied for study

Flow chart of methodology



4. Shifting of channel

Channel shifting is considered one of the natural phenomena on the earth's surface. Shifting of channel refers to changing of channel course from one direction to another, which is controlled by numerous factors such as channel gradient, flow velocity of water, climate and vegetation cover, precipitation and rainfall, etc. Flood and erosion of river banks are the primary factor influencing the channel for changing its course based on spatio-temporally, also called spatio-temporal change of river channel. River channel migration is not only

taken as a physical phenomenon on the earth, but the process also greatly impacts the human environment. Economically socially, human beings face numerous problems due to river bank erosion and changing the channel direction. Land degradation is one of the primary issues in the high flood-prone regions as the floods have affected many households, and the erosion rate is high due to high flooding in a particular area. Degradation of agricultural land, infrastructure destruction, loss of education, and loss of income sources are

significant consequences of the erosion of banks in a flood-prone region. Apart from this impact on the human environment, the physical environment suffered greatly from bank erosion and the shifting of river courses. Many aquatic plants and species are destroyed and damaged, and vegetation and forest cover change due to river erosion. Local dwellers living near the riverside sometimes cannot get the time to prepare for moving their place to another region for rehabilitation when the river action becomes more serious, and it becomes a very pathetic situation for people, which disrupts their day-to-day life and affects their economic activities. Bank erosion and river course shifting are more familiar in an alluvial and perineal river. The river Ranganadi has been taken for the study in the Lakhimpur district of Assam. The river is one of the significant tributaries of Subansiri River located in Assam. During the monsoon season, Assam experiences flood every year, and the level of water has risen from the minimum level, leading to erosion and channel shifting. It is essential to study channel-shifting behaviour to understand the geomorphological features of the channel. Multiple cross-sections were used in changing areas to assess the rate of channel shifting in this study, and the total length of the changed area and its change direction were calculated. The data was applied from 1995 to 2023 in satellite imagery and Google Earth Pro. The topographical map of SOI has also been used to understand basin better and analysed in the GIS software. The Ranganadi River

has observed that maximum changes occur in the lowermost part of the river; it changes the direction from one place to another.

4.1. Ranganadi river course changes from the period of 1995-2002

In between the period of 1995-2002, the average shifting of the channel is 433.71 meters. (Figure 2 shows the river course shifting from 1995-2002). It is considering both side of the river bank. The maximum shifting of the Ranganadi channel is found in cross-section two, which is 960.57 meters on the right bank of the river near the lowermost segment of the basin; in the basin mouth, the maximum changes occurred due to the old stage of the basin, river old stage, it leads to highly braided and tiny rills and gullies are separated from the mainstream due high sediment deposition. Similarly, cross-sections 3, 4, 5, and 6 also tend to show the high shifting of the Ranganadi river basin, which is 755.52, 749.20, 770.53, and 677.46 meters, respectively. On the other hand, cross-section 15 shows the lowest rate of shifting of river Ranganadi, which is 76.18 meters, mainly upstream of the basin where water flow velocity tends to be very high. (Table 2 shows the direction and total length of the channel). It is seen that between 1995 and 2002, the channel shifted maximum towards the right bank of the channel, and near the confluence point of the river, there was a high sediment deposition, and the river tended to be highly braided.

