A dissertation submitted on

"STUDY OF MORPHOLOGICAL CHANGE OF KOPILI RIVER AND ITS SOCIAL IMPACTS BY REMOTE SENSING"

Submitted in Partial Fulfillment for the Requirement for the Award of the

Degree of

MASTER OF TECHNOLOGY

CIVIL ENGINEERING
(With specialization in Water Resource Engineering)

Of

Assam Science & Technology University
Session: 2023-2025

Submitted By

CHESONG KIRI TIMUNG

MTECH 3rd SEMESTER

ROLL NO: 230620061008

Under the Guidance of

DR. PULENDRA DUTTA

ASSOCIATE PROFESSOR

DEPARTMENT OF CIVIL ENGINEERING

ASSAM ENGINEERING COLLEGE

JALUKBARI, GUWAHATI-781013

DECLARATION

I hereby declare that the work presented in the dissertation **"STUDY OF MORPHOLOGICAL CHANGE OF KOPILI RIVER AND ITS SOCIAL IMPACTS BY REMOTE SENSING"** in partial fulfillment of the requirement for the award of the degree of **"MASTER OF TECHNOLOGY"** in Civil Engineering (With specialization in Water Resource Engineering), submitted in the Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati-13 under Assam Science & Technology University, is a real record of the work carried out under the supervision of **DR. PULENDRA DUTTA**, Associate Professor, Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati- 13.

I do hereby declare that this project report is solemnly done by me and is my effort and that no part of it has been plagiarized without citation.

Date:

Place:

CHESONG KIRI TIMUNG

M.Tech, 3rd Semester

Department of Civil Engineering

Assam Engineering College Guwahati-781013

CERTIFICATE

This is to certify that the work presented in the project report entitled "**STUDY OF MORPHOLOGICAL CHANGE OF KOPILI RIVER AND ITS SOCIAL IMPACTS BY REMOTE SENSING**" is submitted by Chesong kiri Timung, [Roll no- **230620061008**], a student of M.Tech 3rd semester, Department of Civil Engineering, Assam Engineering College, to the Assam Science & Technology University in partial fulfillment of the requirement for award of the degree of Master of Technology in Civil Engineering with specialization in Water Resource Engineering under my guidance and supervision.

DR. PULENDRA DUTTA

Date:

Associate Professor Department of Civil Engineering

Place:

Assam Engineering College Guwahati-781013

CERTIFICATE FROM HEAD OF THE DEPARTMENT

This is to certify that the project report entitled **“STUDY OF MORPHOLOGICAL CHANGE OF KOPILI RIVER AND ITS SOCIAL IMPACTS BY REMOTE SENSING”** has been submitted by Chesong kiri Timung, [Roll no- **230620061008**], a student of M.Tech 3rd Semester, Civil Engineering (With specialization in Water Resource Engineering), Assam Engineering College, in partial fulfillment of the requirements for the award of the degree of Master of Technology in Water Resource Engineering of Assam Science & Technology University.

Date:

Place

DR. JAYANTA PATHAK

Professor & Head

Civil Engineering Department Assam Engineering College

Guwahati-781013

ACKNOWLEDGEMENT

The present study on "**STUDY OF MORPHOLOGICAL CHANGE OF KOPILI RIVER AND ITS SOCIAL IMPACTS BY REMOTE SENSING**," has significantly enriched our understanding of this field. It has provided us with valuable insights into distinct theoretical and vocational aspects.

I extend our deepest gratitude to the faculty of the Civil Engineering Department. Their personal initiative and guidance have been instrumental in the successful completion of this dissertation.

I am particularly indebted to Dr. Pulendra Dutta, Associate Professor, Department of Civil Engineering, Assam Engineering College, Guwahati. Her invaluable guidance and personal interest have been crucial in helping us navigate this dissertation.

CHESONG KIRI TIMUNG

ROLL NO-230620061008

Water Resource Engineering
Department of Civil
Engineering Assam
Engineering College Jalukbari,
Guwahati-13

Date:

Place:

ABSTRACT

The study investigates river morphology employing ArcGIS, an advanced Geographic Information System (GIS) software. This research explores the dynamic nature of river systems, focusing on their form, structure, and changes over time. Through ArcGIS, spatial data analysis and visualization techniques are employed to comprehend the intricate patterns and characteristics of river morphology.

The methodology involves acquiring various geospatial data, such as satellite imagery, digital elevation models (DEMs), and hydro-climatological data. Utilizing ArcGIS tools, these datasets are processed, integrated, and analyzed to derive valuable insights into river morphology parameters, including channel width, depth, sinuosity, and meander evolution.

This research aims to provide a comprehensive understanding of how natural processes and anthropogenic influences shape river systems. This study's outcomes can aid in effective river management, environmental conservation, and decision-making processes related to land use planning, flood risk assessment, and habitat preservation. By using ArcGIS, this study helps us understand how rivers change over time, promoting better ways to manage and protect these important natural resources.

LIST OF FIGURES

LIST OF TABLES

CONTENTS

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

River morphology is the study of the structure, shape, and characteristics of rivers, including their physical attributes, processes, and evolution over time. Rivers are dynamic natural systems influenced by a range of factors such as geology, climate, human activities, and the interactions between water and the surrounding environment.

1.2 RIVER MORPHOLOGY

Rivers are dynamic in nature that undergo continuous morphological changes over time due to various environmental and anthropogenic factors. The Kopli River, which flows through the states of Meghalaya and Assam, is no exception. This river has experienced significant morphological alterations in recent decades and has had substantial social and environmental impacts on the surrounding communities. The primary objective of this study was to investigate the morphological changes in the Kopli River using remote sensing techniques, and to analyze the associated social impacts on the local population. Remote sensing is a powerful tool for monitoring and assessing river dynamics over large spatial and temporal scales, offering valuable insights that are otherwise difficult to obtain through conventional ground-based methods. By employing satellite imagery analysis and geographic information systems (GIS), this study aims to quantify the changes in planform, channel geometry, and land use and land cover along the Kopli River corridor. The study also explored the linkages between these physical changes and their implications on the socioeconomic conditions of riparian communities, such as impacts on agricultural practices, access to water resources, and changes in livelihood opportunities. Understanding the complex interplay between river morphology and social impact is crucial for developing effective management strategies and interventions to mitigate the adverse consequences of river change. The findings of this study will contribute to the existing knowledge on river dynamics and provide a framework for assessing the social vulnerabilities associated with river morphological alterations in similar riverine environments.

1.3 OBJECTIVE OF THE STUDY

1. Quantifying the morphological changes in the Kopili River over time using remote sensing data and GIS analysis.

    i. Quantifying land use/land cover (LULC) changes for the last 30 years (1994 to 2024).

    ii. Analyzing and compare the River migration for the last 30 years and identify any changes in the pattern.

    iii. To obtain meandering parameters such as radius of curvature, center line distance, mender neck length, axis length, river width, and sinuosity.

2. Assessing the impact of river morphological changes on the socioeconomic conditions and livelihood of the local communities along the Kopili River.

1.4 ORGANIZATION OF REPORT

- **Chapter 2** provides a comprehensive literature review on River morphology, encompassing research from various scholars.
- **Chapter 3** provides details about the study area, including the data collection methods, data processing techniques, and tools employed in the study.
- **Chapter 4** focuses on methodology. It describes the process of gathering data through Landsat imagery, employing techniques such as digitizing river paths and analyzing meander parameters, as well as evaluating morphological shifts and changes in land use and land cover (LULC). This chapter discusses crucial details impacting the investigation's findings.

- **Chapter 5** encompasses the results obtained from LULC analysis and River migration for three decades.

- **Chapter 6** wraps up the report on river morphology and future prospects, highlighting the crucial role of ArcGIS in uncovering complex river patterns. It stresses the significance of this tool in facilitating informed decision-making for sustainable river management and environmental protection.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A literature review is one of the basic components of academic research, being a systematic feature of productive scholarship on a specific theme. This is a systematic process of searching, selecting, and synthesizing all related studies, articles, and books, in an attempt to identify trends, gaps, and key insights. The literature review is a vital part of a research paper, by critique earlier researches it not only puts the current study in a more general academic context but also sheds light on the contributions and limitations of previous works. The importance of carrying out this process is two-fold; it informs the approach of prior research in the field, which helps establish the grounds of credibility for the research itself, as well as the process by which the research questions and methods are formed in order to conduct a well-informed and rigorous study. The following is discussed in a number of papers:

2.2 LITERATURE REVIEW

- **Chuen Siang Kang** & **Kasturi Devi Kanniah (2022):** Investigates land use and land cover (LULC) changes and river morphology alterations in the Johor River Basin from 1990 to 2020, utilizing remote sensing and Google Earth Engine for analysis. Key findings include significant transitions from forest to agricultural land and increased water areas due to dam constructions, with an average annual LULC change of 3.48%. The research emphasizes the need for further understanding of anthropogenic impacts on ecosystems and suggests that future planning should consider these changes to ensure water security and environmental sustainability.
- **Apurba Nath & Susmita Ghosh (2022):** This research investigates the morphological changes of the Barak River from 1990 to 2020, focusing on meander parameters, land use and land cover (LULC) changes, and river migration. Utilizing remote sensing and GIS techniques, the study compares machine learning (ML) and Support Vector Machine (SVM) methods for LULC classification, finding SVM to be more accurate. The findings indicate significant shifts in river morphology due to land use changes, highlighting the

need for improved river management strategies to mitigate adverse effects on the economy and livelihoods.

