ASSESSMENT OF CHANNEL MIGRATION CHARACTERISTICS OF BHARATHAPUZHA RIVER FROM PALLIPURAM TO PURATHUR REACH USING GIS AND RS

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DECLARATION

We hereby declare that this project report entitled **"ASSESSMENT OF CHANNEL MIGRATION CHARACTERISTICS OF BHARATHAPUZHA RIVER FROM PALLIPURAM TO PURATHUR REACH USING GIS AND RS"** by us during the course and the project report is not previously formed the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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However, we alone are responsible for the views expressed here.

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SYMBOLS AND ABBREVIATION

~	Approximately
°	Degree
'	Minute
/	Per
%	Percentage
ASTER	Advance Space-borne Thermal Emission and Reflectance Radiometer
cm	Centimeter
DEM	Digital elevation model
DSAS	Digital shoreline analysis system
e.g	Example
et al.	And Others
ETM	Enhanced thematic mapper
Fig.	Figure
GIS	Geographic information system
i.e	That is
IMD	Intra multi decadal
KCAET	Kelappaji College of Agricultural Engineering and Technology
km	Kilometer
KVK	Krishi Vigyan Kendra
LiDAR	Light detection and ranging
m	Meter
MATLAB	Matrix lab
MSS	Multi-Spectral scanner
OLI	Operational land imager
RADAR	Radio detection and ranging
RS	Remote sensing
SRTM	Shuttle radar topography mission

CHAPTER I

INTRODUCTION

Water is one of the most essential needs for life. About 0.3% of the water resources in the world are usable. Water is essential to life because it heavily influence public health and living standard. However, the water is distributed unequally throughout the world in oceans, rivers, streams etc (Kilic, 2020).

Rivers are the prime agents controlling the global water cycle or technically called as the hydrologic cycle, which play a major role in integrating and organizing the landscape, and moulding the ecological setting of a basin. They then perform the most dynamic modes of transport. Rivers carry elements, in suspended or in dissolved form, from their source and deposit them sequentially based on their physico-chemical nature at different locations. And it is this life-giving liquid treasured in these rivers enables sustenance of life on earth. Rapid increase in demand of water in agriculture, industry and domestic uses, to meet the requirements of increasing population has forced man to develop new management and conservation techniques for river systems (Jose and Thomas,2007).

Rivers and streams are natural watercourses on the surface of earth and are of great geological importance. They are dynamic in nature and show great spatiotemporal variation in their shapes and sizes. Because of erosion and deposition, there are regular changes in the shape and size of a river. A firm understanding of channel migration and associated processes of erosion and deposition will allow for management of river behaviour and decision-making process of water resource management (Alam *et al*.,2007).

Most of the rivers in the world are subjected to bank erosion and channel migration at some point of time. The monsoon runoff is known to affect the river bank erosion rates. The river has to face a number of problems that have resulted in its degeneration to the point that it can no longer be saved. People's chaotic, non-conservative attitude has rendered much of the country's water unfit for human consumption. Until a few decades ago, the river used to flow freely even during the hottest summer months. However, in the last 30 years, sand mining has entirely destroyed the thick sand bed, which has been replaced with grasses and plants, resulting in an environmental disaster (Padmalal and Maya,2014)

Soil erosion hazards is a challenging assignment due to multiple concurrent processes that affect individually other complicated relationships and affect quantities also that vary in both time and place. For soil erosion risk assessment, a number of models were used for assessing soil loss through erosion by rainwater, a steep slope, or a tiny catchment since 1960s. The efforts have been focused to be based on spatially distributed models simulating erosion dynamics and surface runoff of increasingly complex and larger catchments using to GIS competences (Bahrawi *et al.*,2016).

For the assessment and administration of water management, sophisticated tools such as remote sensing, global positioning systems, and geographic information systems can be very useful. Remote sensing and geographic information systems (GIS) are critical tools with a wide range of applications for addressing many agricultural and water management concerns. Crop discrimination, crop growth monitoring, stress detection, crop inventory, soil moisture estimation, crop evapo-transpiration computation, site-specific management or precision agriculture, crop acreage estimation, and yield prediction are just a few of the applications for these technologies in agriculture. Remote sensing and GIS techniques can be used to provide such information on a regional scale. Land use or land cover analysis, as well as damage assessment due to drought, floods, and other extreme weather events, can all benefit from remote sensing and GIS (Kingra *et al.*,2016).

In the sphere of agronomical research, remote sensing provides various advantages. The analysis of agricultural crop canopies has yielded useful information on agronomic aspects. Crop classification, crop monitoring, and yield evaluation all benefit from remote sensing. Because they are particularly vulnerable to variations in soil, climate, and other physico-chemical changes.Remote sensing is required in the field of agronomical research. In relation to the biological life cycle of crops, the monitoring of agricultural production systems follows strong seasonal trends. Furthermore, due to unfavourable growth circumstances, agricultural productivity can fluctuate dramatically over short periods of time. Agricultural systems should be monitored on a regular basis. Remote sensing is an important technology for providing an accurate image of the agriculture sector with a high revisit frequency and accuracy. For sustainable agricultural management, all elements influencing the agricultural sector must be examined on a spatiotemporal basis (Palanisamy *et al.*,2019).

River morphological study can be done quantitatively and qualitatively using remote sensing and geographic information systems (Tariqul.I.M,2010). The most recent river configuration, shift in river courses, formation of new channels or oxbow lakes, bank erosion or deposition, drainage-congested areas, and so on can be mapped at various scales using multi-temporal high-resolution satellite data (Manjusree *et al*.,2013).

Morphological analysis of river streams is necessary for disaster prevention and mitigation planning, including guaranteeing navigational safety, suitable intake structure allocation, and scour estimates at bridges. It also aids in the delineation of the basin and planning for long-term management. River channels are often examined in the discipline of fluvial geomorphology with measurements of widths and water volume. The utilisation of remote sensing-based decision-support information is a step forward from the largely localised and equipment-based assessment of river channel conditions. These techniques are found to be very effective in hydrology. The techniques will serve as a model for future research, especially since the imageries are mostly free and accessible to most researchers, and software for geographical information analysis is available in both proprietary (e.g. ArcGIS, IDRIS, and MATLAB) and open-source (e.g. QGIS and Scilab) forms. The findings can be used to give decision-making information to relevant governmental and non-governmental organisations (Ibitoye,2021).

Kerala has 44 rivers, in which 41 are west flowing and 3 are east flowing. West flowing rivers drains into the join the Arabian sea or the backwater lakes. All 44 rivers originate from the Sahyadri hills of the Western Ghats. The most important rivers in Kerala are Periyar which has a length of 244 km, the Bharathapuzha of 209 km, the Pamba of 176km, the Chalakudy Puzha of 144 km, the Kadalundipuzha 130 km, and the Achancoil 128 km (Gurumurthy and Tripthi,2015).

In Kerala, the Bharathapuzha river basin is located between 10° 26' and 11° 13' north latitudes and 75° 53' and 77° 13' east longitudes. With a length of about 209 kilometres, Bharatapuzha, also known as Nila, is Kerala's second longest river. The Aliyar river originates in the Anamudi peak, which stands at 2695 metres above mean sea level on the Anamalai Hills in the Western Ghats, and flows westwards to meet another river, Palar, which also originates from the same hill range. The river is known as the Kannadipuzha in Kerala until it meets the Kalpathipuzha. It is known as Bharathapuzha or Ponnani river after it meets the Kalpathipuzha. As it flows down to the Arabian Sea, it is joined on the left bank by the Gayathripuzha at Mayannur and on the right bank by Thuthapuzha at Pallipuram. It is India's largest bio-diversity river. The unpredictability of rainfall and recurring floods in

Kerala have resulted in a noticeable trend in river bank erosion. (Gurumurthy and Tripthi,2015).

Considering Bharathapuzha basin the average annual water discharge and sediment load of the Bharathapuzha basin to the Arabian Sea are found as 4.71 km^3 and 0.37×10^6 tons. Many areas along the Ponnani shoreline are seeing serious erosion, according to the findings. In many studies related to the erosion in Bharathapuzha, the impact of these shoreline protection structures and coastal processes on the erosion process was also considered. Ponnani is an actively eroding coast with varying erosion rates, according to the study. The rate of erosion was determined to be high, with a rate of more than -4 m/year for the 35 km of coastline studied. Areas of increased erosion along the Ponnani coast require long-term management and protection (Sheeja *et al.*,2020).

In the river Bharathapuzha, area from Pallipuram to Purathur having a length of 20.11 km is a highly erosion prone and the livelihood and habitats of people was affected by the erosion of land. Huge amount of fertile agricultural land is eroded every year. The recurring flood has caused several random shift in river banks and direction of the river. Thus, it appeared necessary to conduct a study and analyse the morphological characters of the river to implement accurate conservation measures and control measures.

This study aimed at using satellite imagery to identify spatial trends in the channel migration and erosion and accretion rates in the river Bharathapuzha over a time period of 4 years, i.e., from 2017 to 2020. By using remote sensing and GIS technology, the river profiles from Pallipuram to Purathur were developed and the rates of bank erosion and channel migration have been found. Hence this project has been undertaken to study about the given area in Bharathapuzha with the following specific objectives:

1. To identify the changes in the left and right bank reach of Bharathapuzha from Pallipuram to Purathur using GIS & RS.
2. To identify the hotspots for maximum stream bank erosion in this reach.

CHAPTER II

REVIEW OF LITERATURE

A critical review of major studies conducted to analyse the channel flow migration, bank erosion and deposition and role of GIS and RS in river morphological study is presented in this chapter.

2.1 STUDIES RELATED TO BHARATHAPPUZHA

Bharathapuzha also known as the Nila or Ponnani River is the second longest river that flow in the state of Kerala with a length of 209 km. The river flow from Anamalai hills in Western Ghats and flow westward through Malappuram, Palakkad, Thrissur district of Kerala. Bharathappuzha is the lifeline of lots of people in state, but now experiences terrific pressure because of invasions, sand and clay mining and illegal diversions of water and also losses its fertilization.

Raj and Azeez (2009) examined the spatiotemporal variation in water quality and quantity of Bharathapuzha river basin using multivariate statistical analysis tools. The sub basins varied considerably in terms of river discharge, elemental concentration as well as elemental load. It was found that basins that are more disturbed, monsoonal discharge was very advanced than the discharges in other seasons, while the slightly disturbed basin had stable level of discharge throughout the season. Changes in land use and the impact of dams are major reasons for the spatiotemporal variations in the surface water chemistry of the river.

Raj and Azeez (2009) investigated the rainfall trend using Mann Kendal's rank correlation statistics and wavelet analysis. The basin's annual rainfall, southwest monsoon, and pre-monsoon rainfall all show a significant decrease. The primary causes of variation are global climate and local environmental changes.

Jagadeesh and Anupama (2014) studied to define trends in the annual and seasonal total rainfall over Bharathapuzha basin. The method was based on the nonparametric Mann–Kendall test for the trend and the nonparametric Sen’s method for the magnitude of the trend. An alike trend observed from liner regression analysis, existed for annual and seasonal rainfall series estimated by Mann–Kendall Z statistics and Sen’s Slope method. Overall trend analysis for annual rainfall discloses stations in the north and east shows a growing trend and stations in the south and west a declining trend. Recent study will direct the future planning and management of water resources at Bharathapuzha river basin.

Varughese (2016) studied that the monthly stream flow during the observed period is less compared to the current scenario in the Bharathapuzha basin. By the gridded data provided by IMD, also determines the trend in rainfall by Mann-Kendall test as an indicative of catchment hydrology, it was found that the system was seriously affected by unsustainable exploitation of its surface water and ground water resources. A drastic increase in urban area, deforestation, sand mining and decrease in natural vegetation causes increase in temperature and decrease in rainfall.

Manjula and Warrier (2019) studied the Hydro chemical investigation of open well and river water samples of Thuthapuzha Sub-basin of Bharathapuzha, Kerala, was carried out to determine the spatial and temporal variations in the physico-chemical parameters. The suitability of water for drinking and irrigation purposes and the processes controlling the water chemistry. The chemical properties of the river water samples were controlled by alkaline earths and weak acids ($CaHCO_3$ type). Even though bulk of the open well samples belonged to $CaHCO_3$ type, few samples belonged to NaCl, mixed CaMgCl and mixed $CaNaHCO_3$ water type. The groundwater and river water chemistry of the region was influenced by the chemistry of the host rock rather than precipitation and evaporation. Except pH and the total iron concentration, all other physicochemical parameters of the open well samples of the study area were within the satisfactory limit of drinking purposes.

Drissia and Anjali (2020) studied and gave a route for the evaluation of water scarcity in a river basin. The study area was the Bharathapuzha river basin in Kerala, India. The study has two steps (i) assessment of water scarcity using blue water scarcity indicator and (ii) analysis of influential factors. The magnitude and severity of water scarcity rise during January and February and reach maximum during March. The influential factors such as variation in change in demand, hydrological parameters, and the impact of land use change and engineering measures on stream flow are analysed. Among the findings it was the increase in demand due to growth in industries and population, long-term reduction in annual and southwest monsoon, especially in water scarce regions. In addition, Soil Water Assessment Tool model has been carried out to find the impact of land use change and engineering measures.

2.2 CHANNEL FLOW MIGRATION

The flood plain management in any area requires identification of the zones of river migration, and regulate the development within these areas The shifting of river channels across their floodplain terraces and the occasional erosion of the terrace banks was a natural process (Randle. T.J, 2006) over period, the natural rates of channel migration may be accelerated by anthropogenic activities.

Aiswarya *et al*. (2009) focused on measures to sustain this water source throughout the year, with the specific goals of modelling the topography of the river using a Geographical Information System (GIS), studying the existing flow pattern of the river using a simulation model, and, based on the findings, suggesting sustainable interventions to improve the river's summer flow regimes. Information on sub basin water balances can be particularly useful in planning in-situ water conservation strategies to increase the river system's dry weather flow.

Samanta and Pal (2012) used an empirical methodology for mapping and analyzing the channel morphology using remote sensing and Geographic Information Systems (GIS) techniques. The study area was the part of Kasai river which is located nearer to the Medinipur municipality under West Bengal, India. IRS 1D LISS III; LANDSAT MSS and ETM+ and Cartosat-1 satellite data were used along with field survey data. Different cross-sectional data of river bed elevation are collected across and along the Kasai river. Channel morphology mentions by cross sectional characteristics, channel length, channel width, slope, meandering, channel bed topography, channel pattern etc. This study was to find out the Land use or land cover characteristics of the flood plain, erosional and depositional characteristics of river bed and river bank, changes of channel morphology, the human activities like sand extraction from river bed,agricultural activity ,disposal of muncipal waste and construction of dam are the reason to change the channel morphology of Kasai River in Paschim Medinipur.

