Analysis of Sedimentation pattern in Brahmaputra River due to change in Land Used Land Covered

A Dissertation submitted in
Partial Fulfilment of the Requirement for the Award of the Degree of

MASTERS OF TECHNOLOGY
In
CIVIL ENGINEERING
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DECLARATION

I hereby declare that the work presented in the dissertation "Analysis of Sedimentation pattern in Brahmaputra River due to change in Land Used Land Covered"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 my work carried out in the said college under the supervision of Dr. PANKAJ GOSWAMI, Professor, Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati – 13.

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: KISHOR RAJKHOWA

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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CERTIFICATE

This is the certified that the work presented in the project report entitled “Analysis of Sedimentation Pattern in Brahmaputra River due to Change in Land Used Land Covered” is submitted by Kishor Rajkhowa, Roll No: PG/CE/23/30, a student of M.Tech 3th semester, Department of Civil Engineering, Assam Engineering College, to the Assam Science and Technology University in partial fulfillment of the requirement for award of the degree of Master of Technology in Civil Engineering with Specialization in Water Resources Engineering under my guidance and supervision.

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CERTIFICATE FROM HEAD OF THE DEPARTMENT

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ABSTRACT

This report presents an analysis of sedimentation patterns and land loss along the Brahmaputra River in Assam, focusing on six different sections: Narayanpur, Gohpur, Biswanath, Tezpur, Mangaldai, and Guwahati. The study involved analyzing particle size distributions, silt and clay concentrations, and conducting hydrometer and sieve analyses on sediment samples collected from these sections. To assess changes over time, satellite images were studied. The findings revealed that the maximum erosion occurred in Mangaldai, which experienced an expansion in width towards the South bank by 1815 meters and towards the North bank by 533 meters between 1990 and 2023. Additionally, sediment concentrations, particularly silt, were found to be highest in Mangaldai, Biswanath, Gohpur, and Narayanpur. The total erosion on the South bank and North bank of these four locations amounted to 2145 meters, 1266 meters, 258 meters, and 830 meters, respectively. The overall land loss of the river Brahmaputra from 1990 to 2023 was approximately 61272 hectares or 612720000 square meters. The sediment analysis indicated a linear variation in particle size with depth, except in Mangaldai, where the surface exhibited higher sediment concentrations compared to a depth of 2 meters. Additionally, the presence of clay in the river Brahmaputra was found to be relatively low compared to silt. Mapping and measurement were facilitated using ArcGIS and Google Earth Pro, aiding in determining changes in the river's width and land loss over time. These findings provide valuable insights into the sedimentation patterns and land dynamics of the Brahmaputra River, which can contribute to better understanding and management of this important water resource.

Keywords: ArcGIS, Sedimentation pattern, Google Earth Pro, Brahmaputra Rive

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CHAPTER 1

INTRODUCTION

Origin of River Brahmaputra

The Brahmaputra River is one of the largest rivers in Asia, spanning across multiple countries including Bangladesh, China, and India. Its journey begins in Tibet, which is an autonomous territory of China, where it is known as the Yarlung Tsangpo River. The Yarlung Tsangpo originates from glacial sources near Mount Kailash and Mansarovar Lake in the Himalayas. The Angsi Glacier and Zangmu Glacier contribute to the river's water volume in this region. Flowing eastward from its source, the river traverses the Tibetan Plateau, carving its way through narrow valleys and gorges, including the Great Rift Valley in southeastern Tibet. Upon leaving Tibet, the river enters the Indian state of Arunachal Pradesh, where it is referred to as the Siang. Descending rapidly from its elevated Tibetan location, it eventually enters the plains and becomes known as the Dihang. At the head of the Assam Valley, specifically in the Kobo area in western Sadiya, the Dibang River and the Lohit River merge with it. From this point, the river is recognized as the Brahmaputra until it reaches Dhubri. In the state of Assam, the Brahmaputra River has a total length of 918 kilometers.

Sedimentation Analysis

The Brahmaputra River in Assam has seen an increase in sedimentation over time, creating a number of difficulties for both the environment and human activity. When sediment particles, such as sand, silt, and clay, are deposited on the riverbed, the water depth, channel morphology, and river flow dynamics change. Numerous natural and man-made factors, such as the high sediment input from upstream sources, deforestation, soil erosion, and agricultural practises in the Brahmaputra basin, have been implicated in this sedimentation phenomenon.

Sedimentation has numerous effects that have a significant impact on the infrastructure, economy, and ecology of the area. Sandbars, islands, and new channels may form as a result of increased sediment deposition, altering the course of the river and posing a transportation and navigational challenge. Additionally, the stability of bridges, embankments, and other engineering feats built alongside the river is in danger due to sedimentation, which could lead to expensive damages and disruptions in transportation systems. Additionally, sediment-filled water can harm aquatic ecosystems by lowering water quality and affecting plant and animal survival.

It is crucial to comprehend the Brahmaputra River's sedimentation patterns in order to create efficient mitigation plans and long-term management strategies. We can learn a lot about the processes causing sedimentation and the variables affecting it by looking into the sediment dynamics, including sediment transport, deposition rates, and sediment composition. Having this knowledge will help us come up with appropriate strategies for reducing the negative effects of sedimentation, maintaining the ecological balance of the river, and defending the socioeconomic interests of the area.

Sedimentation Analysis through Hydrometer

The sedimentation process in rivers is influenced by multiple factors, such as the river's hydrodynamics, sediment transport capacity, and sediment characteristics. Accurate assessment ofsediment properties is essential to study about the sedimentation process.For this,hydrometer analysis is reliable method to determine the particle size distribution of sediments in a river.By measuring the rate at which particles settle in a liquid medium, this technique can provide important details about sediment composition and distribution.

By examining the sediment properties, we learn more about the river's patterns of sedimentation, spot potential hotspots for sedimentation, and gauge the effect of sediment deposition on the hydraulic and ecological functions of the river.

A thorough field sampling campaign was carried out along various sections of the Brahmaputra River in Assam in order to perform hydrometer test. To ensure representative samples from different river sections, sediment samples was collected using standardised procedures at designated locations. The collected sediment samples subjected to laboratory tests to determine the particle size distribution and sediment characteristics through hydrometer analysis. To make conclusions about sedimentation patterns and their effects on the river system, statistical analysisand data interpretation was carried out.

Geographic Information System software

Traditional methods to study the sedimentation in rivers involve physical measurements, which are time-consuming, costly, and limited in spatial coverage. However, with the development of Geographic Information System (GIS) technologies, it is now possible to effectively study and monitor sedimentation patterns by combining remote sensing data, hydrological modelling, and geospatial analysis techniques.In order to identify high sedimentation zones, erosion-prone regions, and potential mitigation strategies, GIS software offers a potent tool for data visualisation, analysis, and interpretation.

Analysis of the changes of width of the river in different reference time in different location was done using GIS softwares. In this project the analysis was done by using Arc GIS an QGIS software. ArcGIS is one of the widely used software developed by ESRI, which enables the integration of spatial data, analysis, and visualisation, making it a crucial tool for analysing river systems. And QGIS (Quantum GIS) is an open source cross platform that allows users of the software to visualize,analyse and interpret the geospatial data.

1.1 OBJECTIVES OF THE STUDY

The objective of the project study is given below:

- To Determine the land loss due to erosion by the river.
- To determine the change in width in different location in different reference time.
- To determine the concentration of sediment with varying in depth.
- Amount of silt and clay in different location of the river.

CHAPTER 2

LITERATURE REVIEW

GENERAL

A literature review has been compiled to analyse the sedimentation pattern and width of the river Brahmaputra changes from the previous years along with the land loss. This consists of various research paper, Thesis and Journal carried out by some student, investigators/Researchers and published in various national and international journals, magazines and websites.

