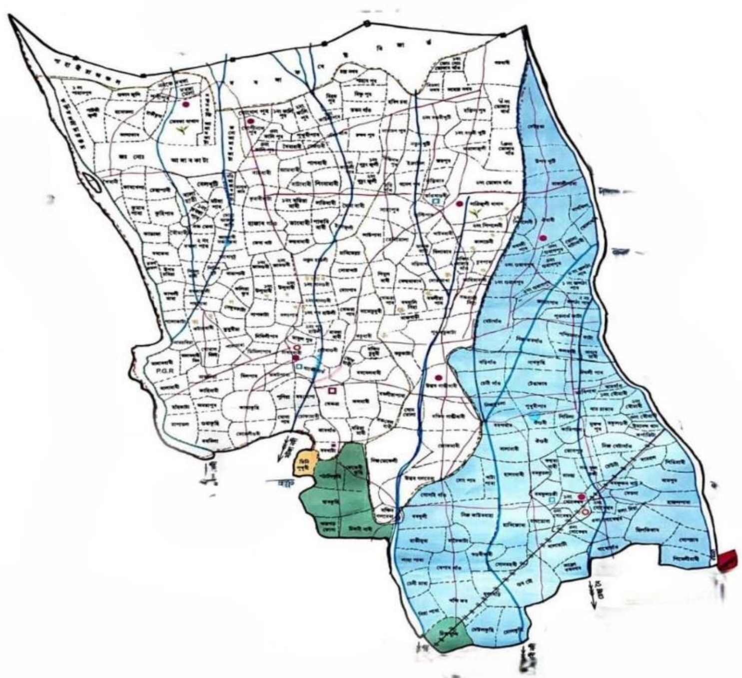
DRAFT
DISTRICT SURVEY REPORT
OF
TAMULPUR DISTRICT, ASSAM
(For sand or river bed mining)



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PREFACE

The need for a District Survey Report (DSR) has been mandated by the Ministry of Environment, Forest, and Climate Change (MoEF&CC) through Notification No. 125 (Extraordinary, Part II Section 3, Sub-section ii), S.O. 141 (E), dated 15th January 2016. This notification introduced amendments to the EIA Notification 2006, aimed at improving legislative control. As part of these changes, district-level committees were introduced, and the preparation of DSRs became a requirement.

Subsequently, Notification No. 3611 (E), dated 25th July 2018, expanded the DSR's scope to include "Minerals Other than Sand" and provided a specific format for its preparation. The DSR's purpose is to identify areas with mineral potential where mining activities can be permitted, as well as to flag areas where mining should be restricted due to proximity to infrastructure, erosion-prone zones, or environmentally sensitive regions.

The preparation of the DSR involves both primary and secondary data collection. Primary data includes site inspections, surveys, and ground truthing, while secondary data comes from authenticated sources and satellite imagery studies. The secondary data covers information such as the district profile, local geology, mineralization, and other relevant activities, often compiled from disparate sources.

Key Aspects of District Survey Report (DSR)

Assessment of Resources: The DSR provides a comprehensive evaluation of the mineral resources available in riverbeds within the district. It includes detailed data on the quantity, quality, and distribution of sand and other minor minerals, helping to prevent over-extraction and resource depletion through accurate estimation.

Environmental Impact Analysis: The report analyzes the environmental effects of riverbed mining, addressing changes in river morphology, hydrology, and impacts on aquatic ecosystems and biodiversity. This analysis is vital for mitigating harmful environmental impacts and conserving riverine habitats.

Regulation and Compliance: The DSR serves as a regulatory tool for riverbed mining, outlining standards and guidelines to ensure compliance with national and state environmental laws. It helps curb illegal mining activities and promotes regulated, lawful mining operations.

Sustainable Mining Practices: The DSR advocates for sustainable mining practices that reduce environmental degradation. Recommendations may include controlled mining depths, designated extraction zones, and periodic studies to maintain the ecological balance of river systems.

Socio-Economic Considerations: The report addresses the socioeconomic implications of riverbed mining, such as employment generation and local government revenue. It also considers the negative impacts on communities, including displacement and loss of livelihoods.

Data-Driven Decision Making: The DSR provides a scientific foundation for decisions regarding riverbed mining. Incorporating geospatial data, remote sensing images, and field surveys enhances the accuracy and reliability of the report, supporting informed policy-making and resource management.

Stakeholder Involvement: The preparation of the DSR involves consultations with various stakeholders, such as government bodies, local communities, environmentalists, and industry representatives. This inclusive approach ensures diverse perspectives are considered, promoting balanced and equitable mining practices.

1. Introduction of District Survey Report (DSR) of Tamulpur District

1.1 Introduction

The District Survey Report (DSR) of Tamulpur District has been prepared following the guidelines of the Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India. This report aligns with the MoEF&CC Notification S.O.-1533(E) dated 14th September 2006 and subsequent notification S.O. 141(E) dated 15th January 2016. It aims to ensure the scientific and systematic utilization of natural resources for the benefit of present and future generations. Furthermore, MoEF&CC's notification S.O. 3611(E) dated 25th July 2018 recommends the format for preparing the DSR.

The main objective of the DSR is to identify areas of aggradation where mining can be allowed, and areas of erosion where mining should be restricted. It also involves the calculation of the annual replenishment rate to maintain ecological balance. Additionally, the DSR includes assessing the development potential of in-situ minor minerals.

Objectives of the DSR:

1. Identification and quantification of minor mineral resources for optimal utilization.
2. Regulation of river bed mining, and reduction of demand-supply gaps.
3. Use of Information Technology (IT) for surveillance of river bed mining activities.
4. Facilitation of environmental clearance for clusters of mines.
5. Restriction of illegal mining.
6. Reduction of flood occurrences in the area.
7. Preservation of aquatic habitats.
8. Protection of groundwater by limiting extraction to above base flow levels.
9. Maintenance of data records related to mineral resources, leases, and revenue generation.
10. Creation of a scientific mining plan, including ultimate pit limit estimation.
11. Development of comprehensive guidelines for mining minor minerals.

The DSR includes secondary data on the district's geology, climate, mineral resources, and other relevant factors, compiled from published and unpublished reports, as well as government websites.