- **Ebrahim Brooshkeh & Reza Sokuti (2017):** The paper investigates the morphological changes of the Zarrineh-Rood River from 1955 to 2011, utilizing remote sensing and GIS techniques. Key findings indicate a significant reduction in riverbed area from 561.1 ha to 221.3 ha, with a decrease in meanders and increased sedimentation due to dam construction. The study highlights the urgent need for effective river management strategies to address sedimentation issues and mitigate flood risks.
- **Apurba Nath & Susmita Ghosh (2022):** Investigates the morphological changes of the Barak River in Assam, focusing on the sinuosity index and bank erosion using Landsat data from 1990 to 2020. It identifies erosion-prone zones and assesses the effectiveness of protective structures, revealing that decreased sinuosity correlates with increased bank erosion. The Seasonal Autoregressive Integrated Moving Average (SARIMA) model is developed to predict future discharge and morphological changes, emphasizing the need for effective river management and planning to mitigate erosion impacts.
- **N Mohamad *et al.* (2018):** A spatio-temporal analysis of river morphological changes and erosion detection at Kilim River has been conducted using very high-resolution satellite imagery from 2005 to 2012. It employs remote sensing techniques, including image fusion and GIS tools, to assess channel migration and erosion rates, providing insights into the river's dynamics. The findings aim to assist local authorities in implementing measures to mitigate erosion impacts on the ecosystem.
- **Shivaprasad Sharma SV *et al.* (2017):** The paper investigates flood hazard zones in the Kopili River Basin, Assam, India, using multi-temporal satellite data to analyze historical flood inundation patterns. It identifies villages at risk by mapping 183 flood events over the past two decades, employing data from Indian Remote Sensing and RADARSAT satellites. The study aims to enhance flood risk assessment and inform decision-makers for effective flood management strategies.
- **S M Ehasanul Haque Minhaz (2022):** Studied the long-term morphological changes of the Meghna River using remote sensing and GIS techniques, revealing significant bankline shifting, erosion, and accretion patterns over the past thirty years. The findings indicate that the lower Meghna River experiences more dynamic changes due to higher water discharge and sediment load compared to the upper river. The research identifies various contributing factors, such as hydrological changes and human activities, and

emphasizes the need for comprehensive monitoring and data collection to enhance understanding and management of the river's behavior.

- **Ravindra Kumar Singh *et al.* (2020):** Studied the spatio-temporal changes in the morphology of the Damodar River between Durgapur barrage and Bardhhaman town from 1990 to 2015, utilizing remote sensing and GIS techniques. It finds that human interventions, particularly dam constructions, have significantly altered the river's flow and morphology, leading to a 50% reduction in average cross-sectional area and substantial sediment deposition. The study concludes that these changes have resulted in increased bank erosion and a decline in the river's carrying capacity, necessitating careful management of river systems.
- **Adedeji *et al*** (2014): The study analyzes the spatio-temporal changes in the morphology of the River Kaduna,Nigeri using GIS and remote sensing techniques from high-resolution satellite images taken in 2003, 2008, and 2014. It reveals a significant increase in urbanization along the river, with built-up areas rising from 3.67% in 2003 to 34.30% in 2014, and the number of buildings within a 100m buffer zone increasing from 50 to 108. The findings highlight the urgent need for balanced land use planning and water resource management to address the environmental challenges posed by rapid urban development.
- **Mangambit Juliandar *et al* (2021):** The paper investigates the effects of river meanders on the morphology of the Citarum River in Majalaya, Bandung, using a comparative causal method.The study collected both primary and secondary data. Primary data included photos of existing conditions, river geometry size, river border-width size, and river plan, while secondary data comprised the Citarum River map, River Border Act, and long section data. It analyzes factors such as river speed, geometry, and the impact of meander shapes on the environment, highlighting issues like decreased water quality and erosion due to changes in river borders. The study concludes with recommendations for erosion control and community involvement in maintaining river sustainability.
- **Temple Probyne Abali & Lucky Baripara Nkii (2024):** The paper examines the impact of urbanization on the New Calabar River, highlighting significant changes in its morphology and hydrological dynamics due to increased paved surfaces. It discusses how urban development has led to enhanced runoff, altered channel dimensions, and affected sediment transport, necessitating improved watershed management strategies. The methodology adopted in the study involved a detailed examination of the New

Calabar River through the establishment of sample stations to assess human activities and their impacts on the river ecosystem. Data collection included measuring hydraulic variables such as width, mean depth, velocity, and discharge at various stations, complemented by spatial analysis of urbanization effects on channel morphologyThe findings emphasize the need for sustainable practices to mitigate negative impacts on river ecosystems and support local economic development.

- **Maya Fitri (2018):** Research investigates the morphology of settlements along the Musi River, focusing on how river characteristics influence settlement patterns. Data was collected through satellite maps, field surveys, and interviews, revealing that community dependence on the river affects building orientation, distance from the river, and housing typology. The study concludes that sustainable riverbank settlements should harmonize human activities with the conservation of river ecosystems.
- **Birhanu Kebede & Fedhasa Chalchissa Benti (2024):** The paper discusses land use and land cover changes in the Guder River Sub-Basin, Ethiopia, and their impacts on ecosystem services. It analyzes how these changes affect environmental health and resource availability, emphasizing the need for sustainable land management practices. The study aims to provide insights for policymakers to mitigate negative effects on the ecosystem.The study includes remote sensing and GIS techniques to analyze land use and land cover changes over time. Field surveys and interviews were conducted to gather data on local perceptions and impacts on ecosystem services.
- **Eggy Arya Giofandi *et al.* (2022):** The use of the Modified Normalized Difference Water Index (MNDWI) to analyze river morphology changes due to cut banks and point bars over a decade (2008-2018). The study found significant changes, with cut bank areas reaching 12.133 ha and point bars 4.488 ha, indicating the impact of environmental factors on river dynamics. The research highlights the effectiveness of remote sensing data in monitoring and understanding river morphology changes.The study involved the use of Landsat 5 and Landsat 8 satellite imagery from 2008 and 2018, respectively, to analyze the morphology changes of the Siak River.
- **J. B. Alam et al. (2007):** The research focuses on the morphological changes of the Old Brahmaputra River in Bangladesh, utilizing remote sensing and GIS technology to analyze sedimentation patterns and their socio-economic impacts. It emphasizes the importance of data collection, including socio-economic surveys and historical map analysis, to understand the effects of erosion and siltation on local communities. The

methodology adopted in the study involves a combination of remote sensing, GIS technology, and socio-economic surveys. Landsat TM data from two time points (1997 and 2004) were used for change detection through unsupervised classification, while GIS tools facilitated the analysis of hydrological parameters and sedimentation patterns. Additionally, a questionnaire survey was conducted among local communities to assess the socio-economic impacts of morphological changes, integrating both qualitative and quantitative data for comprehensive analysis.

- **Apurba Nath & Susmita Ghosh (2022):** The study analyzes morphological changes in the Barak River, India, focusing on the sinuosity index and bank erosion using Landsat data from 1990 to 2020. It assesses the effectiveness of existing protective structures and develops a model to predict future river discharges, highlighting the inverse relationship between sinuosity index and bank erosion. The findings emphasize the need for comprehensive erosion control and effective planning for vulnerable river sections to mitigate downstream hazards.They found that the Barak River exhibits significant morphological changes over the studied period, with a notable correlation between the sinuosity index and bank erosion rates. The SARIMA model effectively predicted river discharge, indicating that improved data collection could enhance model accuracy and river management strategies.
- **Masud Rana (2018):** Investigates the morphometric changes and socio-economic impacts of riverbank erosion along the Padma River, utilizing multi-date Landsat satellite imagery and GIS techniques. It highlights significant land loss due to continuous bank erosion, affecting the livelihoods of local farmers and fishermen, and emphasizes the need for further research with larger sample sizes for broader applicability. The study also discusses the limitations of using secondary data and lower-resolution satellite imagery in assessing the full extent of riverbank erosion impacts.

2.3 CRITICAL REVIEW

The research gave us a lot of information about how rivers change shape over time. It used different methods to study various rivers in different places and times. Each study used technology like GIS and remote sensing to look at how rivers have changed in the past and to understand how land use, river bends, and river shapes are connected. Together, these studies showed that rivers are always changing and can be affected by many things, including human activities like city building, farming, and building roads, as well as natural processes like erosion and climate change.

The research highlighted how changes in land use can greatly affect river shapes. It showed that when the land around rivers changes, it can change how fast rivers move, how they bend, and their overall shape. The studies also found important information about erosion and accretion and how these processes affect river movement.