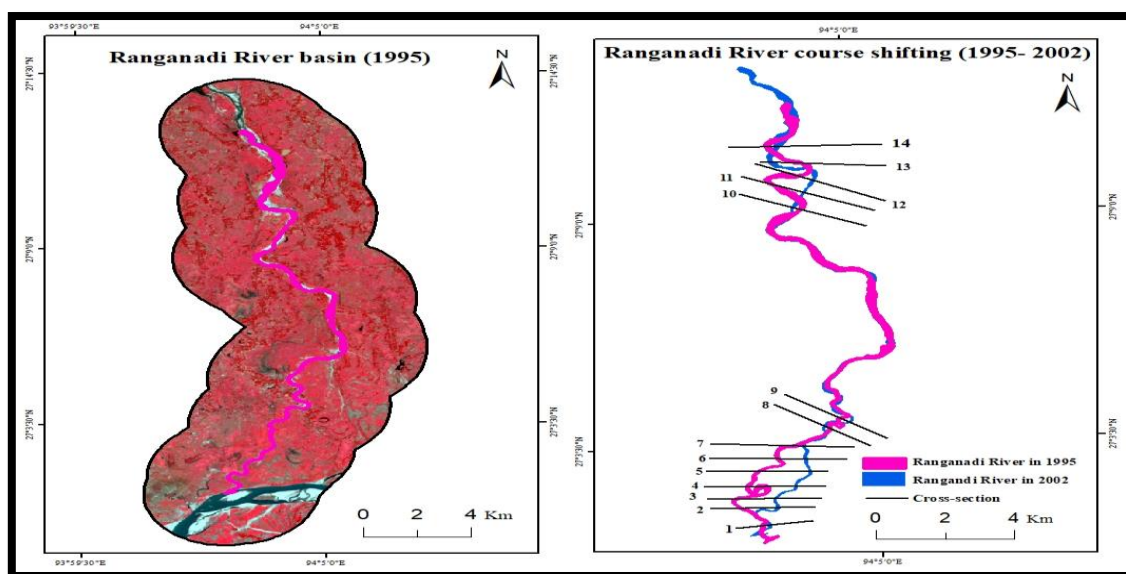


Figure 2: River channel shifting from 1995-2002

Year 1995-2002		
Cross-Section	Length (in meter)	Direction of shifting
Cross-Section 1	108.00	Right bank
Cross-Section 2	960.57	Right bank
Cross-Section 3	755.52	Right bank
Cross-Section 4	749.20	Right bank
Cross-Section 5	770.53	Right bank
Cross-Section 6	677.46	Right bank
Cross-Section 7	97.57	Right bank
Cross-Section 8	98.45	Left bank
Cross-Section 9	257.71	Right bank
Cross-Section 10	159.16	Left bank
Cross-Section 11	834.60	Right bank
Cross-Section 12	379.86	Left bank
Cross-Section 13	468.64	Left bank
Cross-Section 14	112.22	Right bank
Cross-Section 15	76.18	Right bank

Table 2: Changes of total length and bank direction (1995-2002)

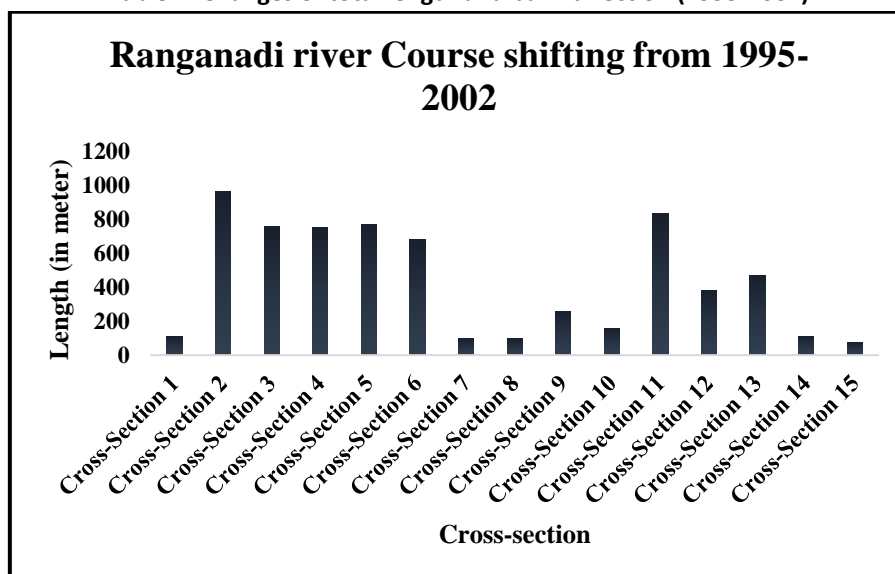


Figure 3: Graphical representation of river course shifting (1995-2002)

4.2. Ranganadi river course changes from the period of 2002-2023

From 2002 to 2023, the average shifting of the Ranganadi basin is observed at 2008.32 meters. (Figure 4 shows the river course shifting from 2002-2023). It is considering both sides of the river. In this mentioned year, the highest shifting occurs near cross section 1, that is 5725.41 meters on left bank of channel. It is one of the highest changing courses of river Ranganadi; these tremendous changes are observed in the lowermost part of the basin, which is covered by a floodplain region. Population

settlement is high in this region; people are mainly based on agriculture, which is the region's primary activity, but due to the high rate of channel shifting, it affected the local dwellers and physical environment. Cross-sections 2, 3, 4, 5, and 6 also show the high shifting rate of the Ranganadi river basin, that is, 3879.80, 3684.01, 2598.06, 2834.29, and 1778.11 meters, respectively. Maximum shifting takes place on the left bank of the channel. Whereas the lowest shifting occurs in cross-section

7, which is 100.25 meters on the right bank, the channel mainly occupies the middle of the river, between 21 years of temporal variation. (Table 4 represent the channel shifting direction and total

length). Ranganadi River has changed the course tremendously due to multiple factors influencing the shift, such as channel gradient, flow velocity, many anthropogenic activities, etc.