1.2 Statutory Framework

The MoEF&CC has issued several notifications and guidelines over the years to regulate mining and formulate DSRs for each district. Below is a summary of the legal framework:

Year	Particulars
1994	The MoEF&CC issued the Environmental Impact Assessment (EIA) Notification for major minerals covering areas over 5 hectares.
2006	EIA Notification SO 1533 (E) made it mandatory to obtain environmental clearance (EC) for minor minerals exceeding 5 hectares.
2012	The Hon'ble Supreme Court mandated EC for minor minerals, even for areas under 5 hectares.
2016	"Sustainable Sand Mining Guidelines (SSMG)" introduced, requiring EC for all minor minerals and district-level monitoring.
2018	MoEF&CC issued notification S.O. 3611(E) with a recommended DSR format for identifying aggradation areas, replenishment rates, and protected zones.
2020	The "Enforcement and Monitoring Guidelines for Sand Mining (EMGSM)" introduced for improved regulatory enforcement and technological monitoring of sand mining activities.

Enforcement & Monitoring Guidelines, 2020

These guidelines address illegal mining, directing states to implement monitoring mechanisms like river audits, aerial surveys, and drone-based surveillance.

1.3Utilization and Demand of the minerals

River bed minerals like sand, gravel, stone etc. plays an essential role in construction and is widely used in concrete production, glass manufacturing, road base formation, and many more. River bed mining is a prevalent practice in Tamulpur District, mainly for construction. The rise in real estate and government infrastructure projects has significantly increased the demand for sand and bricks. The minor minerals of TamulpurDistrictdistrict comes under B-category mining and it is included in sub-category B2.

Uses of minerals:

1. **Construction**: Sand, gravel, silt, clay and ordinary earth are key ingredients in concrete, mortar and asphalt.
2. **Industrial**: Used in glass production and abrasives.
3. **Environmental**: The minerals can improve traffic safety by providing grip on icy roads, and it helps in soil conditioning for agriculture.
4. **Decorative**: Sand, gravel and stones are used in candles, aquariums, and for enhancing aesthetic appeal in landscaping.
5. **Flood Protection**: Proper management of sand mining helps maintain river flood discharge capacity, reducing the risk of floods.

This DSR aims to provide a well-rounded, data-driven approach for sustainable mineral resource management, ensuring compliance with environmental guidelines and promoting socio-economic benefits for the district.

1.4 Methodology of DSR Preparation

The District Survey Report (DSR) preparation follows a systematic methodology to ensure accuracy and comprehensiveness. The steps involved in the preparation of the DSR are described in detail in the following sections.

a. Data Source Identification

The DSR is based on both primary and secondary data collected from reliable and authoritative sources. Identifying authentic data sources is critical for compiling accurate data. The primary data sources for the DSR are collected through field surveys and replenishment studies. Secondary data sources include publicly available information from government publications, reports, and reputable journals.

- **District Profile**: Information related to the district's demographics and basic statistics is sourced from the **District Census Report, 2011** and the **District Statistical Handbook** published by the Government of Assam.
- **Mineral Resources**: The potential mineral resources of the district are described based on reports published by the **Geological Survey of India (GSI)** or other government agencies
- **Mining Data**: Information on mining leases, lease holders, lease areas, resource allocations, and revenue generation is collected from the **Forest Department.**
- **Satellite Images**: Satellite imagery is utilized to prepare maps related to the district's physiography and land use/land cover.

b. Data Analysis and Map Preparation

After collecting data, a detailed analysis is conducted to extract relevant insights. This involves analyzing spatial data and preparing maps that depict:

- Geomorphology of the district
- Topography
- Land use patterns
- Mineral resource distribution

These maps help visualize the key characteristics of the district and identify potential mining areas.

c. *Primary Data Collection*

Primary data is essential for preparing a comprehensive DSR. Fieldwork is conducted across the district to assess mineral resources. This field study provides a detailed understanding of the mineral composition and their distribution in the area.

d. *Replenishment Study*

A key aspect of sustainable mining is ensuring that the amount of sediment removed from riverbeds is replenished naturally. Therefore, replenishment studies are conducted to assess the annual rate of replenishment of riverbed sand. This helps avoid the adverse impacts of excessive sand extraction.

- Physical surveys of the riverbed are carried out using **GPS/DGPS** to define the topography, contours, and offsets.
- The surveys provide a detailed depiction of important features in and around the river, including nearby civil structures and other key landmarks.
- This information helps define the spatial area eligible for sand mining and estimate the sand reserves.

e. *Report Preparation*

The DSR covers various aspects of the district, including:

- **General Profile**: A brief overview of the district, including demographics, land use patterns, and economic activities.
- **Geomorphology and Geology**: An assessment of the district's physical landscape, including its geological structure.
- **Mineral Resources**: A detailed account of riverbed sands and other minor minerals in the district, including their distribution and potential for extraction.
- **Mining Block Delineation**: Identification of potential mining blocks and mineral reserves within the district.

- **Production Trends**: An analysis of recent trends in the production of minor minerals and the revenue generated from the mining sector.
- **Replenishment Estimation**: The annual replenishment rate of riverbed sand, based on field surveys.
- **Environmental Impact and Mitigation**: An evaluation of the potential environmental impacts of mining activities, along with proposed mitigation measures.
- **Risk Assessment and Disaster Management**: A strategy for managing risks associated with mining and minimizing the impact of any potential disasters.
- **Reclamation Strategy**: A plan for the reclamation of already mined-out areas to restore the ecological balance.

This structured approach ensures that the DSR not only identifies mineral resources but also emphasizes sustainable mining practices and environmental preservation.

2. Overview of mining activity in the district

Mining activity in the newly formed Tamulpur district of Assam is still relatively undeveloped compared to other regions in the state. Most mining efforts in Assam are centered on minerals like limestone, coal, sand, and gravel. In nearby areas like Baksa and other regions of Assam, there is significant limestone and sand mining activity that contributes to local construction projects and industry needs.

In the Tamulpur district collection of sand, clay/silt etc. from river- bed is considered as one of the main minor mineral sources of the district. These materials are primarily utilized for construction purpose.