Jennifer G. Duan (2005) stated a probabilistic approach to calculate rate of bank erosion. Bank erosion occurs due to two processes i.e., basal erosion due to fluvial hydraulic force and bank failure under the influence of gravity. The frequency of bank failure is correlated to the frequency of flooding; therefore, bank failure frequently occurs in recessing limb of a storm hydrograph. This approach is applicable for cohesive bank material of planar bank failure. Limitation of this study is lack of field data, so further research needs to done considering theimpact of flood hydrographs. evolution of tension crack with basal erosion, bank material saturation prior to bank erosion and time period to wash away failed bank material. This paperindicates that the rate of bank erosion is a function of the hydraulic forces, bank geometry, bank material cohesion and frequency of failure.

Mahabaleshwara et al. (2013) have conducted a case study on soil erosion and its impact on sedimentation and floods by considering various relevant cases and also give some of the potential remedial measures. For this they used GIS (Geographical Information System) and Remote sensing tool to give a Digital representation of the hydrological variables like soil erosion and sedimentation. The Universal Soil Loss Equation (USLE) (Wischmeier & Smith, 1978) has also been used for estimation of on-site erosion rates.

$S_{am} = C\ P0.6\ F_e^{\ 1.7} S^{\ 0.25}\ D_d^{\ 0.10}\ (P_{max} / P)\ 0.19$

$F_e = (0.8\ F_A + 0.6\ F_G + 0.3\ F_F + 0.1\ F_W) / A$

S_{am} = Mean annual sediment yield in cm C = Coefficient depending on the geographical location of the catchment P = Average annual rainfall in cm, A = Catchment area in km^2 S = Land slope D_d = Drainage density in km/km^2 P_{max} = Average max monthly rainfall in cm F_e = Erosion factor F_A = Area of arable land in the catchment F_G = Area occupied by the grass andcscrub F_W = Area of waste land F_F = Forested area.They concluded that Erosion of soil from the catchments involves the process of detachment of soil from the soil surface and its transport by rainfall and runoff. Deposition of detached material takes place when the transport capacity of flow is smaller than the quantity of materialbeing transported. And also, they found that the main cause for the erosion is due to deforestation, lithological characteristics of the soil of particular area, improper treatment of catchment and other anthropogenic activities etc. For preventing further negative impacts suitable erosion controlling measures are to be implemented so that reservoirs can be maintained with their storage capacity and damages due to floods can be minimized.

Goswami P.et al (2016) have studied the effect of soil properties on river bank erosion in lower assam region. The bank materials along the river Gangadhar, Tipkat, Gaurang, Champamati (or Champabati), Puthimari (north bank tributary of the mighty Brahmaputra River) and Palashbari with erosion potentiality have been investigated. After analyzing the experimental results, it was found that majority of the erodible river banks was made up of poorly graded soil with silt, low clay content, weak erosion resistant strength, highly permeable with low or no plasticity and low liquid limit. It is expected that such type of study will help in providing certain inevitable baseline information for various channel management practices for extremelyflood prone areas.

Talukdar et al. (2018) have studied role of Critical Shear Stress and Erodibility of Soil in Stream Bank Erosion in Lower Assam Region of River Brahmaputra. The span of the river Assam it is about 700 km. The depth of the river differs from just few meters to 120 m in certainsites with mean depth of about 38 m in rainy season. The breadth of the river is also changingjust more than 1 km to around 10 km. The nature of the river Brahmaputra is vast and unpredictable in terms of migration and channel cutting and creating wonderful havoc by eroding its banks to the people living near its sides. The critical shear stress is determined on the base of clay and silt content as suggested by Torres and Julian (2006) and on the basis of clay content only as suggested by Beasly and Smerdon (1961). In both methods the value of critical shear stress was found much in all safe and erosion free locations than all other vulnerable areas without any exception. They summarized that the value of critical shear stress and coefficient of erodibility of soil are two significant parameters to measure the weakness oferosion in lower Assam region of Brahmaputr

Misganaw et al. (2019) have studied the impacts of land use/land cover change on stream flowand sediment yield of Gojeb watershed, Omo-Gibe basin, Ethiopia. In this study, Soil and Water Assessment Tool (SWAT) model was used to examine the effects of LULC on the hydrological process as well as the sedimentation of Gojeb Watershed in the Omo-Gibe basin.The LULC change analyses for three periods (1989, 2000 and 2013) were performed using ERDAS Imagine 2014 with a maximum likelihood classifier. The result has shown that duringthe study period most parts of the forest land were converted into cultivated land with an increase of cultivated land by 14.97% over the study periods which resulted in an increase of stream flow and sediment yield by 8.6 m 3 /s and 41.07ton/km^2 respectively. Based on the validated sediment yield results of 2013 land use, high potential source of spatial variability ofsediment was found at middle and downstream of the watershed.

Das Luna Moni (2020) has carried out a study to understand the pattern of change of sedimentload in the Jiadhol River of the Brahmaputra valley. A Sediment rating curve has also been derived to establish an empirical relationship between Discharge and Sediment load of the river. The study shows that fast siltation occurs in the riverbed during the rainy season while the river is dry for half of the year. Due to this rapid siltation, the carrying capacity of the Jiadhol river decreases overtime and as a result of this frequent overflow of the river during monsoon season occur along with frequent breaching of bridges is a common fact in the foothills of Jiadhol river.

Debnath et al. (2023) have assessed the changes in the Brahmaputra River planform using theGIS-based Digital Shoreline Analysis System (DSAS) and relates it with the changing LULC of the floodplain evaluated using the CA-Markov model. This study involves the future channelof the Brahmaputra River and its flood plain's future LULC were forecasted to pinpoint the erosion-vulnerable zone. For this they used forty-eight years (1973-2021) of remotely sensed data to estimate the rate of Bankline migration. The result from this study shows that the river'serosion-accretion rate was higher in early times than in more recent ones. The left and right banks' average shifting rates between 1973 and 1988 were 55.44 m/y and 56.79 m/ y, respectively, while they were 17.25 m/y and 48.49 m/y from 2011 to 2021.The Brahmaputra River's left bank had more erosion than the right, which suggests that the river is moving left (Southward) direction and also they found that Zones A (Lower course) and B (Middle course)of this river course got adversely affected than zone C (Upper course).According to their predicted results, the left bank, has the average rate of erosion and deposition w and 79.50 m/y, respectively, is anticipated to be more vulnerable to bank erosion than the rightbank. The left bank's average rate of erosion was 111.22 m/y. The study also evaluates river channel dynamics and the LULC study in locations where infrastructure and settlements wereat risk from channel migration.

CHAPTER 3

DESCRIPTION OF THE STUDY AREA

3.1 INTRODUCTION

The Study of Brahmaputra River and its tributaries are discussed in this chapter.

3.2 STUDY AREA

The study area of this project focuses on the Brahmaputra River basin which is lies between 24ºN to 28ºN latitude and 90º0'E to 95º0'E longitude as shown in the figure 3.1 and Along with six different locations from upper Assam to lower Assam situated near the bank of the river namely Narayanpur,Gohpur,Biswanath,Tezpur,Pandu(Guwahati) and Mangaldoi.The length of the river is about 2840 km with having a total area about 65 million ha .The total length of the river that lies in Assam is approximately 720 km and 80-90 km wide and with over 40% of its area under cultivation and rest are vegetation and settlement.(Goswami et.al 1985).