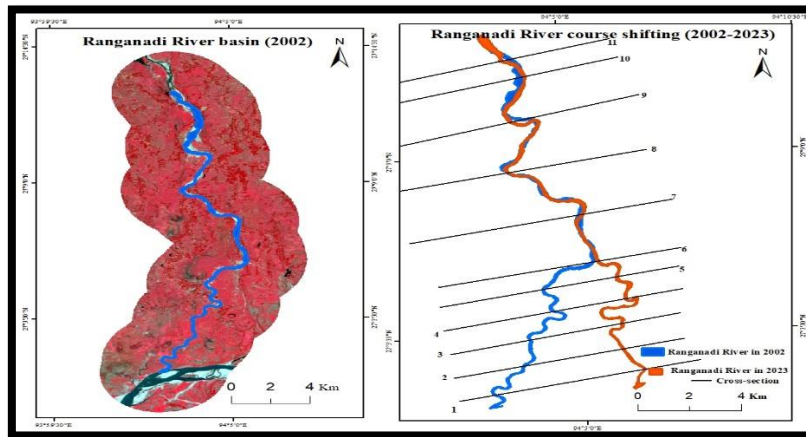


Figure 4: River course shifting from 2002-2023

Year 2002-2023		
Cross-Section	Length (in meter)	Direction of shifting
Cross-Section 1	5725.41	Left
Cross-Section 2	3879.80	Left
Cross-Section 3	3684.01	Left
Cross-Section 4	2598.06	Left
Cross-Section 5	2834.29	Left
Cross-Section 6	1778.11	Right
Cross-Section 7	100.25	Right
Cross-Section 8	207.64	Right
Cross-Section 9	650.80	Left
Cross-Section 10	303.48	Right
Cross-Section 11	330.14	Right

Table 4: Changes of total length and bank direction (2002-2023)

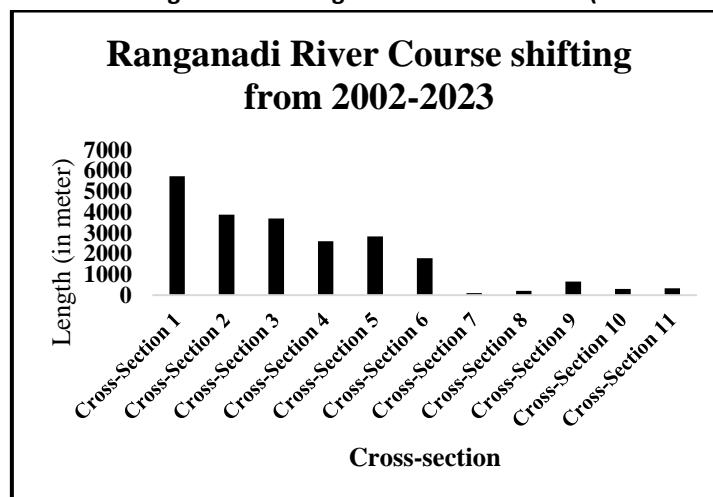


Figure 5: Graphical representation of river course shifting (2002-2023)

4.3. Ranganadi river course changes from the period of 1995-2023

During 1995-2023, the average channel shifting is observed at 1959.00 meters along the river. (Figure 6 shows the river course shifting from 1995-2023). It is one of the significant changes in the river Ranganadi, which flows through Lakhimpur district of Assam. The maximum changes of the river are seen in cross-section 2, with an average length of 5759.56 meters along the right bank of the river. Cross-sections 1 and 3,4,5 also show a big change in the river channel with total lengths of 5660.88, 4712.49, 2864.59, and 2879.91, respectively. Similarly, cross-section 8 shows the lowest change with a total length of 140.60 meters. During this

period from 1995-2023, the lowermost part of the basin has observed high changes as it changes its path from the left bank to the right bank due to high erosive activities of the basin. (Table 6 represent changes channel direction and its length). It is observed that the Ranganadi River basin has changed its course maximum in the lowermost part rather than the uppermost part of the basin, and it has a strong influence on the physical environment as well as the human environment, such as agricultural land loss, people homestead areas, loss of enormous aquatic species, etc.

