GOVT OF ASSAM
OFFICE OF THE DISTRICT COMMISSIONER, :DARRANG
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Office of the District Commissioner ★ Darrang
20 9

DEV/1155/2023-DEV-DRR

Dated 20/09/2024

NOTICE

Comments, suggestions, claims and objections are being invited from all the interested persons, authorities, individuals, departments etc. in connection with the draft District Survey Report(DSR),Darrang District for sand etc (minor minerals) within 21(two) days from the date of uploading of the draft DSR of the district Darrang,Assam in the District Website https://darrang.gov.in/

Feedback may be sent to the E-mail ID dc-darrang@nic.in of the District Commissioner, Darrang

District Commissioner
Darrang, Mangaldai

District Commissioner
Darrang, Mangalda.

Copy to:

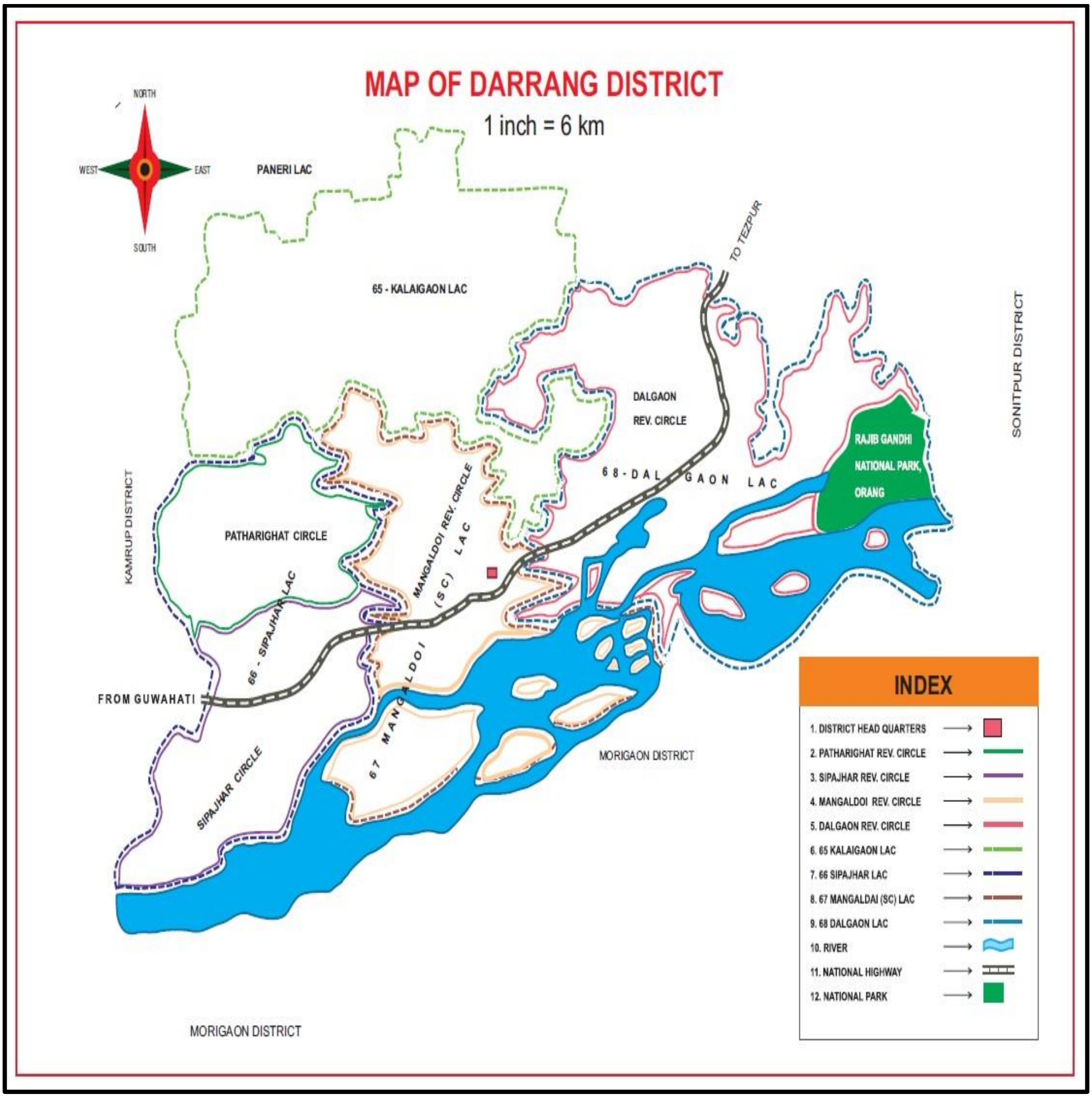
1. The Principal Chief Conservator of Forest & Head of Forest Force, Assam, Aranya Bhawan, Panjabari,Ghy-37 for favour of kind information
2. The Divisional Forest Officer, NK Division for information. He is requested to take necessary action towards uploading of the DSR in the district website mentioned above in consultation with the DIO NIC Darrang
3. The Executive Engineer, Water Resource/ PHED Irrigation Department Darrang for information and necessary action
4. The Executive Engineer, Pollution Control Board, Regional Office, Tezpur for information and necessary action
5. The Sr. Geologist, Mines & Minerals, Darrang for information and necessary action.
6. The DIO, NIC,Darrang for information and necessary action.

District Commissioner
Darrang, Mangaldai

District Commissioner
Darrang, Mangalda.

DISTRICT SURVEY REPORT(Draft)

DARRANG DISTRICT, ASSAM



Prepared by:

OFFICE OF THE DISTRICT COMMISSIONER

DARRANG DISTRICT

GOVERNMENT OF ASSAM

CONTENT

LIST OF FIGURES

C. Maps

Site Photographs (Page 85- 86)

1.0 Introduction

According to MoEF&CC Notification No.125 (Extraordinary, Part II Section 3, Sub-section (ii),S.O.141(E) dated 15thJanuary 2016, it is mandatory to have District Survey Report (DSR) for Mining of Minor Minerals. This will ensure environmentally sustainable mining for minor minerals under close supervision of district authorities. A detailed procedure and format for preparation of District Survey Report (DSR) has been discretely discussed under Para 7(iii)(a) and Annexure (x) of the Notification issued by Ministry of Environment, Forest and Climate Change, Government of India on 15th January 2016.

As per MoEF&CC Notificatioin dated 25th July 2018, preparation of DSR requires both primary and secondary data generation. District Survey Report will cover General information of the district, Demography, Geomorphology, Topography, Forest and Agricultural information, Climate and Rainfall conditions, Land Use pattern, calculation of total amount of replenishment, details of Royalty and revenue received in last three years etc. etc.

Mineral wise District Survey Report must be prepared in every district for Sand mining / River bed mining and other minor minerals mining in order to obtain Environment Clearance.

The main purpose of preparing the district survey report. Identification of areas of aggradations or deposition where mining can be allowed and identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited and calculation of annual rate of replenishment and allowing time for replenishment after mining in that area".

The District Survey Report (DSR) will contain mainly data published and endorsed by various departments and websites about Geology of the area, Mineral wealth details of rivers, Details of Lease and Mining activity in the district along with Sand mining and revenue of minerals

1.1 The process involved in the preparation of DSR

A. Collection of Baseline Data from the Districts.

B. Development of related maps from satellite and secondary sources

C. Understanding river flows and sedimentation vis-a vis sand mining

D. Tabulation and mapping of existing sand / gravel mining locations and yield

E. Correlation with satellite data for pre and post monsoon sand MM yield

F. Suggesting new locations for sand and other MM approval

G. To design and prepare DSR as per MoEF guidelines

H. Interaction with line department for data / document ownership

G. Draft DSR in to be kept in public domain for 21 days including public consultation.

1.1a Objective of DSR

1) Identification of areas of aggradations or deposition where mining can be allowed.
2) Identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited.
3) Calculation of annual rate of replenishment and allowing time for replenishment after mining in that area.
4) To balance development and environment.

1.2 Methodology of DSR preparation |

Step 1 : Identification of Date Source ….

DSR has been prepared on the basis of Primary data base and Secondary data base collected from various sources. This is a critical process in order to identify the authentic data sources prior to collation of data set. Sources of secondary data used in this DSR are mostly data published by the State government and district census in 2011. Mining lease and revenue generated from minor minerals have been prepared on the basis of available data from the DFO office of the district.

Step 2 : Data analysis and Preparation of Maps……

DSR involves the analytical implication of dataset captured during the preparation of report. The principal steps in map preparation involves determination of appropriate classification system through Visual Image Interpretation, selection of samples, Satellite Image pre-processing and accuracy assessment. ISRO RESOURCE has been adapted for supervised classification.

Step 3. Primary Data Collection :

During the preparation of DSR, primary or field data has been collected from the district which involves assessment of the mineral resources in the district by means of pitting and trenching in pre-determined interval. This gave a clear picture about characterization of minerals and their distribution.

Step 4 : Replenishment Study :

Replenishment study is very important in the sense that in case more sediment is removed than the system can replenish, then there will be adverse and severe impact on environment. Physical survey has been carried out in order to define the topography, contours and offsets of the riverbed. Annual replenishment of the riverbed has been calculated using field survey, satellite imagery and empirical formula. The study was carried out on existing mine leases and an approach of direct measurement methodology was adapted. The depth and area of mining leases are measured through GPS/ Total Station just before the closure of the mines during pre-monsoon period and the same area was resurveyed in the post-monsoon period.