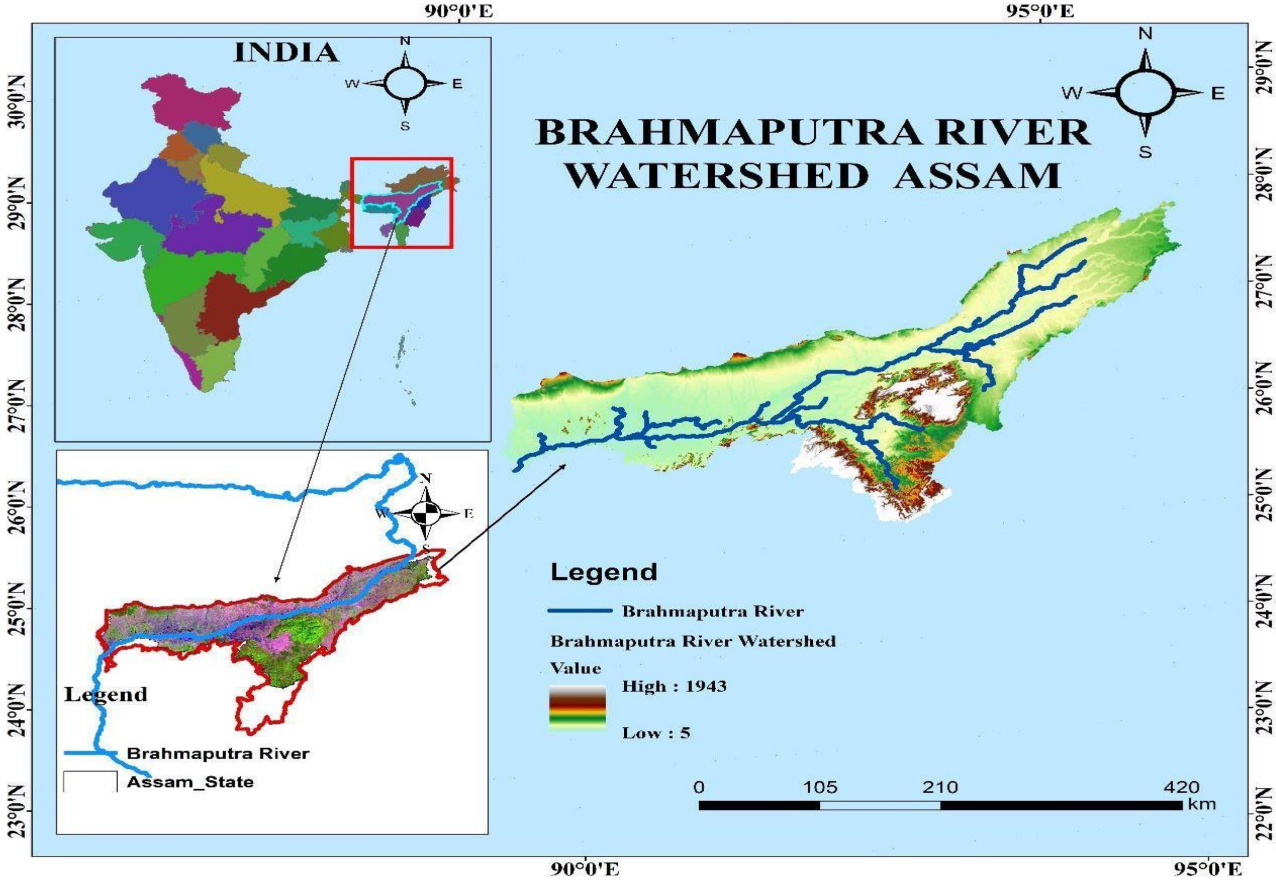

Fig 3.1 Map of the study area (Drawn with Arc Map 10.4)

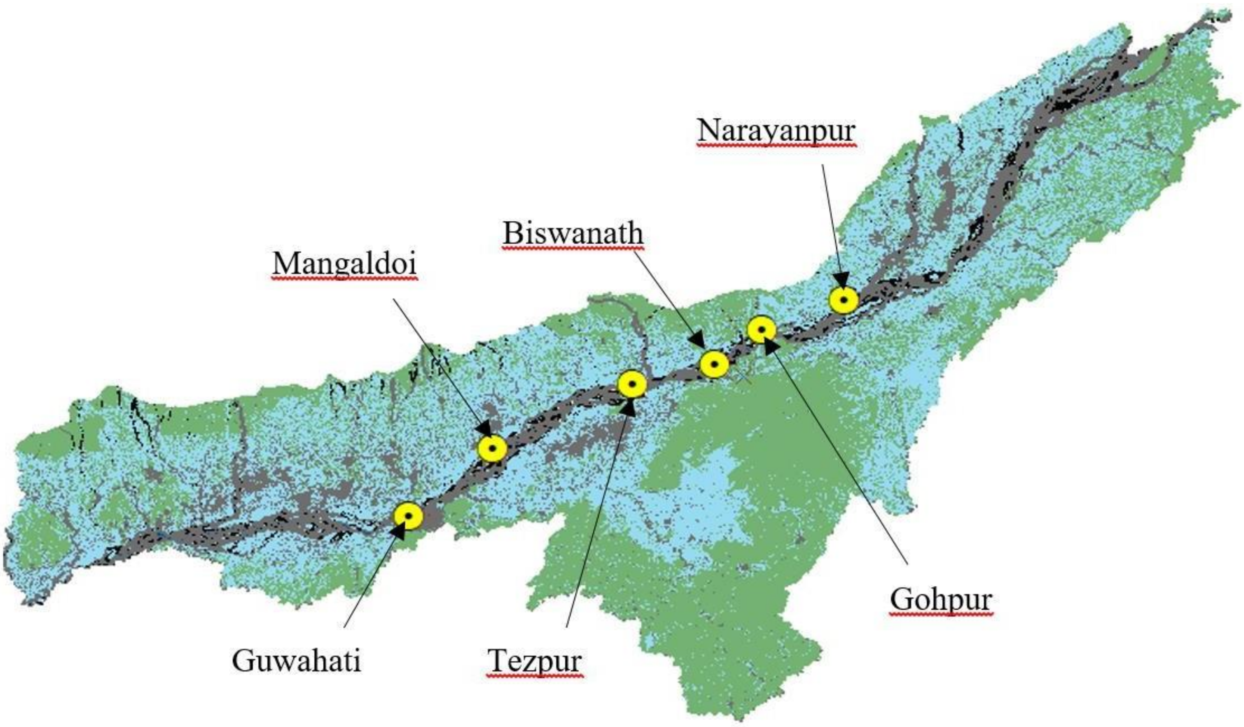

Fig 3.2: Sampling point

CHAPTER 4

METHODOLOGY

The project work is divided into three parts including field work, laboratory work and softwarework using ArcGIS along with Google earth pro as shown in the flow chart given below. The studies contain the collection of sediment sample from six different locations situated near thebank of the river Brahmaputra and test all the sample in the Water resource Engineering laboratory.