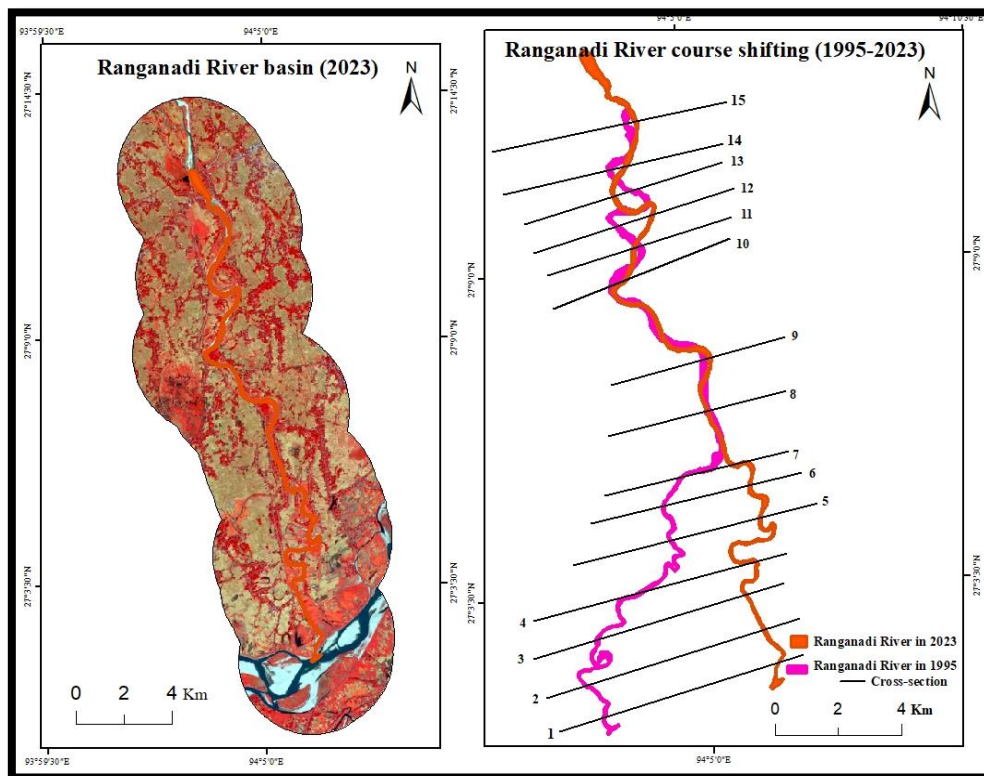


Figure 6: River course shifting from 1995-2023

Year 1995-2023		
Cross-Section	Length (in meter)	Direction of shifting
Cross-Section 1	5660.88	Right
Cross-Section 2	5759.56	Right
Cross-Section 3	4712.49	Right
Cross-Section 4	2864.59	Right
Cross-Section 5	2879.91	Right
Cross-Section 6	2641.64	Right
Cross-Section 7	1769.14	Right

Cross-Section 8	140.60	Left
Cross-Section 9	172.50	Left
Cross-Section 10	373.05	Left
Cross-Section 11	397.05	Left
Cross-Section 12	956.72	Right
Cross-Section 13	475.35	Left
Cross-Section 14	313.49	Left
Cross-Section 15	268.14	Left

Table 6: Changes of total length and bank direction (1995-2023)

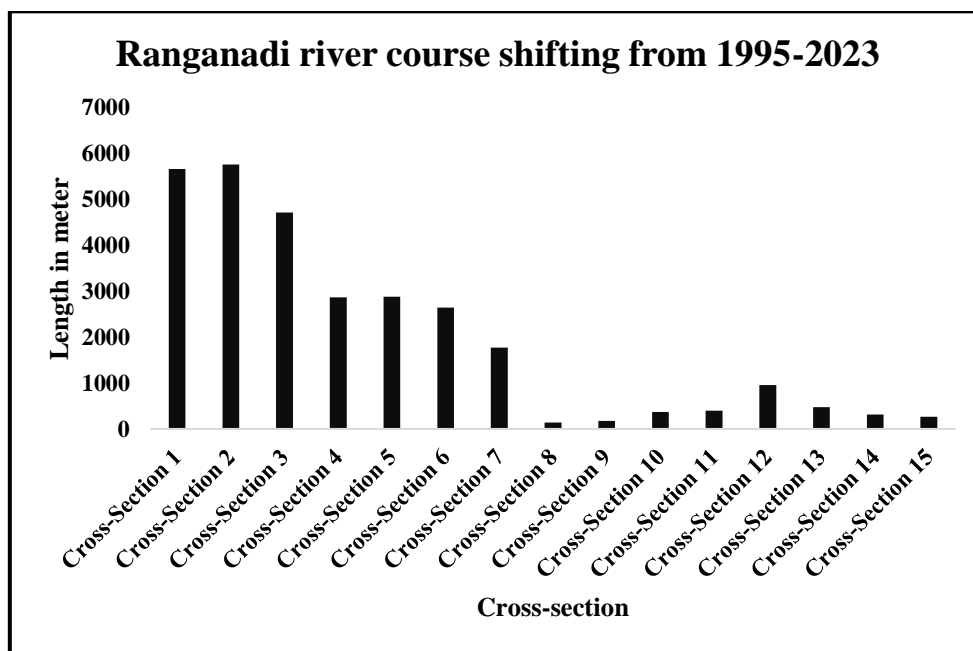


Figure7: Graphical representation of river course shifting (1995-2023)

4.4. Erosion-deposition assessment from 1995-2023

The erosion process is most common in the locality where flood occurrence is very high. It is a familiar occurrence all over the world. In a country like India, these natural calamities are most prominent as majority of the country lies under the plain region. However, the nature and effect of erosion may differ from region to region. The term erosion refers to removing soil from the earth's surface. The process from which soil may erode, such as high intensity of water flow, winds, waves, etc. River bank erosion is a "geo-morphological process of alluvial floodplain rivers." It is explained as the

process of wearing off the banks of a stream river. This is because bank adjustment, trampling, bed elevation, and topography changes react to modified flow conditions or bank resistance. Erosion of the bank is a natural process; without it, the channel would not meander, and change would occur (Baki, A., 2014). Very high riverbank erosion causes heavy displacements along the bank line of the rivers, and impacts result in socio-economic change and physical environment. (Figure 8 shows the bank erosion and accretion rate from 1995-2023).