3. List of existing mining leases of the districts

Sl. No.	Name of Mahal	Name of the lessee	Location and area of mining lease	Period of lease	Status (working/ closed)
1	Barnadi Sand Gravel & Stone Mahal No-7	Pani ram Boro	Barnadi River 4.9 Ha	5 years	Existing
2	Barnadi Sand Mahal No-5	PabinBoro	Barnadi River 4.98 Ha	5 years	Existing
3	Barnadi Sand Gravel & Stone Mahal No-6	Ganesh Boro	Barnadi River 4.99 Ha	5 years	Existing
4	Barnadi Sand Mahal No-2	Detchung Kr Brahma	Barnadi River 4.99 Ha	5 years	Existing
5	Barnadi Sand & Stone Mahal No-3	Ram Chandra Swargiary	Barnadi River 4.97 Ha	3 years	Existing
6	Motonga Sand Gravel & Stone Mahal No-1	MonojGoyari	Motonga River 4.98 Ha	5 years	Existing
7	Barnadi Sand Mahal No-8	RatulSwargiary	Barnadi River 4.98 Ha	5 years	Existing
8	Barnadi Sand Mahal No-9	BaneswarBoro	Barnadi River 4.98 Ha	5 years	Existing

9	Barnadi Sand & Stone Mahal No-1(A)	BasudevUzir	Barnadi River 4.98 Ha	3 years	Existing
10	Balti Clay/Silt Mahal	Const. Of Medical College at Tamulpur	Balti River	2 years	Existing
11	Barnadi Sand Mahal No-12		Barnadi River 4.8 Ha	5 years	Proposed
12	Barnadi Sand & Stone Mahal No-1(B)	Pani ram Boro	Barnadi River 4.98 Ha		Proposed
13	Barnadi Sand Gravel & Stone Mahal No-10	MithunBasumatary	Barnadi River 4.90 Ha	5 years	Proposed
14	Barnadi Sand Mahal No-13		Barnadi River 4.9 Ha	7 years	Proposed
15	Motonga Sand & Stone Mahal No-5	MadhabChoudhury	Motonga River 10.62 Ha		Proposed
16	Darranga Sand & Stone Mahal No-6	MadhuBoro	Darranga River 5 Ha	5 years	Proposed
17	Motonga Sand Gravel & Stone Mahal No-3		Motonga River 4.5 Ha	3 years	Proposed

18	Motonga Sand Gravel & Stone Mahal No-4	Md. Alauddin Ahmed	Motonga River 4.99 Ha	5 years	Proposed
19	Keleng Chock B		Puthimari River 4.95 Ha	2 years	Proposed
20	Keleng Chock A		Puthimari River 4.9 Ha	2 years	Proposed
21	Darranga Sand & Stone Mahal No-5	Chem Kr Mosahary	Darranga River 4.99 Ha	2 years	Proposed
22	Barnadi Sand Gravel & Stone Mahal No-11		Barnadi River 4.5 Ha	5 years	Proposed
23	Barnadi Sand & Stone Mahal No-4	ApurbaBasumatary	Barnadi River 4.9 Ha	5 years	Proposed

4. Details of revenue generated from mineral sector during last three years

Revenue generated for last 3 years in Tamulpur District is furnished in the following table:

Table: District revenue generation from mineral sector (In INR)

Financial Year	Royalty			Total revenue
2022-23				
2021-22				
2020-21				

5. Detail of Production of Sand or Bajri or minor mineral in last three years

Sl. No	Financial Year	Production(Cum)
1	2022-23	
2	2021-22	
3	2020-21	

6. Process of Deposition of Sediments in the rivers of the District of Tamulpur:

Many rivers originate from the Himalayan and Shivalik regions which supply water in down streams. The greatest sediment yields are generally associated with rivers draining areas of intensive tectonic activity therefore, Himalayan rivers cause tremendous erosion and carry large amounts of sediment. Sediment load can be divided into bed load and suspended load based on the mode of transport. Bed load is transported close to the bed where particles move by rolling, sliding, or jumping transport in natural rivers is a complicated phenomenon. Its movement is quite uneven in both the transverse and longitudinal directions, which varies considerably. Some sediment particles roll or slide along the bed intermittently and some others state (hopping or bouncing along the bed).

The sediment of a river is commonly considered to be aesthetically displeasing and environmentally degrading. Conversely, part of the sediment (sand and gravel) may represent a natural resource for use by society. The potential usefulness of the sediment is enhanced when it is composed of particle sizes found in deposits on the river- bed that would be replenished by newly transported sediment after mining. As such, river deposits become renewable resources, periodically replaced by sediment transport in the river.

Sediment transport is the movement of organic and inorganic particles by water. In general, the greater the flow, the more sediment that will be conveyed. Water flow can be strong enough to suspend particles in the water column as they move downstream, or simply push them along the bottom of a water way. Transported sediment may include mineral matter, chemical sand pollutants, and organic material. Another name for sediment transport is sediment load. The total load includes all particles moving as bed load, suspended load, and wash load. Sediment deposition is the process of settling down of suspended particles to the bottom of a body of water. This settling often occurs when water flow slows down or stops, and heavy particles can no longer be supported by the bed turbulence. Sediment deposition can be found anywhere in a water system, from high mountain streams, to rivers, lakes, delta, floodplains.

Sediment transport is critical to understanding how rivers work because it is the set of processes that mediates between the flowing water and the channel boundary. Erosion involves removal and transport of sediment (mainly from the boundary) and deposition involves the transport and placement of sediment on the boundary. Erosion and deposition are what form the channel of any alluvial river as well as the flood plain through which it moves. The amount and size of sediment moving through a river channel are determined by three fundamental controls: competence, capacity and sediment supply. Competence refers to the largest size (diameter) of sediment particle or grain that the flow is capable of moving; it is a hydraulic limitation. If a river is sluggish and moving very slowly it simply may not have the power to mobilize and transport sediment of a given size even though such sediment is available to transport. So a river may be competent or incompetent with respect to a given grain size. If it is incompetent it will not transport sediment of the given size. If it is competent it may transport sediment of that size if such sediment is available (that is, the river is not supply-limited). Capacity refers to the maximum amount of sediment of a given size that a stream can transport in traction as bed load. Given a supply of sediment, capacity depends on channel gradient, discharge and the caliber of the load (the Presence of fines may increase fluid density and increase capacity; the presence of large particles may obstruct the flow and reduce capacity). Capacity transport only occurs when sediment supply is abundant (non- limiting). Sediment supply refers to the amount and size of sediment available for sediment transport. Capacity transport for a given grain size is only achieved if the supply of that caliber of sediment is not limiting (that is, the maximum amount of sediment in stream is capable of transporting is actually available). Because of these two different potential constraints (hydraulic sand sediment supply) distinction is often made between supply- limited and capacity- limited transport.