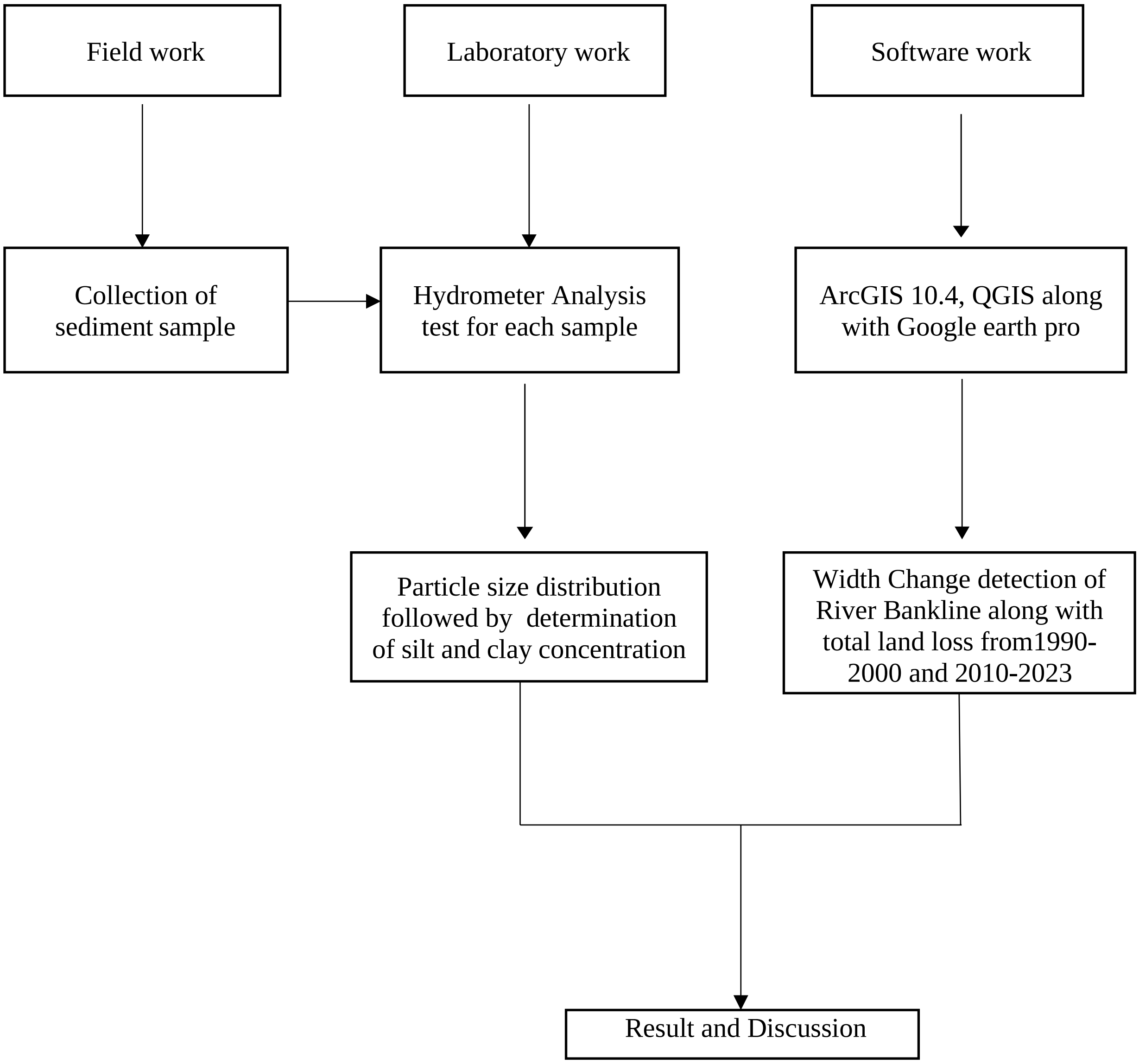

Figure 3.3: Flow chart showing the methodology

5.1 FIELD WORK

5.1.1 Sample Collection

Sediment samples were gathered from various points along the Brahmaputra River using a suspended sediment sampler. The collection took place both at the river's surface and 2 meters below the surface, as depicted in Figure 3.4. The latitude and longitude coordinates of each sampling location were recorded using a mobile GPS camera. To minimize the risk of contamination during the analysis, the samples were carefully collected in 1000ml sterile sampling bottles, specific to each depth. Following these precautions, the samples were transported to Water Resource Department laboratory for further analysis.

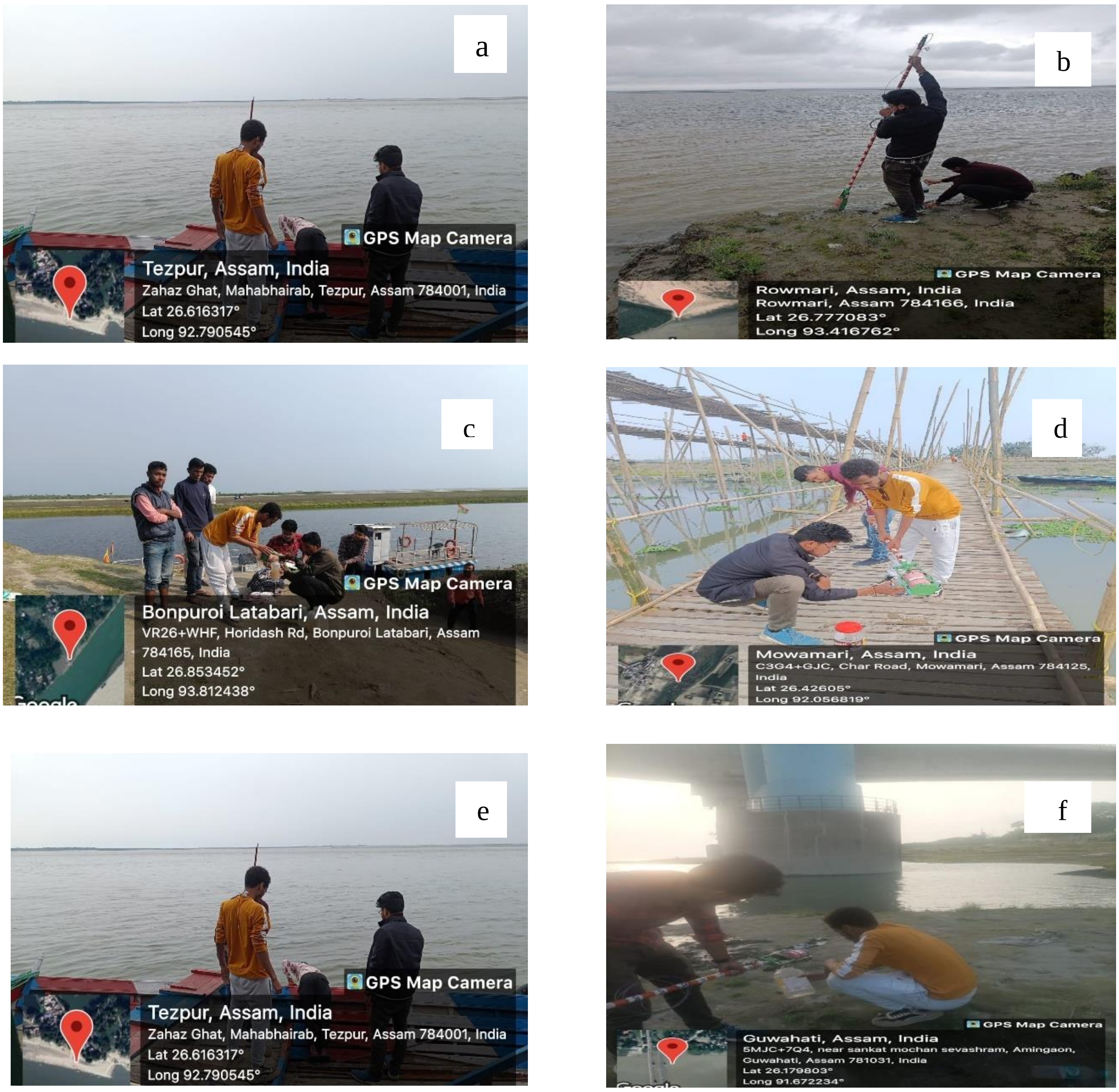

Figure 3.4: Sample collection from (a)Tezpur (b)Narayanpur (c)Gphpur(d)Mangaldai (e)Biswanath (f)Guwahati

5.2 LABORATORY WORK

The analysis of the samples was conducted using the Hydrometer analysis method and sieve analysis method, in accordance with the provisions outlined in IS:2720 (Part 4) 1985. The reason for performing the Hydrometer analysis test was that the samples primarily comprised of extremely fine particles. After conducting the sieve analysis and subsequently drying the samples in an oven, it was observed that no particles were retained in the 4.75 mm sieve and the 75 micron IS sieve.