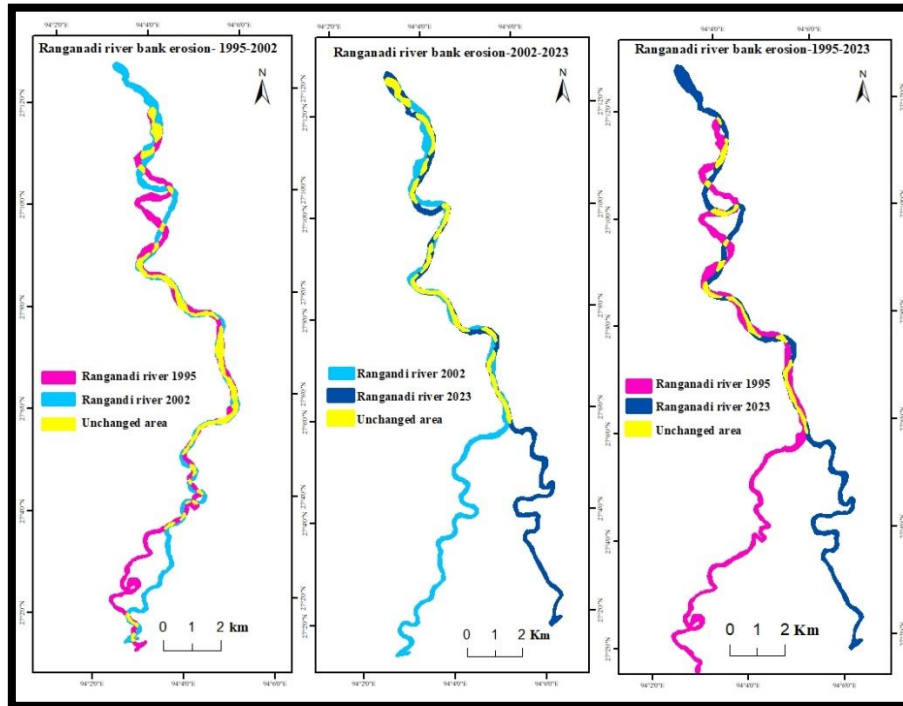


Figure 8: Assessment of bank erosion from 1995-2023

In this present study, the Ranganadi River has been considered for assessment of channel line shifting and erosion of the bank from 1995-2023 using different years of satellite imageries and Google Earth tools, and all the analysis has been done by implementing GIS tools. The river has changed its morphology behaviour throughout time and space. In some regions of the basin, a drastic change

occurred due to the sudden occurrence of floods, which created a disaster situation for the dwellers of that particular place. This district experiences high-intensity rainfall yearly; floods have been apparent in this region. Therefore, in this region, the probability of bank failure is very high, and banks are most vulnerable to bank line erosion during the monsoon season.

Year	Previous years	Next year	Unchanged area	Erosion	Accretion
1995-2002	3.45	3.60	1.340	2.11	2.269
2002-2023	3.60	2.79	0.981	2.628	1.816
1995-2023	3.45	2.79	0.521	2.931	2.277

Table 7: Bank erosion and accretion from 1995- 2023

This study found that, from 1995-2002, the erosion rate is calculated at 2.11sq. Meters, whereas the rate of accretion is calculated at 2.269sq. Meters. Comparatively, the accretion rate is more significant during this time frame than the erosion rate. It denotes that during this period, accretion is higher than erosion, mainly near the lower basin; due to the low velocity of water flow, the sediments have settled down more quickly, slowly turning into floodplain regions. Similarly, from 2002 to 2023, the

erosion rate of the basin is calculated as 2.628 sq. meters, whereas the accretion rate of the basin is calculated as 1.816 sq. meters. (Figure 9 shows the graphical representation of river bank erosion and accretion.) In this period, the erosion rate is higher than the accretion rate because of the changing channel pattern. From 1995-2023, the erosion rate of the channel is calculated as 2.931sq. Meter similarly, accretion rate is calculated as 2.277 sq. meters.