Much of the material supplied to a stream is so fine (silt and clay) that provided it can be carried in suspension, almost any flow will transport it. Although there must be an upper limit to the capacity of the stream to transport such fines, it is probably never reached in natural channels and the amount moved is limited in supply. In contrast, transport of coarser material (say, coarser than fine sand) is largely capacity limited.

Modes of Sediment Transport: The sediment load of a river is transported in various ways although these distinctions are to some extent arbitrary and not always very practical in the sense that not all of the components can be separated in practice.

The modes are:
1. Dissolved Load.
2. Suspended Load.
3. Intermittent Suspension (Siltation) Load
4. Wash Load
5. Bed Load

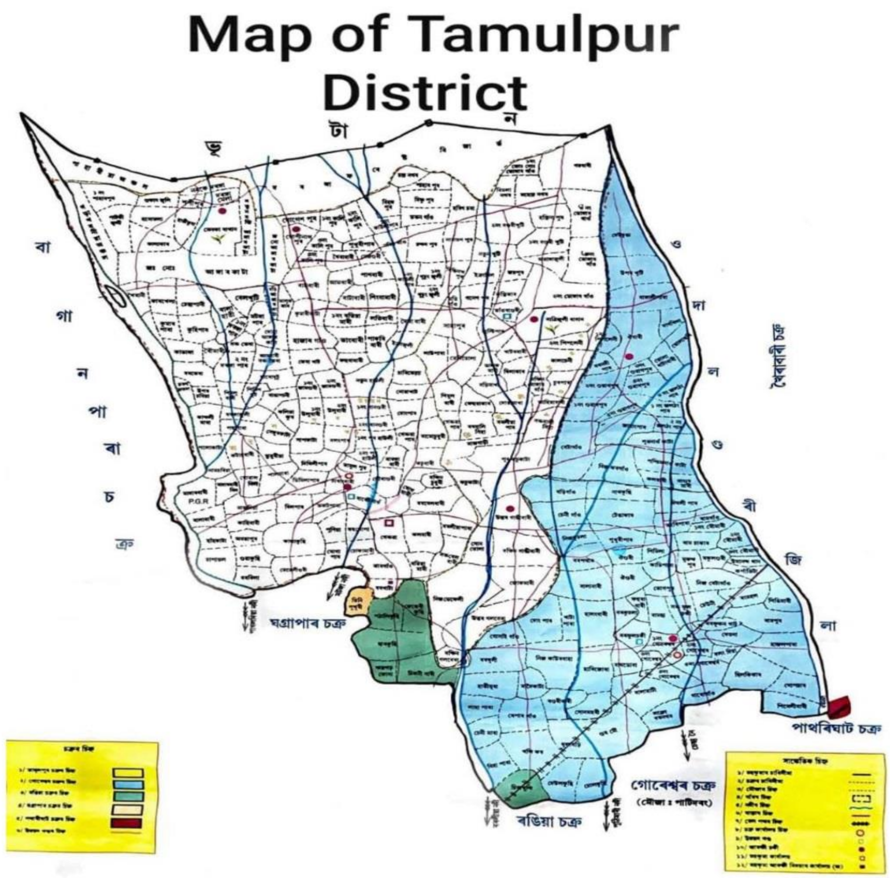
7. General Profile of the district

a) General Information

The Tamulpur District recreated as 35th District of Assam after the Delimitation on 11 August 2023 as per Section 8 A of the RP Act, 1950 of Election Commission and approval of 100th Cabinet meeting held in Guwahati, Dispur on 26th August, 2023 sharing 29.6 km of Bhutan, having geographical area of 461.25 sq km approx. with 4, 06,371 cosmopolitian population, where Male 206348 and female 200023 (2011 Census) and literacy rate 85.71% included in the district in two Administrative Revenue Circle namely Tamulpur Revenue Circle and Goreswar Revenue Circle. The three Development Block- Tamulpur, Nagrijuli and GoreswarDev Block and two Legislative Assembly Council- 43 tamulpur LAC (ST) and 44 Goreswar LAC are included within the jurisdiction of the district after delimitation. The District is agrian based covering Agriculture area with 47383.89 bigha mainly with Paddy and producing honey keeping bee.

1	GeographicalArea	5,70,762B-4K-18.5L
2	TotalPopulation	4,06,371(M-206348,F-200023)(Asper2011Census)
3	Sub-Divisions	1
4	No.ofRevenueCircles	2(Tamulpur and Goreswar)
5	No.ofDevelopmentBlocks	3**(**Tamulpur**,**Goreswar**,**Nagrijuli**)**
6	TotalPolice Stations	2(Tamulpur and Goresswar)
7	Total Outposts	5 (Darrangamela OP, Nagrijuli OP, Kumarikata OP, Gandhibari OP,Suagpur OP)
8	TotalPatrol Posts	1(Kaurbaha PP)
9	No.of Villages	284
10	No.ofTea Gardens	2(Nagrijuli TE andMenoka TE)
11	No.ofBTC Constituencies	5(Darrangajuli,Nagrijuli,Tamulpur,SuklaiSerfang, Goreswar)
12	No.of LAC	2(43- TamulpurLAC&44-Goreswar LAC)
13	Major Rivers	Pagladia,Puthimari,Kaldia
14	No.ofRailway Station	1(Goreswar)
15	No.ofFire& Emergency Services	Goreswar & Tamulpur
16	No.ofMouzas	8 (Pub Baska, Kumarikata, Defeli, Panduri, PaschimBanbhag, Betna,Kaurbaha,Patidarrang)
17	Firing Ranges	3(Darrangamela Long Firing Range at Sukanjali, No.1 PaharpurLong Firing Range and Menoka Firing Range at Menoka TE)
18	Numberof Helipad	1

LULCareainTamulpurdistrict	
Totalgeographicalarea	5,70,762 B-4K-18.5 L
Agriculture	72592hectre
Forest	6317.852hectre
Builtup	12806.92hectre
Water	130km



Map: Administrative Map of Tamulpur District

b) Climate Condition

The district witnessed a sub-tropical humid climate with a hot summer and moderate winter. The winter temperature drops to 10 degree Celsius and summer temperature goes up to 38 degree

C. The drastic Climate Change have been witnessed in Tamulpur district in the month of April with a temperature 38 degree Celsius and changes in Rainfall intensity and early pre monsoon due to global Warming. The total annual rainfall of the district is 1346 mm from May to October 2023. The maximum rainfall was 60. 98 mm on 21 June 2023. The flash flood mainly occurs in the district due to heavy rainfall in the adjacent areas of Bhutan. The flash flood and heavy rainfall in Bhutan, when flows above danger level, affects Tamulpur district with flash flood for around 2 to 3 hours and the water flows down and inundated Nalbari, Darrang and Kamrup(R) district. The early warning system has been developed and the weather condition marked in Bhutan to all the stakeholders.

c) Drainage System

Number of perennial streams flow through the district from north to south and join the Brahmaputra River.