5.2.1 Hydrometer Analysis

After collection of samples, separation of sediment was done in the laboratory by settlement technique in which the particles are allowed to settle according to their size. The upper portionof water was then removed gently without disturbing the sample and subjected to wet sieving i.e., allowed to passing through the 4.75 mm IS sieve. The passing portion then oven-dried at 105 to 110°C.The oven dried samples finally subjected to hydrometer analysis as per IS:2720 (Part4) 1985 to get the particle size distribution along with percentage finer followed by determination of silt and clay concentration for each sample at different depth. The hydrometermeasures the specific gravity of the soil suspension at the measuring cylinder. The specific gravity depends upon the mass of solid present, which in turn depends upon the particle size.50gram of oven dried samples were taken for the analysis. Before the test, pre-treatment of sediment sample was done to remove organic content and soluble salt by adding 150 ml of Hydrogen Peroxide and stand overnight to evaporate H_2O_2 along with the soluble compound (figure 3.5).

(a) (b)

Figure 3.5: Photo shows (a) Soil sample passing through 0.075mm sieve (b) During pre-treatment of all the sediment samples

It was then added 100ml of dispersion solution (33g of sodiumhexametaphosphate+7g of sodium carbonate in 1000ml of distilled water). Then the sample mixture was mixed with the help of soil dispersion mixer (VGRS220230) for about 10 mins. The suspension then allowedto pass through 75micron IS sieve as shown in figure 3.6. and the passing portion transferred to 1000ml measuring cylinder and was made the suspension up to 1000ml (figure 3.6 c).

(a) **(b)** **(c)**

Figure 3.6: (a) soil dispersion mixer(b)Passing of soil dispersion mixture to 0.075mm sieve(c)Soil suspension in 1000 ml cylinder

The particle settlement was then measured after calibration of hydrometer (ASTM 152H) with dispersing solution to get the corrected hydrometer reading. The reading and temperature were measured after half min,1 min,2 min,4 min,8 min, 15 min, 30 min, 1hr, 2hr, 4 hr and 24 hr accordingly.After the analysis, the weight of the settled soil mass at the measuring cylinder were taken for each sample of different depth for calculation of silt and clay concentration.

5.3 SOFTWARE WORK

To analyze the morphology of the Brahmaputra River from 1990 to 2023, software tools suchas ArcGIS, QGIS, and Google Earth Pro were employed. The focus was on delineating the bank lines at six specific locations along the river. Satellite imagery of the Brahmaputra Riverwas utilized for each reference year to observe and record changes in width. Additionally, thisanalysis facilitated the calculation of the total land loss experienced by the river over the specified time periods.

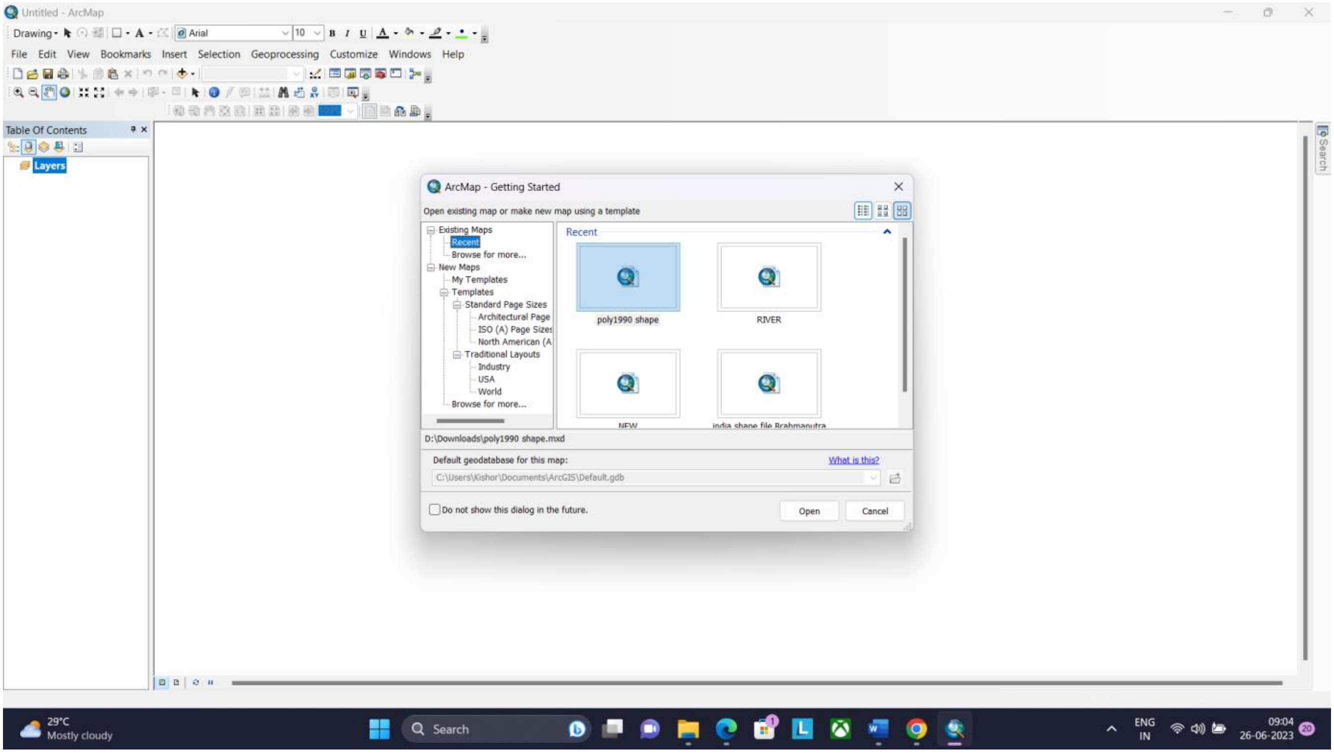

Fig: 3.7 Arc map10.4 interface

CHAPTER 5

RESULTS & DISCUSSION

5.1Hydrometer analysis of sediment sample

5.1.1Particle size distribution of sediment sample for 0 meter and 2-meter Depth

The table below presents the results of the hydrometer analysis test, indicating the particle size and the percentage of finer particles at depths of 0m and 2m for various locations. According to the test results, the highest percentage of finer particles was observed at Biswanath, with 5.08% at0m depth and 7.94% at 2m depth. On the other hand, the lowest percentage of finer particles was found at Tezpur, with 1.44% at 0m depth and 1.75% at 2m depth. The particle size ranges varied for each location, with Gohpur, Naryanpur, Biswanath, Tezpur, Mangaldai, and 0m/2m depthshaving different ranges from 0.069 µ to 0.001 µ, 0.071 µ to 0.001 µ, 0.072 µ to 0.001 µ, 0.072 µ to 0.001 µ, 0.07230 µ to 0.001 µ and 0.0714 µ to0.0013 µ, and 0.069 µ to 0.001 µ, respectively. These findings are summarized in Table 5.1.