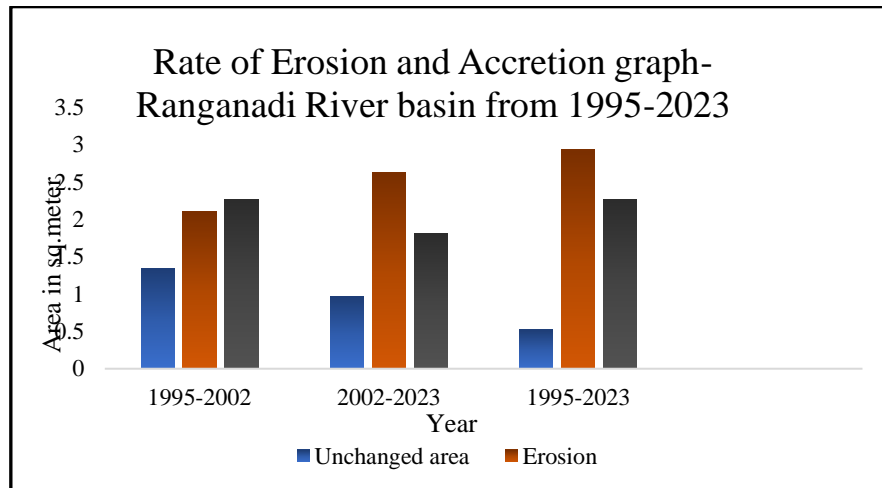


Figure 9: Graphical representation of bank erosion and accretion

The analysis shows that the bank erosion is not so fluctuating compared with the time period of the study. Due to the occurrence of flood and accreted sediment from one place to another, the river is eroded more or less every year. With this process, the river morphology has changed based on space and time, and the river has created many new landforms; this is examined as a primary characteristic of the channel. Erosion of river bank has a vast concussion on human beings. Local dwellers of this region suffered from multiple socio-economic issues socio-economically. Loss of cultivation land is a usual problem in this area. The remarkable consequence of river bank erosion is the lack of medical and educational facilities. Medical care units that were all lost which were on the eroded land. Therefore, they have to travel longer distances than before for medical treatment and bear extra costs. This is the case for education. Apart from this, because of the loss of occupation, they need to spend money on essential items like food and shelter, even if education and medical facilities exist in their newly occupied places. As a result, children's illiteracy rate is increasing; they are suffering from poor health.

4.5. Land use land cover analysis of Ranganadi river basin

LULC changes has a great impact on the environment as well as human being. Land use mainly refers to the activity by people on the surface of the earth. (Ram & Kalarkar 1993) LULC change is a widespread phenomenon on the planet's surface; with time and space, the environments are changing spatially and

temporally, termed spatiotemporal changes; the changes may occur in physical or socio-economic environments. Ecological changes, geological structure, slope, and altitudes are some factors that determine the land use/cover changes socially as well as physically. Considering the present-day scenario, LULC has been changing quickly due to increasing population growth, urbanization, and high industrialization, so the environment is turning man-made rather than natural. LULC is considered one of the significant processes that change the landscape globally. The land is transforming with time and space, and vegetation forest cover is transforming to built-up land; practicing cultivation is the primary factor for changing landscape as one-third of land surface is occupied by cultivation land for growing crops (FAO,2004). In this study, the LULC of the Ranganadi River basin was assessed, considering it to be 3 km. buffer zone. With the help of remote sensing data, the study has analysed and categorized the LULC changes in the buffer region of the Ranganadi river basin from the duration of 1995 to 2023, viz., water bodies, vegetation cover, built-up areas, sand bars, and agricultural land. Water bodies are one the vital land cover of the earth surface, where it includes all man-made as well as natural features of water, comprising rivers, canals, lakes, wetlands, ponds, water reservoirs, etc. The study analysed that water bodies have reduced from 1995 to 2023, that is, 15.44 sq. km to 7.22 sq. km. Due to high sediment deposition, the water bodies are reduced according to time and space. Vegetation or forest cover denotes a large area covered by dense scrubs or trees in large land masses. In the study

area, the vegetation cover has changed spatio-temporally due to increasing population growth. Human beings are clearing the forest cover for their benefit, population are settled down in the land and cleared the forest or vegetation. Due to the decreasing forest cover rate, global warming is increasing, resulting in intolerable heat faced by all living beings. Temperature is rising gradually. In this study, in 1995, the vegetation covered a total area of 91.30sq.km. Whereas in the year 2023, total area of vegetation covered only 73.43 sq. km. The area occupied by vegetation cover decreases with time and space. Built-up areas are considered settlement areas of any region. Human beings are settled in a region where they will survive and get their basic needs, such as food, shelter, and clothes. As the population is increasing gradually, built-up-up areas are also increasing simultaneously; a positive relationship exists between settlement built-up growth and population growth. Therefore, clearing forest and vegetation cover leads to deforestation, urbanization, and industrialization. In this study, the built-up region tends to show positive growth. In 1995, the built-up region was analysed up to 28.30 sq. km; in 2002, the built-up region increased by 32.89 sq. km. Similarly, in the year 2023, the area of the built-up region increased by 36.96 sq. km. Sand bars are another classification of LULC, which