Step 5 : Preparation of Report :

The DSR clearly elaborates the general profile, geomorphology, land use pattern and geology of the district. This report describes the availability and distribution of riverbed sands and other minor minerals in the district and at the same time, includes inventorization of the minerals, recent trends of production of minor minerals and revenue generated from them. Moreover, potential environmental impacts due to mining of such materials, required mitigation measures to be adapted along with risk assessment and hazard management have also been indicated.

2.0 About Darrang District

DISTRICT AT GLANCE

Sl.No.	Items	Statistics
1.	GENERAL INFORMATION	
	i) Geographical Area (Sq.Km.)	1,630
	ii) Administrative Divisions	
	Number of Blocks	6
	Number of Villages	520
	iii) Population (as on 2001 Census)	7,64,300
	iv) Average Annual Rainfall (mm)	2,127
2.	GEOMORPHOLOGY	
	Major Physiographic Units	Alluvial plains
	Major Drainages	Brahmaputra, Dhansiri, Bega, Mangaldoi and Noa rivers
3.	LAND USE (Sq.Km.)	
	a) Forest Area	27.0
	b) Net area sown	1,140
	c) Cultivable area	950.0

4.	MAJOR SOIL TYPES	Younger and Older Alluvial Soils
5.	AREA UNDER PRINCIPAL CROPS (as on 2007 in sq.km.)	1,400

History

The present Darrang district of Assam was bifurcated into two districts namely Darrang and the other is newly created Udalguri district under B.T.C. area. It is located in the central part of state of Assam on north of the River Brahmaputra. The new Darrang district consists of 6 (six) blocks and 520 villages.

The district occupies part of the Brahmaputra basin and the mighty river Brahmaputra is flowing westerly direction through the southern boundary. The district is also drained by perennial rivers flowing from north to south.

No definitive records about Darrang are available for the pre-medieval period. According to Maheswar Neog, the Darrang became mentioned only after the uprising of the king Nara Narayan. Darrang at different times might have been under the rule of the Chutia Kingdom, Bodo people and Baro-Bhuyans.

During the reign of Dharmanarayan 3000 Chutia families were established in Darrang.

In the 16th century, Darrang was subject to the Kamata king Nara Narayan, and on the division of his dominion among his heirs, Darrang became a part of Koch Hajo. Early in the 17th century the Raja Bali Narayan invoked the aid of the Ahoms of Upper Assam against the Mughal invaders; after his defeat and death in 1637 the Ahoms dominated the whole district. About 1785 the Darrang rajas took advantage of the decline of the Ahom kingdom to try and re-establish their independence, but they were defeated by a British expedition in 1792, and in 1826 Darrang, with the rest of Assam, passed under British control.

By early 17th century, the Kingdom of Bhutan took control of the Darrang Duars as far as Gohain Kamal Ali road. The Bhutan control over these regions were through local authorities, who were appointed by Bhutanese provincial governors called Ponlops. By 1865, with the Duar Wars the British East India company took control of the Duars and removed Bhutanese influence from the area.

In 1785 it was Darrang was surveyed by one Ahom officer named Dhani Ram Gohain.

On 28 January 1894, there was a peasant's uprising against the increased land revenue by the British Raj in Patharighat, a village in Darrang district. In the British response that followed, 140 peasants belonging to both Hindu and Muslim communities died from bullet wounds and another 150 were injured.

In 1984 Sonitpur district was formed from part of Darrang.This was repeated on 14June 2004 with the creation of Udalguri district.

Geography

Darrang district occupies an area of 1,585 square kilometers (612 sq mi).

National protected area

Darrang is home to Orang National Park, which it shares with Sonitpur district. Orang was established in 1999 and has an area of 79 km^2(30.5 sq mi).

Divisions

There are four Assam Legislative Assembly constituencies in this district: Kalaigaon, Sipajhar, Mangaldoi, and Dalgaon. Mangaldoi is designated for scheduled castes. All four are in the Mangaldoi Lok Sabha constituency.

Villages

- Bahgarah
- Dipila
- Gakhirkhowa para
- Namkhola
- Patharighat

According to the 2011 census Darrang district has a population of 928,500, roughly equal to the nation of Fili. This gives it a ranking of 463rd in India (out of a total of 640). The district has a population density of 586 inhabitants per square kilometre (1,520/sq mi). Its population growth rate over the decade 2001-2011 was 22.19% Darrang has a sex ratio of 954 females for every 1000 male, and a literacy rate of 63.08%. 93.9% of the population live in rural areas while 6.1% live in urban areas. Poverty rate of the district stands at 45.5% 5.98% of the population lives in urban areas. Scheduled

Castes and Scheduled Tribes make up 4.34% and 0.91% of the population respectively.

Religion

In Darrang district, as per the 2011 census record, Islam is the most followed religion with 597,392 adherents i.e. (64.34%), while Hinduism is followed by 327,322 i.e. 35.25% of the district population. Dalgaon in particular contained nearly half the population of the entire district. Way back in 1971, Hindus were slight majority in undivided Darrang district (which includes present Sonitpur and Udalguri districts) forming 70.3% of the population, while Muslims were 23.9% at that time.

Languages

Languages in Darrang district (2011)

- Assamese (49.29%)
- Bengali (48.40%)
- Hindi (0.68%)
- Boro (0.45%)
- Bhojpuri (0.37%)
- Sadri (0.19%)
- Others (0.62%)

All the time of the 2011 census, the Assamese-speaking population was 457,696 and the Bengali-speaking population was 449,205.

Location

The district is situated in the central part of Assam and on the Northern side of the river Mighty Brahmaputra. The district is Bounded by Arunachal Pradesh (State) and Bhutan (Country) and Udalguri district in the North. The River Brahmaputra flows in the South. The district Sonitpur and kamrup districts are in the East and West respectively.

Economy

The economy of the Darrang district is basically agrarian where the majority (about 85%) of the population is engaged in agriculture and allied activities.

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The irrigation facilities mostly confined to a few lift and surface water schemes.

However, farmers are utilizing ground water from shallow tube wells for multiple crop harvesting. The district is famous for its vegetable productions and other Rabi crops.

The detailed hydrogeological survey aided by exploratory drilling has been carried out in the area. In addition, Central Ground Water Board is monitoring Ground Water Monitoring Stations. Ground water development potential of the district has been assessed for future planning and development. A number of investigations for the feasibility of tube well have been carried out for various user agencies and required supports have also been provided to State Government from time to time.

3.0 Geology of Darrang District

Darrang district consists of a narrow strip of plain lying between Himalayas and Brahmaputra River in the north-west part of Assam. The Mighty River Brahmaputra flows along the southern boundary of the district. The area falls under Survey of India Toposheet No. 78 P/9, 10, 13 & 14 with longitudes 26°15'N−26°95'N and latitudes 91°45'E− 92°22'E. The district is bounded by Udalguri and Sonitpur districts in the North.