Table 5.1 Hydrometer data for different location of 0 m depth

PARTICLE SIZE(µ)	PERCENTAGE FINER (%)					
	GOHPUR	NARAYANPUR	BISWANATH	TEZPUR	MANGALDOI	GUWAHATI
0.07	3.86	3.739	5.085	2.78	4.405	4.034
0.05	3.374	3.378	4.66	2.778	3.934	4.034
0.035	3.132	3.378	4.66	2.445	3.934	3.782
0.025	3.132	3.017	4.234	2.445	3.463	3.53
0.018	2.648	3.017	4.234	2.112	3.463	3.53
0.013	2.406	2.655	3.808	2.112	2.991	3.277
0.009	2.406	2.655	3.383	1.78	2.991	2.773
0.007	2.164	2.294	3.383	1.78	2.991	2.773
0.005	2.164	2.294	2.532	1.78	2.52	2.017
0.003	1.922	1.571	2.532	1.447	2.52	2.017
0.001	1.922	1.571	2.957	1.447	2.049	1.765

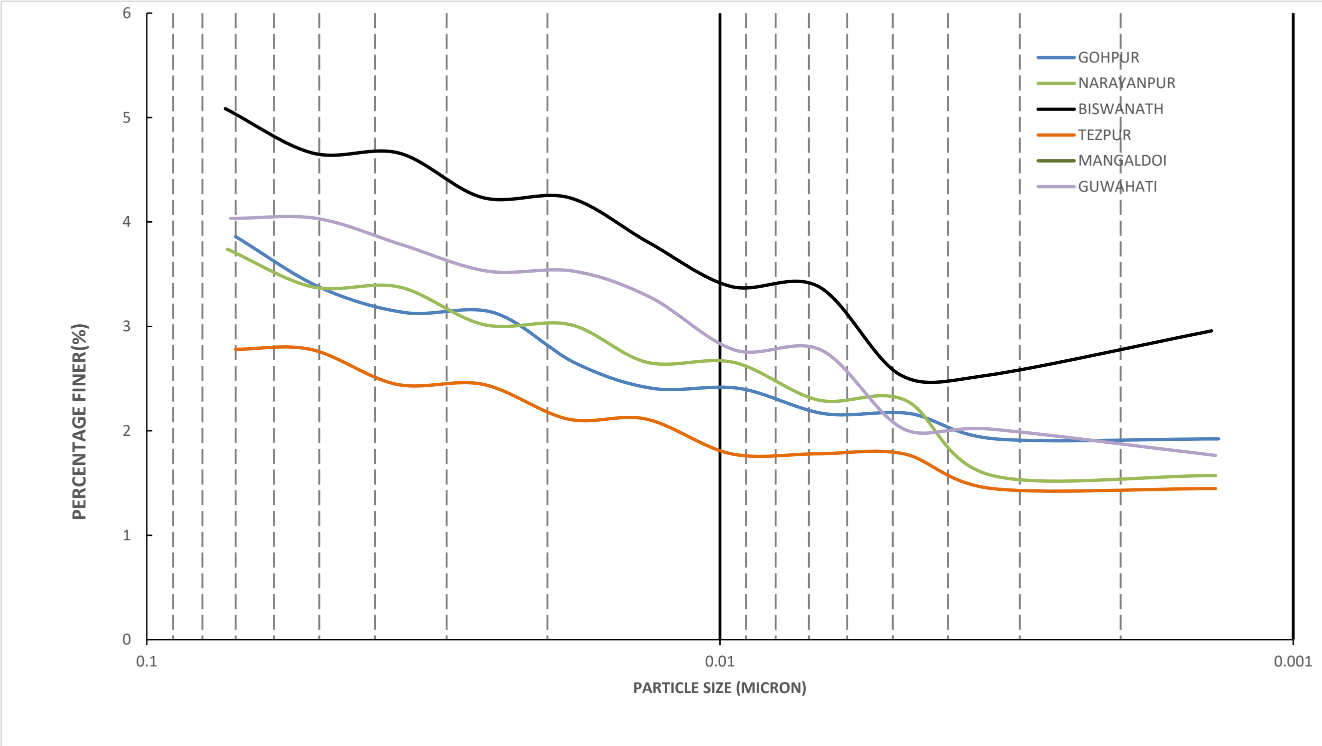

Fig 5.1: Particle size curve for 0 meter depth

Table 5.2 Hydrometer data for different location of 2 m depth

PARTICLE SIZE	PERCENTAGE FINER(%)					
	GOHPUR	**NARAYANPUR**	**BISWANATH**	**TEZPUR**	**MANGALDOI**	**GUWAHATI**
0.07	4.944	6.039	7.941	4.988	7.824	3.635
0.049	4.944	6.039	7.941	4.584	7.335	3.306
0.035	4.634	5.587	7.437	4.18	7.335	2.977
0.025	4.634	5.134	7.437	3.372	6.846	2.977
0.018	4.324	5.134	6.932	2.968	6.357	2.846
0.013	4.324	4.682	6.932	2.968	6.357	2.648
0.009	4.014	4.682	6.428	2.564	5.378	2.648
0.006	4.014	4.229	6.428	2.564	5.378	2.648
0.005	3.704	4.229	5.924	2.16	5.378	2.319
0.003	3.704	3.777	5.42	2.16	4.889	2.319
0.001	3.084	3.324	4.411	1.756	4.4	2.254

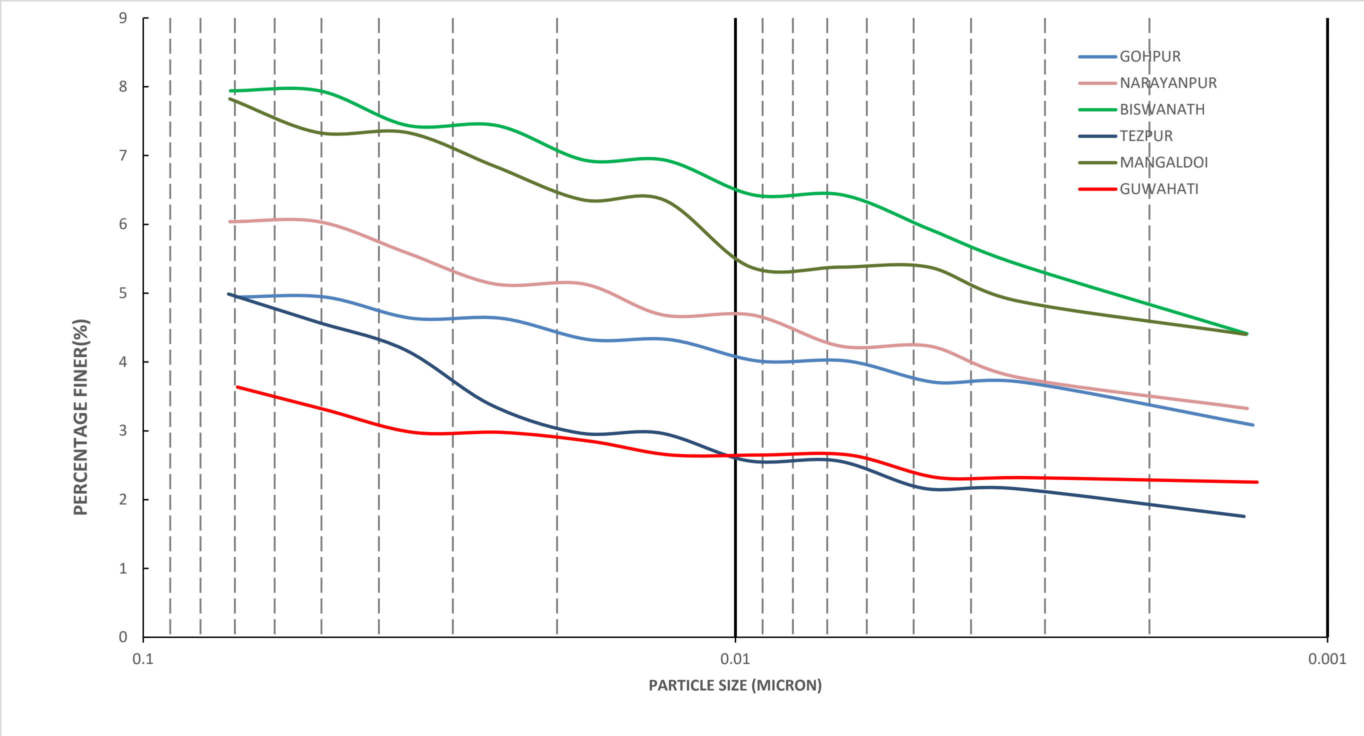

Fig 5.2: Particle size curve for 2 meter depth

Table 5.3 Silt and clay compositions at 0m and 2m depth

Location	Silt(gm)		Clay(gm)	
	0m	**2m**	**0m**	**2m**
Gohpur	7.38	9.35	0.15	0.3
Tezpur	10.21	12.35	0.15	0.2
Biswanath	12.85	14.99	0.42	0.7
Naryanpur	11.07	13.61	0.18	0.47
Mangaldai	14.37	14.55	0.3	0.67
Guwahati	7.71	10	0.14	0.24