Abubakar and Bashir (2013) observed that the changes in channel morphology, particularly changes in channel width, have a socioeconomic impact on crop output in neighbouring land. The channel width was determined using LandSat MSS images as well as LandSat ETM images. Data on the socioeconomic impacts of the alterations was gathered by the distribution of 300 questionnaires to randomly selected respondents in nine riverine settlements. The findings revealed that the vast majority of respondents work in land-based economic activities, with 55.1 percent and 13.4 percent engaged in farming and grazing, respectively. The respondents were exposed to the vagaries of changes in the channel morphology, with losses in farm produce as a result of increasing incidence of bank erosion, which causes channel widening, on average 61 percent have their farmlands located less than 100 metres from the channel bank. The other factors, expose the respondents to the vagaries of changes in the channel morphology, with losses in farm produce as a result of increasing incidence of bank erosion, which causes channel widening.

Hussain *et al.* (2016) provides an overview of the trend of riverbank erosion along the Padma River in the districts of Munshiganj, Madaripur, and Shariatpur. It also depicts the change in land cover caused by riverbank erosion. Remote sensing and geographic information systems (GIS) techniques were used to calculate riverbank erosion. To achieve the research objectives, only secondary data were used. To process and analyse raw data, various computer software such as Erdas Imagine, Arc GIS, Google Earth, Environment for Visualizing Images, and others were used. The riverbank migration patterns and land dynamics of Padma caused by accretion/erosion processes were investigated in this study using seven selected Landsat TM and OLI images acquired from 1988 to 2017. Using this software, it can analyse the erosion of Padma.

Khan *et .al.* (2018) studied River planform characteristics and sinuosity and theses are well-known geomorphological indices that regulate channel hydraulics and stream power, determining flow velocity and sediment supply to downstream reaches. Despite their importance, little research has been done on these indicators in the Yamuna River to better understand topographic control and hydraulic regime. This paper examined the channel planform features and sinuosity by using topographic map, digital elevation model (DEM), and satellite imageries to explain the morphological, sedimentological, and hydrological characteristics of the channel. The parameters examined to determine the factors influencing sinuosity development indicate geomorphological and anthropologic control. Because the studied stretch flows through an alluvial plain with a low rate of discharge, tectonic control of sinuosity was ruled out.

Yunus *et.al* (2020) evaluates the river migration behaviour and quantifies the adjustment on an alluvial reach of the Yamuna River through an analysis of topographic map and satellite imageries for the period between 1954 and 2015. The Digital Shoreline Analysis System (DSAS) tool in a geographic information system (GIS) was used to quantify the river migration: (i) net river migration; (ii) linear regression rate, and (iii) end point rate was calculated for ~70 km length of stream reach by casting 1580 transects at 50 m intervals. The results showed that the River Yamuna at the studied reach of meandering bend 5 has adjusted to the effects of the flood in the 1970’s. The decline in river discharge rate over the last couple of decades were reduced the erosional capacity of the river and subsequent migratory behaviour. Sinuosity indices indicate that the river was both increased and decreased in length after 1954. Our result shows that the DSAS method has the potential for assessing and quantifying past and potential future channel migration, and then define the migration boundaries.

Sarkar (2020) studied the channel migration of Nagar river situated in west Bengal. The main objectives of their studies was to analyse the hydraulic characteristics of the Nagar river, explain the trend and rate of Channel migration and to find out the relation between river hydraulic and channel migration. To analyse the hydraulic characteristics between the variables of the using power law equation, hydraulic characteristics of the river are analysed by the using Leopold and Maddock equations. There are two methods for measuring channel migration trend and rate i.e., sinuosity index and cross section analysis, which applied in the study area of Nagar River. The result shows that the width instead of increase randomly increases or decreases due to human interventions like construction of the bridge, embankment, settlement, etc. depth also varied along the channel instead of gradual decrease from source to mouth region. As a consequence of modification channel artificially, fluctuation in river energy was the result and effect which again affects the channel pattern that is sinuousness or the planimetry.

2.3 ROLE OF REMOTE SENSING AND GIS

It can be stated beyond doubt that GIS can be a very efficient tool in the process of identification and mapping of river changes and bank erosion. Remote Sensing digital data can give the better results than the conventional methods. Finally, it can be said that in spite of some changes, topographical remote sensing data and GIS studies can help to change detection and other field of fluvial sciences.

Senanayake (2007) found that remote sensing-based airborne and space-borne sensors such as multi-spectral, hyperspectral, Radio Detection and Ranging (RADAR), and Light Detection and Ranging (LiDAR), and their many applications, have been utilised to monitor soil erosion at various landscape sizes around the world.

Aher *et al.* (2012) pointed out that the earth's surface is constantly changing due to a variety of natural and human agent actions. These agents remove the materials from the land surface by cutting, carrying, and depositing them. The erosion capability of running water is greater than that of other geomorphologic forces. This research project is focused on the Pravara River, whose channel is constantly changing as a result of geomorphic, climatic, and human activity in the area surrounding the river. The major goal of this research is to identify changes and make positive ideas for controlling bank erosion and shifting of the Pravara River by using GIS and remote sensing. The comparative result illustrates the 35-year changes in the river bank as a result of numerous natural and man-made activities such as floods, water velocity, sand excavation, vegetation removal, and fertile soil excavation for various purposes by the surrounding surrounds region's inhabitants.

Khan *et al.*(2014) a complete analysis was performed utilising cutting-edge GIS technology to determine the river's vulnerable portions in terms of bank erosion. GIS and RS are useful tools for identifying river changes and bank erosion problems. This computer-based technique provides a platform for analysing spatially diverse data and aids in the discovery of influential outcomes. The main aim of the work was to estimate the real rates of bank erosion along the Jamuna River using time series analysis of satellite pictures. This investigation also focuses on the pattern of channel alignment change and the identification of reaches that are at risk of bank erosion.

Sunny (2014) analysed that using DTA various geomorphological parameters of the Bharathapuzha basin was derived which is important in hydrology. The Digital Terrain Analysis of the Bharathapuzha basin resulted in the creation of slope map, aspect map, drainage density, flow length map etc. It is observed that the river had an elongated nature with moderate relief and slope. The relief parameters and linear parameters was analysed quantitatively using GIS and was found very helpful in linear basin evolution, basin prioritization for soil and water conservation and natural resource management.

Das *et al.* (2015) described that remote sensing and GIS could be used on rapid assessments without disturbing the soil surface and have vast spatial coverage. In addition, these technologies help for a sequence of a time-period assessment with a less cost. Although high spatial resolution satellite imagery such as IKONOS, QuickBird and Spot 5 are in high cost, coarse resolution satellite imagery: Landsat, Moderate Resolution Imaging Spectrometer (MODIS), National Oceanic and Atmospheric Administration Advanced Very High-Resolution Radiometer (NOAA-AVHRR) and Advance Space-borne Thermal Emission and Reflectance Radiometer (ASTER) are freely available freely available for researchers and can be utilized for the time series analysis.

2.4 BANK EROSION AND DEPOSITION

Sarma *et al.* (2007) studied the Burhi Dining river flows in a meandering course for about 220 km through alluvial plains of Assam together with a short rocky and hilly tract in between. Sequential changes in the position of bank lines of the river due to regular bank erosion have been considered from Survey of India topographic maps of 1934 and 1972, and digital satellite data of 2001 and 2004 using GIS. Two broad kinds of changes have been observed, e.g. alteration of direction of flow due to neck cut-off and progressive gradual change of the meander bends that accounts for translational, lateral, rotational, extensional and other types of movement of the meander bends. The amounts of the bank area lost due to erosion and gained due to sediment deposition are estimated separately. The results shows hard rocks of the hilly tract situated in between result in development of entrenched meandering and this tract has suffered minimum bank erosion.

Sarma and Acharjee (2012) studied about the Kaziranga National Park which is located at the foot of the Mikir Hills on the southern bank of the Brahmaputra River. The Brahmaputra River flows through Kaziranga National Park in a braided course for approximately 53 kilometres. The sequence of changes in the position of the river's bank lines due to consistent bank erosion was studied using GIS and topographic maps from the Survey of India, as well as satellite IRS LISS III images. Separate estimates are made for the amount of bank area lost due to erosion and gained due to sediment deposition. A lineament and a few faults have controlled the trend of the course of the Brahmaputra around Kaziranga area. The main cause of erosion of the Brahmaputra is the loose non-cohesive sediments of the bank throughout the park. The braided channel of the river strikes the bank directly and undermines the silty bank causing overhanging blocks to be carried away easily by the river current.

Soil, one of the non-renewable resources on this planet, is being depleted at an alarming rate due to various anthropogenic activities. Soil erosion is a natural dynamic process driven by various agents such as water and wind, resulting in degradation of the topsoil; the rate of soil erosion is accelerated by anthropogenic interventions such as land use–land cover modification, overgrazing, deforestation, mining, unscientific agricultural activities, and construction practices. The erosion process starts with soil particle dislodgement by the raindrops in the highlands. These dislodged particles are carried away by surface runoff and moves downslope through the channels. The effect of soil erosion could range from on-site ecosystem fragmentation to off-site reservoir storage capacity loss. Though soil erosion is caused by various agents such as wind, water, etc., water erosion is the major type. Heavy rainfall during the monsoons and the relatively thin cover of soil over the bedrock aggravates the damage potential of this form of erosion in the state of Kerala, India (Bhattacharya *et al.*,2016)

Wilson (2017) studied the effect of sand mining from the reach of bharathapuzha river between pattambi and kuttipuram using remote sensing and GIS, assess the impact of sand mining and also spatial and temporal variation of channel enlargement and lateral migration. CARTOSAT-1 DEM& SRTM DEM from earth explorer and bhuvan are used to analyse the cross sectional details also. Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) imageries for analyzing the spatial and temporal variation in the river reach imageries were processed using ArcGIS 10.5 software. The result shows illegal sand mining in this reach of river causes the change in river flow pattern and bank erosion is predominant which causes decrease in river width.

Sheeja *et al.* (2020) studied the coastal erosion along the Ponnani coast by using the multispectral imageries band GIS were undertaken to assess the temporal changes in coastal erosion, its extent, magnitude, and trends in the region. The digital image processing software used for calculating the erosion rate was TNTmips 2014 professional version (Map and Image Processing System - MIPS) by microi mages, Inc. Results disclosed that many places along the Ponnani shoreline are under severe erosion. Short-term erosion assessment revealed that many places were having coastal erosion rates more than -4 m/year. The study showed the impact of those shoreline protection structures and coastal processes on the erosion process. The study revealed that Ponnani is an actively eroding coast with fluctuating erosion rates. The erosion rates were found to be high with a rate more than -4 m/year for about 35 km of the coastline considered. The areas with accelerated erosion along the coast of Ponnani need sustainable management and protective measures.

CHAPTER III

MATERIALS AND METHODS

This chapter covers the study area, methods used to analyse the changes in the river morphology, different softwares used for the study and the methodology adopted to achieve the objectives of the study.

3.1 DESCRIPTION OF THE STUDY AREA

The Bharathapuzha ("River of Bhārata") is also known as the River Nila, Perar or Ponnanipuzha. It is the second longest river in Kerala with a total length of 209 km and it lies in the central part of Kerala state, India. The river is considered to be one of the west-flowing ‘medium’ rivers of the country and lies approximately between 10° 26' and 11° 13' north latitudes and 75° 53' and 77° 13' east longitudes. Bharathapuzha originates at Kovittola Betta of Kundra reserve forest in the Western Ghats, located in Tamil Nadu, at an elevation of 2461 m above MSL, and flows westward to join the Arabian Sea at Ponnani (10° 47' 13" N, 75° 54' 40" E) Kerala, India.Plate.3.1.1 below shows the location map of Bharathapuzha watershed. The river flows northwards till Pollachi from the head waters at Anamalai hills and then takes a westward course. The confluence of Chitturpuzha and Kalpathipuzha at Parli creates Bharathapuzha which flow westwards. Bharathapuzha’s conflux with Gayathripuzha, originating from the Anaimalai hills, is at Mayannur. The Thuthapuzha joins Bharathapuzha at Pallipuram in its westward flow towards the Arabian Sea. The four major tributaries of the river are Kalpathipuzha, Gayathripuzha, Thootha, and Chitturpuzha. Plate.3.1.2 shows the google earth image of the area from Pallipuram to Purathur. Plate.3.1.3 shows the google map image of the region from Pallipuram to Purathur. The river is the life line water resource for almost one-eighth of Kerala’s population. Eleven irrigation projects and several surface dams in the river basin cater 493064 ha agriculture. The general land use in the bowl fluctuates as indicated by the nearby physiography. Rice and coconut are the predominant yields in the beach front areas of the bowl. In the mid grounds, the real yields are rice, banana, custard, vegetables and coconut while in the high land region and some of the mid land region rubber plantations and coconut grooves dominates.

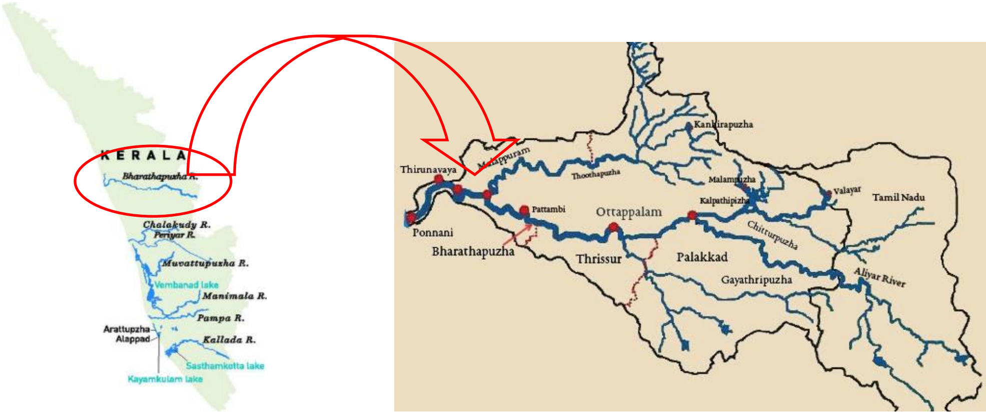

Plate.3.1.1. Location map of Bharatapuzha

Plate.3.1.2. Google Earth image of Purathur to Pallippuram

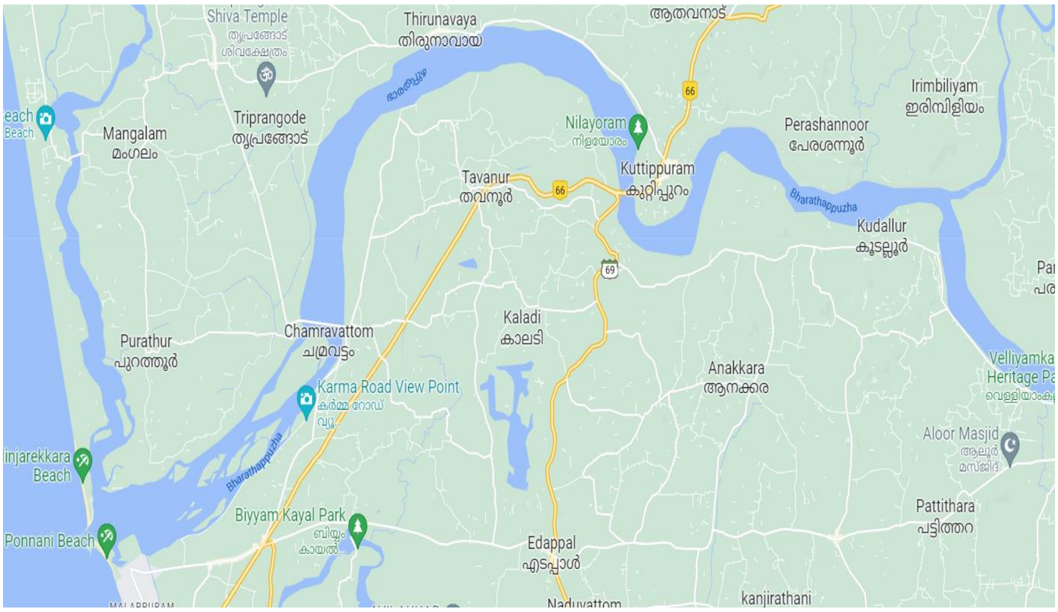

Plate.3.1.3 Google Map image of Purathur to Pallippuram

3.2 DATA COLLECTION

Sentinal 2-A datas were used to study about Bharatapuzha river and its various tributaries between Pallippuram and Puruthur. Data of the months of February and October were obtained of the years 2017,2018,2019 and 2020. The imageries were processed and assessed using ArcGIS 10.5 software.