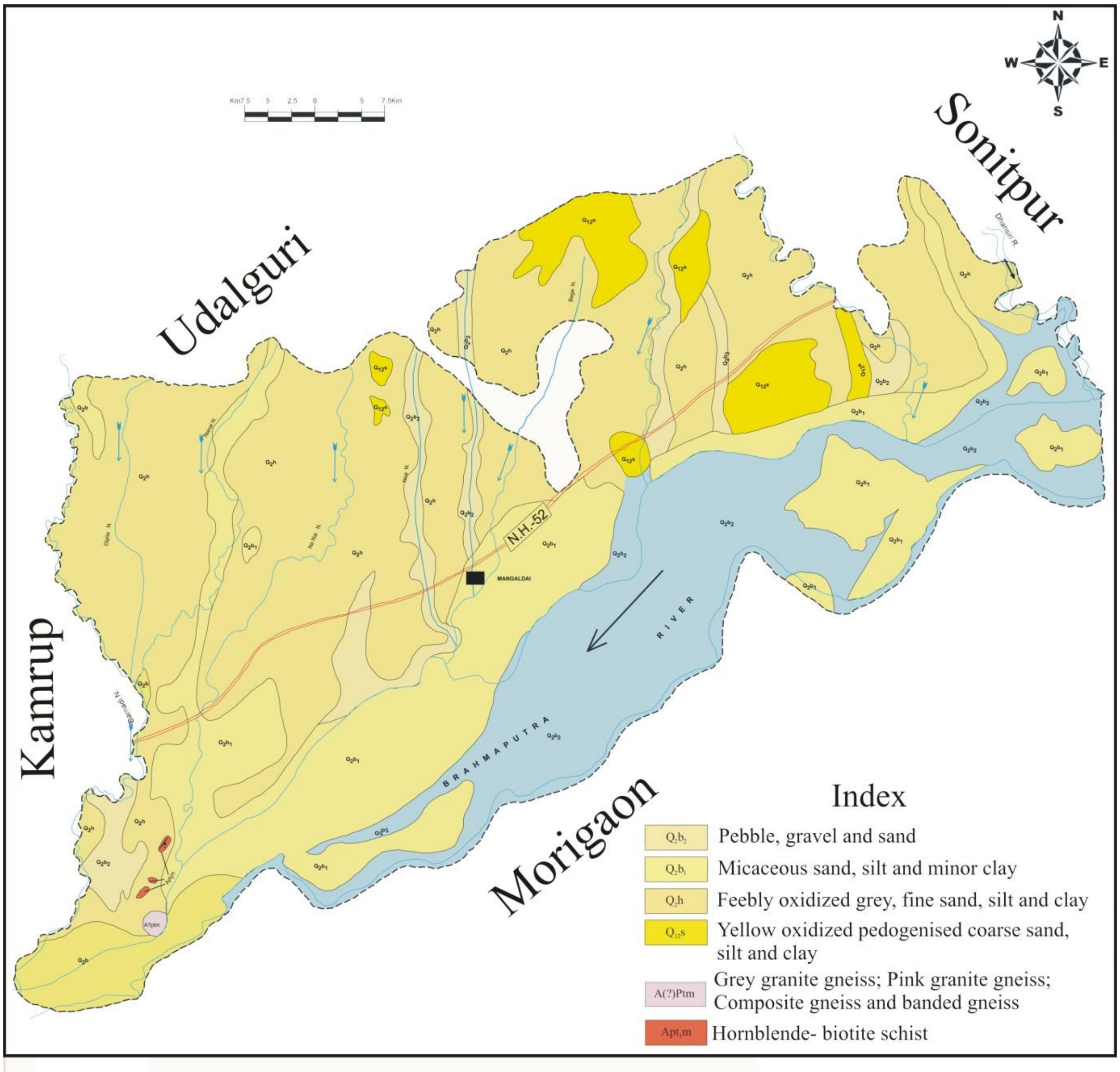

Figure: Geological map of Darrang district (Source: District resource map published by Geological Survey India, Kolkata)

Physiographically, the entire district is an alluvial plain with flat topography and there is a very gentle slope towards Brahmaputra river, which makes the southern boundary of the district. The tributaries of the Brahmaputra river viz. Barnadi, Nanoi, Mangaldai, Noanodi, Saktola, Dhansiri, which are the main River flowing through the District and the rivers are perennial in nature. The area encompasses the foot hills of Bhutan Himalaya in the north, a vast stretch of Brahmaputra Valley with a few scattered inselbergs in the south west. The northern alluvial flank of the valley is much wider owing to much greater sediment deposition by the Himalayan torrents.

Geologically, the area is occupied by rocks ranging in age from Proterozoic to Quaternary. The Proterozoic rocks are exposed in the south eastern part of the area and comprises crystalline rocks. The Proterozoic suit includes the Assam- Meghalaya Gneissic complex which comprise grey to pink granitic gneiss as well as biotite gneiss.

Age	Group/Formation	Lithology
Holocene	Barpeta formation (II)	Pebble, gravel and sand
	Barpeta formation (I)	Micaceous sand, silt and minor clay
	Hauli formation	Feebly oxidized grey, fine sand, silt and clay (semiconsolidated)
Pleistocene to Holocene	Sorbhog formation	Yellow oxidized pedogenised coarse sand, silt and clay
Archaean (?)- Proterozoic	Assam- Meghalaya Gneissic Complex	Grey granite gneiss; Pink granite gneiss; Composite gneiss and banded gneiss
Archaean to Palaeoproterozoic	Older Metamorphic Group	Hornblende- biotite schist

The gneissic suit at places contains huge enclaves of older metamorphic rocks such as hornblende- biotite schist. The Quaternary deposits of the area lying unconformably above the crystalline basement have been classified into four major morphostratigraphic units, based on their specific geomorphic expression defined by dissection pattern, pedogenic character, vegetation and land use. The units are generally separated from each other by abrupt erosional scarp (of variable relative height) or break in slope. At places, the contacts are gradational due to subsequent modifications by fluvial activity, anthropogenic interference or on lap relationship between morphostratigraphic units. The four morphostratigraphic units mapped in order of antiquity are described below:

Chapar formation is the oldest Quaternary alluvial formation. The surface occurs as a highly dissected surface. The surface generally represented by high and dry land and form a bench like profile in the stream. The alluvium comprises red yellow to brick red semi consolidated, poorly sorted assemblage of gravels (boulders to pebbles and gravels) sands and silts with chocolate colored humus rich silty loams. Chapar formation is a highly altered alluvium. The sedimentary structures are highly obliterated in the in the solum. The alluvium is characterized by mottling and incipient development of ferruginous nodules at places. The solum is very thick (4 – 10 m). The base of B zone' has not been found to be exposed. The A zone is marked by humus enrichment in top soil in forests. The Chapar surface is characterized by extensive sal, limited teak plantations and extensive tea gardens. The latosolic soil is highly suitable for tea cultivation. The surface is completely immune to flood but prone to erosion by gullies and creeks.

Sorbhog formation is the next older and upper morphostratigraphic unit/ surface forming a part of the flat alluvium plain. The formation represents a moderately dissected surface with thin soil cover. This surface is, in general, bounded by erosional scarps of 1- 3 m relative height. Its contact with the younger **Hauli formation** is commonly erosional. However, at places transitional and overlapping contacts are seen. On the surface, this unit exhibits presence of some palaeochannels and depressions, which, however, highly modified by natural and human activity. The surface can be easily distinguished from its older and the younger surfaces by its landuse, soil type, lithology etc. The alluvium is dark coffee colored to blackish brown loamy soil. The soil profile is well developed. A zone (0.1 – 0.5 m) is ubiquitously developed by pedogenic weathering of very coarse sandy alluvium. The B zone is characterized by golden yellow color due to ferric hydroxide pigment. The geochemical activity is marked by leaching of ferrous ions from the A zone and deposition of ferric hydroxide in B zone. Abundant mica persists in the solum. The soil pH of the alluvium is feebly acidic due to humus content. The surface is immune to flooding and is co relatable to Dimakuchi and Atharighat formation of Tangla area. Sand is quarried from this formation for construction purpose.

Hauli formation occupies an extensive area. This surface also includes the valley flats through which flow the first and second order tributaries of Pagladiya. The contact of Hauli formation to the next older surface is often marked by erosional scarps usually 1 – 2m in relative height. However, their contacts with the younger, Barpeta surface vary in space. The contact may be marked by either scarps, just break in slope or at places by on lap of overlying alluvial unit. The surface shows presence of numerous palaeo channels, water bodies, depressions and higher grounds (remnants of earlier channel bars and natural levee). Usually, the surface remains unaffected by annual flood (except during unusual flood) but often gets water logged because of microtopographic undulations. The surface is represented by light grey practically unaltered alluvium and azonal soil. The incipient changes that are visible in the top layer are mainly due to biological activity. The mineral weathering and geochemical changes are minimum in this alluvium. The sedimentary structures are, often seen to be well preserved in this unit. The alluvium includes pebbly sand, silt and bog clay depending upon the environment of Hauli sedimentation. The soil pH of this unit is generally weekly alkaline save the bog soils. The surface is very rarely for tea cultivation since the soil type is not suitable for the purpose. A few silt and clay quarries are scattered over this surface.

Barpeta formation is the youngest morphostratigraphic unit, still in the process of forming the present flood plain characterized by typical flood plain features e.g. the meander loops/ cut offs, the channel bars, point bars, lateral bars, natural levee, ox bows and large depressions or ‘ bils’ (back swamps). The flood plain of the tributary streams are rather narrow and often discontinuous, while in the case of the Brahmaputra river the flood plain is predictably extensive where its outer limit is difficult to demarcate because of human interference with the fluvial system. The sediment is characterized by light to dark gray unaltered alluvium representing broad spectrum of sand, silt and humus rich bog clay. The soil is feebly alkaline. The surface is highly susceptible to flood and annual inundation of extensive areas is common. In terms of Landuse pattern, the surface is characterized by extensive farming, large scale reclamation of swamps and marshes, and their transformation to farmlands by protective embankments along rivers, use of lakes as fisheries, its proneness to annual flooding and absence of major urban centers/ orchards/ tea gardens etc. The ecosystem is dominated by aquatic vegetation like reeds hyacinths and tall grass in high grounds. Boulder, gravel and sand quarries located on this surface, serves the construction material to the adjoining locality.

Darrang district is not particularly rich in mineral resources but sand and gravel are found in the riverbeds and floodplains of the Brahmaputra River and its tributaries. They are the primary resources. These materials are vital for construction activities in the district and surrounding areas. It also has deposits of clay, which are used for making bricks and pottery which is usually sourced from the alluvial plains of rivers

4.0 Drainage System

`The Brahmaputra is the main river in the border of the south of the District on the east to west direction. Other important tributaries of the Brahmaputra are Barnadi, Nanoi, Mangaldai, Noanodi, Saktola, Dhansiri, which are the main River flowing through the District and the rivers are perennial in nature.

5.0 Rainfall and Climate

The climate of the district is sun-tropical and humid. The winter season starts by November and continues till February. December/January is the coldest month and the temperature comes down to almost 15° C. The temperature starts rising from the month of February/March and July/August is the hottest month and it reaches up to about 40° C. The air is highly humid throughout the year and during rainy season; the relative humidity is about 90 percent.