Even though the studies had different results and methods, some common themes came up: the need for better ways to manage rivers, the importance of understanding how land has been used in the past, and how remote sensing can help predict future changes in rivers. However, there were challenges in understanding and combining data from different studies, which means we need to be careful when making conclusions. Overall, these studies provided useful information about how rivers work and highlighted the need for careful management that considers the relationship between land use and river changes.

CHAPTER 3

STUDY AREA, DATA & TOOLS

3.1 STUDY AREA

3.1.1 KOPILI RIVER

The Kopili River is a major left bank tributary of the Brahmaputra in Northeast India. It originates from the Saipong Reserve Forest in southeast Meghalaya..The 256 km long Kopili forms a common border between Meghalaya and Assam for 78 km. The remaining 178 km of the river flows through Assam before joining the Brahmaputra at Kopilimukh.The Kopili has a total catchment area of 16,420 sq km. It is the largest south bank tributary of the Brahmaputra in Assam.The river flows through the Meghalaya plateau, central Assam and the hill districts of Assam. Known for its rocky and swift nature, the Kopili features many waterfalls and supports rare wildlife.The river has been harnessed for irrigation and power projects, including the Kopili Flow Irrigation Scheme and the Kopili Hydro Electric Project. It is an important geographical and ecological feature of Northeast India.However, in recent years the Kopili has faced increasing pollution threats from unauthorized mining activities, domestic sewage, agricultural runoff, and soil erosion. This has led to issues like acidic pH and high sediment loads in the river. Proper management and conservation efforts are needed to restore the environmental integrity of this important Himalayan river system. The Kopili's biodiversity and role in supporting local livelihoods make it a river basin worth protecting through sustainable development policies.

3.1.2 ORIGIN AND COURSE

The Kopili River originates from the south-western slopes of the Shillong Peak in the state of Meghalaya. It is an inter-state river that flows through the Indian states of Meghalaya and Assam.The Kopili river basin extends across a geographical area of around 13,556 sq km. It is bounded by the Jayanti Hills to the west and the South Cachar and Mikir Hills to the east.Some of the major tributaries of the Kopili in its upper reaches are Kharkor, Myntriang, Dinar, Longsom, Amring, Umrong, Longku and Langkri rivers.In the lower stretches in Assam, the Kopili is joined by tributaries like Diyung, Jamuna, Umkhen-Borapani, Killing, Umtrew/Digaru and Kolong.The total length of the Kopili River is around 290 km before it merges with the Brahmaputra River. The river has a catchment area of 16,420 sq km. It flows in a southwest direction after originating from Meghalaya, traversing the Assam-Meghalaya border before entering the plains of Assam. The Kopili finally joins the Brahmaputra at a place known as Kopilimukh.The Kopili River flows past several major towns and cities as it traverses through the two states of Meghalaya and Assam. Some of the key urban centers located along the course of the river include Resubelpara, Jowai, Umrangso and Kampur. A substantial part of the Kopili river basin is situated in Assam's Karbi Anglong district. In addition to Karbi Anglong, the basin area also covers portions of the North Cachar Hills region in the state.

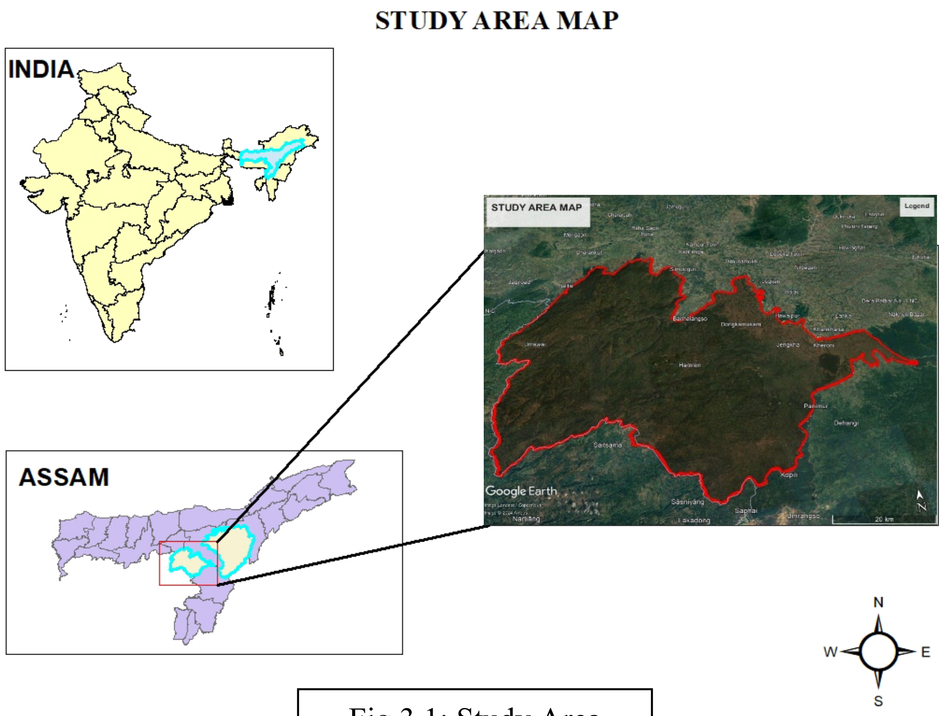

Fig 3.1: Study Area

3.2 DATA

This study employed river morphology data obtained from the United States Geological Survey (USGS). The dataset was accessed and downloaded to examine alterations in channel morphology, patterns of erosion, dynamics of sediment transport, and features of the floodplain.

Crucial information for comprehending the effects of both human activities and natural occurrences on river morphology within the study region was furnished by the USGS data.

Table 3.1 satellite data used

Spacecraft ID	**Landsat 4-5**	**Landsat 7**	**Landsat 8-9**	**Landsat 8-9**
Date	26-10-1994	20-12-2004	16-12-2014	29-11-2024
Sensor ID	TM	ETM	OLI_TIRS	OLI_TIRS
WRS Path	136	136	136	136
WRS Row	42	42	42	42
Resolution(m)	30×30	30×30	30×30	30×30

3.3 TOOLS

The primary tool utilized in the present study is ArcGIS (Geographic Information System) software, developed by Esri. ArcGIS is instrumental for spatial analysis, mapping, and visualization of geographic data, crucial for studying river morphology, land use patterns, and environmental changes. It integrates various data formats such as satellite imagery, digital elevation models (DEMs), and field survey data, enabling sophisticated analysis and modeling of terrain, hydrology, and vegetation. ArcGIS facilitates the creation of maps, identification of spatial relationships, and generation of insightful outputs like flood risk maps and habitat suitability models, essential for informed decision-making in environmental and geographical research. some of the key tool discuss below:

3.3.1. Hydrology Tools

Hydrology tools in ArcGIS are used to analyze and model the movement, distribution, and quality of water within a watershed. Some sub tool are

a) Flow Direction: Determines the direction of flow from each cell to its steepest downslope neighbour.

b) Flow Accumulation: Calculates accumulated flow as the accumulated weight of all cells flowing into each downslope cell.

c) Watershed: Delineates drainage basins and watersheds.

d) Stream Order: Assigns a numeric order to streams.

3.3.2 Spatial Analyst Extension

The Spatial Analyst extension in ArcGIS provides advanced spatial modeling and analysis capabilities, including tools for surface analysis, hydrology, terrain analysis, and raster operations. Some sub tool are

a) Raster Calculator: Performs map algebra operations.

b) Slope: Creates a raster representing the slope (gradient) of the terrain.

c) Aspect: Determines the direction that each cell's slope faces.

d) Hillshade: Creates a shaded relief from a surface raster by considering the illumination source angle and shadows.

3.3.3 Analyst Extension

The Analyst Extension in ArcGIS provides advanced spatial analysis tools for tasks such as hydrological modeling, terrain analysis, and surface analysis to support complex geospatial decision-making. Some sub tools are

a) TIN (Triangulated Irregular Network) Creation: Converts raster data to TIN for detailed terrain modeling.

b) Elevation Analysis: Examines the elevation profile of the river.

3.3.4 Geostatistical Analyst Extension

The Geostatistical Analyst extension in ArcGIS provides advanced spatial data analysis tools for creating predictive surfaces and assessing the uncertainty of spatial predictions using various geostatistical methods.Some sub tool are discuss below

a) Interpolation Tools: Kriging, Inverse Distance Weighting (IDW), and other interpolation methods to estimate unknown values from scattered data points.

3.3.5. Model Builder

Model Builder in ArcGIS is a visual programming tool that allows users to create, edit, and manage geoprocessing workflows and models by connecting sequences of geoprocessing tools using a drag-and-drop interface. Some sub tool are discuss below

a) Custom Model Creation: Automates complex workflows by chaining together multiple geoprocessing tools.

3.3.6. Network Analyst

Network Analyst in ArcGIS is a toolset used for performing complex network-based spatial analyses, such as finding the best route, closest facility, service areas, and vehicle routing problems. Some sub tools are discused below

a) Hydrological Network Analysis: Analyzes the river as a network, useful for understanding flow connectivity and stream ordering.