Sentinal 2-A

Sentinel-2 is an Earth observation mission from the Copernicus Programme that systematically acquires optical imagery at high spatial resolution (10 m to 60 m) over land and coastal waters. The mission is currently a constellation with two satellites, Sentinel-2A and Sentinel-2B; a third satellite, Sentinel-2C, is currently undergoing testing in preparation for launch in 2024.

The mission supports a broad range of services and applications such as agricultural monitoring, emergencies management, land cover classification or water quality.

Sentinel-2 has been developed and is being operated by the European Space Agency, and the satellites were manufactured by a consortium led by Airbus Defence and Space.

The Sentinel-2 mission has the following key characteristics:

- Multi-spectral data with 13 bands in the visible, near infrared, and short wave infrared part of the spectrum
- Systematic global coverage of land surfaces from 56° S to 84° N, coastal waters, and all of the Mediterranean Sea
- Revisiting every 10 days under the same viewing angles. At high latitudes, Sentinel-2 swath overlap and some regions will be observed twice or more every 10 days, but with different viewing angles.
- Spatial resolution of 10 m, 20 m and 60 m
- 290 km field of view
- Free and open data policy

Sentinel-2 serves a wide range of applications related to Earth's land and coastal water.

The mission provides information for agricultural and forestry practices and for helping manage food security. Satellite images will be used to determine various plant indices such as leaf area chlorophyll and water content indexes. This is particularly important for effective yield prediction and applications related to Earth's vegetation.

As well as monitoring plant growth, Sentinel-2 is used to map changes in land cover and to monitor the world's forests. It also provides information on pollution in lakes and coastal waters. Images of floods, volcanic eruptions and landslides contribute to disaster mapping and help humanitarian relief efforts.

3.3 IMAGE DATA PROCESSING

Image processing and assessment of the impact of sand mining on the morphology of the severely affected reach of Bharathapuzha river were carried out using the ArcGIS 10.5 software.

3.3.1. ArcGIS 10.5 Software

ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It performs the function of creating maps, compiles geographic data, analyse mapped information, share and discover geographic information, using maps and geographic information in a range of applications, and manage geographic information in a database. An infrastructure is provided by the system to create maps and geographic information is made available throughout an organization, across a community, and openly on the Web. Contextual tools for mapping and spatial reasoning are also provided by ArcGIS to explore data and share 45 location-based insights. ArcGIS in the field of imagery and remote sensing gives everything needed to manage, process, analyse, and share imagery.

ArcGIS includes the following Windows desktop software:

• ArcReader, which allows one to view and query maps created with the other ArcGIS products; • ArcGIS for Desktop, which is licensed under three functionality levels:

- ArcGIS for Desktop Basic (formerly known as ArcView), which allows one to view spatial data, create layered maps, and perform basic spatial analysis;

- ArcGIS for Desktop Standard (formerly known as ArcEditor), which in addition to the functionality of ArcView, includes more advanced tools for manipulation of shapefiles and geodatabases;
- ArcGIS for Desktop Advanced (formerly known as ArcInfo), which includes capabilities for data manipulation, editing, and analysis.

ArcGIS 10.5, a major release that comes with many new capabilities with regards to its server and cloud capabilities. The big takeaways for 10.5 are large-scale analytics, big data capabilities plus a renamed and reorganized ArcGIS Server product family. ArcGIS Server has been renamed ArcGIS Enterprise as of the 10.5 release. As it turns out, ArcGIS Enterprise is now a collective term for the ArcGIS for Server product family that includes ArcGIS Server, Portal for ArcGIS, ArcGIS Data Store, and ArcGIS Web Adaptor. Two of these individual products have been updated with new features as well: Portal for ArcGIS software component now has with 3D capabilities, while the ArcGIS Server software component enables you to set up five different servers with one single server software component. In addition to this, three other server-based products offer large-scale analytics and big data capabilities. It is worth noting is that these applications add more scalability with regards to spatial analytics to the platform. The first ArcGIS Enterprise product adding large-scale analytics is ArcGIS GeoAnalytics Server, through tools that improve processing time for large volumes and detailed datasets. It is designed for space-time analysis on massive vector and tabular data. Second, there´s the ArcGIS Image Server product which enables fast and efficient processing, analysis and sharing of massive collections of imagery and rasters. Both ArcGIS GeoAnalytics Server and ArcGIS Image Server introduce distributed and parallelized computing, speeding up analysis time. Third, there´s ArcGIS GeoEvent Server, which replaces the ArcGIS Server GeoEvent Extension available in previous releases. It is designed to handle high volume, high velocity real-time and streaming data, provides solutions through on-the-fly analysis and dynamic aggregation of large datasets, easing data visualization. 10.5 also introduces portal to portal collaboration as a way of sharing content between multiple web GIS implementations. It is now possible to connect multiple on premises ArcGIS organizations and distribute a Web GIS across a network of portals. The benefit of establishing a distributed Web GIS is to organize, network, and share content across departments and geographic areas.

ArcGIS Enterprise is known as the flexible server software for mapping and analytics that allows to easily manage the location enabled data and brings a browser-based GIS into the infrastructure. Designed for flexibility, the heart of ArcGIS Enterprise is powerful server software with specific capabilities to serve, map, and analyse geographic information. Powerful, collaborative, and secure; ArcGIS Enterprise is termed as the epitome of modern GIS.

Overview of ArcGIS Software:

a. Software Modules: (i.) ArcMap – software used to display, analyse, and create GIS data (Plate. 3.3.1). (ii.) ArcToolbox – set of tools and functions used to convert data formats, manage map projections, perform analysis, modify data (Plate. 3.3.2). (iii.) ArcCatalog- tool for viewing and managing spatial data files (Plate. 3.3.3).

b. Extensions: (i.) The Extensions dialog allows to load and unload software capabilities, allowing to enhance working environment with additional objects, scripts and customization. (ii.) We can use extensions provided by ESRI and can also create our own.

c. Data Files in ArcGIS.

The ArcGIS applications Arc Catalog, ArcMap, and Arc Toolbox offers a flexible environment to carry out the GIS work. ArcMap is a powerful mapping application which helps to view, edit, and analyse the geographic data. ArcMap program was launched by double clicking the ArcMap icon on the desktop. ArcMap along with Arc Catalog and Arc Toolbox were opened. A file geodatabase was created to store all the works done under this section. To have common projected coordinate system group layer properties were converted to WGS_1984_UTM ZONE 43N.

Data Management Tool → Projections and Transformations → Define Projections → WGS_84_UTM ZONE 43N

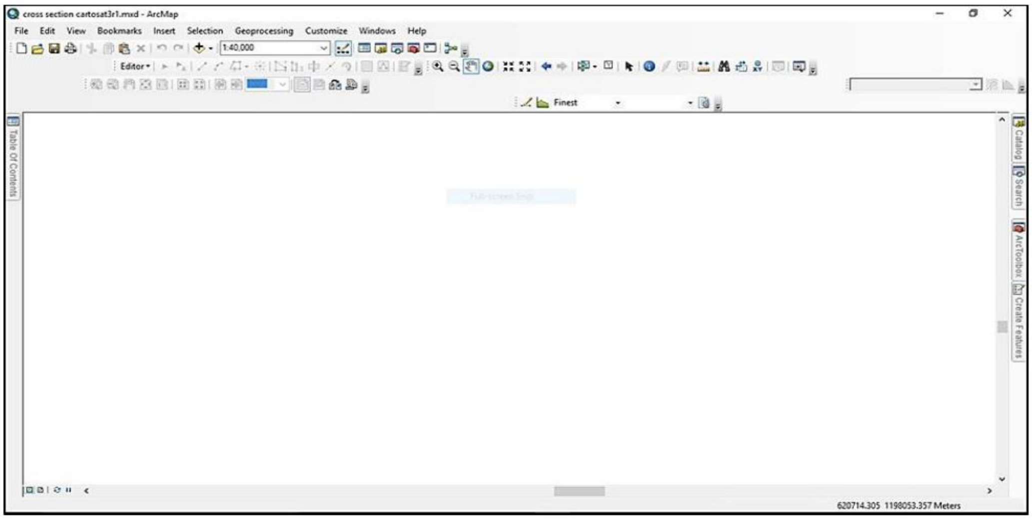

Plate.3.3.1 ArcMap window

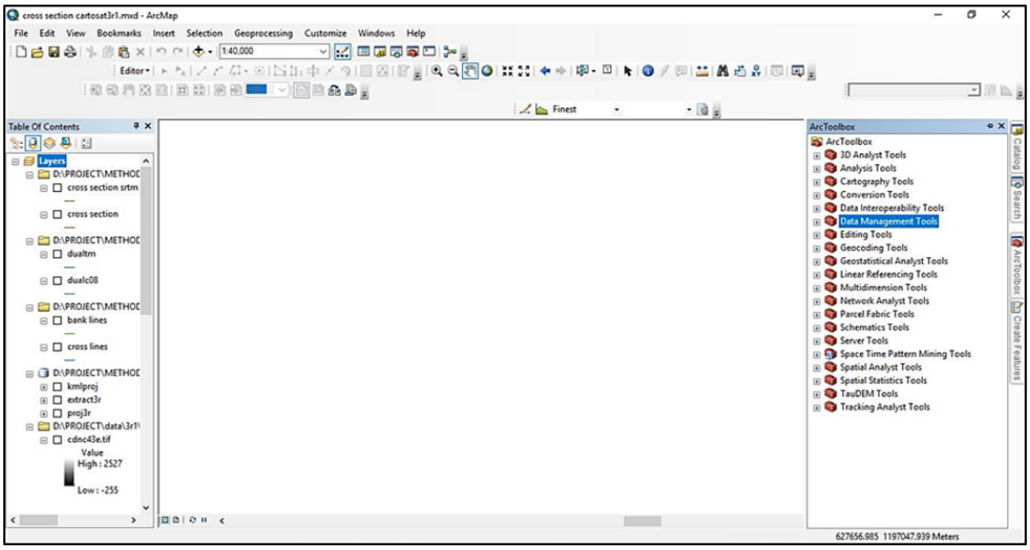

Plate.3.3.2 ArcMap with Arc Toolbox

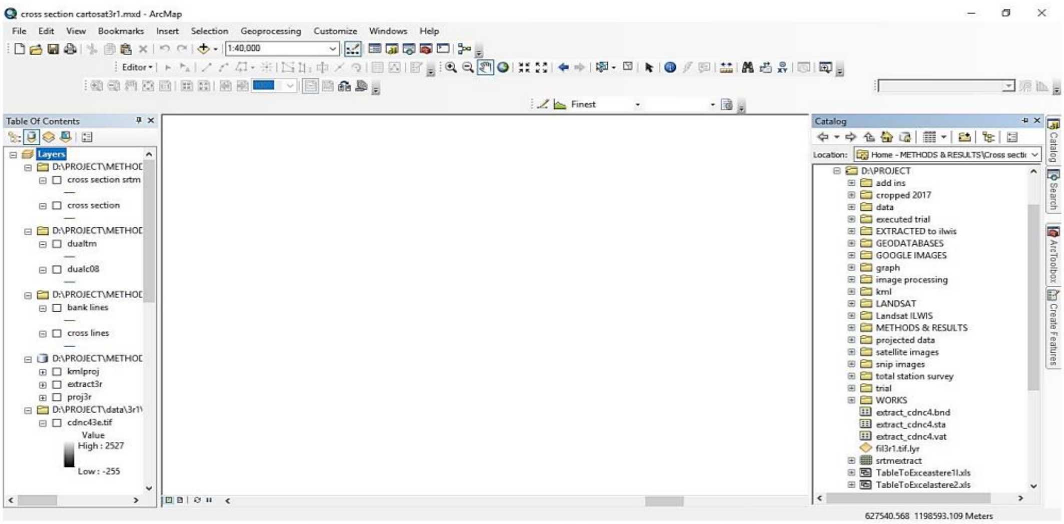

Plate.3.3.3 ArcMap with Arc Catalog

For the extraction of the required river system, following steps were performed (Plate.3.3.4 to Plate. 3.3.9)

1. Arc Toolbox → Spatial Analysis Tool → Extraction → Extraction by Mask (Plate.3.3.4)
2. Spatial Analyst Tool → Multivariate → Iso-Cluster Unsupervised classification (Plate.3.3.5)
3. Spatial Analyst Tool → Reclass → Reclassify (Plate.3.3.6)
4. Then a shape file was created for the extraction of the required river polygon from Purathur to Pallippuram. (Plate.3.3.7)
5. Conversion Tools → From Raster → Raster to Polygon (Plate.3.3.8)
6. For combining layers into a single river shape file: Editor Toolbar → Start editing → Select all patches → Merge (Plate.3.3.9)