The area receives heavy rainfall every year and out of 1,951 mm of annual normal rainfall, 60 to 65% is received during June to September from south-west monsoon. The district also receives about 501 mm of rainfall during pre-monsoon period from March to May in the form of thunder showers and hail storms.

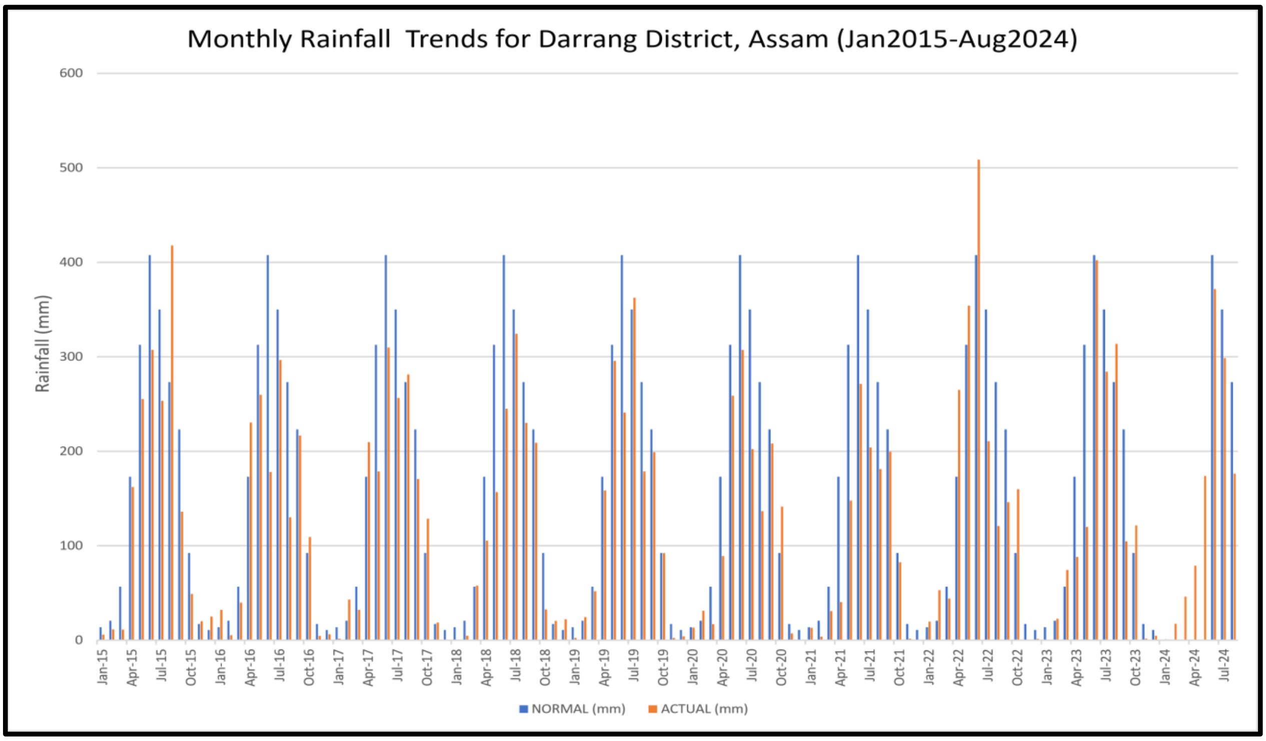

Figure: 1

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	17.3	19.3	23	25.5	26.6	28.2	28.9	29	28.4	26	22.2	18.4
Min. Temperature (°C)	10.9	13	16.6	20.1	22.5	24.7	25.6	25.6	24.9	21.7	16.7	12.2
Max. Temperature (°C)	23.7	25.7	29.5	31	30.8	31.7	32.3	32.4	32	30.4	27.7	24.6
Avg. Temperature (°F)	63.1	66.7	73.4	77.9	79.9	82.8	84.0	84.2	83.1	78.8	72.0	65.1
Min. Temperature (°F)	51.6	55.4	61.9	68.2	72.5	76.5	78.1	78.1	76.8	71.1	62.1	54.0
Max. Temperature (°F)	74.7	78.3	85.1	87.8	87.4	89.1	90.1	90.3	89.6	86.7	81.9	76.3
Precipitation / Rainfall (mm)	15	12	68	142	291	328	276	231	154	98	18	6

Figure: 2 Climate Table/ Historical Weather Data of Darrang District.

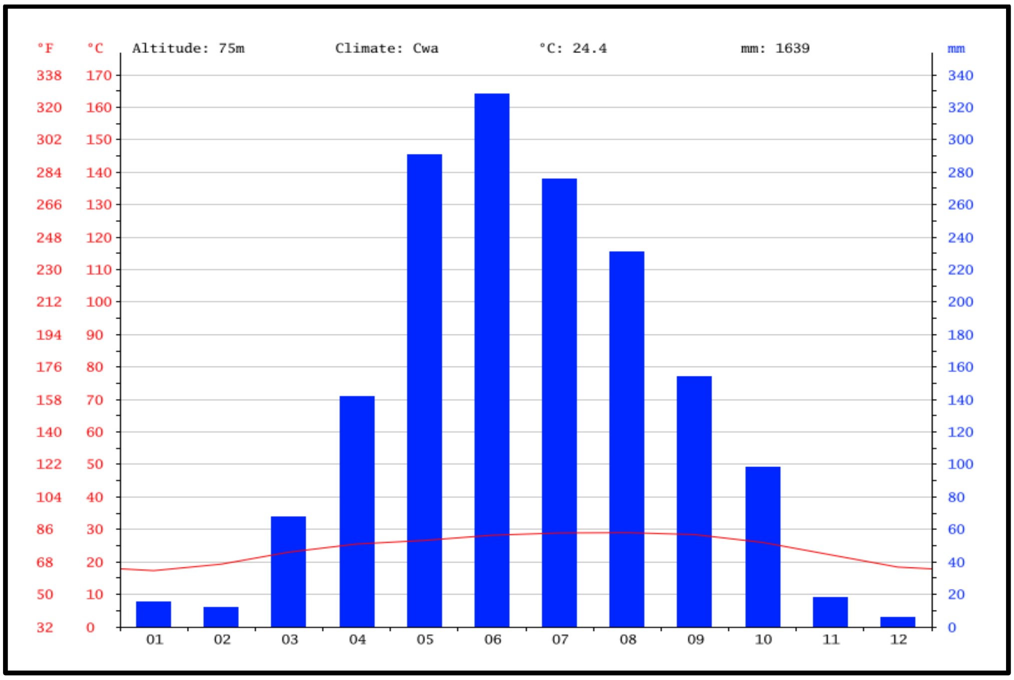

Figure: 3 Climate Graph of Darrang District.

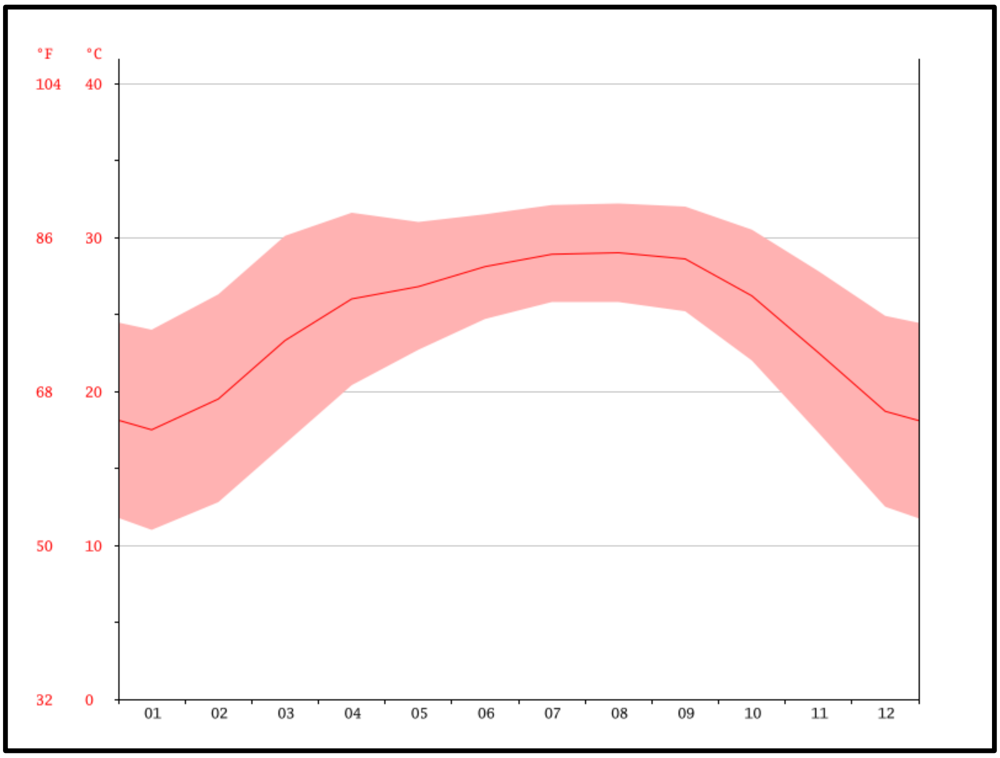

Figure: 4 Temperature Graph of Darrang District.