denotes mainly bare soil, fellow land, and sand deposited by the riverside. The sandbars increased in this study area; it shows that the total sandbars in 1995 were covered by 3.65 sq. km. Similarly, in 2002 and 2023, the area covered by sandbars was 8.77 sq. km. and 12.95 sq. km. accordingly. As water bodies show decreasing rates, sandbars are increasing in this study based on space and time. Similarly, the agricultural land also expands with time as human settlements increase, and the rapid growth of population results from the increasing man-made environment rather than the physical environment. People are cutting trees and clearing forests for the cultivation of multiple crops. In 1995, the total area covered by agricultural land is 39.09 sq. km. In 2002 and 2023, it increased by 44.49 sq. km and 45.47 sq. km, respectively. (Figure 10 shows the LULC map from 1995-2023). It is necessary to analyse the changes of LULC so that people are aware of them and try to reduce all types of activity inconvenient for the environment and human beings. This kind of helpful study is for those engaged in environmental protection and conservation; they can further analyse the work, implement some project work, and provide some suitable remedies for ecological preservation.

Sl.no.	Class	Description
1.	Water bodies	Water bodies including such as river, pond, stream, lakes, reservoirs etc.
2.	Vegetation cover	Vegetation cover including dense forests, sparse forest, areas dominated by grassland, scrublands etc.
3.	Built-up areas	Built-up including all settlement region such as homestead areas, road, railways networks etc.
4.	Sand bars	Bare soil including all fellow land, sand deposited by river side
5.	Agricultural land	Agricultural land including areas under cultivation such as rice, paddy, maize, vegetables etc.

Table 8: Classification scheme applied for the study.

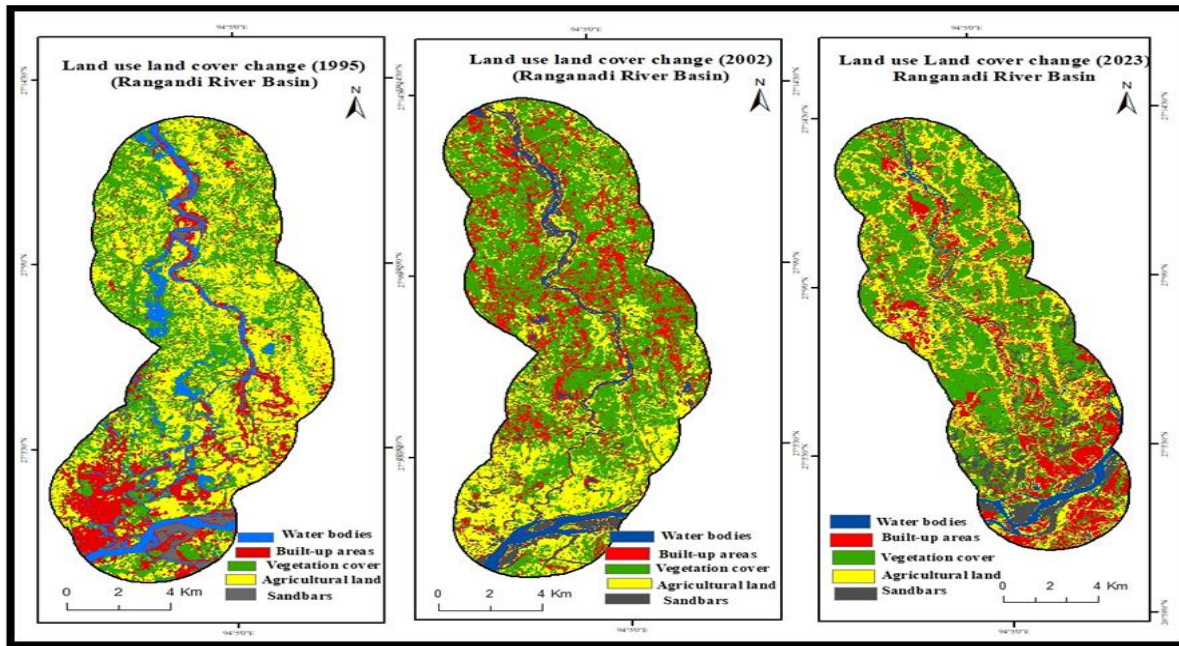


Figure 10: Land use land cover change of Ranganadi river buffer region from 1995-2023

Categories	1995	2002	2023
Water bodies	15.44	8.09	7.22
Vegetation cover	91.30	91.01	73.43
Built-up areas	28.30	32.89	36.96
Sandbars	3.65	8.77	12.95
Agricultural land	39.09	44.49	45.47
Total	177.78	185.25	176.03