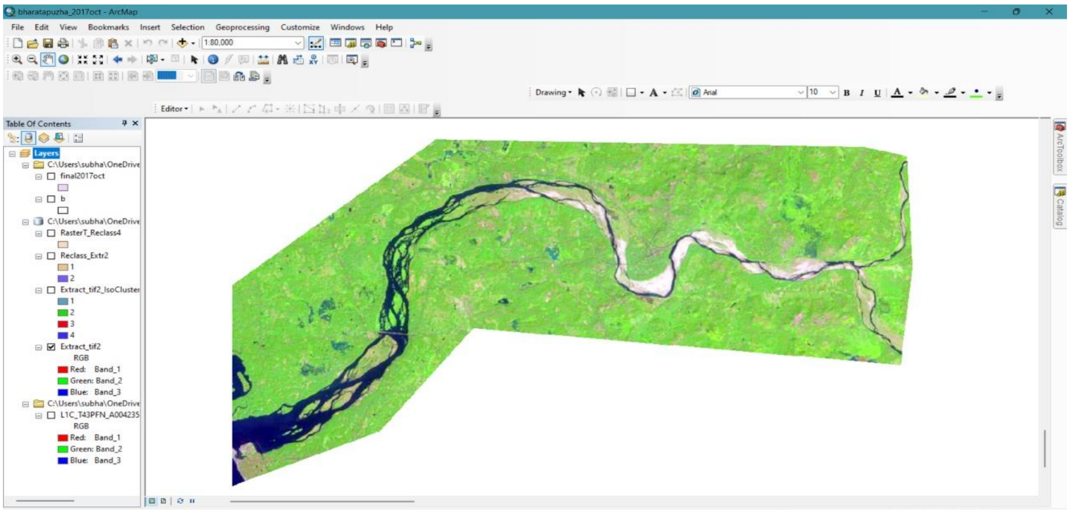

Plate.3.3.4 Extraction by mask data

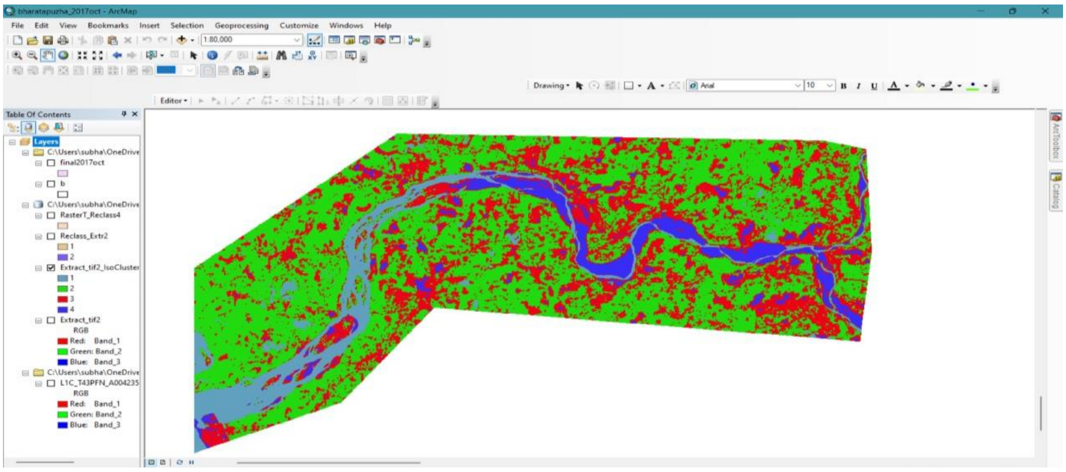

Plate.3.3.5 Iso-Cluster Unsupervised classification data

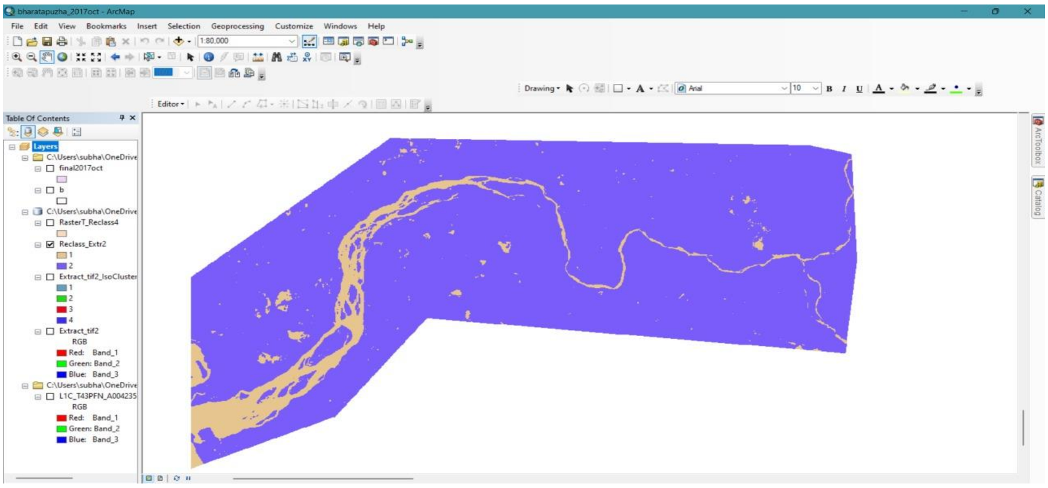

Plate.3.3.6 Reclassified data

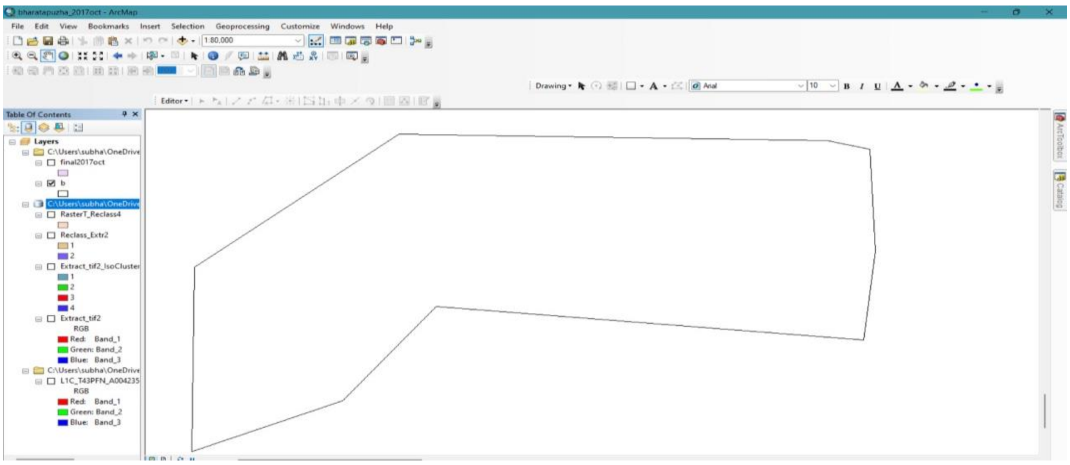

Plate.3.3.7 Polygon shape file

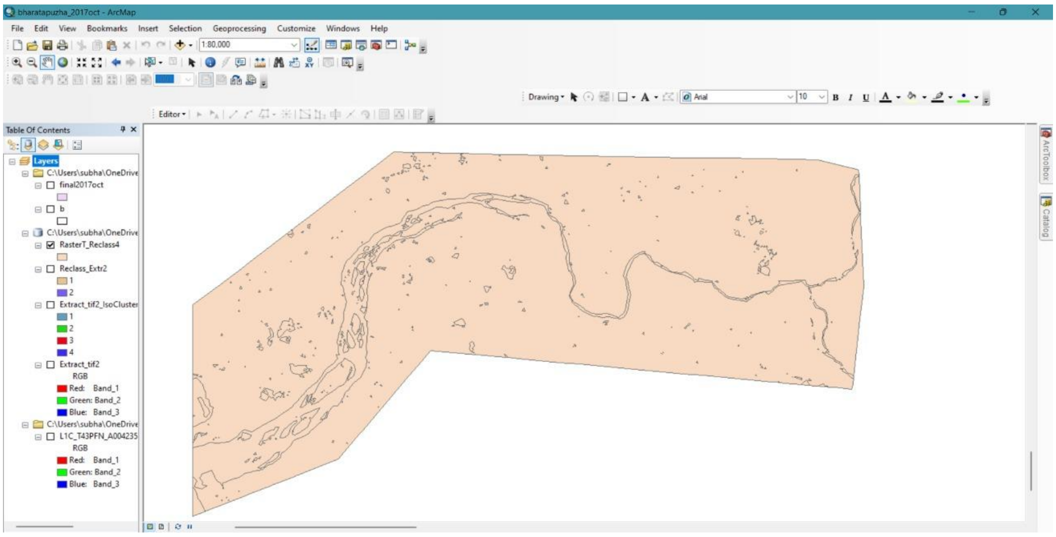

Plate.3.3.8 Raster to polygon data

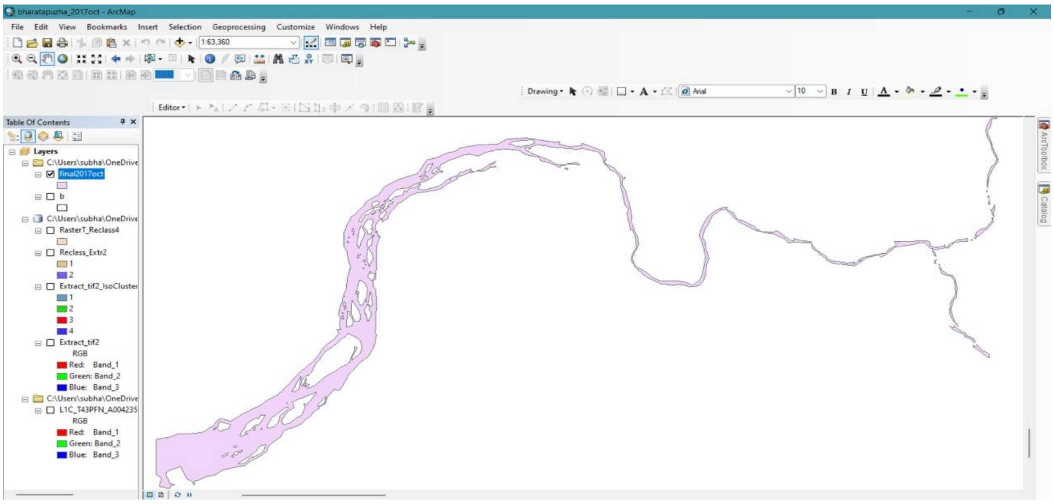

Plate.3.3.9 Single River shape file

3.4 ASSESSMENT OF CHANNEL MIGRATION IN RIVER BANKS

Bharathapuzha's reach from Purathur to Pallippuram was divided into 13 cross sections. The sections were labelled A to M Plate.3.4.1. from draw toolbar.

Then overlapping of two years data was done and the lateral shift (along left and right bank) was noted along the cross-sections shown in Plate.3.4.2. by using Measure tool in Edit toolbar.

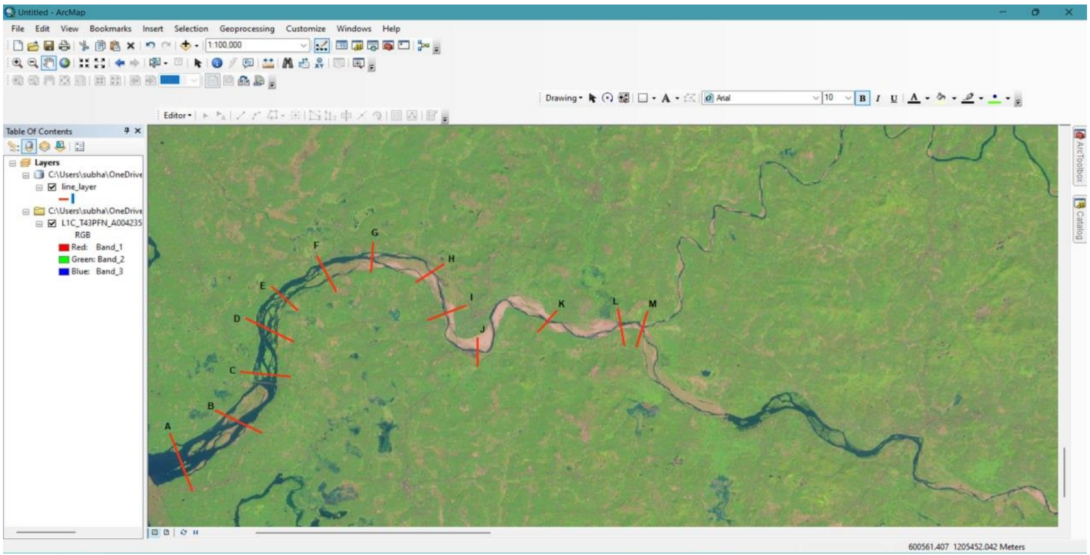

Plate.3.4.1 Cross-sections (A-M)

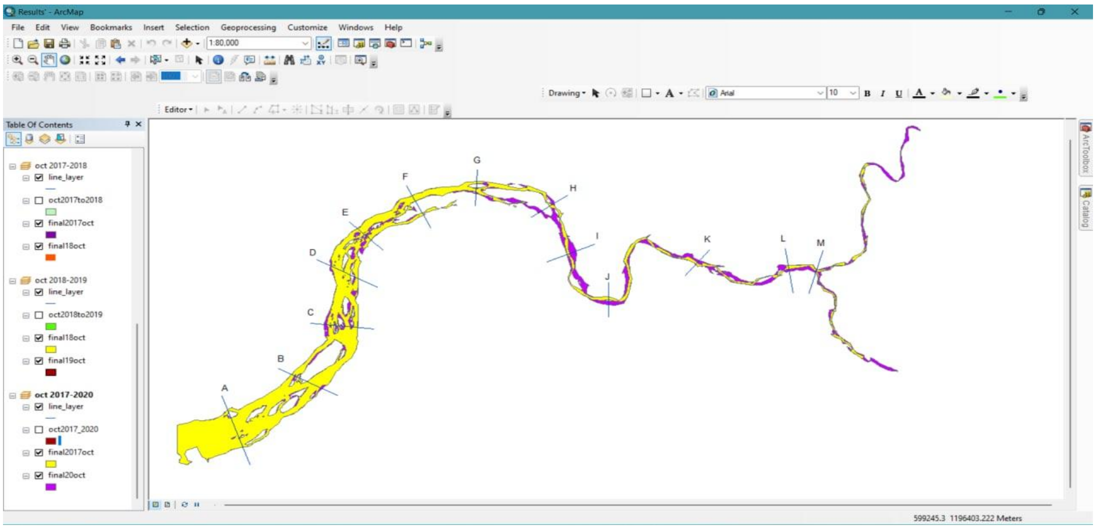

Plate.3.4.2 Overlapped map data with cross-sections

3.5 EROSION AND DEPOSITION AREA

The unchanged area was first calculated from the overlapped sections of rivers from Calculate Geometry option in Attribute table data from Edit toolbar. Erosion area was calculated by subtracting the unchanged area from the area of previous year and deposition area was calculated by subtracting the unchanged area from the area of the next year.

Erosion area = Area of previous area – Unchanged area

Deposition area = Area of next year – Unchanged area

3.6 IDENTIFICATION OF HOTSPOTS

The width along all the cross-sections (A-M) was measured of two years data individually by using Measure tool in Edit toolbar and is shown in Plate.3.6.1. The change in width along each cross-section was found out and the rate of change in width was found out. Based on the rate of change in width hotspots were identified.