6.0. Geology of Assam:

Introduction

Assam, located in the north eastern part of India, is geologically diverse, encompassing a range of geological formations that reflect its complex tectonic history. Assam geological province is an onshore province covering approximately 78,438 km2. The geological province is bounded to the north by the Brahmaputra valley bordering Arunachal Pradesh, to the west by the West Bengal and Bangladesh plains, and to the south and east by the Indo-Burma Ranges and the Central Burma Basin. Major features within the Assam geological province include the Assam Shelf, Brahmaputra River valley, the Barak Valley, parts of the Shillong Plateau, Mikir Hills, and a foreland portion of the Indian Shield. The Assam Shelf consists of a portion of the Paleocene to Eocene continental shelf of the Indian plate which became emergent and which is being overthrust by the Himalayas to the northwest and by the Burma micro-plate to the southeast.

Geotectonic evolution of Assam

Geological province of Assam has passed through five important phases during its geological history. The first of these relates to when it was a part of the Gondwana Supercontinent. The second phase came in the Permo- Carboniferous, when its adjoining areas were rifted and the coal-bearing Gondwana was deposited. This phase seems to have been accompanied locally by some volcanic activity and the area was still a part of the Gondwanaland. The third phase came in Late Triassic/Early Jurassic when, with the drifting away of Southern Tibet, the northern fringe of India including the part that is now Assam became open to marine Sedimentation. The Sung Valley Carbonatite intrusion took place during this period. The fourth phase started when the eastern boundary also broke apart in Late Jurassic-Early Cretaceous and the southern and eastern shores of Assam became open to marine sedimentation. This phase also saw the beginning of some igneous activity with the outpouring of Garo Hills, Sylhet, and Mikir Hills Traps (basalts), and the formation of a number of basic and ultrabasic intrusives.

The fifth phase started with its collision with Myanmar to the east and Tibet to the north around Early Eocene and continued with all the stages of collision tectonics thereafter. During this phase, the entire land was caught up, as in a vice, between the two collision zones. The Mishmi Hills added a third compressional force from the northeast and subsequently a major uplift of the Shillong Plateau-Mikir Hills also contributed.

Stratigraphy

The lithology of Assam comprises (a) Proterozoic Gneissic Complex, (b) Palaeo-Mesoproterozoic Shillong Group of rocks, (c) Granite Plutons of Neo-Proterozoic−Lower Palaeozoic age, (d) Lower Gondwana sedimentary rocks of Permo-carboniferous age, (e) Alkali Complexes of Samchampi and volcanic rocks represented by Sylhet Trap of Cretaceous age, (f) Lower Tertiary (Paleocene-Eocene) shelf sediments of the Jaintia Group extending along the southern and eastern flanks of Mikir Hills and geosynclinals sediments of Disang Group in parts of the North Cachar Hills, (g) Upper Tertiary (Oligocene to Pliocene) shelf and General Geology and Stratigraphy geosynclinal sediments covering the southern flanks of Mikir Hills, the North Cachar Hills and the hills of the Cachar district in the Surma valley area. These rocks are also exposed along the northern foothills of Naga-Patkai range. Along the southern foothills of Eastern Himalaya facing the northern border of Assam a narrow strip of Siwalik rocks are exposed, (h) the Quaternary deposits comprising of Older and Newer Alluvium occur in flood plains and terraces of the Brahmaputra valley, Surma valley and other river basins of Assam.

The stratigraphic set-up of Assam geological province is as follows:

Age	Group Name	Formation (Thickness)	Lithology
Holocene	Unclassified	Newer or Low Level Alluvium	Sand, silt and clay
Middle to Upper Pleistocene	Unclassified	Older Alluvium	boulder deposit
---Unconformity/Tectonic------------------------------------			

Age	Group Name	Formation (Thickness)	Lithology
Pliocene-Pleistocene	Siwalik Group	Kimin Formation	Sandstone with clay stone
		Subansiri	Micaceous sandstone
Pliocene	Dihing Group	Dihing Formation (900m)	Pebble beds, soft sandy clay,
--Unconformity---			
Mio-Pliocene	Dupitila Group	Dupitila Formation (Surma Valley: 3300 m)	Sandstone, mottled clay, grit and conglomerate; locally with beds of coal, conglomerate and poorly consolidated sandstone with layers and pockets of pebbles
		Namsang Formation	Coarse, gritty, poorly consolidated sandstone and conglomerate of coal pebbles
--Unconformity---			
Mio-Pliocene	Tipam Group	Girujan Clay Formation (1800 m)	Mottled clays, sandy shale and subordinate mottled, coarse to gritty sandstone
		Tipam Sandstone Formation (2300 m)	Bluish grey to greenish, coarse to gritty, false bedded, ferruginous sandstone, clays, shales and conglomerates

Age	Group Name	Formation (Thickness)	Lithology
---Unconformity---			
Miocene	Surma Group	Bokabil Formation (900 to 1800 m)	shale, sandy Shale, siltstone, mudstone and lenticular, coarse ferruginous sandstone
		Bhuban Formation (1400 to 2400 m)	Alternations of sandstone and sandy shale and thin conglomerate, argillaceous in middle part
---Unconformity---			
Eocene-Oligocene	Barail Group	Renji Formation (600 to 1000 m)	Massive bedded sandstone; its equivalent - the Tikak Parbat Formation in the Upper Assam is marked by thick coal seam in basal part
		Jenam Formation (1000 to 3300 m)	Shale, sandy shale, and carbonaceous shales with interbedded hard sandstone; its equivalent the Bargolai Formation in Upper Assam is marked by thin coal seams
		Laisong Formation (2000 to 2500 m)	Well bedded compact flaggy sandstone and subordinate shale; its

Age	Group Name	Formation (Thickness)	Lithology
			equivalent- the Nagaon Formation in Upper Assam is marked by thin bedded, hard sandstone and interbedded shale.
	Disang Group		Splintery dark grey shale and thin sandstone
Palaeocene -Eocene	Jaintia Group	Kopili Formation	Shale, sandstone and marl.
		Shella Formation	Sylhet Limestone (Fossiliferous Limestone) Sylhet sandstone Sandstone, clay and thin coal seam
		Langpar Formation	Calcareous shale, sandstone-Limestone
-- Unconformity --			
Cretaceous	Alkali Complex of Samchampi		Pyroxenite – Serpentinite with abundant development of melilite pyroxene rock, ijolite, syenite and carbonatite
-- Unconformity --			
Cretaceous		Sylhet Trap (exposed in Meghalaya) (600m)	Basalt, alkali basalt, rhyolite, acid tuff

Age	Group Name	Formation (Thickness)	Lithology
--- Unconformity --			
Permo-carboniferous	Lower Gondwana	Kaharbari Formation	Very coarse to coarse grained sandstone with conglomerate lense, shale, carbonaceous shale and coal
		Talchir Formation	Basal tillite, conglomerate with sandstone bands, siltstone and shale
--- Unconformity --			
Neo-Proterozoic - Early Palaeozoic	Granite Plutons		Porphyritic coarse granite, pegmatite, aplite, quartz vein traversed by epidiorite, dolerite
--- Intrusive contact ---			
Palaeo-Meso Proterozoic	Shillong Group		Quartzite, phyllite, quartz – sericite schist, conglomerate
--- Unconformity --			
Archaean (?)Proterozoic	Gneissic Complex		Complex metamorphic group comprising ortho and para gneisses and schists, migmatites granulites etc.

Age	Group Name	Formation (Thickness)	Lithology
			Later intruded acidic and basic intrusives.

PRECAMBRIAN ROCKS

A. Gneissic Complex:

The crustal material of the Precambrian outcrops in Assam exposed in the Mikir Hills, at the fringes of the Shillong Plateau adjoining Meghalaya State. It also forms isolated inselbergs jutting out of the Quaternary plains, straddling both sides of the Brahmaputra river Valley. Elsewhere, the surface of this Precambrian landmass slopes down into basinal depressions and constitutes the basement for their sedimentary cover. Some of these are very minor and are filled with recent alluvium; the others are major features covered by sediments ranging in age from the Cretaceous to the present day Alluvium.

The Gneissic Complex comprises of gneiss, schist, migmatitic rocks intruded by younger acidic (granite, aplite, pegmatite) and basic (metadolerite, epidiorite, amphibolite) rocks. The rocks of the Gneissic Complex exposed in parts of Goalpara, Kamrup districts and in northern part of North Cachar Hills and Nagaon districts including the isolated inselbergs in the Brahmaputra Basin, mainly consist of biotite, and biotite-hornblende gneisses with bands of granulites and bosses of intrusive granites, pegmatites, quartz veins and minor basic bands.

In the Mikir Hills, the rock types vary from coarse grained, porphyritic granite to foliated biotite-granites and seem to be associated with fine grained banded foliated gneisses, schists and granulites with intrusive pegmatite, quartz veins and basic sills and dykes. The structural framework of the gneissic complex and its history of evolution combined with associated intrusives are complex issues. Effects of polyphase deformation and intrusion are indicated from several places. These rocks have undergone regional metamorphism of amphibolite-granulite facies from place to place and have given rise to gneisses, schists and some granulites.