3.3.7. Data Management Tools

Data Management Tools in ArcGIS provide functionalities for organizing, maintaining, and manipulating geospatial data, including tasks like data conversion, projection, and attribute management. Some sub tools are discussed below

a) Feature Class to Shapefile: Converts data formats.

b) Merge: Combines multiple datasets into a single dataset.

c) Clip: Extracts input features that overlay the clip features.

3.3.8. Field Calculator

The Field Calculator in ArcGIS is a tool used to perform calculations on attribute table data, allowing users to update fields using mathematical expressions, logical statements, or string operations. Some sub tools are discussed below

a) Attribute Calculation: Computes new attributes or updates existing attributes based on expressions.

3.3.9. Charting and Visualization Tools

Charting and visualization tools in ArcGIS allow users to create dynamic and interactive maps, graphs, and charts to analyze and display spatial data effectively. Some sub tools are discussed below

a) Graphing Tools: Creates histograms, scatter plots, and other visual representations of data.

b) Symbology: Visualizes data using various symbology options to distinguish different river characteristics.

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

The research employed multispectral remote sensing data from the United States Geological Survey (USGS). Landsat images were obtained at decade intervals from 1994 to 2024 for examination (Table 3.1).

The investigation utilized layered Landsat imagery to evaluate changes in meandering characteristics, land use/land cover (LULC), and river movement. By examining Landsat data and digitized river courses, the research monitored changes in riverbank positions. Morphological assessments, based on digitized river paths, were crucial in comprehending oxbow formation and effects.

Furthermore, supervised classification methods were implemented to chart LULC, uncovering land use patterns across the examined region. The primary objectives of this study were to highlight morphological changes in the river and identify potential areas of oxbow development. Various techniques, as shown in Figure 4.1, were used to evaluate morphological and land use/land cover (LULC) changes along the channel in the selected study area. The research used different Landsat images, as detailed in Table 3.1. These images were used without atmospheric correction due to clear skies during observation. However, a significant limitation in this study is the 30-meter spatial resolution of the images used to create land use maps. These resolution constraints contribute to uncertainty in the study's results.

4.2 METHODOLOGY

Methodology is a systematic framework for analyzing research methods in a specific field of study. It provides a structured approach to collecting, interpreting, and validating data, guiding researchers in understanding complex phenomena. By establishing principles that ensure research reliability and accuracy, methodology serves as a strategic blueprint for conducting rigorous scientific investigations This systematic approach helps researchers design appropriate experiments, select suitable data collection techniques, and apply appropriate analytical tools to answer their research questions effectively. Methodology also enables scholars to critically evaluate existing research, identify gaps in knowledge, and propose innovative solutions to address complex problems in their respective fields. Furthermore, a well-defined methodology enhances the transparency and reproducibility of research findings, contributing to the overall advancement of scientific knowledge and fostering collaboration among researchers across disciplines.

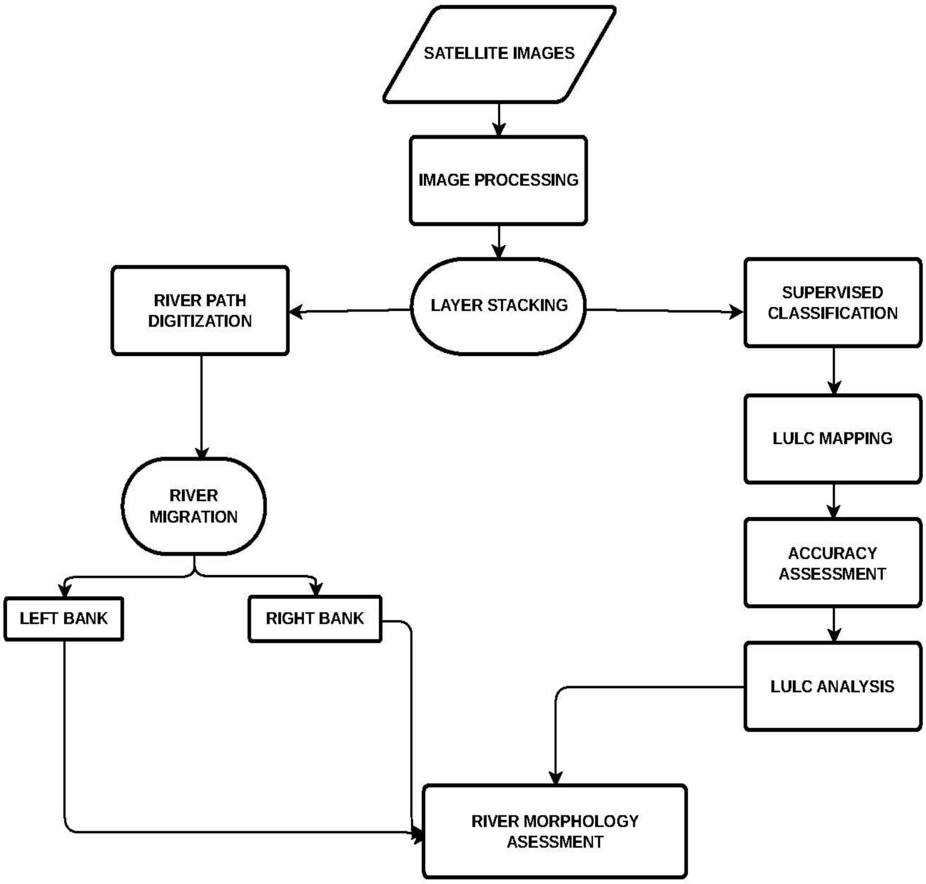

Fig 4.1: Operational Flowchart

4.3 LULC ANALYSIS

Land Use and Land Cover (LULC) analysis examines and maps how land is used and the natural features on Earth's surface. This process aids in comprehending the distribution, patterns, and shifts in land use and cover over time. It employs remote sensing, geographic information systems (GIS), and other data gathering techniques to categorize land into groups such as urban areas, agricultural regions, forests, and water bodies. LULC analysis is essential for urban planning, environmental management, and evaluating human activities' impact on ecosystems, supporting sustainable development and conservation initiatives. The following steps outline the process:

- Georeferencing: Align all images to a shared coordinate system accurately.
- Radiometric and Atmospheric Corrections: Implement corrections to eliminate sensor noise and atmospheric interference.
- Cloud Masking: Eliminate clouds and their shadows if present in the images.
- Select Classification Method

- Supervised Classification: Necessitates training data (examples of known land cover types).
  - Steps:
    1. Training Data Collection: Gather representative samples for each land cover class.
    2. Classification Algorithm: Utilize algorithms like Maximum Likelihood, Support Vector Machines (SVM), Random Forest, etc.
    3. Classification: Categorize the image based on the training data.
- Unsupervised Classification: Does not require training data.
  - Steps:
    1. Clustering Algorithm: Employ clustering algorithms such as K-means or ISODATA.

2. Cluster Analysis: Group pixels into clusters based on spectral similarities.

3. Labeling: Manually assign labels to clusters, creating meaningful land cover classes.

- Post-Classification Processing

    1. Smoothing: Apply filters to remove classification noise.

    2. Accuracy Assessment: Assess the classification's accuracy using ground truth data or validation samples.

- Analysis and Interpretation

    1. Change Detection: Compare LULC maps from various time periods to identify changes.

    2. Statistical Analysis: Examine the spatial distribution and area of each land cover class.

    3. Visualization: Generate maps and charts to illustrate the results.

4.4 RIVER MIGRATION

The morphology of rivers is significantly influenced by river migration. While field techniques are limited in accessing most alluvial river lengths, multi-temporal high-resolution data enables the tracking of changes in river configurations and riverbank erosion or deposition over time. Landsat data from 1994 to 2024 was utilized to monitor the shifting of riverbank lines along the Kopili River. River migration analysis was conducted by digitizing river paths from these Landsat images. To calculate the river migration rate, the river's centerline was created in ArcGIS, and the riverbank migration position was examined. The river was segmented into various sections, with each section assigned a station from which migration was measured for three decades.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 INTRODUCTION

Land Use Land Cover (LULC) and Meander Parameters are key elements in evaluating and comprehending the changes in Earth's surface features and waterbodies.

LULC involves categorizing and representing different landscape types based on their natural characteristics and man-made structures. This classification system divides land areas into groups such as woodlands, metropolitan regions, farmlands, and aquatic environments. The study of LULC is vital for various applications, including city planning, ecological surveillance, management of natural resources, and research on climate change.

Conversely, meander parameters focus on the attributes and behaviors of river channels, particularly their serpentine patterns. These parameters encompass aspects like the bend of the channel, its winding nature, erosion of banks, and the shifting of river curves. Examining meander parameters helps in understanding river dynamics, the movement of sediment, flood plain administration, and the effects on nearby ecosystems.

LULC and Meander parameters both serve crucial functions in diverse environmental studies, providing valuable insights into landscape transformations, water-related processes, and the interplay between humans and their surroundings. The combination and examination of these factors significantly contribute to well-informed choices in land stewardship, preservation endeavors, and initiatives for sustainable growth.