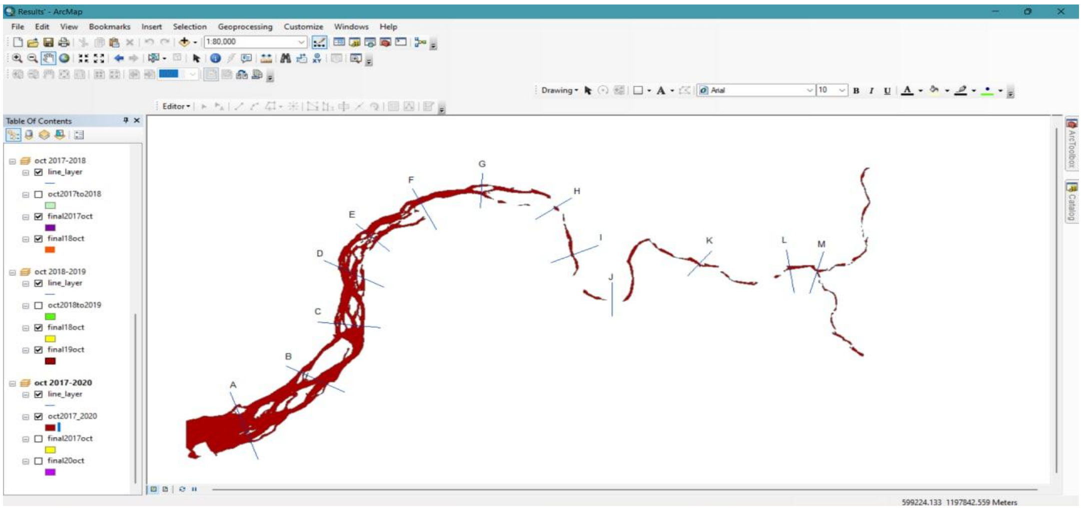

Plate.3.6.1. Width of individual river section of a year for all cross-sections

CHAPTER IV

RESULTS AND DISCUSSION

The temporal changes in the river channel and the adjoining river banks of Bharathapuzha river was assessed to identify the changes in left and right bank reach of Bharthapuzha and hotspot for maximum stream bank erosion in this reach using multitemporal multispectral remote sensing image assessment and GIS. Sentinal imageries were used for the evaluation of morphological changes in the river channel. LANDSAT imageries for the period 2017-2020 were used for the assessment of bank erosion, deposition and lateral migration. The GIS processing software used for this study was ArcGIS 10.5.

4.1 ASSESSMENT OF CHANNEL MIGRATION IN RIVER BANKS

Bharathapuzha's reach from Purathur to Pallippuram was taken for the study and it was divided into 13 cross sections. The sections were labelled A to M, with A being the first section from the downstream section of the river and M being the last section at the upstream endpoint. For analysing the changes during pre-monsoon and post monsoon, the data of February and October was taken. The shifting of the channel along both sides from 2017 to 2020 was measured in 13 cross-sections along the river (Plate.4.1), and the findings are shown in Tables.

These 13 cross sections are selected by visual interpretation of erosion and deposition and the curvature of the river channel. It shows the shift in bank at different cross sections along the length of the river. For the 4-year data, the inward shifts were indicated by negative values(-ve) and the outward shifts were indicated by positive values(+ve) for both the left and right bank shifts. Zero indicates no change in the bank shift.

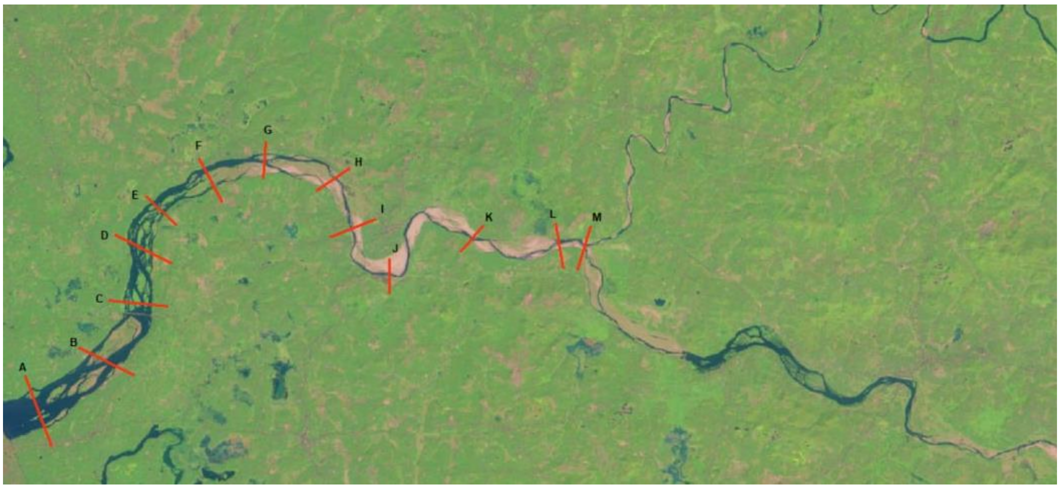

Plate.4.1 Cross sections marked in river section (October,2017)

4.1.1. Lateral shift during the time period 2017-2018 in the month of February

From the given Table 4.1.1 and Fig 4.1.1, it is found out that the maximum shift of left bank is along section C (290.46 m) and right bank is along section D (276.04 m). Section I and K showed no shift during this period at right bank. It is observed that the channel has shifted more at left bank during this period.

Table 4.1.1 Lateral shift of left and right banks during February 2017-2018

Cross-sections	Left bank shift(m)	Right bank shift(m)
A	-12.38	15.48
B	5.10	11.98
C	290.46	-4.54
D	0.03	276.04
E	7.69	21.49
F	2.07	39.61
G	52.11	-26.57
H	10.61	15.22
I	82.12	0
J	-13.23	70.06
K	46.70	0
L	12.86	21.87
M	-26.81	33.95

4.1.2. Lateral shift during the time period 2017-2018 in the month of October

According to the Table 4.1.2 and Fig 4.1.2, the maximum shift of the right bank is along section H (399.33 m), and the maximum shift of the left bank is along section K (145.75 m). The sections H, M, and L had the greatest change in width. Sections B, C, and F had the least channel shift. Section B showed no shift on the left bank during this time period. During this time period, the channel appears to have shifted more towards right.

Table 4.1.2 Lateral shift of left and right banks during October 2017-2018

Cross-sections	**Left bank Shift(m)**	**Right bank shift(m)**
A	-14.85	8.29
B	0	35.14
C	71.79	-5.38
D	37.45	-37.45
E	-9.43	-15.11
F	-4.08	1.56
G	12.56	103.76
H	119.26	399.33
I	103.76	5.02
J	-72.26	121.17
K	145.75	-12.19
L	-3.53	144.96
M	119.42	105.54

During the time period of 2017-2018 maximum river bank shift was observed during the October post monsoon at the right bank of the river.

4.1.3. Lateral shift during the time period 2018-2019 in the month of February

From the given Table 4.1.3 and Fig 4.1.3, it is found out that the maximum shift of right bank is along section J (117.49 m) and left bank is along section I (173.31 m). A greater change in width was observed along the sections I, K and J. The channel shift was found lowest in sections A, E and L. Section A showed a very less shift during this period at left bank. It is observed that the channel has shifted more at left bank during this period.

Table 4.1.3. Lateral shift of left and right banks during February 2018-2019

Cross-sections	**Left bank Shift(m)**	**Right bank shift(m)**
A	0.61	2.47
B	2.22	49.36
C	88.96	14.01
D	24.58	2.23
E	-9.76	1.23
F	11.21	25.11
G	-7.79	73.67
H	80.06	-67.83
I	173.31	6.35
J	-105.51	117.49
K	126.59	11.12
L	-4.30	95.07
M	44.77	95.80

4.1.4. Lateral shift during the time period 2018-2019 in the month of October

According to the Table 4.1.4 and Fig 4.1.4, the maximum shift of the right bank is along section J (54.39 m) and the maximum shift of the left bank is along section C (19.85 m). Sections D in right bank, F and L in the left bank had the least shift in banks. During this time, the channel has shifted more in the right bank.

Table 4.1.4. Lateral shift of left and right banks during October 2018-2019

Cross sections	Left bank Shift(m)	Right bank shift(m)
A	-9.27	-7.45
B	-16.01	-9.63
C	-19.85	12.59
D	-16.45	4.70
E	-1.85	9.82
F	2.09	8.43
G	9.27	12.68
H	7.48	10.18
I	11.18	-8.50
J	-16.42	54.39
K	-13.41	-12.22
L	0.41	-7.64
M	-11.94	6.51

Comparing both pre monsoon and post monsoon data, the shift was found to be more during the month of February at the left bank during the period of 2018-2019. The shift was observed more in the left bank in all years in pre monsoon and more in right bank in all years during post monsoon

4.1.5. Lateral shift during the time period 2017-2020 in the month of February

From the given Table 4.1.5 and Fig 4.1.5 it is found out that the maximum shift of right bank is along section D (278.13 m) and left bank is along section C (397.55 m). A greater change in width was observed along the sections H and J in the left bank and J in the right bank also. The channel shift was found lowest in sections A and I. Section A showed a very less shift during this period at left bank. There was no shift in both the banks at section I. It is observed that the channel has shifted more at left bank during this period.

Table 4.1.5. Lateral shift of left and right banks during February 2017-2020

Cross sections	**Left bank Shift (m)**	**Right bank shift(m)**
A	0	15.36
B	7.98	75.11
C	397.55	12.33
D	29.12	278.13
E	-2.19	28.07
F	10.39	11.01
G	40.78	31.26
H	127.48	76.41
I	0	0
J	123.86	223.91
K	56.28	14.62
L	9.74	124.31
M	11.18	128.39

4.1.6. Lateral shift during the time period 2017-2020 in the month of October

According to the Table 4.1.6 and Fig 4.1.6, the maximum right bank shift is along section J (174.40 m), and the maximum left bank shift is along section I (195.90 m).At section L no shift were observed at left bank of the river. Banks shifted the least at sections A and L in left bank. At section J a greater shift was observed in right bank. The channel has shifted more to the left bank during this time.

Table 4.1.6. Lateral shift of left and right banks during October 2017-2020

Cross sections	Left bank Shift(m)	Right bank shift(m)
A	-0.52	1.84
B	7.69	63.26
C	85.91	10.84
D	41.53	-13.70
E	6.51	11.04
F	6.27	7.00
G	0.77	75.93
H	96.87	-19.81
I	195.90	7.55
J	-116.92	174.40
K	96.66	4.69
L	0	63.61
M	-4.39	90.11

From the two data, the shift was found to be maximum along the left bank in October during the time period of 2017-2020.