RiverName	Fromwhereitstarts	Km
Puthimari	Kangpar,Bhutan	68.76
Pagladiya	Narphu,Bhutan	56.68
Borolia	SamdrupJongkhar,Bhutan	15.23
Baralia	Nagrijuli	74.59
Suklai	SamdrupJongkhar,Bhutan	29.9
Matanga(noona)	Samdrup Jongkhar, Assam-Bhutan boundary	40.48
Deosunga	Bhutan	20
Lebra	Bhutan	7
Naobandha	Bhutan	15
Kalanadi	SamdrupJongkhar,Bhutan	15
Sukan	Bhutan	8
Balti	Samdrup Jongkhar,Assam-Bhutan boundary	20
Dimila	Boiling	15
Darranga	SamdrupJongkharBhutan	18
Bogamati	Puthimari,Assam-BhutanBoundary	3.56
Barnadi	SamdrupJongkhar,Bhutan	15.52

d) Stream ordering

The stream order hierarchy was officially proposed in 1952 by Arthur Newell Strahler, a geoscience professor at Columbia University in New York City, in his article "Hypsometric (Area Altitude) Analysis of Erosional Topology". The article, which appeared in the Geological Society of America Bulletin outlined the order of streams as a way to define the size of perennial (a stream with water in its bed continuously throughout the year) and recurring (a stream with water in its bed only part of the year) streams. When using stream order to classify a stream, the sizes range from a first-order stream all the way to the largest, a 12th- order stream.

A first- order stream is the smallest of the world's streams and consists of small tributaries. These are the streams that flow into and "feed" larger streams but do not normally have any water flowing into them. In addition, first and second- order streams generally form on steep slopes and flow quickly until they slow down and meet the next-order waterway.

First through third- order streams are also called headwater streams and constitute any waterways in the upper reaches of the watershed. It is estimated that over 80% of the world's waterways are these first through third- order, or headwater streams. Going up in size and strength, streams that are classified as fourth through sixth order are medium streams while anything larger (up to 12th order) is considered a river.

The world's largest river, the Amazon in South America, is considered a 12th- order stream. Unlike the smaller order streams, these medium and large rivers are usually less steep and flow slower. They do however tend to have larger volumes of runoff and debris as it collects in them from the smaller waterways flowing into them.

This method of classifying stream size is important to geographers, geologists,hydrologistsand other scientists because it gives them an idea of the size and strength of specific waterways within stream networks- an important component of water management. In addition, classifying stream order allows scientists to more easily study the amount of sediment in an area and more effectively use waterways as natural resources. Stream order also helps people like biogeographers and biologists in determining what types of life might be present in the waterway. This is the idea behind the River Continuum Concept, a model used to determine the number and types of organisms present in a stream of a given size. Different types of plants for example canlive in sediment-filled, slower-flowing rivers like the lower Ganges than can live in a fast-flowing tributary of the same river. Field investigation depicts that order of all the rivers is of 1^{st} order nature: drainage pattern is dendritic; drainage density is very low.

e) Irrigation

For Irrigation the district relies heavily on natural water sources, including rivers, canals, ponds, and rain-fed systems.

Sources of Irrigation

- Rivers: The primary sources of water for irrigation in Tamulpur are the Pagladiya River and other smaller streams that originate from the foothills of Bhutan. These rivers contribute significantly to the irrigation of crops, especially during the monsoon season. However, the river systems are prone to seasonal flooding, which can both enhance and challenge irrigation practices (Bhattacharya et al., 2020).

- Canals: The district has limited canal-based irrigation systems, but small-scale canals, locally managed by farmers, are used to divert water from the rivers and streams for irrigation. These systems are not fully developed and often face challenges due to siltation and irregular water flow (Sharma &Goswami, 2021).

- Ponds and Tanks: Ponds and small tanks are essential sources of irrigation, especially during the dry season. These water bodies are used for both irrigation and fish farming, providing a dual resource for local communities (Dutta, 2018).

Types of Irrigation

- Surface Irrigation: Surface irrigation, including flood irrigation, is the most commonly practiced form of irrigation in Tamulpur. This method uses the natural flow of rivers and streams to inundate fields, particularly for paddy cultivation. However, it is inefficient in terms of water use, leading to water wastage and potential crop damage during periods of excessive flooding (Sharma et al., 2020).

- Lift Irrigation: In certain areas where surface irrigation is not feasible, farmers use lift irrigation systems. These systems involve pumping water from rivers, ponds, or wells to irrigate fields. The use of pumps is limited due to the high cost of equipment and electricity (Goswami& Ahmed, 2019).
- Rain-fed Agriculture: A significant portion of the agriculture in Tamulpur is dependent on rain-fed irrigation, where crops rely on monsoon rains. While this is a natural form of irrigation, it makes agriculture highly vulnerable to fluctuations in rainfall, leading to inconsistent crop yields (Ahmed &Sarma, 2019).

Major Irrigated Crops

- The primary crops that benefit from irrigation in Tamulpur are rice (paddy), wheat, maize, and mustard. Rice, being the staple crop of Assam, requires significant amounts of water and is mostly cultivated in the kharif season using flood irrigation (Bhattacharya et al., 2020).
- Vegetables and horticultural crops, such as potatoes, onions, and bananas, are also cultivated with supplementary irrigation from ponds and wells, particularly during the winter months when rainfall is minimal (Sharma &Goswami, 2021).

f) Soil resources

Tamulpur district, located in the northwestern part of Assam, is part of the Brahmaputra valley. Its geographical location, near the Brahmaputra River and the Bhutan foothills, plays a significant role in the formation of its soils. The district's soils are crucial for its agrarian economy, supporting the cultivation of rice, maize, and other crops. This report aims to provide a scientific analysis of the soil resources of Tamulpur, covering types, fertility, and challenges.

The geology of Tamulpur includes alluvial plains formed by deposits from the Brahmaputra River and its tributaries. The soils here are mostly derived from the weathering of these alluvial deposits, as well as sediments from the Himalayas and Bhutan hills.The parent material primarily consists of alluvium brought down by rivers, along with some colluvial material from the hills.Tamulpur experiences a humid subtropical climate, with a heavy monsoon season that influences soil formation and erosion patterns.