The data from the table indicates that the quantity of silt present in the river varies from 7.38g to 14.37g at the surface level, and from 9.35g to 14.99g at a depth of 2m. However, the amount of clay is relatively minimal, ranging from 0.15g to 0.42g at the surface and from 0.2g to 0.67g at 2m depth. Among the locations, the highest silt load was recorded at Mangaldai at the surface level, while the lowest amount was observed at Gohpur, measuring 14.37g. This information has been visually represented in Figure 5.3 using a column chart based on the data provided in the table.

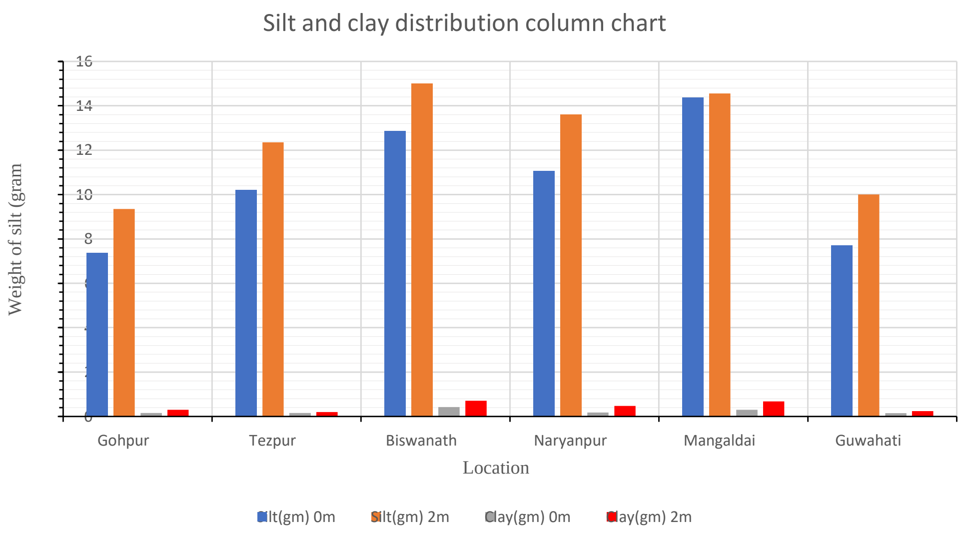

Fig5.3: Column chart showing silt and clay distribution

By examining the column chart, it becomes evident that the silt composition reaches its maximum at a depth of 2m in Biswanath, with a quantityof 14.99g. Conversely, Gohpur exhibits the lowest silt composition at 2m depth, measuring 9.35g. The chart also reveals that the presence of clayfraction is extremely minimal in all the locations. Therefore, it is evident from the chart that the Brahmaputra River carries a significant amount of silt and a negligible fraction of clay. Moreover, the concentration levels of silt and clay differ with depth, as the amount of silt tends to be higherat 2m depth compared to the surface level.

5.2 Variation in sediment concentration level with depth

Sediment concentration(mg/l) was determined for the sample particles which were smaller than 0.075mm for every section with varying depth after hydrometer analysis of the sample as shown in the table 5.4. The results show that out of six sections for 0m depth the sediment concentrationis highest at Mangaldai and the value is 14.67 g and for 2m depth the concentration is highest at Biswanath which is 15.69 mg/l. And the lowest sediment concentration found at Gohpur which is 7.53g and 9.53g for 0m and 2m depth respectively.

Table 5.4 sediment concentration level with depth

TEZPUR		**BISWANATH**		**GOHPUR**		**NARAYANPUR**		**MANGALDAI**		**GUWAHATI**	
Amount of sediment(g)	Depth(m)	Amount of sediment(g)	Depth	Amount of sediment(g)	Depth	Amount of sediment(g)	Depth	Amount of sediment(g)	Depth	Amount of sediment(g)	Depth
10.36	0	13.25	0	7.53	0	11.25	0	14.67	0	7.85	0
12.5762	-2	15.69	-2	9.652	-2	14.08	-2	15.22	-2	10.24	-2

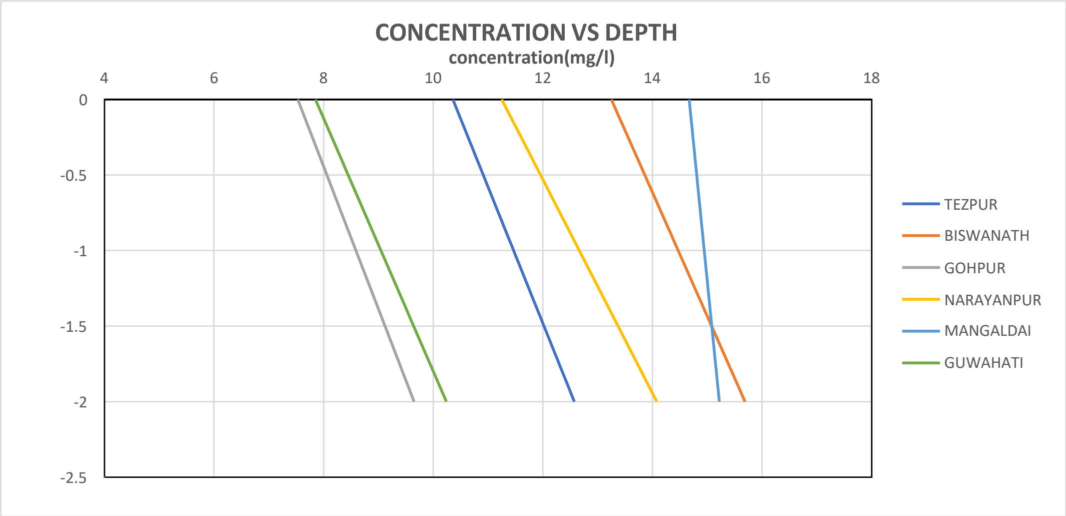

Fig 5.4 concentration vs Depth for six locations

From the graph it shows that sediment concentration increases with depth in similar pattern but in case of Mangaldai it shows slightly differentpattern because of at zero-meter depth i.e., at surface it has highest sediment concentration of 14.67g.

5.3 Width of the River Bankline changes in North Bank and South Bank in terms of Erosion and Deposition

Table 5.5 showing change in river width due to erosion(E) and deposition of river bankline in North bank and South bank of the river Brahmaputra for each reference year (1990,2000,2010 and 2023). "– 'indicates erosion and "+" indicates deposition in the table given below.From the Table 3.6 it shows that Maximum erosion is being seen at Mangaldai which expand its width towards Southbank and North bank by 1815 m and 533m respectively from 1990-2023.Total Southbank and North bank erosion of the river has found to be 4025 m and 1317 m in the six sections respectively from 1990-2023.