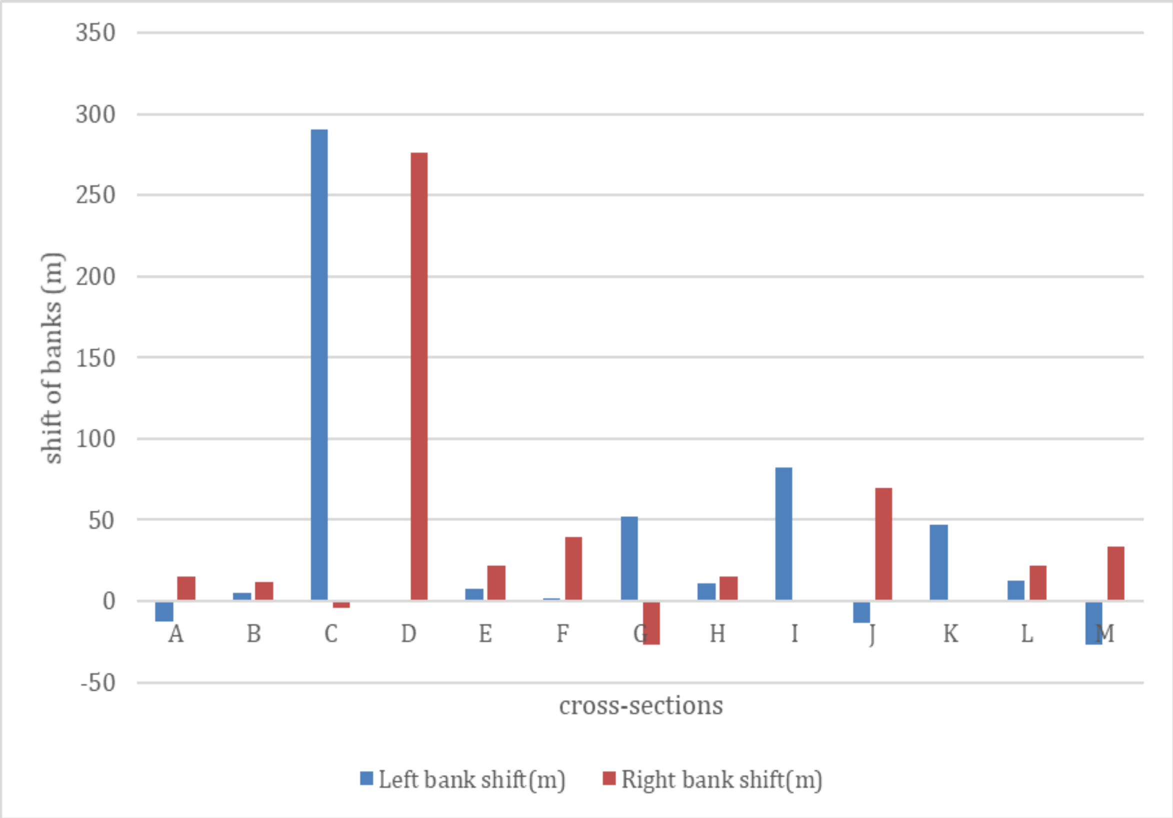

Fig 4.1.1. Lateral shift of left and right banks during February 2017-2018

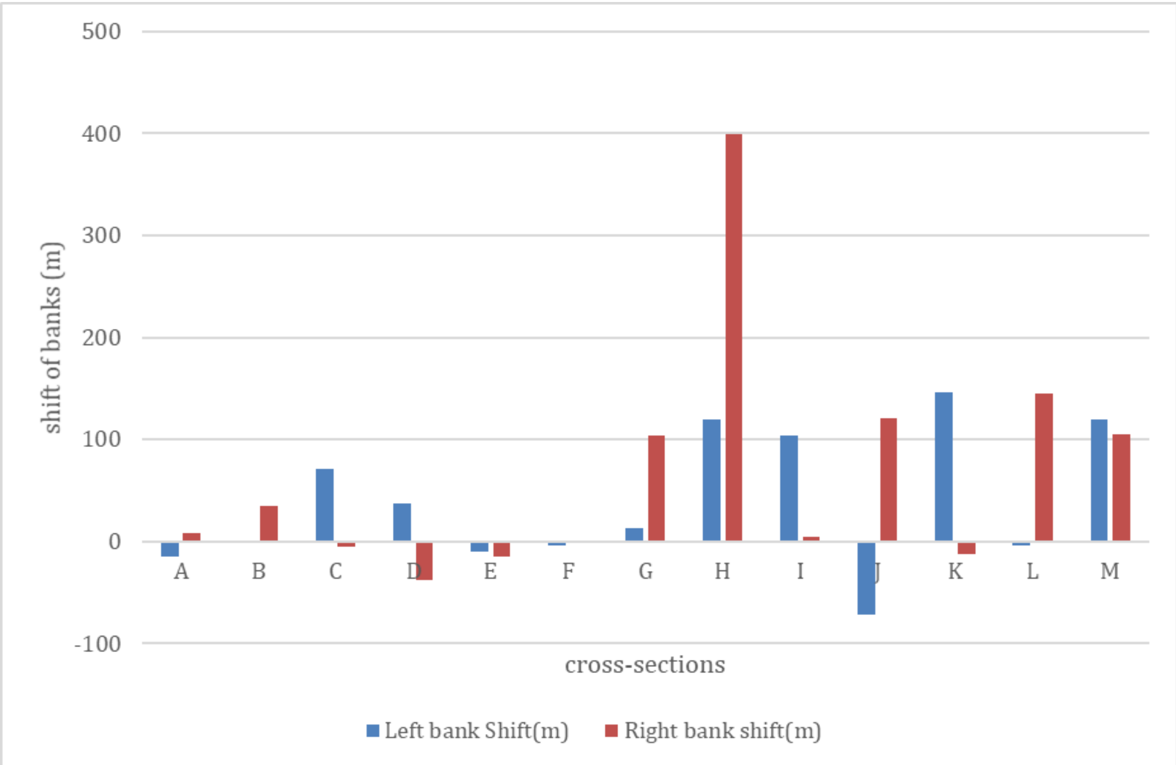

Fig 4.1.2. Lateral shift of left and right banks during October 2017-2018

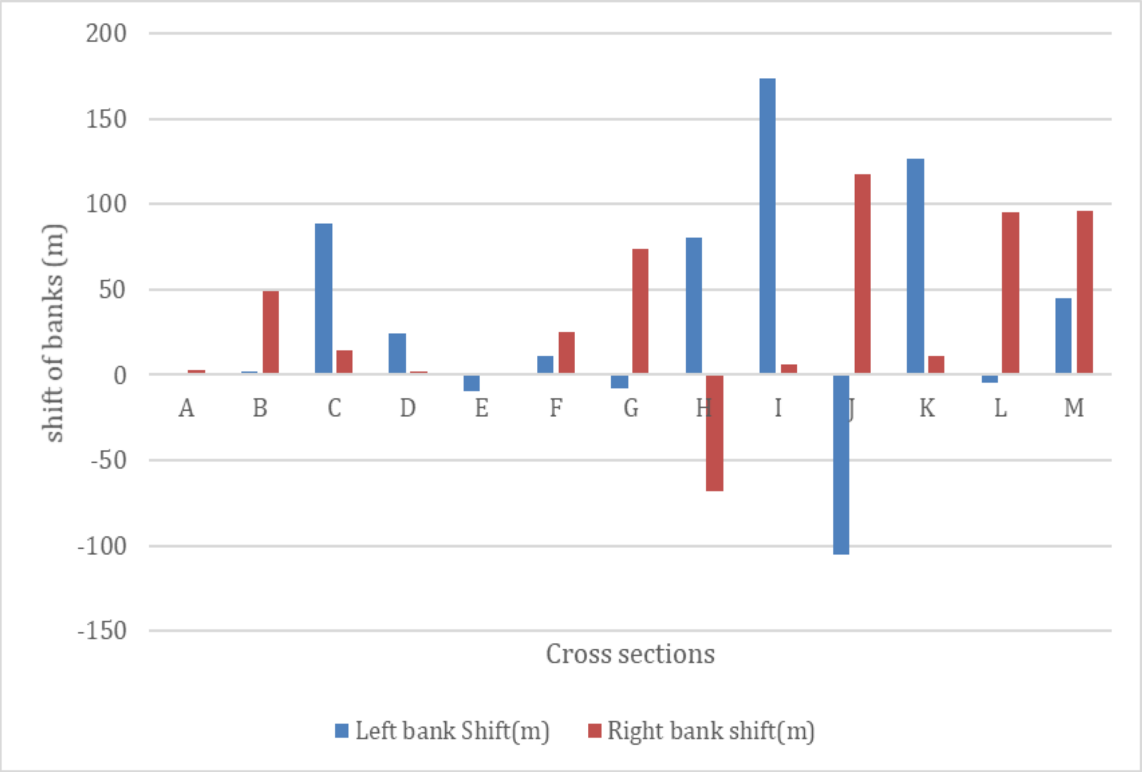

Fig 4.1.3. Lateral shift of left and right banks during February 2018-2019

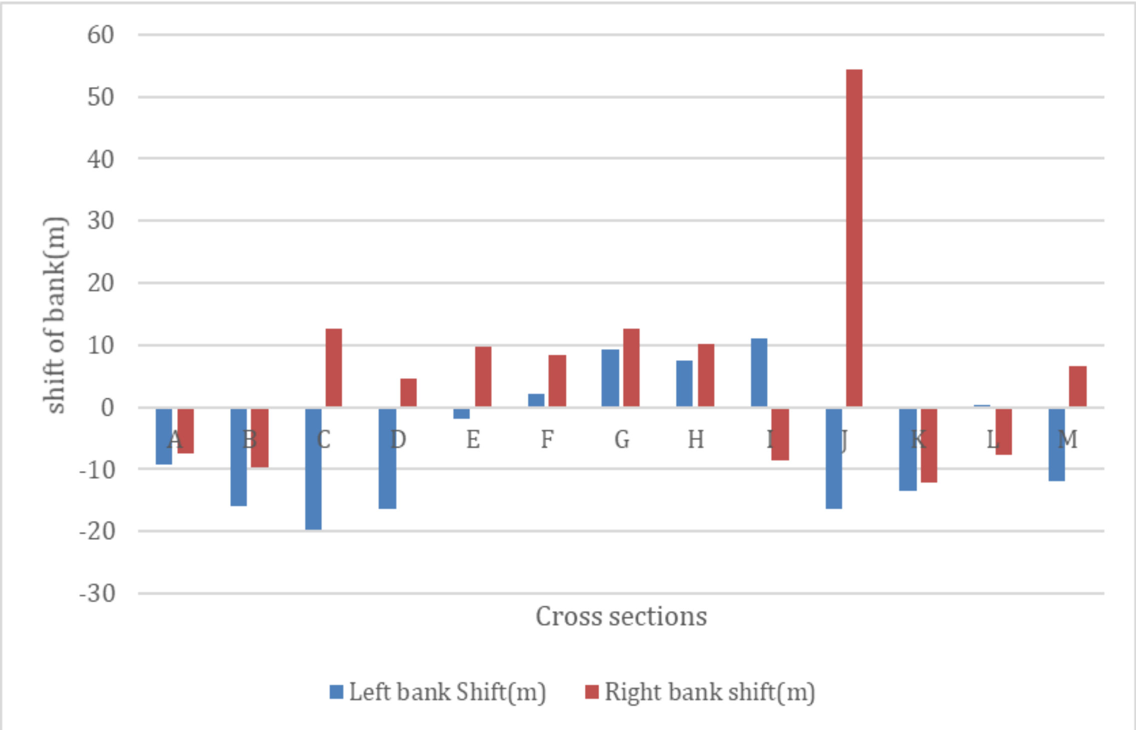

Fig 4.1.4. Lateral shift of left and right banks during October 2018-2019

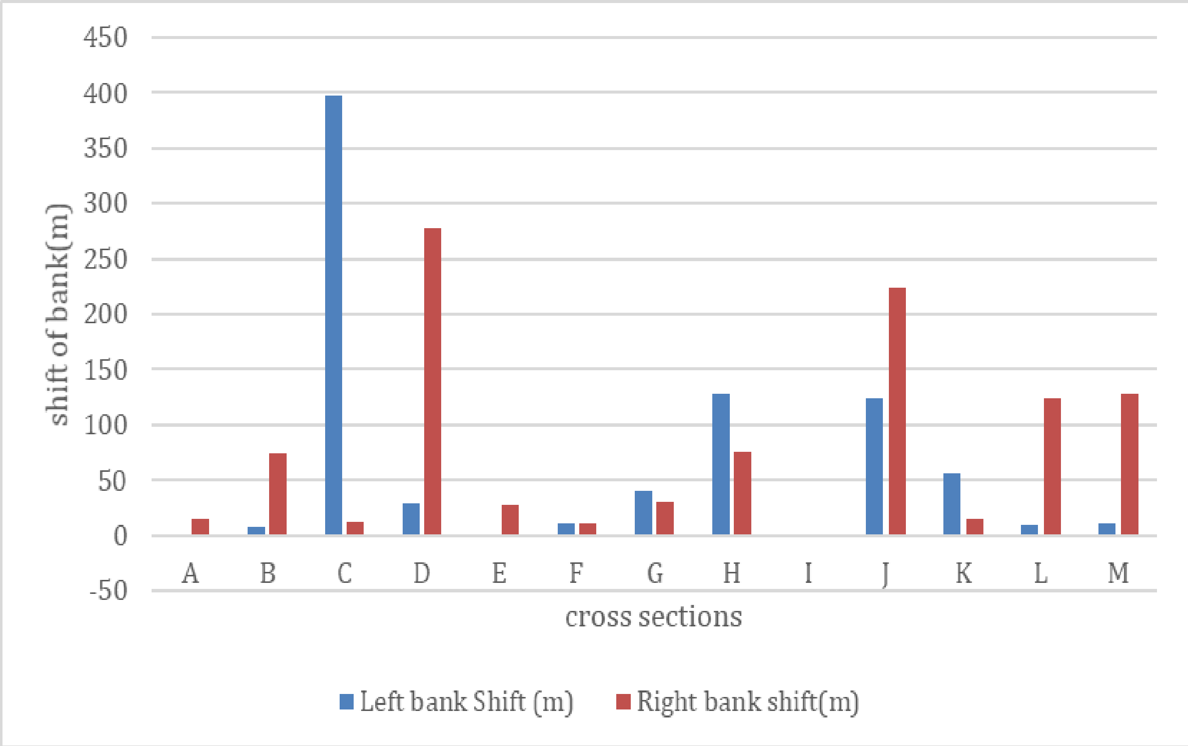

Fig 4.1.5. Lateral shift of left and right banks during February 2017-2020

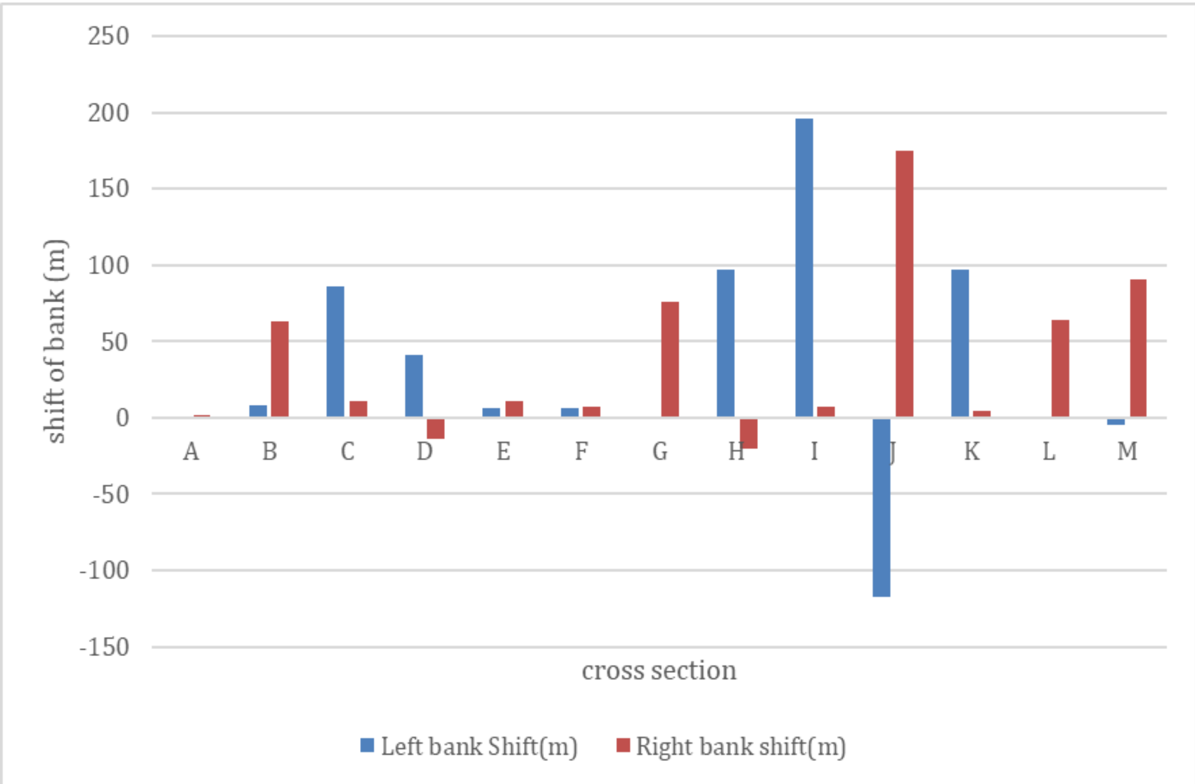

Fig 4.1.6 Lateral shift of left and right banks during October 2017-2020

4.2 EROSION AND DEPOSITION AREA

The Erosion and Deposition area along the reach from Purathur to Pallippuram of Bharatapuzha river was analysed by comparing the changes in the area of the reach during the years 2017-2020. The results are given in the Table 4.2.1 and Fig. 4.2.1 for month of February and Table 4.2.2 and Fig. 4.2.2 for the month of October.

Table 4.2.1. Erosion and deposition area for the month February

Year	Previous year (km^2)	Next year (km^2)	Unchanged area (km^2)	Erosion (km^2)	Deposition (km^2)
2017-2018	8.201	9.899	7.857	0.344	2.043
2018-2019	9.899	11.392	9.082	0.817	2.310
2017-2020	8.201	11.964	7.820	0.381	4.143

The maximum Erosion area for February was found in the time period 2018-2019 of 0.817 km^2. The maximum Deposition area was found for the time period 2017-2020 of 4.143 km^2.