B. Shillong Group :

The Gneissic Complex is unconformably overlain by the Shillong Group of rocks of Palaeo-Mesoproterozoic age. These rocks mainly comprise of conglomerate and metasedimentaries like quartzite, phyllite, schist association. In Assam, the rocks of Shillong Group are exposed along the western and northern part of the Mikir Hills across the Kopili valley. These rocks are metamorphosed to greenschist facies condition. Intrusion by granite plutons in Shillong Group exhibits contact metamorphism. The continuity of the Gneissic Complex and the Shillong Group across the Kopili valley in a roughly collinear trend suggests the continuity of the rocks from the Shillong Plateau is possibly separated by the Kopili lineament.

C. Granite Pluton:

A number of granite bodies transect both Gneissic Complex and Shillong Group. In Mikir Hills area, two types of granite occur, a) nonporphyritic foliated medium to coarse grained pink granite, occurring in the central part and b) porphyritic granite encircling the non-porphyritic granite. It is seen that these two granites evolved in separate phases of intrusions which is less studied. Also, these granite bodies have been exposed in the central and western part of the Assam covering the northern fringe of the Shillong plateau and few isolated inselbergs jutting out of the Quaternary plains which are straddling both sides of the Brahmaputra basins.

PALEOZOIC-MESOZOIC ROCKS

D. Lower Gondwana Group:

The occurrence of Lower Gondwana rocks are exposed in Singrimari area along the Meghalaya border in the extreme western corner of Assam. Fox (1934) reported plant fossils and coal from these beds, based on which he concluded Gondwana affinity. Acharyya and Ghosh (1968) grouped the entire sequence into Karharbari Formation (Permian). De and Boral (1978) further differentiated these sediments lithostratigraphically into the Talchir and Karharbari Formations.

E. Alkali Complex of Samchampi:

Alkaline mafic-ultramafic-carbonatite complex at Samchampi is emplaced within granitic host rock. The rock types include mainly a variety of syenites which cover large part of the area, mafic rocks which include alkaline pyroxenite, shonkinite, biotite pyroxenite, ultramafics (ijolite, melteigite), apatite-hematite-magnetite rock, carbonatite and cherty rocks. Carbonatite occurs mainly in the northern and eastern peripheral parts of the complex as dykes. At places, they laterally grade into mafics and ultramafic rocks and occasionally contain partly digested xenoliths of syenites and mafic-ultramafic rocks. Carbonatite bodies with associated rhyolite flows have been found along Brik nala, south of Matikhola Parbat in Mikir Hills. This occurrence resembles the carbonatite complex of Sung valley in Meghalaya.

F. Sylhet Trap:

Direct evidence of Cretaceous basaltic lava flows and intrusive from Assam is limited to the Mikir Hills area. Sylhet traps are well exposed in the Um Sohringknew and a no. of places of Shillong Plateau. Patchy occurrences of basaltic lava flows presumably belonging to Sylhet suite of Meghalaya have been reported from vicinity of Koilajan and its neighborhood, and in the Puja Nala in Mikir Hills of Assam. The outcrop shows highly weathered and altered chert/olive green trap rocks overlying the gneisses. About 67m of lava flows, with thin intertrappean bed has also been encountered in the Barapathar oil well drilled by Oil and Natural Gas Corporation (ONGC). Palynofossils obtained from the section suggests an early Cretaceous age.

TERTIARY ROCKS

The Tertiary rocks, rest over the weathered platforms of Precambrian rocks, these comprise of both shelf and geosynclinal facies sediments of Palaeocene-Eocene age represented by the Jaintia and Disang Groups respectively. The overlying Barail (Eocene-Oligocene), Surma (Lower Miocene), Tipam (Mio-Pliocene), Dupitila (Mio-Pliocene) and Dihing (Pliocene) Groups also represent both shelf and geosynclinal facies. The Tertiary sedimentary history of Assam is an integral part of the tectonosedimentary setting of the Tertiary sediments of the North East India and is influenced by the prominent ‘Brahmaputra Arch’ running parallel to Brahmaputra River. The thickness of Tertiary rocks is seen to increase towards southeast whereas the thickness of Quaternary sediments of Brahmaputra Basin increases towards north and northwest.

In the Early Tertiary sediments there is a sharp distinction between a geosynclinal facies and a shelf facies. In the Late-Tertiary sediments, there are minor differences in lithology, except that the shelf sediments are much thinner. The geosynclinal sediments are very thick where deposition took place in a sinking basin.

G. Jaintia Group:

The Jaintia Group (shelf facies sediments) of Eocene age is calcareous and abundantly fossiliferous. They differ markedly from the Eocene shales of the geosyncline (Disang Group) facies. Jaintia Group comprising Shella and overlying Kopili Formations is seen around Garampani area of the North Cachar Hills. It also extends north-easterly along the southern and eastern slopes of the Mikir Hills. These rocks are exposed from the vicinity of Selvetta in west through Dilai Parbat in the east and then through Doigrung further north-east. Workable seams of coal are present in the Sylhet Sandstone Member at Selvetta, Koilajan and Sylhet Limestone Member in Selvetta, Jarapgaon, Koilajan and Nambar areas.

The Shella Formation is well developed with three limestone bands alternating with three interbedded clastic sandstone units. The underlying unit, Lower Sylhet Sandstone Member in Assam exposed in Garampani area rests unconformably over the Precambrian basement. It is about 60 m thick and includes thick beds of sandstone with interstratified shale, carbonaceous shale and thin (0.3 m) coal seam, which overlies 2 to 3 meters thick basal conglomerate bed. The Shella Formation is conformably overlain by Kopili Formation, consisting mainly of greyish, usually ferruginous, splintery shales with interbedded sandstone and calcareous marl of variable thickness. Northeast of Lumding, Kopili Formation is overlapped by beds of Surma Group.

H. Disang Group:

Disang Group in Assam is represented by monotonous sequence of dark grey, splintery, shale with thin sandstone interbands. The shale is usually limonite coated. The Disang are predominantly arenaceous in the upper part and exhibit vertical as well as lateral facies change to its overlying Barail Group of rocks. In Assam, Disang Group is exposed along a narrow strip southwest of Haflong-Disang thrust in the central part of North Cachar Hills. This sequence is exposed from Jatinga valley eastward upto the headwaters of Dhansiri. In Upper Assam, Disang Group comprises of a thick sequence of alternating splintery shale with thin partings of hard greyish flaggy sandstone and sandy shales.

I. Barail Group :

Barail Group represents a sequence of lithology belonging to the geosynclinal facies. Rocks of this group are exposed along two different strips, in the south-eastern part of North Cachar Hills, i.e. to the South of Haflong-Disang Thrust and secondly in parts North of the Cachar and Mikir Hills i.e. to the north of Haflong-Disang Thrust in Upper Assam.

The unclassified shelf facies rocks of Barail Group which overlie the Kopili Formation cover a large area with a gross thickness of about 1000 m. Lithologically, they consist of fairly coarse sandstone, shale and carbonaceous shale with streaks of minor seams of coal. Outcrops of Barail Group in this part of the area are seen near Mupa, Langling, Latikhali, Chota Langher along the exposure of Lumding- Badarpur railway cuttings as well as along road section between Haflong and Garampani-Kopili. The geosynclinal facies of Barail Group in Surma valley and North Cachar Hills are subdivided into Laisong, Jenam and Renji Formations. But in upper Assam, the equivalent formations have been classified as Nagaon Formation, Bargolai Formation and Tikak Parbat Formation, respectively.

Laisong Formation consists of thin bedded greyish sandstone with interbedded thin sandy shale, rare massive sandstone, carbonaceous shales and streaks of coal. Laisong Formation gradationally passes into argillaceous Jenam Formation comprising mainly of shale, sandy shale, carbonaceous shale with streaks of coal and interbedded hard sandstone.

Renji Formation comprises of hard massive sandstone with rare beds of shale and sandy shale. The Renji Formation is distinguished from the former two by the increased frequency of microfauna and palyno-fossil. The thickness of Barail Group in southeastern part of Upper Assam Valley decreases in a north-westerly direction.

J. Surma Group:

Barail Group is unconformably overlain by Lower Miocene Surma Group, which covers a large area in Surma valley and North Cachar Hills. This group is divided into a lower arenaceous facies (Bhuban Formation) and an upper argillaceous facies (Bokabil Formation). Bhuban Formation consists of sandstones, sandy shales and conglomerate intervened by shale, sandy shale and lenticular sandstone. Bokabil Formation is represented by shale, sandy shale, siltstone, mudstone and fairly thick lenticular, coarse grained, ferruginous sandstone. Surma Group as a whole is well exposed as inliers in the southern part of the Surma valley and also occupies a strip in the northern part of the valley. In the North Cachar Hills, the rocks of Surma Group occupy a large tract in the vicinity of Maibong and further northeastward upto Lumding. These rocks further continue northwards and are exposed in the south-eastern part of the Mikir Hills, as a narrow strip over the eastern base of the Mikir Hills. Surma Group in Upper Assam is represented by about 30 to 60 m thick estuarine sandstone, shale and conglomerate unconformably overlying the Barails.