5.2 RESULT & DISCUSSION

5.2.1 LULC ANALYSIS

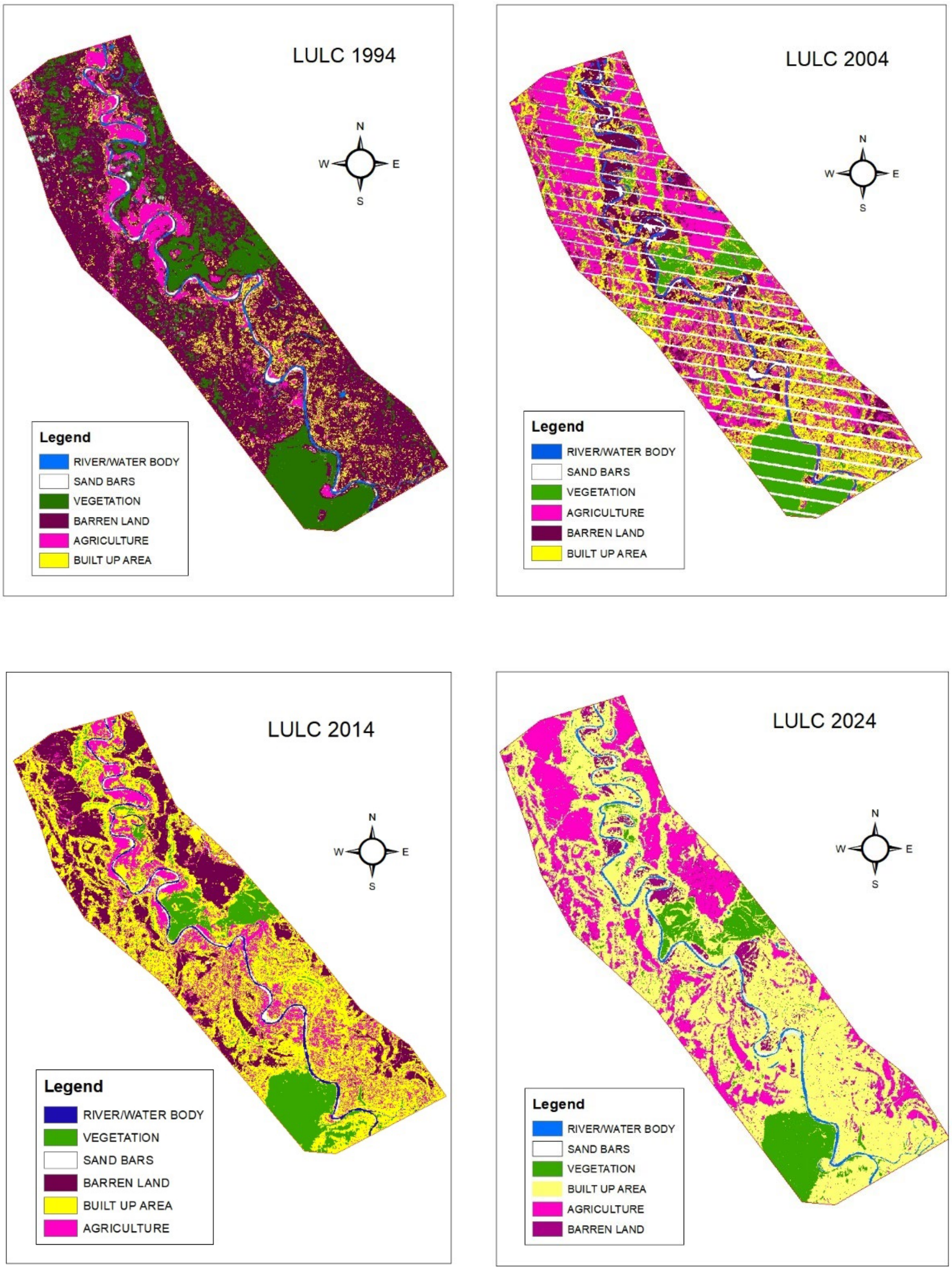

FIG 5.1 - LULC Mapping for years, a)2024, b)2014, c)2004, d) 1994

Table 5.1 RESULT OF LULC ANALYSIS :

NAME	1994		2004		2014		2024	
	Sum of Area(Km^2)	Total Area(%)	Sum of Area(Km^2)	Total Area(%)	Sum of Area(Km^2)	Total Area(%)	Sum of Area(Km^2)	Total Area(%)
AGRICULTURAL LAND	26.62	9%	102.26	36%	55.36	17%	76.23	23%
BARREN LAND	189.5	61%	43.55	15%	68.45	21%	16.59	5%
BUILT UP AREA	28.88	9%	86.63	30%	157.54	47%	195.18	59%
RIVER/WATER BODIES	4.41	1%	9.06	3%	7.21	2%	8.50	3%
SAND BARS	1.8	1%	3.16	1%	5.91	2%	2.78	1%
VEGETATION	61.42	20%	42.27	15%	37.81	11%	33.04	10%
Total Area (Km^2)	312.003769 5	100%	286.95	100%	332.30	100%	332.32	100%

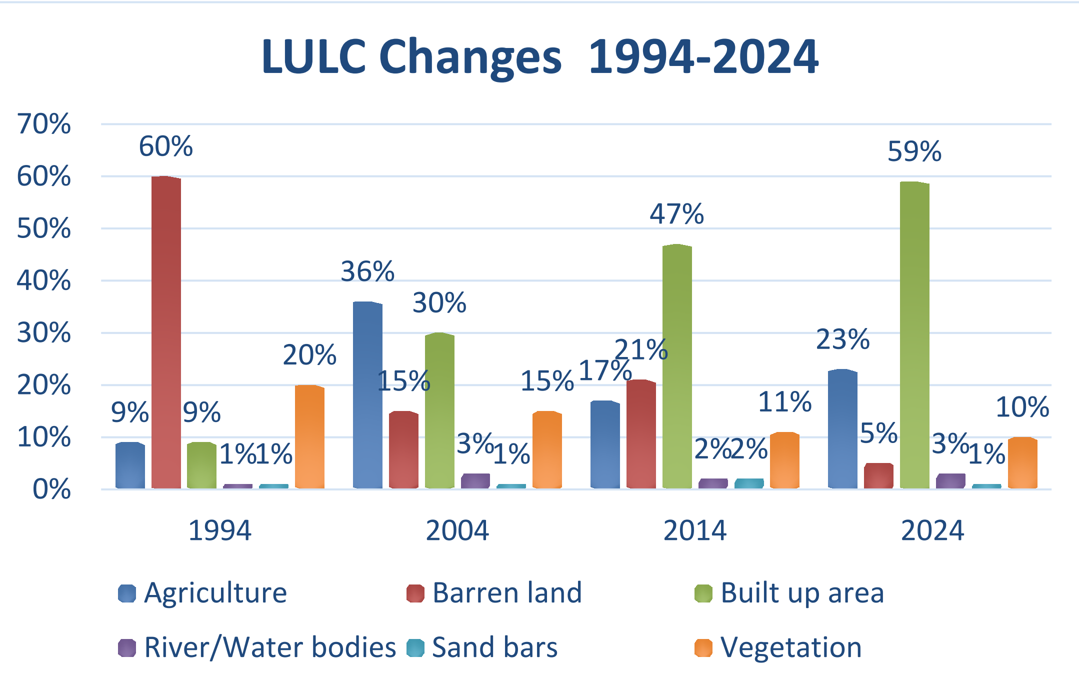

FIG 5.2 - LULC Changes 1994-2024

5.2.1.1 Agricultural land : It experienced a significant expansion from 9% in 1994 to 36% in 2004, representing a substantial 27% growth during this decade. However, the following decade saw a sharp decline, with agricultural land decreasing to 17% by 2014. Subsequently, a modest uptick occurred, with the percentage rising to 23% by 2024.

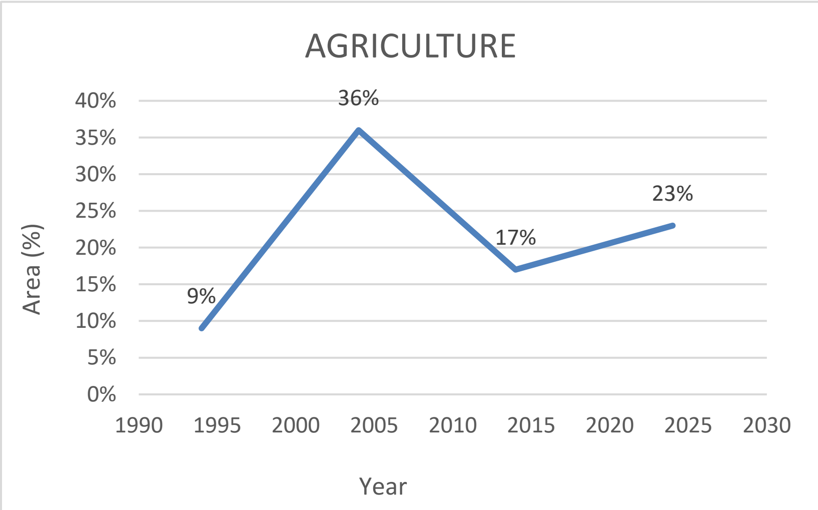

FIG 5.3 - Changes of Agriculture land 1994-2024

5.2.1.2 Barren land : The proportion of barren land experienced a dramatic reduction from 60% in 1994 to 15% in 2004, representing a substantial 45% decline during this timeframe. Subsequently, a minor uptick occurred between 2004 and 2014, with the percentage rising slightly from 15% to 21%. However, the downward trend resumed thereafter, with barren land further diminishing from 21% in 2014 to a mere 5% by 2024.