Soil Classification

The soils of Tamulpur district can be classified into the following groups:

- Alluvial Soils (Inceptisols and Entisols): Found predominantly in the plains and river basins.These soils are sandy loam to loam in texture, well-drained, and have high fertility. They are young soils with limited profile development. The soil is Ideal for rice, wheat, maize, and pulses.
- Sandy Loam and Loamy Soils (Entisols): Found near riverbanks and areas with good drainage. These soils are light-textured, well-drained, and moderately fertile. Due to their sandy nature, they may require organic matter additions to improve fertility. Suitable for vegetables, maize, sugarcane, and horticultural crops.
- Clayey Soils (Vertisols): Found in Low-lying regions and areas prone to waterlogging. These are Heavy clayey soils with poor drainage, often prone to waterlogging during the monsoon. These soils crack during the dry season.
- Red Loamy Soils (Alfisols): Found in the upland regions near the Bhutan foothills. It Red loamy soils are moderately fertile but often acidic. They are well-drained and generally have low organic matter content.

g) Groundwater prospects in the district

Based on the behaviour and occurrence of ground water, the regional ground water flow system of district has been described under following categories. i. Shallow aquifer group occurring within 50 m depth. ii. Deeper aquifer group beyond a depth of 50 m and down to 200 m bgl. i. Shallow Aquifer Group: It constituted of a mixture of boulders, gravel, sand, silt and clay. The thickness of the aquifer varies from 15 to 40 m. Ground water in this aquifer generally occurs under water table to semi-confined conditions. The development of ground water from this aquifer for both domestic and irrigation purposes is by open wells and shallow tube wells. The boulders are restricted mostly to the northern parts of the district. They occur between GL to 50 m bgl and thickness varies from 20 - 30 m. The thickness increases from south to north. The water level in the major part of the district generally lies between 2 to 4 m bgl. The northern most part occupied by the piedmont zones and the areas adjoining to the inselbergs are having deeper water level. The movement of ground water is southerly towards Brahmaputra River. The water table contour follows the topography of the area and lies more or less parallel to the Brahmaputra River. The hydraulic gradient becomes gentler towards the south. ii. Deeper Aquifer Group It constituted of coarse to medium sand with intercalation of clay. Ground water occurs under water table to semi-confined conditions. Detailed hydrogeological surveys aided by exploratory drilling revealed the existence of two to three promising aquifer zones down to the depth of maximum 200 m bgl. Aquifer displays various degree of lateral and vertical variation of aquifer indicating various degree of depositional environment both in space and time. The piezometric surface is highly variable and the movement of ground water is towards the south.

The ground water of the district is both slightly acidic and alkaline in nature with pH values ranging from 6.82 to 7.21. Ground water has low content of dissolved minerals. The iron content is generally high for drinking purposes in some areas, the range being from 1.02 - 3.0 ppm. But, in most of the sources, it is within permissible limit as per BIS (1991) standard of 1.0 ppm and as such, it does not pose any serious health hazards. High iron concentration has been observed in and around Runikhata area. Except high iron content, the ground water of the district is suitable and safe for drinking and other uses. The water is soft and has low bi-carbonate content. The formation water of both shallow and deep aquifers is suitable for most of the irrigational and industrial purposes. Ground water is having a little higher concentration of iron but can be used after treatment.

8. Land and land use pattern:

The land use pattern of Tamulpur district, Assam, reflects its agrarian focus, shaped by its fertile plains, proximity to the Brahmaputra River, and hilly terrain near the Bhutan foothills.

Agricultural Land:

The majority of the district's land is under agriculture, which supports the local economy. The fertile alluvial soils in the plains are ideal for cultivating rice, which is the primary crop, along with maize, pulses, mustard, and vegetables.The district follows a multi-cropping system, and farmers often grow two or more crops annually. The kharif season (monsoon) is dominated by rice, while the rabi season (winter) sees crops like mustard, vegetables, and pulses.Agriculture occupies more than 60-70% of the total land area in the district.

Forest Land:

Forested areas are primarily found near the foothills of the Bhutan region, forming part of the eastern Himalayan biodiversity hotspot.The forests in Tamulpur are semi-evergreen to deciduous, comprising both dense and open forests. These forests are rich in biodiversity and provide resources such as timber, firewood, and medicinal plants.Forests cover approximately 15-20% of the district's total area.

Water Bodies and Wetlands:ThePagladiya River, a tributary of the Brahmaputra, along with other smaller rivers and streams, plays an important role in irrigation and replenishing groundwater.Water bodies account for around 2-5% of the total land area.

Residential and Urban Areas: The district has small towns and growing settlements, especially with its recent establishment as a district. Urban areas are expanding due to population growth and infrastructural development. Most of the population lives in rural areas, with agriculture being the main occupation. Residential and urban land use covers approximately 5-10% of the district's area.

Barren and Uncultivable Land: Some areas of the district are classified as barren or uncultivable due to poor soil quality, rocky terrain, or waterlogging, particularly in flood-prone regions. Barren land constitutes around 2-4% of the total land area.

Pasture and Grazing Land: Small tracts of land are designated for grazing livestock, though this is a minor part of the land use in the district. Grazing land covers less than 2% of the total land area.

Industrial and Infrastructural Land: Tamulpur, as a newly formed district, has limited industrial development, but small-scale industries and infrastructural projects are emerging, particularly in rural development, road construction, and education. Industrial and infrastructural land covers about 1-2% of the total land.