Table 9: total area covered by different LULC

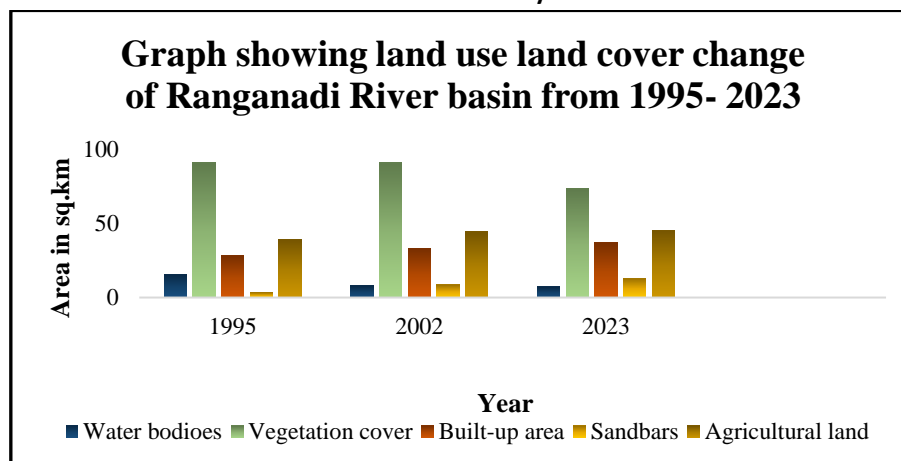


Figure 11: Graphical representation of total area covered by different LULC

5. Conclusion

Erosion of river banks is one of the natural calamities among all other natural phenomena, and

it is caused highly by floods and leads to channel shifting. It contributes immensely to the

marginalization of many people and undesirably affects the socio-economic circumstances of people and the physical environment. In this current study, an investigation has been done on river channel shifting and river bank erosion of the Ranganadi River, which is a perennial river basin of Assam. The state experiences flood every year during the monsoon seasons. therefore, the region is highly prone to bank erosion. In the study, an attempt has been made to assess the spatio-temporal course changes of the Ranganadi river basin from 1995-2023, situated in the district of Lakhimpur of Assam. From the analysis, it has been observed that the river has changed mostly in the lower part and middle part of the basin, creating high meandering and that some ox-bow lakes have also been developed due to the meander cut-off of the river. River's experience flooding every year due to high precipitation, leading to the shifting of channels from one direction to another. Channel has shifted equally in both the right and left bank. From the analysis, it has been recognized that from 1995-2002, the highest rate of shifting is taken place in the lower portion of river and migrated towards the rightwards direction, study assumed that the topography and geological features are quite low due to which channel find its easiest way to flow, but it also destroyed the many human properties, their agricultural land, homestead areas, etc. it has a tremendous influence on social environment as well as the physical environment. This year, the average shifting rate was 433.71 meters long in both directions. From 2002-2023, it is observed that the river shifted mostly to the right bank, indicating that from 2002 to 2023, it has shifted continuously to the right bank. In this period, the average shifting of the channel is identified as 2008.32 meters in length, which is greater than earlier shifting; it denotes that shifting is increasing in the course of basin Ranganadi. During 1995-2023, the average shifting was found to be 1959.00 meters in length, whereas the greatest change is observed in the middle part of the basin, which consists of high meanders, and some places create an ox-bow lake due to high meandering of basin. The channel falls under the district of Lakhimpur. Therefore, the district experiences high flood intensity as the river is in a stage of maturity with high flowing velocity. It has

also been monitored that the entire basin has changed its direction more or less, but the lower stream of the basin has changed more compared with all the years. Similarly, the changes have also been noticed upstream of the basin; in this region, accretion was high; therefore, the channel has changed to braided in shape. In this region, high intensity of rainfall affects bank erosion. Due to high precipitation, the topsoil has been loosening up and tends to erode more easily due to the course shifting by the channel, which affected the environment vastly. The nearby homestead region faces an innumerable issue, from bank erosion and changes in the river course, destroying many lives and infrastructure. with increasing urbanization, the natural vegetation declines daily, transforming the natural region into a human-use region. Every year during the monsoon season, people are losing their farmlands and their homestead region, and several domestic animals are dying. These are very significant issues in this region. To shed light upon these issues, there is a need to implement some tools and techniques for conservation of soil near the watershed of the basin, more plantations near the affected areas, assessment of land cover changes, strong embankments in the river bank need to be enacted so that people can get certain amount comfort from the hazardous problem. In the present study, river dynamics with changing flow paths have created a large floodplain. People have shifted their homeland from their original place to some other temporary place due to the sudden devastating situation created by the river; flash floods are more common in this study area. Many croplands, agricultural product, and settlement is destroyed due to the sudden occurrence of flood. The output of the study could expand understanding of the dynamics of the Ranganadi River in Lakhimpur, and the techniques adopted in this study can be a useful framework for assessing the channel dynamics in other regions. This study can be implemented for the geomorphological study of the Ranganadi River and to consider various land and water management initiatives, flood control programs, and transboundary river planning. The study is necessary for a better understanding of real field problems and their direct influences on livelihood and the environment. Therefore, it is necessary to

take proper management for suitable remedial measures from which the villages' local dwellers can benefit.

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