Table 4.2.2. Erosion and deposition area for the month October

Year	Previous year (km^2)	Next year (km^2)	Unchanged area (km^2)	Erosion (km^2)	Deposition (km^2)
2017-2018	9.984	12.428	8.700	1.284	3.728
2018-2019	12.428	13.011	11.475	0.953	1.536
2017-2020	9.984	12.361	9.376	0.607	2.985

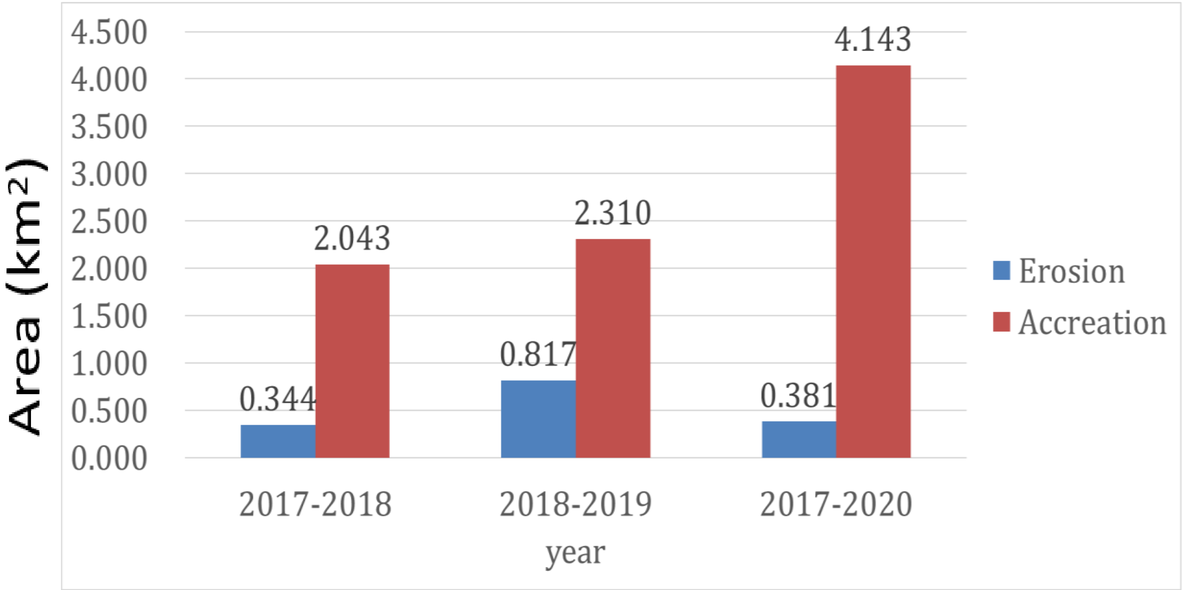

Fig. 4.2.1. Erosion and deposition area for the month February

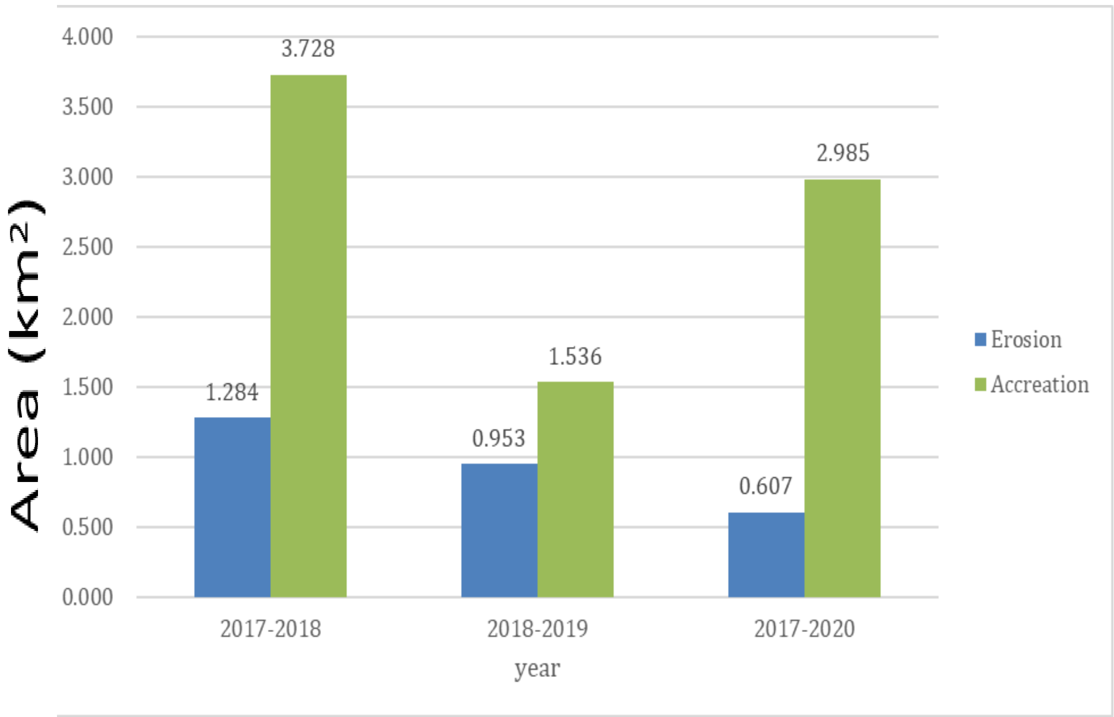

Fig. 4.2.2. Erosion and deposition area for the month October

The maximum Erosion area for October was found in the time period 2017-2018 of 1.284 km^2. The maximum Deposition area was found for the time period 2017-2018 of 3.728 km^2.

4.3 IDENTIFICATION OF HOTSPOTS

The shifting of the channel along both sides from 2017 to 2020 was measured in 13 cross-sections along the river, and the findings are shown in the Table 4.3.1, Table 4.3.2, Table 4.3.3, Table 4.3.4, Table 4.3.5 and Table 4.3.6. It shows the change in width of bank at different cross sections along the length of the river. The negative values (-) indicate the decrease in width and the positive values (+) indicate the increase in width of the channel. The positive value shows Erosion and negative value shows Deposition.

Table 4.3.1. Rate of change of width in Bharathapuzha river for February from 2017-2018

Cross-section	**2017 section width(m)**	**2018 section width(m)**	**change in width(m)**
A	1323.69	1343.50	19.81
B	956.43	973.43	17.00
C	617.18	908.88	291.70
D	631.55	907.71	276.16
E	534.39	563.45	29.06
F	676.00	717.31	41.32
G	338.71	325.95	-12.77
H	41.99	68.47	26.48
I	0.00	81.63	81.63
J	17.07	74.08	57.02
K	28.43	45.85	17.41
L	89.13	124.75	35.62
M	34.40	45.39	10.99

Table 4.3.2. Rate of change of width in Bharathapuzha river for February from 2018-2019

Cross-section	2018 section width (m)	2019 section width(m)	Change in width (m)
A	1,343.50	1,340.96	-2.54
B	973.43	1,024.43	50.99
C	908.88	1,008.97	100.09
D	907.71	933.69	25.98
E	563.45	556.61	-6.84
F	717.31	751.97	34.66
G	325.95	388.83	62.88
H	68.47	82.92	14.45
I	81.63	261.68	180.05
J	74.08	89.11	15.03
K	45.85	183.63	137.78
L	124.75	215.64	90.89
M	45.39	186.81	141.42

Table 4.3.3. Rate of change of width in Bharathapuzha river for February from 2017-2020

Cross-section	2017 section width(m)	2020 section width(m)	Change in width(m)	Rate of change in width(m/year)
A	1,323.69	1,339.27	15.58	3.89
B	956.43	1,039.66	83.23	20.81
C	617.18	1,024.05	406.87	101.72
D	631.55	937.97	306.42	76.61
E	534.39	560.00	25.61	6.40
F	676.00	224.26	-451.73	-112.93
G	338.71	412.18	73.47	18.37
H	41.99	92.29	50.30	12.57
I	0.00	271.51	271.51	67.88
J	17.07	120.72	103.65	25.91
K	28.43	98.22	69.79	17.45
L	89.13	223.89	134.76	33.69
M	34.40	173.32	138.92	34.73

Table 4.3.4. Rate of change of width in Bharathapuzha river for October from 2017-2018

Cross-section	2017 section width (m)	2018 section width(m)	Change in width(m)
A	1,339.37	1,318.37	-21.00
B	967.59	999.56	31.96
C	913.69	975.10	61.41
D	897.58	914.57	16.98
E	555.20	530.54	-24.65
F	734.20	713.41	-20.79
G	327.41	415.73	88.32
H	77.05	596.89	519.84
I	84.86	329.24	244.39
J	85.99	133.66	47.67
K	64.86	199.91	135.06
L	136.86	276.19	139.33
M	46.63	271.13	224.50

Table 4.3.5. Rate of change of width in Bharathapuzha river for October from 2018-2019

Cross-section	2018 section width(m)	2019 section width(m)	Change in width(m)
A	1,318.37	1,291.71	-26.66
B	999.56	964.59	-34.97
C	975.10	972.55	-2.55
D	914.57	903.83	-10.74
E	530.54	539.05	8.51
F	713.41	640.45	-72.96
G	415.73	437.52	21.79
H	596.89	616.37	19.48
I	329.24	330.60	1.36
J	133.66	171.50	37.84
K	199.91	173.94	-25.97
L	276.18	267.80	-8.38
M	271.12	264.77	-6.35

Table 4.3.6. Rate of change of width in Bharathapuzha river for October from 2017-2020

Cross-section	2017 section width(m)	2020 section width(m)	Change in width(m)	Rate of change in width(m/year)
A	1,339.37	1,344.31	4.94	1.23
B	967.59	1,035.18	67.59	16.90
C	913.69	1,007.22	93.53	23.38
D	897.58	931.86	34.28	8.57
E	555.20	576.50	21.30	5.33
F	734.20	220.52	-513.68	-128.42
G	327.41	403.37	75.96	18.99
H	77.05	573.38	496.33	124.08
I	84.86	289.14	204.28	51.07
J	85.99	142.56	56.57	14.14
K	64.86	166.34	101.48	25.37
L	136.86	200.11	63.25	15.81
M	46.63	131.27	84.64	21.16

According to the Table 4.3.3 and Fig 4.3.1, for the month of February of 2017-2020, the maximum rate of change in width is along cross-section C (101.72 m/year), hence indicates highest erosion at cross-section C. The maximum negative rate of change of width is along cross-section F (-112.93 m/year), hence showing highest deposition at cross-section F. The cross-sections C, I, and D had the greatest change in width showing large rate of erosion. Cross-sections A, E, and H had the least change in width. During this time period, the channel appears to have more positive shift indicating more erosion.

From the Table 4.3.6 and Fig 4.3.2, for the month of October of 2017-2020, the maximum rate of change in width is along cross-section H (124.08 m/year), hence indicates highest erosion at cross-section H. The maximum negative rate of change of width is along cross-section F (-128.42 m/year), hence showing highest deposition at cross-section F. The crosss-sections H, I, and K had the greatest change in width. Cross-sections A, E, and D had the least change in width. During this time period, the channel appears to have more positive shift indicating more erosion.