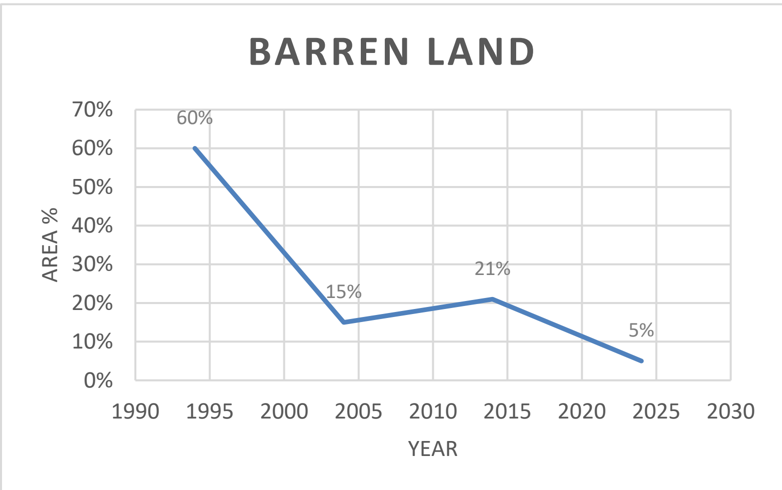

FIG 5.4 - Changes of Barren land 1994-2024

5.2.1.3 Built up area : The built-up area coverage has experienced a notable expansion, escalating from 9% in 1994 to 59% in 2024. This substantial 50% increase indicates potential factors such as urban development and demographic expansion.

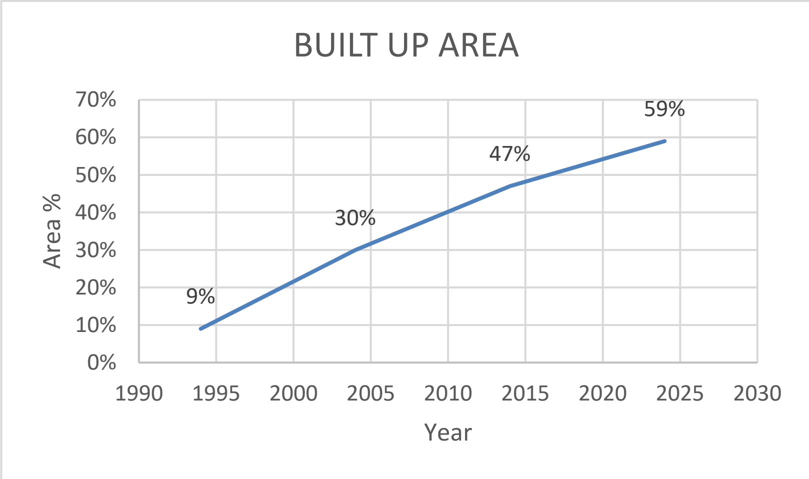

FIG 5.5 - Changes of Built up area 1994-2024

5.2.1.4 River/Water bodies : The area categorized as river/water body exhibited a variable trend over time. Initially, it rose from 1% in 1994 to 3% in 2004. Subsequently, a notable decline occurred, bringing the percentage down to 2% between 2004 and 2014. However, this was followed by another uptick in 2024. These fluctuations could be attributed to various factors, including natural processes or human-induced changes.

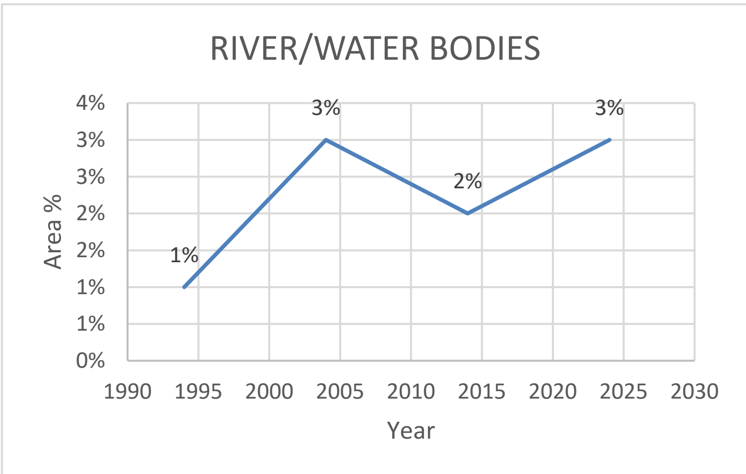

FIG 5.6 - Changes of River/Water bodies 1994-2024

5.2.1.5 Sand Bars : While the sand bars remained relatively consistent between 1994 and 2004, there were minor fluctuations, with a 1% increase from 2004 to 2014, followed by another 1% decrease from 2014 to 2024. These changes could indicate alterations in water management or natural variations.

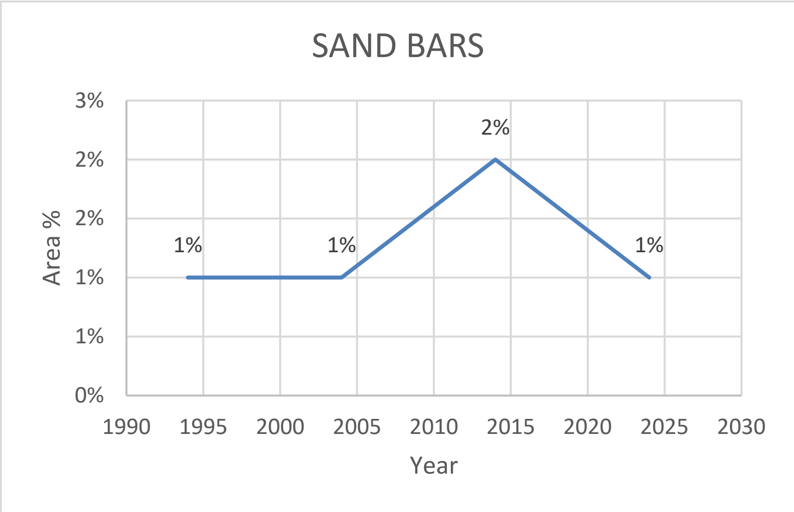

FIG 5.7 - Changes of Sand Bars 1994-2024

5.2.1.6 Vegetation : A remarkable decrease in vegetation coverage has been observed, falling from 20% in 1994 to 10% in 2024. This significant 10% decline suggests potential deforestation, urbanization, or changes in climate conditions.