K. Tipam Group:

Tipam Group comprises a lower arenaceous facies Tipam Sandstone Formation and an upper argillaceous facies Girujan Clay Formation. Tipam Sandstone consists of fairly coarse to gritty false-bedded, ferruginous sandstone interbedded with shale, sandy shale, clay and conglomerate. Whereas The Girujan Clay Formation consists of lacustrine mottled clay, sandy mottled clay, sandy shale and subordinate mottled, coarse to gritty, ferruginous sandstone. Tipam Group has a general strike of ENE–WSW with a northerly dip varying from 50º-70º.

The rocks of Tipam Group are exposed in many areas in the Surma valley. Upper part of the Tipam sequence at many places is found to be eroded away, prior to the deposition of overlying Dupitila Group. However, Girujan Clay is exposed in the hills between Chargola and Longai valleys and the low hills to the east of Jatinga and Cachar district. Rocks of this group are present also in the Labak-Diksha and Darby-Dwarband areas. In Assam valley, Tipam Group occupies a 300 km long strip from Langting to Digboi interrupted by small patches of alluvium cover. Tipam Group also includes several oil-sand horizons in Upper Assam.

L. Dupitila Group:

Tipam Group is unconformably overlain by the Mio-Pliocene Dupitila Group consisting of coarse, loose and ferruginous sand, clay, mottled clay, mottled sandstone and poorly consolidated sand with layers and pockets of pebbles. These beds are well exposed at intervals, as patches over Tipam Group in Cachar and Karimganj districts, forming low mounds in valley areas.

The rock of Dupitila Group is exposed in Surma valley attaining a thickness of 3300 m and is named as Dupitila Formation. It comprises of sandstone, mottled clay, grit and conglomerate, locally with beds of coal, conglomerate and poorly consolidated sand with layers and pockets of pebbles. In Upper Assam, Dupitila Group is represented by fluviatile Namsang Formation, which consists of coarse, gritty, poorly consolidated sandstone, mottled clay and conglomerate, which at places, is almost entirely composed of pebbles of coal derived from Barail Group. Namsang Formation overlies Girujan Clay Formation with an unconformable contact at places and is well exposed in Dihing river section near Jaipur.

M. Dihing Group:

Lithology of Dupitila Group are unconformably succeeded by fluvial Pliocene Dihing Group consisting of thick pebble beds alternating with coarse, soft sandstone, clay, grit and conglomerate containing half decomposed plant remains. The unconformable relationship between Dihing and underlying Namsang Formation is well exposed along Dihing river section near Jaipur in Upper Assam. In Makum coalfields, this group comprises alternating pebble beds, sandstone and clays. The sandstones are gritty to coarse grained, loose ferruginous and generally greyish in colour. Along Margherita thrust, Tipam Sandstone is seen in juxtaposition with the Dihing beds. In Surma valley, Dupitila Formation is conformably overlain by a sequence of conglomerate, grit, sandstone and clay corresponding possibly to Dihing Group of Upper Assam. These beds, with steep dip are seen near Bishramkandi and Nagar Tea Garden. Dihing Group is correlated with the Kimi Formation of Siwalik Group exposed in the foothill of Arunachal Himalayas.

N. Siwalik Group:

Middle and Upper Siwalik rocks designated as Subansiri and Kimin formations are exposed in Sonitpur district of Assam, along the foot hills of Arunachal Himalaya. The Subansiri Formation is represented in the area by micaceous massive fine to medium grained pale brown sandstone while the Kimin Formation in the area comprises soft, grey sandstone with bands of claystone.

Quaternary Period

O. Alluvium:

The tectonic movements that took place after the deposition of the Kimins and the Dihings were the last major folding events in the Assam Valley region. Thereafter, all movements have been primarily concerned with the further uplift of already raised mountain masses. In the process, these have helped raise and give minor tilts to erosional surfaces, earlier flood plains and river built terraces. There have also been minor movements along earlier joints, faults and thrust planes.

Dihing Group is unconformably overlain by Quaternary sequence which has been described variously in the Upper Assam like “Terrace Deposits” or “Older or High Level Alluvium” etc.. It consists of indurated, yellow, brown or red clay with sand, gravel and boulder deposits. These deposits do not belong to the typical fluvial Quaternary deposits of the Brahmaputra Basin and are possibly weathered derivatives of the underlying older rocks. On the other hand, a major part of the area flanking the Brahmaputra River in Lower and Upper Assam is covered by thick Quaternary fluvial sequence.

Regional structure and tectonics

The Gneissic Complex of Assam, in continuity with Meghalaya’s geological framework, consists of Peninsular crystalline rocks that exhibit evidence of deformation, characterized by intricate folding and deep-seated fracture lineaments trending E-W and NE-SW. These fractures are possibly connected to sub-crustal movements, which have divided the region into several blocks. The present-day configuration of the Brahmaputra Valley is a result of the uplift and subsidence of different blocks of Precambrian crystalline autochthon, remnants of which are now seen in the Mikir Hills and the Shillong Plateau. This mass forms a "foreland spur" (Mathur and Evans, 1964), which has been overthrust from the northwest by the Eastern Himalayas, from the northeast by the Mishmi Hills, and from the southeast by the Naga-Patkai range during the Tertiary geotectonic cycle.

In Northeast India, four distinct geotectonic provinces have been identified:

1. The comparatively stable shield area of the Shillong Plateau and Mikir Hills.
2. The platform area peripheral to the shield, now covering the Brahmaputra Valley, North Cachar Hills, and Bangladesh plains.
3. The Naga-Patkai and Eastern Himalayan mobile geosyncline belt.
4. Transitional zones between the platform and the geosyncline, likely with narrow pericratonic downwraps marginal to the shield.

These geologic provinces are bounded by major tectonic lineaments that have been active throughout various tectonic cycles, influencing the area since the cratonization of the Gneissic Complex. This was followed by the deposition of the Shillong Group of rocks in intracratonic basins and sedimentation continuing up to Pleistocene times. The major lineaments include the E-W Dauki Fault along the southern margin of the Shillong Plateau, a suspected E-W fault along the Brahmaputra Valley, and the NW-SE Mishmi Thrust along the Lohit foothills.

The Upper Assam oil fields' subsurface geology reveals that the Tertiary sediments overlying the basement are folded into domes and anticlines, with faults trending NE-SW, NNE-SSW, NW-SE, and E-W. Fields like Naharkatiya, Moran, Rudrasagar, and Lakwa display complex fault patterns, some of which involve tensional faults and reverse faults. Faulting, which occurred intermittently from the Eocene to the Pleistocene, played a significant role in basin subsidence and sedimentation. The intricate fault patterns likely originated during Precambrian intrusive movements, with later tectonic reactivations affecting the overlying sediments.

The Schuppen belt, located over the northern part of the Naga-Patkai range, exhibits a series of imbricate thrusts with the Naga Thrust marking the boundary of the Quaternary valley fill of Assam. This belt consists of six thrusts, with the Disang Thrust being a prominent feature. The Cenozoic rocks in the Schuppen belt show a greater thickness of sediments compared to the Assam shelf, indicating a different depositional environment. The Surma Group, for instance, is thin and discontinuous in Upper Assam but well-exposed in the Schuppen belt. Similarly, the Barail coal seams are thicker and more persistent in the Schuppen belt.

The NW-SE Mishmi Thrust, which marks the youngest tectonic feature in the region, causes the metamorphic rocks of the Mishmi Hills to override younger Tertiary and

Quaternary deposits in the frontal Himalayan thrust belt and the Naga-Patkai belt. The Surma Valley, partly extending into the Cachar district of Assam, displays N-S to NE-SW asymmetrical folding, with broad synclines intervening faulted anticlines. Unlike the Schuppen belt, this region does not show overthrusting.

The tectonic evolution of Assam has been a complex interplay of uplift, subsidence, and faulting, with ongoing tectonic movements shaping the Brahmaputra basin and adjacent regions throughout geological history.

Mineral Resources

Assam is rich in a variety of mineral resources, some of which play a significant role in the state’s economy. The state is part of the larger Assam-Arakan Basin, which stretches across northeastern India and into parts of Myanmar, making it one of the major oil and gas-bearing regions in India. Petroleum and natural gas being the most significant natural resources of Assam, especially in the Assam-Arakan Basin, where fields like Digboi, Duliajan, and Naharkatiya have driven India's oil industry since the late 19th century. These fields are part of the Assam Shelf, a rich oil-bearing region. Natural gas is another key resource in Assam, often found alongside oil in the Assam-Arakan Basin. The production of natural gas has grown considerably, especially in fields like Lakwa, Duliajan, and Tengakhat. The coal occurrences in Assam are reported from two geological horizons viz., Gondwana and Tertiary of which Tertiary coal deposits of Makum, Mikir Hills and Dilli-Jeypore are the most important coalfields. The Gondwana coal deposits in the westernmost part of Garo Hills of Meghalaya are extending into the Hallidayganj area of western Assam known as the Singrimari Coal deposits. Assam's coal is known for its high sulfur content but has a low ash content whch supports local industries such as tea processing and brick manufacturing. Limestone deposits are found mainly in the Karbi Anglong district and in parts of the North Cachar Hills, is crucial for cement production. Assam has deposits of various types of clay, including china clay and fire clay used in pottery and ceramics. These are found in districts like Nagaon, Kamrup, and Goalpara. In the Namdang-Ledo area, the fire clay bands occur below the coal seams. Also, in karbi-Anglong district, fire clay bands of 3-5 m thickness in association with coal occur at Koilajan Colliery. Other minerals include silica sand (for glass manufacturing), and smaller deposits of iron ore, granite, gypsum, base metal, beryl, building stone,clay, sillimanite, salt and radioactive minerals which contribute to local construction and industrial activities.