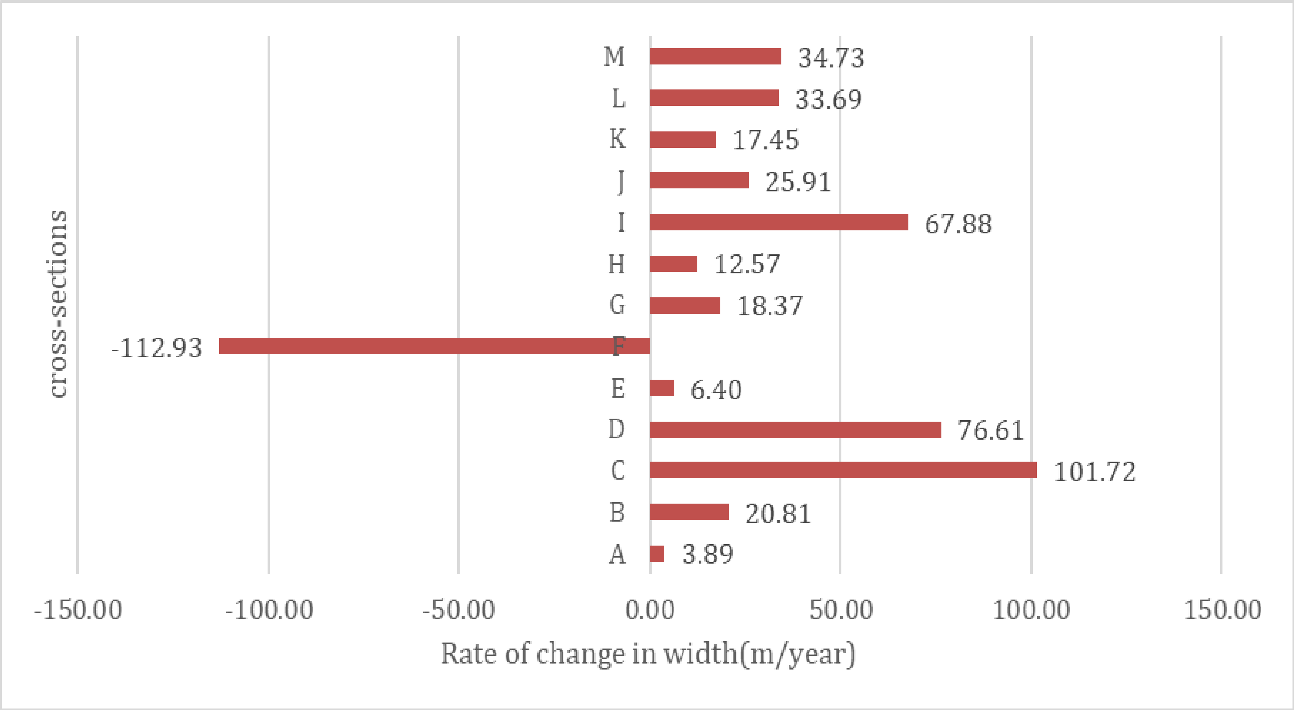

Fig. 4.3.1 Rate of change in width(m/year) for the month of February

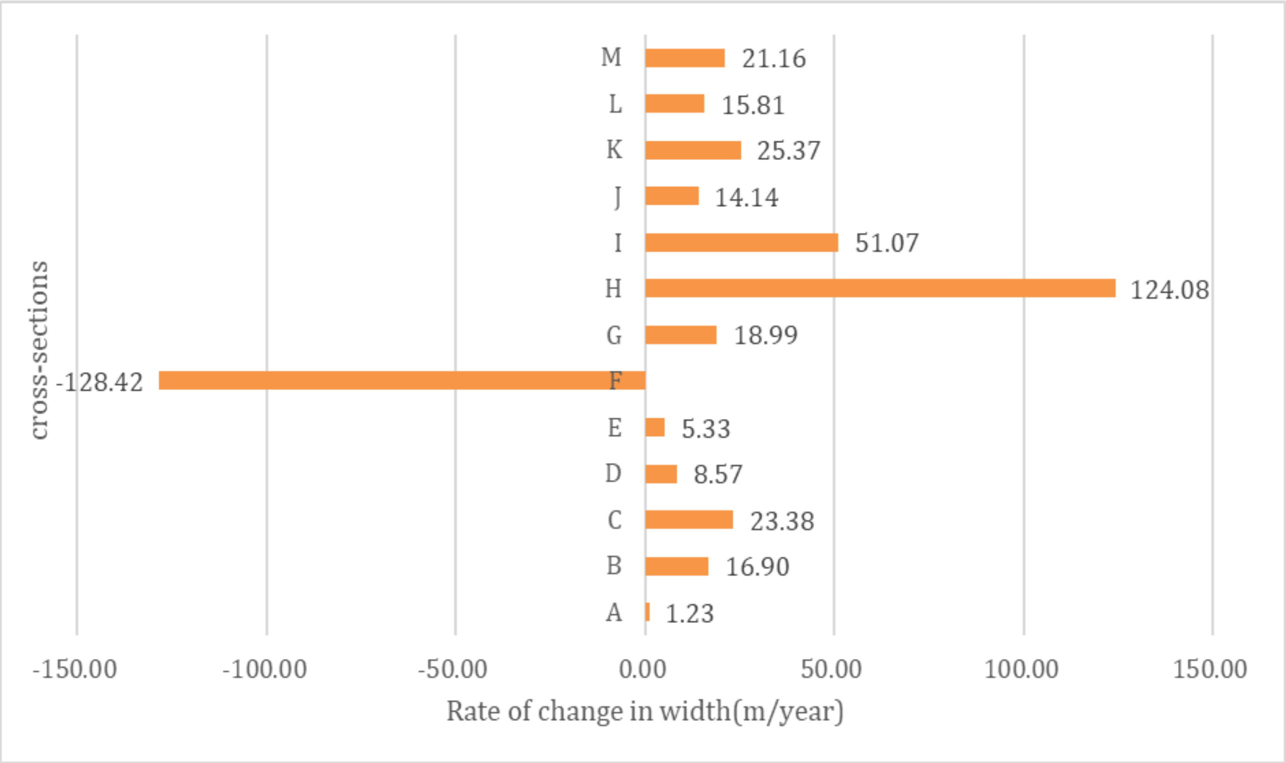

Fig. 4.3.2 Rate of change in width(m/year) for the month of October

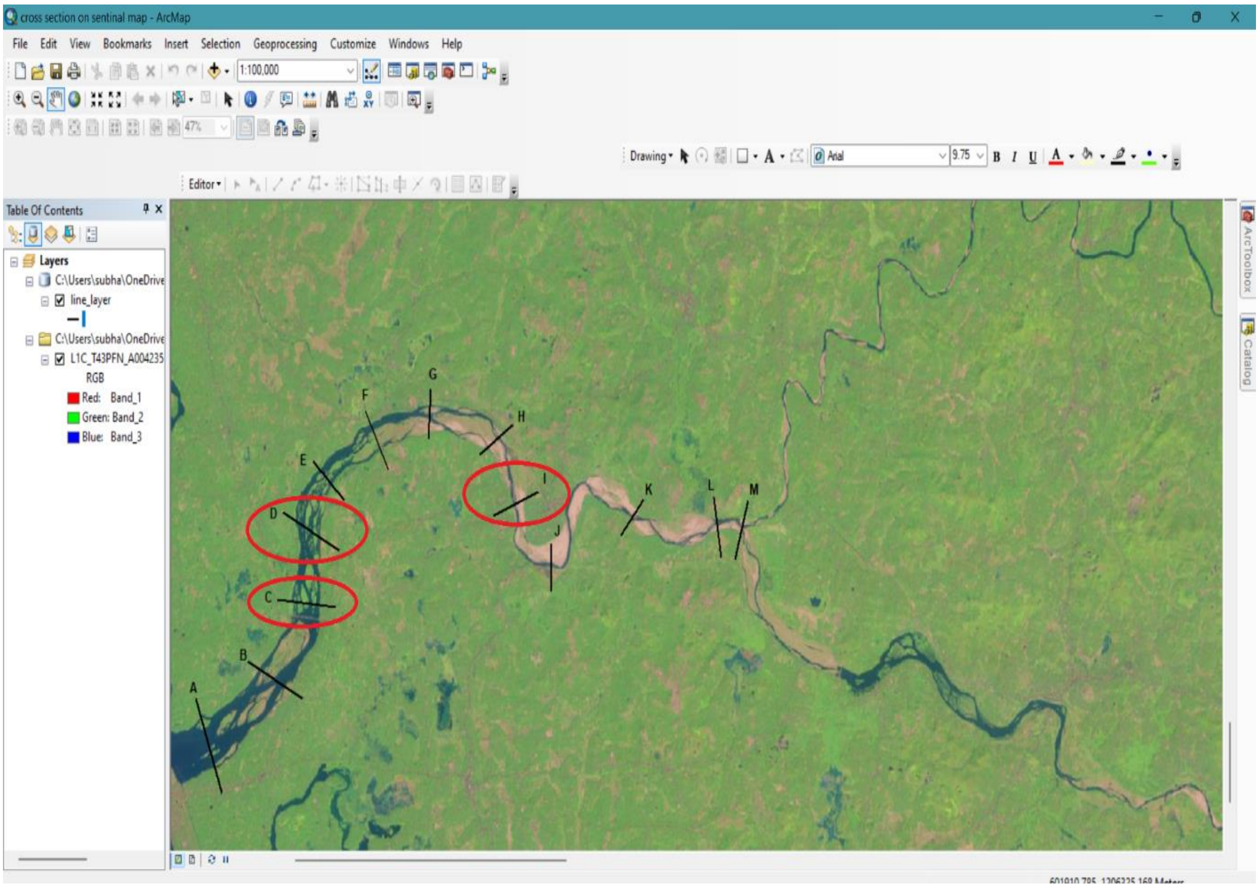

Plate.4.3.3 Hotspots of stream bank erosion for the month of February 2017-2020

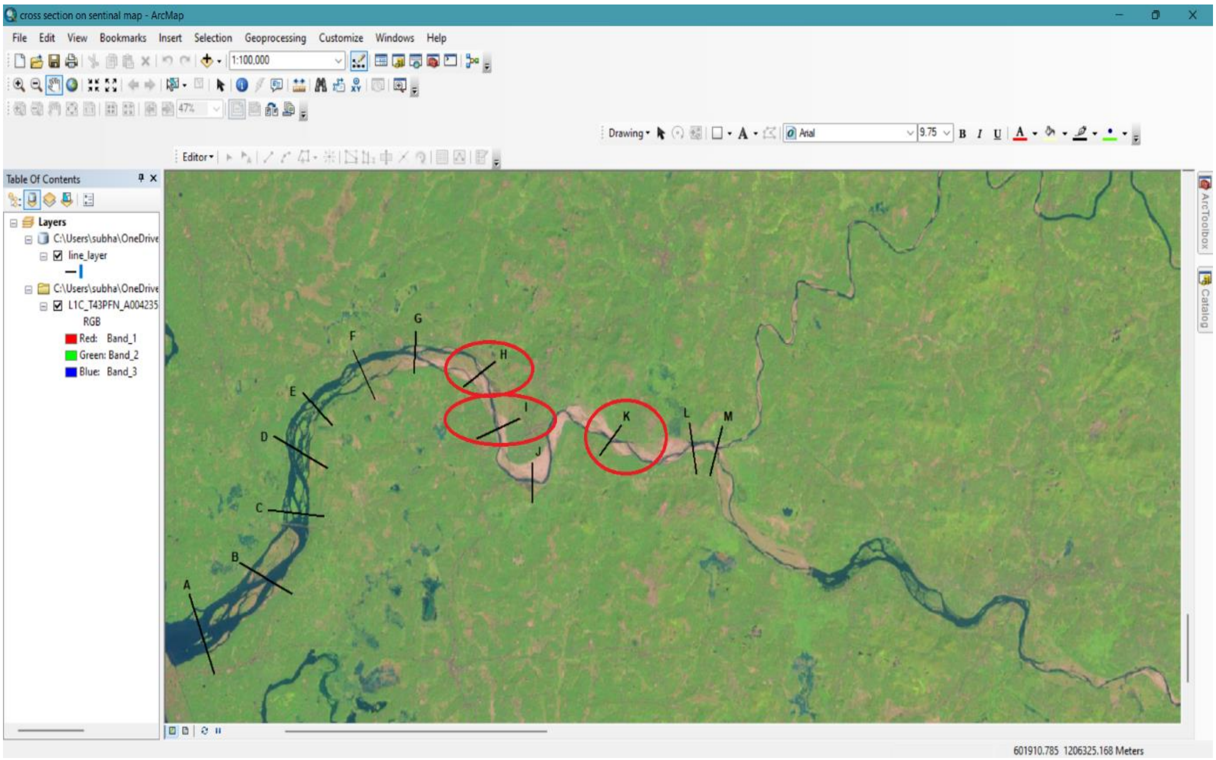

Plate.4.3.4 Hotspots of stream bank erosion for the month of October 2017-2020

In the cross-section C near Chamravatam (10°49’23”N 75°57’09”E), I near Minipamba Temple, Kuttippuram (10°50’35”N 76°01’32”E) and D near Perunthallur (10°50’22”N 75°57’10”E), highest erosion was observed for the month of February for 2017-2020 data and hence, they can be identified as Hotspots Plate.4.3.3.

In the cross-section H near Nilayoram Park (10°51’13”N 76°01’28”E) , I near Minipamba Temple, Kuttippuram (10°50’35”N 76°01’32”E) and K near Kudallur (10°50’42”N 76°03’34”E) highest erosion was observed for the month of October for 2017-2020 data and hence, they can be identified as Hotspots Plate.4.3.4.

CHAPTER V

SUMMARY AND CONCLUSIONS

Rivers, the fundamental component of landscape, have been perceived to evolve as a result of many consistent geological processes and interactions. River channels form the most important component in a river ecosystem. Elements of river channel are planform, cross-sectional shape and channel slope which constitute the morphological characters of rivers. Rivers continuously change their shape and reform their channels by eroding the channel boundary and through reworking and deposition of sediments. There exists a balance between the erosive power of the flow and the resistance, of the bed and bank material to erosion.

The consequences of channel shifting includes channel confluences (for rivers with very high seasonal discharge), marked variation in altitude, sudden fall in slopes, scouring and aggradation which pose serious river management problems and affecting the cultivation and livelihood of the nearby regions.

Use of remote sensing technology coupled with Geographical Information System (GIS) is a quick means of gathering latest accurate information, economically. Integration of Remote sensing and GIS have greatly increased objectivity and efficiency of fluvial geomorphological investigations.

Lateral channel migration has been observed in the stretch between Purathur to Pallippuram of Bharatapuzha river. Considering this fact, the river reaches between Purathur to Pallippuram was selected as the study area. The study was carried out to assess the left and right bank changes, Erosion and Deposition and identification of Hotspots.

Sentinel 2-A imageries of the year 2017, 2018, 2019 and 2020 respectively of two months February and October were used to evaluate the lateral channel migration of the river reach by analysing the cross-sectional details. The analysis and assessment of satellite imageries were carried out using the ArcGIS 10.5 software. The raster imageries were extracted and projected to WGS_1984_UTM ZONE 43N coordinates. The study area was extracted using ‘Extraction by mask’ tool and converting the raster data to polygon. The width of these channel cross-sections was measured using ‘Measure’ tool from edit toolbar along with the rate of change in width. The erosion area and deposition area was also found out for the full river channel sections.

From the analysis we found cross-sections with maximum lateral channel migration all the years between 2017 and 2020. The maximum Erosion area for February was found in the time period 2018-2019 of 0.817 km^2. The maximum Deposition area was found for the time period 2017-2020 of 4.143 km^2. The maximum Erosion area for October was found in the time period 2017-2018 of 1.284 km^2. The maximum Deposition area was found for the time period 2017-2018 of 3.728 km^2.

In the cross-section C near Chamravatam (10°49’23”N 75°57’09”E), I near Minipamba Temple, Kuttippuram (10°50’35”N 76°01’32”E) and D near Perunthallur (10°50’22”N 75°57’10”E), highest erosion was observed for the month of February for 2017-2020 data and hence, they were identified as Hotspots.

In the cross-sections H near Nilayoram Park (10°51’13”N 76°01’28”E) , I near Minipamba Temple, Kuttippuram (10°50’35”N 76°01’32”E) and K near Kudallur (10°50’42”N 76°03’34”E) highest erosion was observed for the month of October for 2017-2020 data and hence, they were identified as Hotspots.

Thus, the objectives of this study to assess the lateral channel migration using remote sensing and Geographical Information Systems (GIS) helped to identify the areas having high rate of erosion and hotspots. The river morphological study using remote sensing and GIS techniques provided realistic information about the channel shifting along Purathur to Pallippuram stretch of Bharathapuzha river and this method can be successfully used for mapping and monitoring river lateral migration changes.

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ASSESSMENT OF CHANNEL MIGRATION CHARACTERISTICS OF BHARATHAPUZHA RIVER FROM PALLIPURAM TO PURATHUR REACH USING GIS AND RS

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PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

AGRICULTURAL ENGINEERING

Faculty of Agricultural Engineering and Technology

Kerala Agricultural University

DEPARTMENT OF SOIL AND WATER CONSERVATION ENGINEERING

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TAVANUR, MALAPPURAM - 679 573

KERALA, INDIA

2022

ABSTRACT

A study on Assessment of channel migration characteristics of Bharathapuzha river from Pallipuram to Purathur was conducted in Kelappaji College of Agricultural Engineering and Technology Tavanur. The objective of the study was to identify the changes in the left and right bank reach of Bharathapuzha using GIS and RS and to identify the hot spots for maximum stream bank erosion in this reach.

Satellite imagery from USGS Earth Explorer Sentinel 2-A was taken for the pre-monsoon (February) and post-monsoon (October) months of 2017,18,19 and 20. Spatial analysis was done in these data sets to obtain results for the given objectives.

The maximum shift on left bank was observed along section C i.e., near Chamravattom and maximum right bank shift along section D i.e., near Perunthallur. The hotsopts were identified near Minipamba Temple, Kuttippuram, near Chamravattom and near Nilayoram Park. More left bank shift was observed in the river channel i.e., more erosion taking place at the left bank of the river channel.

The lateral shift and high rate of erosion along some points were observed. The high rate of erosion taking place may be because of the excessive and unpredictable rainfall leading to floods in recent years and excessive sand mining activities taking place in the Bharathapuzha. This had led to considerable shifting and large amount of deposition taking place on the other side of erosion leading to the shrinking of the river. Water level is decreasing due to deepening of the bed. This had also led to change in river morphology and geometry and flood conditions. Hence, with the help of this study the trend in the river channel flow can be predicted and also steps can be taken for the rejuvenation of the Bharathapuzha river.