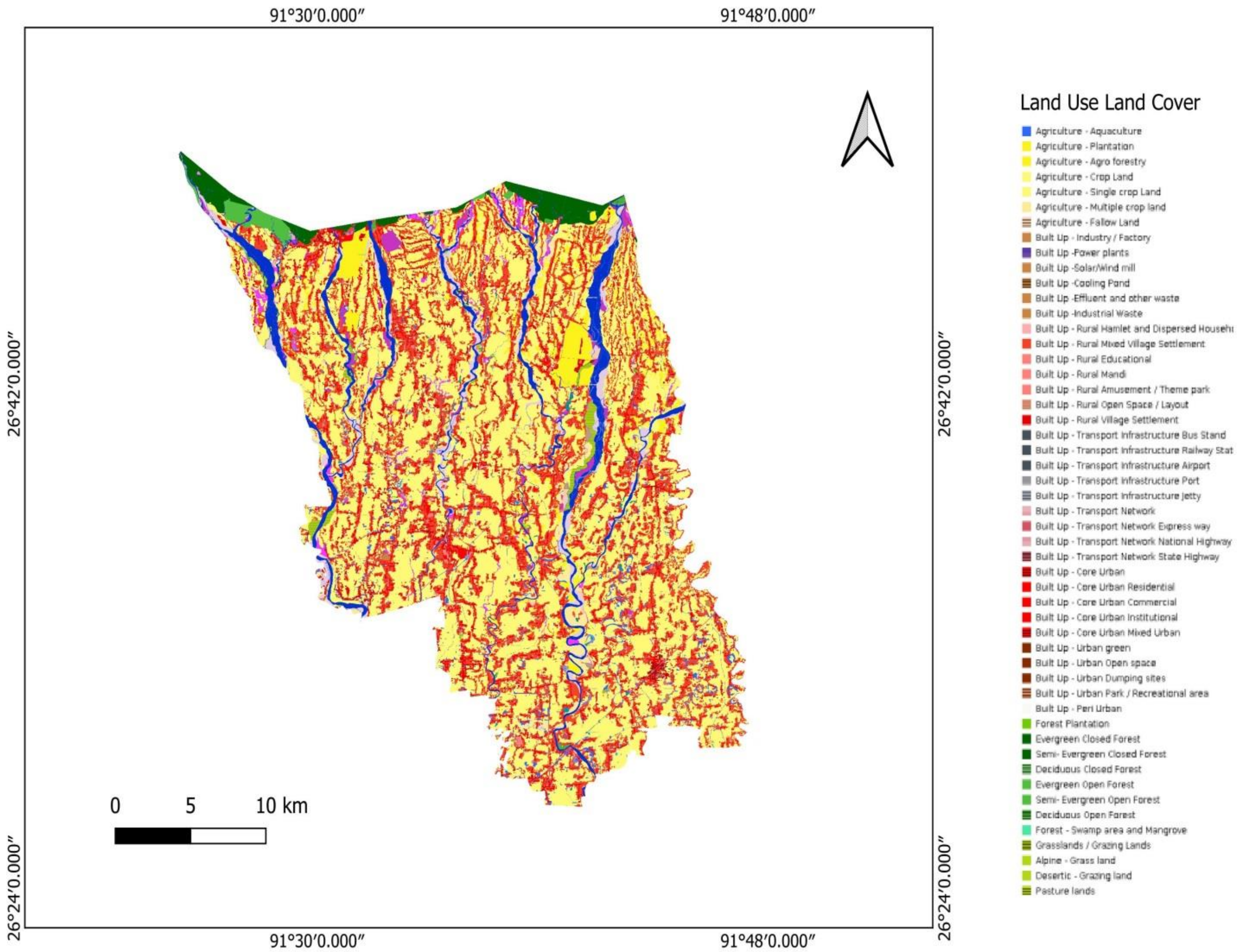


Fig: Map showing Land Use and Land Cover, Tamulpur District.

9. Physiography of the District:

Tamulpur district, located in the northwestern part of Assam, exhibits a diverse physiography. The landscape is characterized by a mix of plains, hills, and riverine systems, contributing to varied topography and land use patterns across the district. he central and southern parts of the district are dominated by alluvial plains formed by the Brahmaputra River and its tributaries, such as the Pagladiya River. These plains are generally flat and low-lying, with elevations ranging from 40 to 60 meters above sea level.

In the northern part of the district, near the Bhutan border, the terrain becomes more undulating as it transitions into the foothills of the eastern Himalayas. he foothills rise to elevations of 200 to 400meters above sea level.

The Pagladiya River is the most prominent river in the district, flowing from the Bhutan hills and merging into the Brahmaputra River system. There are several smaller tributaries and seasonal streams that drain the district. Apart from the northern foothills, some scattered upland regions are found in the central and western parts of the district. These uplands are generally lower than the Bhutan foothills, with elevations ranging between 100 to 200 meters.

Several low-lying areas are found throughout the district, particularly in regions near the rivers and floodplains. The district has a relatively gentle slope in the southern plains, while the northern foothills show more pronounced slopes.

10. Rainfall

The district witnessed a sub-tropical humid climate with a hot summer and moderate winter. The winter temperature drops to 10 degree Celsius and summer temperature goes up to 38 degreeC. The drastic Climate Change have been witnessed in Tamulpur district in the month of April with a temperature 38 degree Celsius and changes in Rainfall intensity and early pre monsoon due to global Warming. The total annual rainfall of the district is 1346 mm from May to October 2023. The maximum rainfall was 60. 98 mm on 21 June 2023. The flash flood mainly occurs in the district due to heavy rainfall in the adjacent areas of Bhutan. The flash flood and heavy rainfall in Bhutan, when flows above danger level, affects Tamulpur district with flash flood for around 2 to 3 hours and the water flows down and inundated Nalbari, Darrang and Kamrup (R) district. The early warning system has been developed and the weather condition marked in Bhutan to all the stakeholders.

11. a) Geology

(i) Regional Geology:

Shillong plateau (covering approx. 47614 sq. km.) is the singular representative of Precambrian cratonic block of northeast India tectonically detached from the mainland of Indian Peninsula. The cratonic block is girdled by dextrally moving Dauki fault to the south, Brahmaputra lineament to the north, Garo- Rajmahal graben, Dhuburi/Madhupur lineament to the west and belt of schuppen to the east. It consists of high to medium grade Paleoproterozoic basement gneisses and schist designated as Basement Gneissic Group (BGG) overlain by Mesoproterozoic metasediments and metavolcanics of the Shillong Group, both being intruded by Neoproterozonic acidic intrusives such as Myllem pluton, South Khasi pluton, Umroi granite, Nongpoh and a few others enlisted by Mazumdar (76); Ghosh*et. al*. (2005); Devi and Sharma (2006, 2010).

The Paleocene to Eocene continental shelf of the Indian plate which became emergent and which is being over-thrust by the Himalayas on the north-northwest and by the Naga hills on the southeast comes under the upper Assam shelf.

The present-day Assam Basin, a cratonic margin, reflects three distinct tectonic phases. The earliest was Late Cretaceous to Eocene block faulting and development of a southeasterly dipping shelf. Duringthe second phase, in Oligocene time, uplift and erosion occurred north of the many basement faults were reactivated; and many basement-controlled structures became prominent.