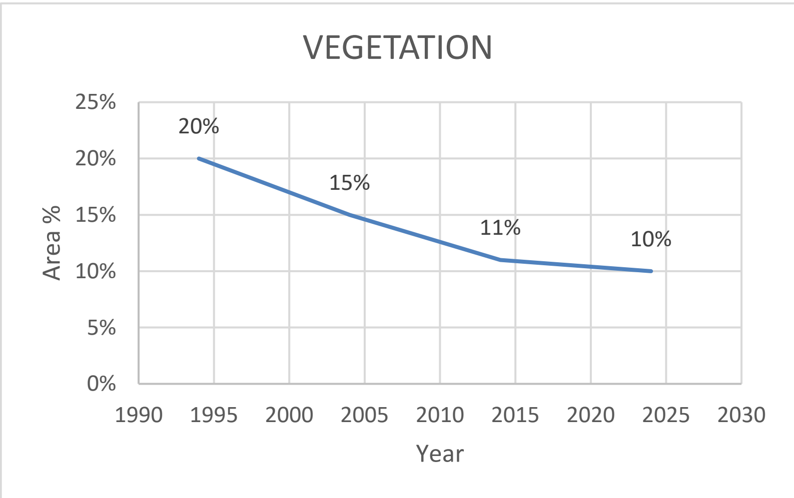

FIG 5.8 - Changes of Vegetation 1994-2024

5.2.2 IMPACT OF RIVER MIGRATION ON RIVER MORPHOLOGY

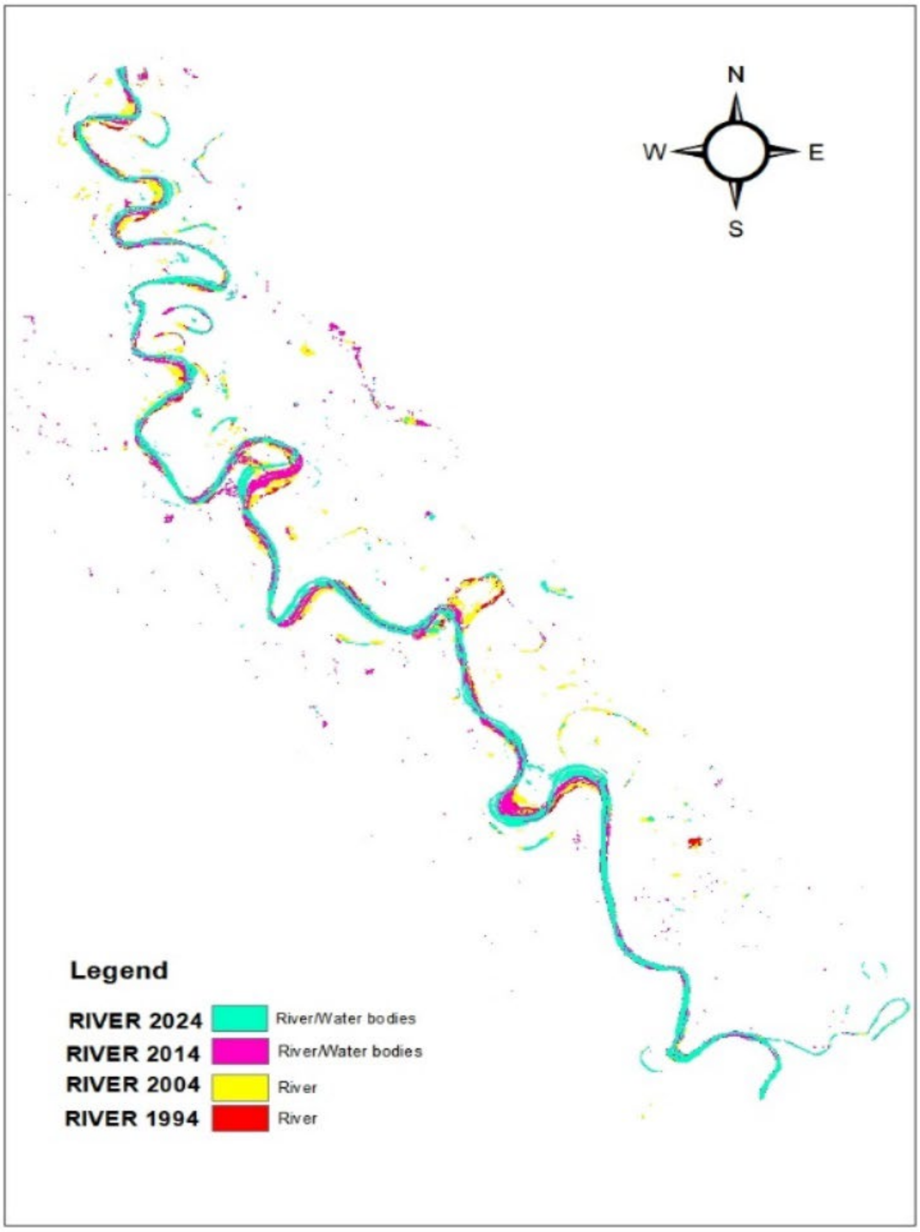

FIG 5.9 – Composit map of shifting of water bodies from 1994-2024

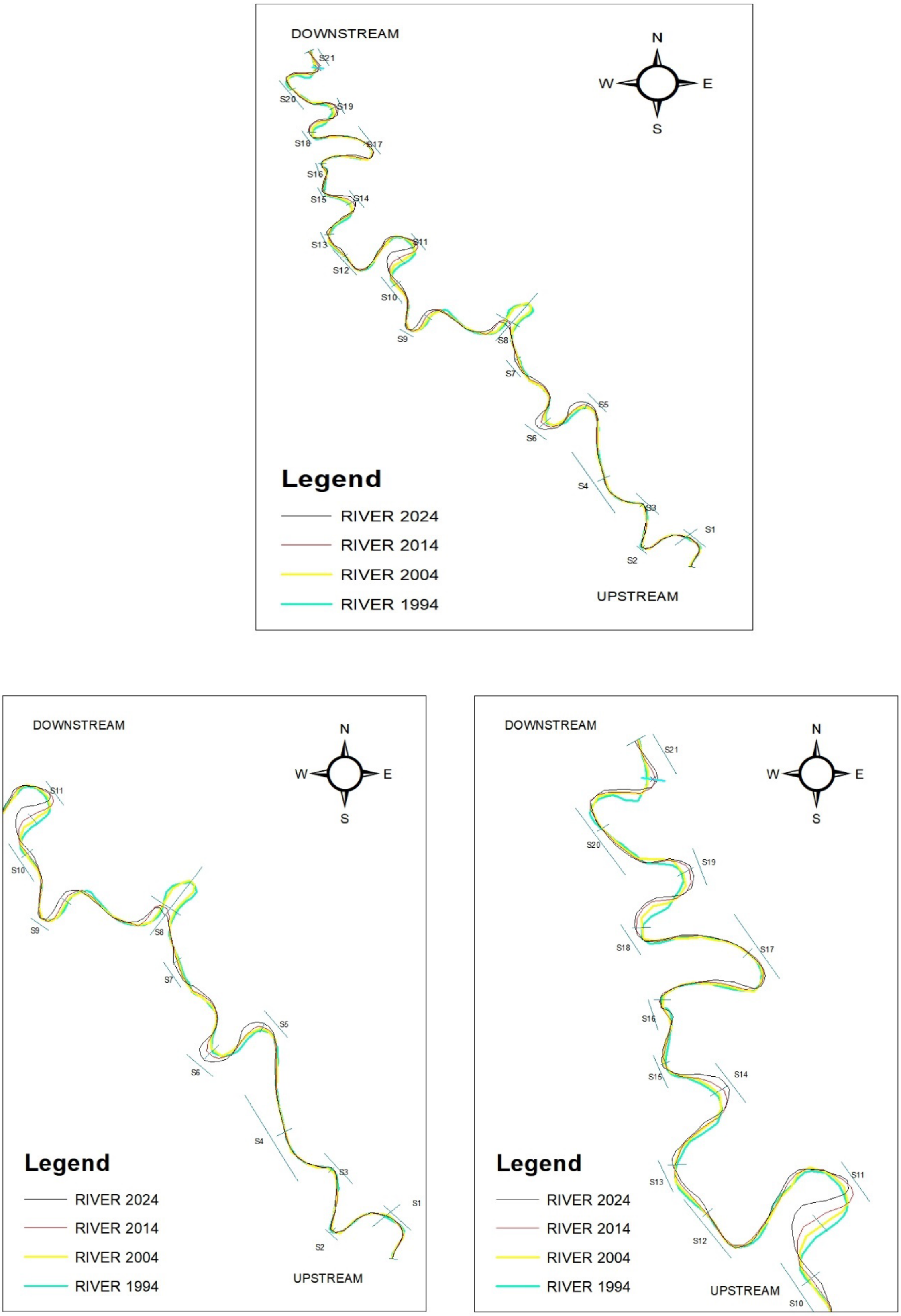

FIG 5.10– River migration in different sections from 1994-2024

Table 5.2 RIVER MIGRATION RATE :

SECTIONS	MIGRATION RATE (1994-2004)		MIGRATION RATE (2004-2014)		MIGRATION RATE (2014-2024)	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
S1	0	99.424	0	15.25	0	11.29
S2	0	67.57	38.15	0	17.24	0
S3	75.62	0	0	93.93	0	3.24
S4	0	0	23.8	0	0	3.13
S5	0	131.74	0	99.97	0	141.65
S6	0	97.17	207.87	0	319.56	0
S7	52.57	0	47.2	0	156.69	0
S8	106.89	0	1488.07	0	170.35	0
S9	0	79.14	0	123.22	0	174.78
S10	0	43.75	0	68.48	0	99.8
S11	174.63	0	204.05	0	459.86	0
S12	0	6.42	0	9.75	0	43.04
S13	46.03	0	0	2.58	54.78	0
S14	0	50.78	0	143.9	0	142.16
S15	69.67	0	0	42.89	65.39	0
S16	0	54.08	71.12	0	0	16.45
S17	0	0	0	20.8	16.04	0
S18	149.53	0	151.19	0	20.04	0
S19	0	42.33	0	161.15	0	52.63
S20	0	91.21	17.33	0	0	0
S21	0	23.93	0	192.87	0	35.02

5.2.2.1 Migration during (1994-2004) :

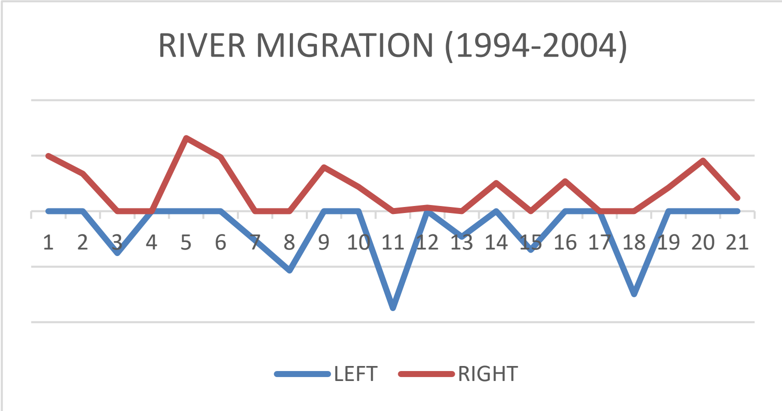

FIG 5.11 –River migration 1994-2004

- RIGHT Migration:

  Section S1, S5, S6, S9 and S20 show significant peaks, indicating a high migration rate to the right direction during the 1994-2004 period.