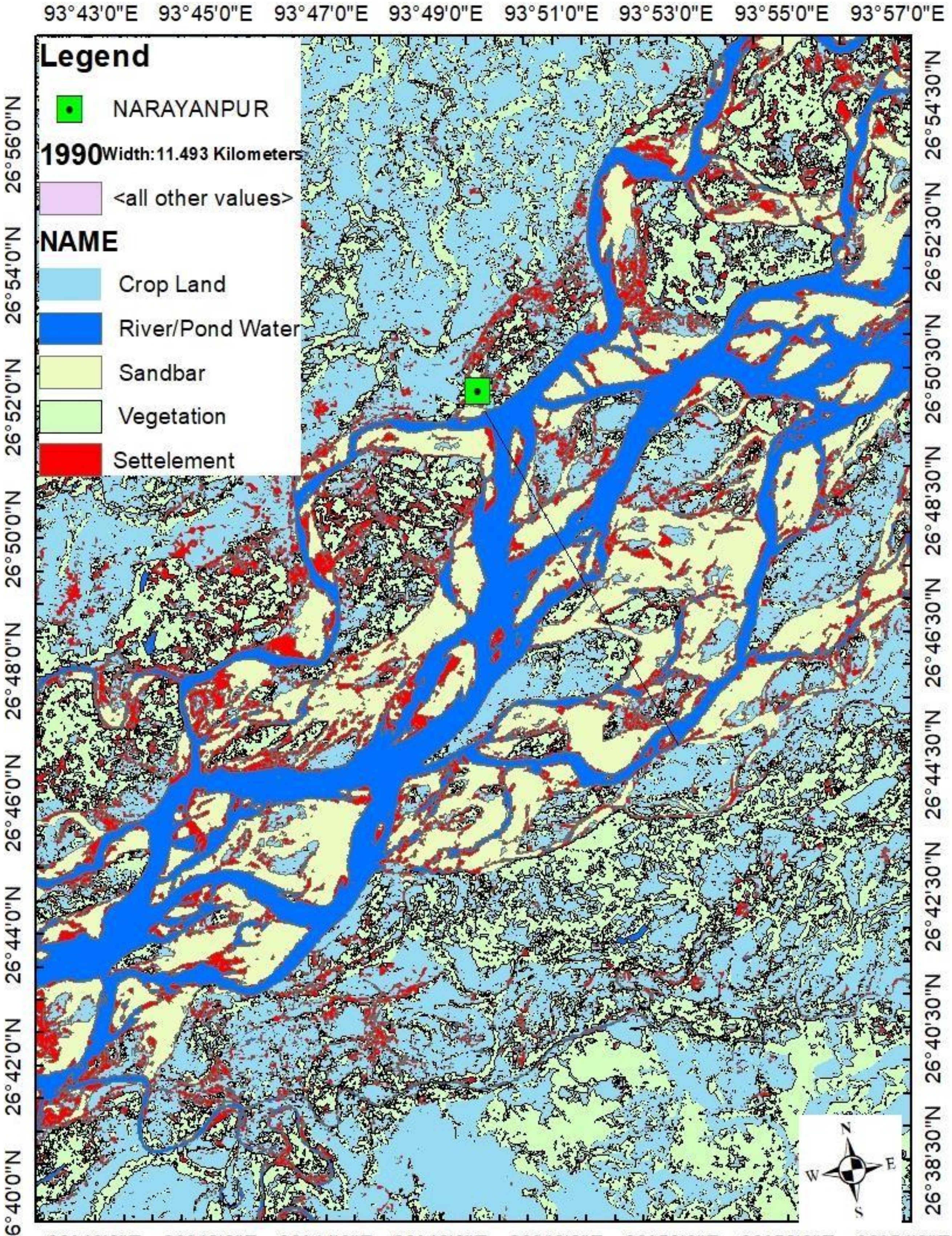

Fig 5.5 Width of the Brahmaputra River in Narayanpur in 1990

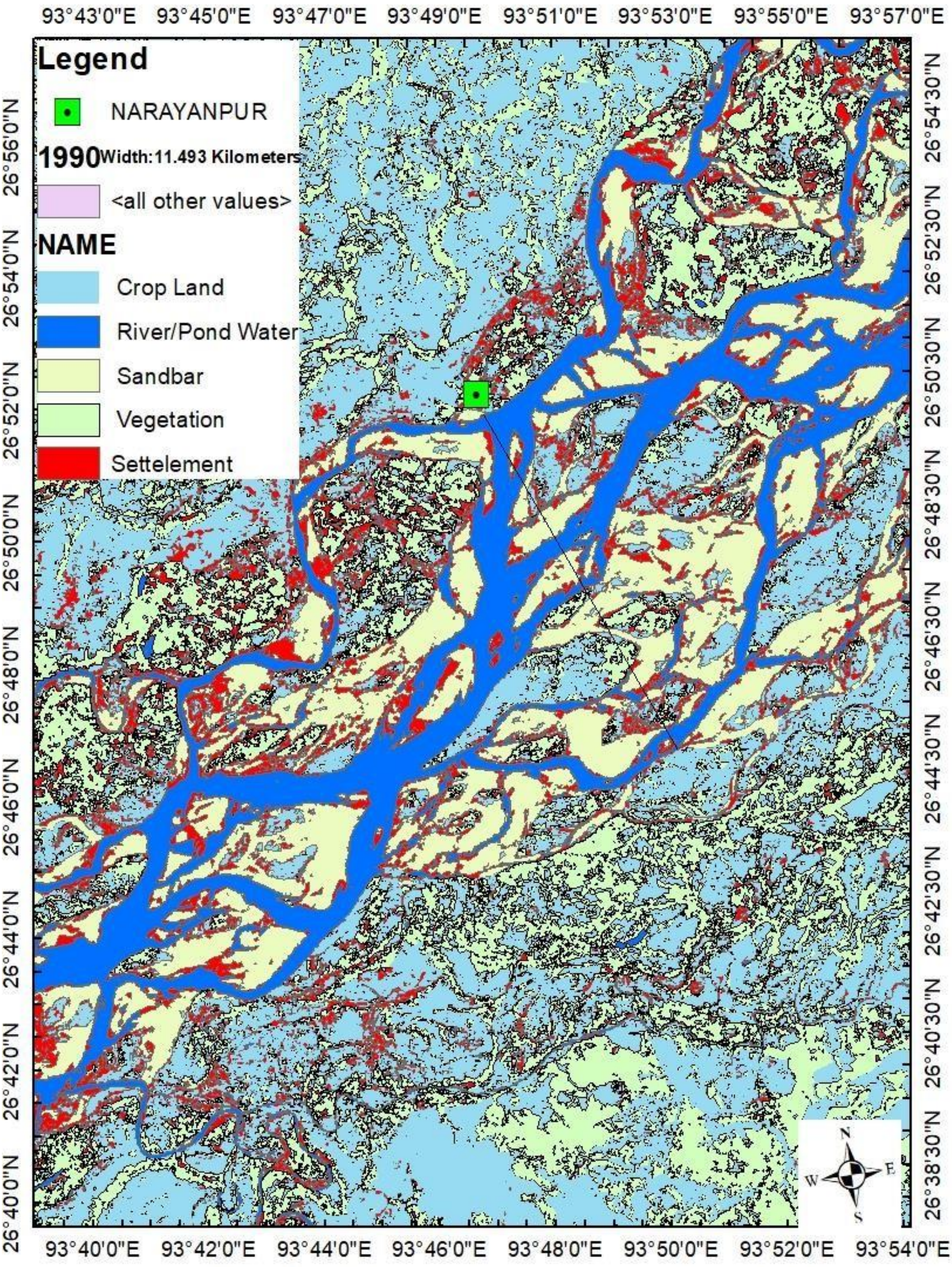

Figure 5.5: Width of the Brahmaputra River in Narayanpur in 1990