The Eocene Sylhet Formation was deposited in a range of environments and was subdivided into the members which generally represents these different depositional environments. The lower Lakadong member was deposited in a lagoonal environment consists of more than 350m of thin sandstones and interbedded shales and coals in it basal parts . The environment of the Lakadong member typically consists of the thick sands of barrier- bar. The members of upper part of the Lakadong Formation are calcareous sandstone of a restricted shallow water platform.

The gneissic groups of rocks are well exposed in the western, northern and north eastern part of the Shillong plateau. Towards the southern boundary it is covered by Cretaceous –Tertiary sedimentary sequences and within the plateau about 2500 sq. km. (approx.) area is occupied by intracratonic basin sediments. Orthogneiss and paragneiss are the two major components of basement gneissic complex. The main characteristic features of the banded gneiss are of bimodal character. Other constituents are migmatite, augen gneiss, BIF, amphibolites, pyroxene granulite, calc granulite, high grade sillimanite bearing metapelite with characteristic cordierite, corundum, spinel and sappherine, lamprophyre, diorite, granodiorite, mafic intrusion, pegmatite and other vein rocks.

(ii) Local Geology

The geomorphology of Tamulpur district in Assam is shaped by its location near the foothills of Bhutan and the presence of major river systems such as the Brahmaputra River and its tributaries. The Pagladiya River and other smaller rivers originating from the foothills of Bhutan shape the district's riverine landforms. These rivers frequently shift their courses, forming new channels, and contributing to the creation of diverse fluvial features.

In some areas, older river terraces, formed by historical river activity, can be observed. These terraces are relatively higher than the current floodplains and are less prone to flooding (Bhattacharya et al., 2020). The rivers in Tamulpur often exhibit meandering channels, which further modify the landscape by eroding banks and depositing sediments at other points. These processes are essential in shaping the district's floodplain dynamics (Dutta, 2021).
he district can be broadly divided into two main geomorphological regions:

- The Northern Foothill Zone: Characterized by hilly terrain, valleys, and terraced slopes.
- The Southern Alluvial Plain: Dominated by flat floodplains, natural levees, and backswamps formed by the river systems (Borthakur, 2016).

The proximity of Tamulpur to the Himalayan foothills makes it susceptible to seismic activity, which can trigger landslides in the hilly areas and affect the district's geomorphological features (Ahmed &Sarma, 2019).

11. b) Mineral Wealth

i. Overview of mineral resources:

While the region does not have extensive mineral deposits compared to other parts of Assam, several key minerals and resources are present.

Sand and gravel are among the most significant mineral resources in Tamulpur district, particularly due to the sedimentary processes of the Brahmaputra River and its tributaries. Riverbeds and floodplains along the Brahmaputra and Pagladiya rivers are major sources. The alluvial deposits in these areas are rich in sand and gravel, which are used for building purposes, road construction, and other civil engineering projects (Dutta& Sharma, 2020).

Clay deposits are found in the alluvial plains and low-lying areas of the district. These clays are used for making bricks, tiles, and pottery. The clays in Tamulpur are typically fine-grained and suitable for traditional brick-making and ceramics (Goswami, 2018).The foothills of Bhutan and areas near the riverbanks provide a supply of boulders and larger rock fragments, which are utilized in various construction activities (Singh, 2019).Peat deposits may be found in swampy or marshy regions within the floodplains (Bhattacharyya, 2017).

Current mining activities in Tamulpur are limited to the extraction of sand, gravel, and clay. There is minimal large-scale mining activity, and resource extraction is primarily for local use (Singh, 2019).

ii. Details of Sand and other riverbed minerals Resources:

The mineral resources of the district whose categorization and estimation to be done will be furnished in final report.

12. (a) District wise detail of river or stream and other sand source

i) Drainage system with description of main rivers

S. No.	Name of the river	Area drained (sq. m)
1	Barnadi	
2	Motonga	
3	Balti	
4	Puthimari	
5	Darranga	

(b) District wise availability of sand or gravel or aggregate resources

i) Annual deposition

S. No	River/ stream	Portion of the river/ stream recommended for mineral concession	Length of area recommended for mineral concession (in km)	Average width of area recommended for mineral concession (in m)	Area recommended for mineral concession (in sq. m)	Mineable mineral potential (in metric T) (60% of total mineral potential)
1	Barnadi					
2	Motonga					
3	Balti					
4	Puthimari					
5	Darranga					
Total for the district						

ii) Mineral potential

Sand (MT)	Total mineable mineral potential (MT)

(TO BE PREPARED AFTERCOLLECTING PRE- MONSOON & POST MONSOON DATA FROM RESPECTIVE DEPARTMENTS)

13. Replenishment Study

Replenishment study for a river solely depends on estimation of sediment load for any river system and the estimation is a time consuming and should be done over a period. The process in general is very slow and hardly measurable on season-to-season basis except otherwise the effect of flood is induced which is again a cyclic phenomenon. Usually, replenishment or sediment deposition quantities can be estimated in the following ways as given below:

A. Replenishment study based on satellite imagery involves demarcation of sand bars potential for riverbed mining. Both pre and post monsoon images need to be analyzed to established potential sand bars. Volume estimation of sand is done by multiplying Depth and Area of the sand bar. The sand bars are interpreted with the help of satellite imagery. Ground truthing has been done for 100% of the total identified sand bars. During ground truthing, width and length of each segment were physically measured. It has also been observed that in few cases, sand bars have attained more than 3 meters height from the average top level of the river beds. Considerations of sand resources have been restricted within 3 meters from the average top surface of the river bed.

B. Direct field measurement of the existing leases involving estimation of the volume difference of sand during pre and post-monsoon period. With systematic data acquisition, a model has developed for calculation of sediment yield and annual replenishment with variable components.

C. The replenishment estimation based on a theoretical empirical formula with the estimation of bed-load transport comprising of analytical models to calculate the replenishment

Field data collation:

Secondary data were collected for pre- monsoon period and during September 2024 post-monsoon data were collected for the river banks. The relative elevation levels were captured through GPS/DGPS. Thickness of the sand bars was measured through sectional profiles.

References:

1. https://asdma.assam.gov.in/
2. **https://en.wikipedia.org/wiki/Tamulpur_district**

Photoplates:


GPS Map Camera
Arangajuli, Assam, India
Arangajuli, Assam 781368, India
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