  These peaks suggest substantial movement or relocation in these specific region.

- LEFT Migration:

  Section S8, S11, S18 shows a significant peak, indicating a high migration rate to the left direction.

  Other sections such as S7,S13 and S15 show moderate migration rates in the left direction.

- Stable or No Migration:

  Several section, including S3, S4, S7, S8, S11, S13, S15,S17 and S18 show zero migration rates in the right direction, indicating stability or no significant migration in these directions.

Section S1, S2, S4, S5, S6, S9, S10, S12, S14, S16, S17, S19, S20 and S21 show zero migration rates in the left direction.

The migration rate data from 1994 to 2004 shows distinct patterns in different sections. These trends suggest that certain categories experienced substantial migration movements, while others remained relatively stable during this period. Understanding these patterns can help in identifying the factors driving migration and aid in planning and resource allocation.

5.2.2.2 Migration during (2004-2014) :

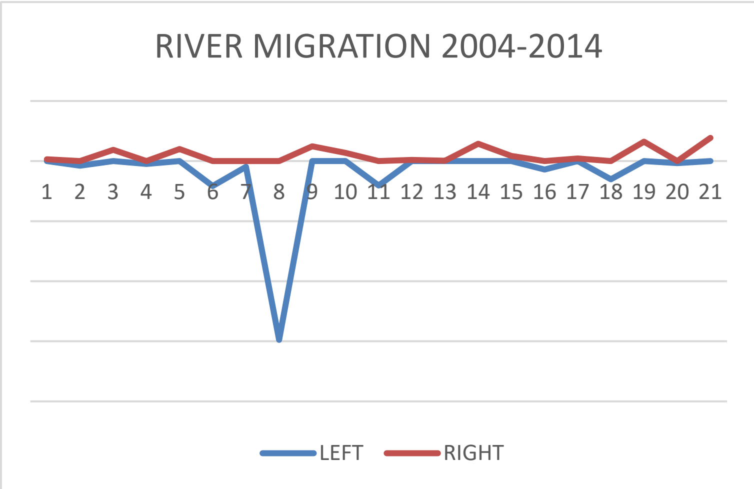

FIG 5.12 – River migration 2004-2014

- RIGHT Migration:

  Section S9, S14, S19 and S21 show significant peaks, indicating a high migration rate to the right direction during the 2004-2014 period.

  These peaks suggest substantial movement or relocation in these specific categories.

- LEFT Migration:

  Section SS6, S8, S11 and S18 show notable migration rates in the left direction.

  These peaks indicate that there was considerable movement or relocation in these region to the left direction.

5.2.2.3 MIGRATION RATE (2014-2024) :

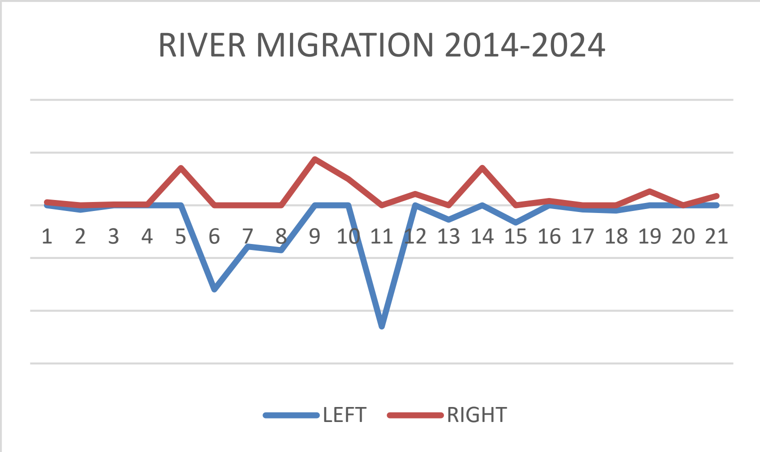

FIG 5.13 – River migration 2014-2024

- RIGHT Migration:

  Section S5, S9, S10 and S14 show significant peaks, indicating a high migration rate to the right direction during the 2014-2024 period.

  These peaks suggest substantial movement or relocation in these specific categories.

- LEFT Migration:

  Section S6, S7, S8 and S11 show significant peaks, indicating a high migration rate to the left direction.

  These peaks indicate considerable movement or relocation in these categories to the left direction.

CHAPTER 6

CONCLUSION

6.1 CONCLUSION

In summary, the LULC analysis assessment reveal significant transformations in the river area over the past three decades. The increase in builtup area land and decrease in vegetation highlight changing land use practices, possibly influenced by urbanization, reforestation efforts, and improved land management.

The examination of migration patterns uncovers significant differences in both the rates and directions of movement across various regions, highlighting the intricate interactions between natural phenomena and human activities.

Understanding these changes is important for managing land sustainably and creating policies that protect ecosystems. The information from this study can help in planning and using resources wisely to manage river shapes and reduce the effects of river movement.

REFERENCES

1. Kang, C.S., & Kanniah, K.D. (2022*). Land use and land cover change and its impact on river morphology in Johor River Basin, Malaysia.* , 41, 101072.

2. Kebede, B., Benti, F. C (2024). *Land Use and Land Cover Change and Its Impacts on the Ecosystem Services in Guder River Sub-Basin, Ethiopia*. 12(2).

3. Giofandi, E. A., Sekarjati, D., Hayat, D., Sekarrini, C. E., & Umar, I. (2022). *Optimization of Remote Sensing Data In Monitoring Morphology Change of Siak River in Pekanbaru City*. , 4(2), 11-17

4. Nath and S. Ghosh(2022),*Assessment of river morphology based on changes in land use and land cover and the spatial and temporal variation of meandering parameters of the barak river*,Civil Engineering Department, National Institute of Technology Silchar, Silchar, Assam, India;.

5. Minhaz, S. M. Ehasanul Haque, & Rezaie, A. M. (2023). *A Study on Morphological Changes of the Meghna River Using GIS & Remote Sensing.* Master of Engineering in Civil Engineering. DOI: 10.13140/RG.2.2.10288.94725.

6. Sharma, S. S. V., Roy, P. S., Chakravarthi, V., Srinivasarao, G., & Bhanumurthy, V. (2017). *Extraction of detailed level flood hazard zones using multi-temporal historical satellite data-sets – a case study of Kopili River Basin, Assam, India*. , 8(2), 792-802.

7. Nath and S. Ghosh(2022), *Meandering rivers' morphological changes analysis and prediction – a case study of Barak river*, Assam,Civil Engineering Department, National Institute of Technology Silchar, Silchar, Assam, India;.

8. Rana, M. (2024*). Morphometric Changes and Their Impact on Livelihood, Padma River, Rajshahi*. Thesis. DOI: 10.13140/RG.2.2.34906.76489.

9. Singh, R. K., Pasupuleti, S., & Villuri, V. G. K. (2020). *Investigation on Spatio-temporal Changes in River Morphology of Lower Damodar between Durgapur barrage to Bardhhaman town over a time Period of 1990-2015*. In , Indian Institute of Technology Roorkee and National Institute of Hydrology, Roorkee, February 26-28, 2020.

10. Adedeji, Y.M., Olorunfemi, J.F., & Fabiyi, I.P. (2014*). Spatio-Temporal Analysis of Changes in River Kaduna Channel Morphology using GIS Techniques.*

11. N Mohamad et al (2018). *Spatio-temporal analysis of river morphological changes and erosion detection using very high resolution satellite image*. IOP Conf. Ser.: Earth Environ. Sci. 169 012020 doi:10.1088/1755-1315/169/1/012020

12. J. B. Alam et al. (2007). *Study of morphological change of river old brahmaputra and its social impacts by remote sensing*.

13. Ebrahim Brooshkeh and Reza Sokuti (2017). *Temporal and Spatial Variations of Zarrineh-Rood River Morphology Using RS and GIS*. ISSN: 0373-2525),2017 Volume. 7(1): PP. 23-31

14. Mangambit Juliandar et al. (2021). *The Effect of River Meanders on River Morphology.* , 1783, 012071. doi:10.1088/1742-6596/1783/1/012071.

15. Abali, T. P., & Nkii, L. B. (2024). *The impact of urban land use changes on the morphology of the New Calabar River catchment.*, 300, 113-125. doi:10.1016/j.jenvman.2024.113125.

16. Fitri, M. (2018). *The Settlement Morphology Along Musi River: The Influence of River Characteristics*. , 45(2), 133-140. DOI: 10.9744/dimensi.45.2.133-140.