7.0 Geomorphology

Physiographically the entire district is an alluvial plain with flat topography and there is a very gentle slope towards Brahmaputra River, which makes the southern boundary of the district.

8.0 Soil Type

The district has soil cover of younger alluvium and older alluvium which have undergone diversified pedagogical changes. The soils are characterised by medium to high organic carbon, low to medium phosphate and potash contents.

The alluvial soils are light yellow to light grey in colour of recent age. The texture of the soil ranges from sandy loam to silty loam in nature. The soil is suitable for cultivation of rice crops.

9.0. Groundwater Scenario:

9.1 Hydrogeology

Hydrogeologically, the entire area except a small pocket in the south western corner of the district is occupied by alluvial sediments of Quaternary age. Ground water occurs under unconfined condition in shallow aquifers and under semi-confined to confined condition in deeper aquifers. The aquifers are consisting of various grades of gravel, sand etc. It has a good yield prospect for both shallow and deep tube wells. The water level rests at shallow depth and in major parts of the district, it rests between 2 and 4 m bgl during pre-monsoon period. The post monsoon water level rests between 1 and 2 m bgl and in some places, it is above ground level. The long-term water level trend shows no significant changes in water level in the last 10 years in the district.

The shallow tube wells tapping aquifers above 50 m bgl are capable of yielding 20 - 100 m^3/hr at drawdown of less than 3 m. Medium to heavy duty tube wells constructed down to 100 to 150 m bgl, tapping about 25 - 40 m granular zones are capable of yielding more than 100 m^3/hr. The summarised results of the exploratory drilling done by Central Ground Water Board in the district are given in Table - 1.

Table - 1 : Summarised Hydrogeological data of Exploratory Well in Darrang district, Assam drilled by C.G.W.B.

Year of contraction	Location	Depth drilled (m)	Aquifer zones tapped (m)	Swl (m bgl)	Dischar-age m^3/hr DD (m)	Transm-issivity m2/Day	Hydra-ulic Condu-tivity (m/d)	Specific capacity (lpm/m)	Storage Co-efficient (s)	Geology	Sub Basin Sub-sub basin
1	2	3	4	5	6	7	8	9	10	11	12
1981-82	Kharupetia EW 26°24′38″ 92°06′35″	300.2 167	56-68, 83-91.76, 90-110.96, 115.45-128, 140-146.21, 158-164.26	7.64	90.24 5.63	11,894	204.43	267.14	-	Alluvium sand (f to c) gravel, pebble gravel, pebble	Mora Dhansiri Mongaldoi

1981-82	Kuyapani EW 26°25'05'' 91°58'29''	300.2 167	36.84-43, 46-52.17, 64-82.56, 93.86-101, 109.74-115, 122-130.96	1.10	251.74 3.724	7902.90	148.80	1126.66	-	-do-	-do-
1981-82	Kalaigaon EW 26°25'05'' 91°58'29''	300.2 167	38-44, 55-60.9, 78.14-84, 106.5-130, 139-145	0.98	188.04 5.23	3447.37	73.07	599.24	$2.8\text{x} 10^{-2}$	-do-	-do-
1981-82	Orang EW+OW 26°42'05'' 92°20'00''	276.42 148	45.95-70.73, 76.01-98.44, 99.47-108.97, 112.09-118.32,138, 85-145	2.48	216.54 10.12	18.75	0.34	356.62	$2.7\text{x} 10^{-3}$	-do-	-do-
2002-03	Mangaldoi EW 26°25'36'' 92°02'00''	202 129	65-77, 83-86, 90-95, 104-110, 117-126	1.60	47.7 0.66	2891	82.60	1205.5	-	-do-	-do-

9.2 Ground Water Resources:

The dynamic Ground Water Resources are estimated based on the methodology adopted as per GEC 97 following water level fluctuation and rainfall infiltration factors methods.

The annual dynamic ground water resources of the newly formed district are estimated to be 1754.32mm (half of the old Darrang district), while the net annual ground water draft is511.61 mcm. The present stage of ground water development is about31 %. The district is under safe category and sufficient resources are still available for development.

9.3 Ground Water Quality:

To study the quality of ground water, water samples collected from GWMS and exploratory wells constructed in the district were analysed in the Chemical Laboratory of C.G.W.B., NER, Guwahati. The interpretation of the results of the Chemical analysis shows that ground water is fresh and suitable for both the domestic and irrigation purposes. Higher contents of iron more than permissible limit occurring sporadically require treatment before being used for drinking purpose.

9.4 Status of Ground Water Development:

Ground water development is at low key at present and estimated to be 230 mcm against the vast annual resources of 575 mcm. After allocation for domestic and industrial purposes, the net annual dynamic resources for future irrigation in 2025 are estimated to be 300-350 mcm.

Ground water is mainly used for drinking and irrigation purposes and industrial use is considered to be negligible. Water supply schemes are executed by Assam Public Health Engineering Department through construction of ground water structures like dug well, hand pump and deep tube wells, etc. Ground water is used for irrigation purposes mainly through shallow tube wells implemented by Agriculture Department. The existing gross ground water draft for irrigation is 215 mcm.

9.5 Ground Water Management Strategy:

Thick and extensive alluvial deposits forming rich aquifer system covering the almost entire district is very much suitable for ground water development through ground water abstraction structures like open wells, shallow and deep tube wells. For drinking and other purposes, individual households construct open wells and filter point wells which are feasible all over the district. Ring wells of 0.80 to 1.20 m diameter constructed at the depth of 5 to 10 n bgl are likely to hold sufficient quantities of water to meet the domestic requirement. Filter point wells constructed at the depth of about 15 to 20 m bgl fitted with galvanised iron/PVC pipes and filter are also suitable for extraction of ground water.

For agriculture purpose, shallow tube wells at the depth of about 30 to 40 m bgl may be constructed. A length of 9 to 12 m slotted pipe in the aquifer may be sufficient. A

Centrifugal pump may be used to irrigate about 2 - 3 ha of land at an average annual draft of 0.03 mcm.

9.6 Ground Water Related Issues and Problems:

A part of the area of the district is devastated with floods every year during monsoon. Most of the area succumbs to water logging condition and utilisation of dynamic ground water resources is essential for lowering of water table which can be done by construction of shallow tube wells for agricultural purposes.

The sporadic occurrence of excess iron content is ground water requires suitable treatment before consumption.

9.7 Awareness and Training Activity

In a progressive society, it is natural that demands of water will be on the rise. The increasing population and urbanization affect these precious resources both in terms of quantity and quality. Therefore, proper understanding of the management, development and conservation of this precious resource is essential for the society. With this view, a Mass Awareness Programme and a Water Management Training Programme were organized at Mangaldoi town on 2nd February, 2005 and 3" February, 2005 respectively.

9.8 Recommendations

Detailed hydrogeological surveys aided by exploratory drilling carried out by Central Ground Water Board, Guwahati have revealed the existence of rich aquifer system down to the depth of 300 m bgl. The area consists of unconsolidated alluvial formation of Quaternary age laid down by River Brahmaputra and its tributaries.

Considering the hydrogeological set up and availability of huge ground water resources and the present stage of ground water draft, it can be concluded that there is an ample scope for the development of ground water through construction of different ground water structures in a planned way.

10.0. Flood Management :

As a practice, three phases of flood management actions are envisaged i.e. pre-flood, during flood and post-flood. The pre-flood activities include preparatory measures involving assessment of vulnerability, development of personnel and organizational database, to chalk-out emergency action plan such as deployment of early warning procedure and training of personnel for evacuation and rescue. Arrangement of commodities and relief materials also to be done along with verification updating of existing search and rescue operations. It is desired that a District Disaster Management Committee is formed well before the onset of the monsoon to guarantee adequate preparedness. It is also welcome that various Non-government Organizations come forward and properly get involved in this venture. All the information relating to disaster management must be well documented in order to accomplish future management plans. It is important to note that The National Commission for Integrated Water Resources Develoopment,1999 recommended management approach rather than control, emphasizing failure to provide complete protection. Such strategies include flood-plain zoning, flood proofing, forecasting, disaster preparedness, response planning and insurance. Regarding flood-plain zoning, the National Commission already proposed a legislation to classify flood prone zones according to occurrence and intensity. Now-a-days, flood forecasting has become easier with advancement of satellite and remote-sensing technology.

Flood-Plain

Flood –plain is said to be an area of land which is adjacent to a stream or river which stretches from the banks of its channel to the base of the enclosing valley walls, and which experiences flooding during periods of high-discharge. The soils usually consist of sands, silts and clays. Flood-plains are formed during erosion of a meander sideways as it travels downstream. At a time when a river breaks its banks, it leaves behind layers of silts (alluvium). These layers gradually build up to create the floor of the plain which generally contain unconsolidated sediments, very often extending below the bed of the stream. Flood-plains are accumulation of sand, gravel, loam, silt, clay and often serve as important aquifers.

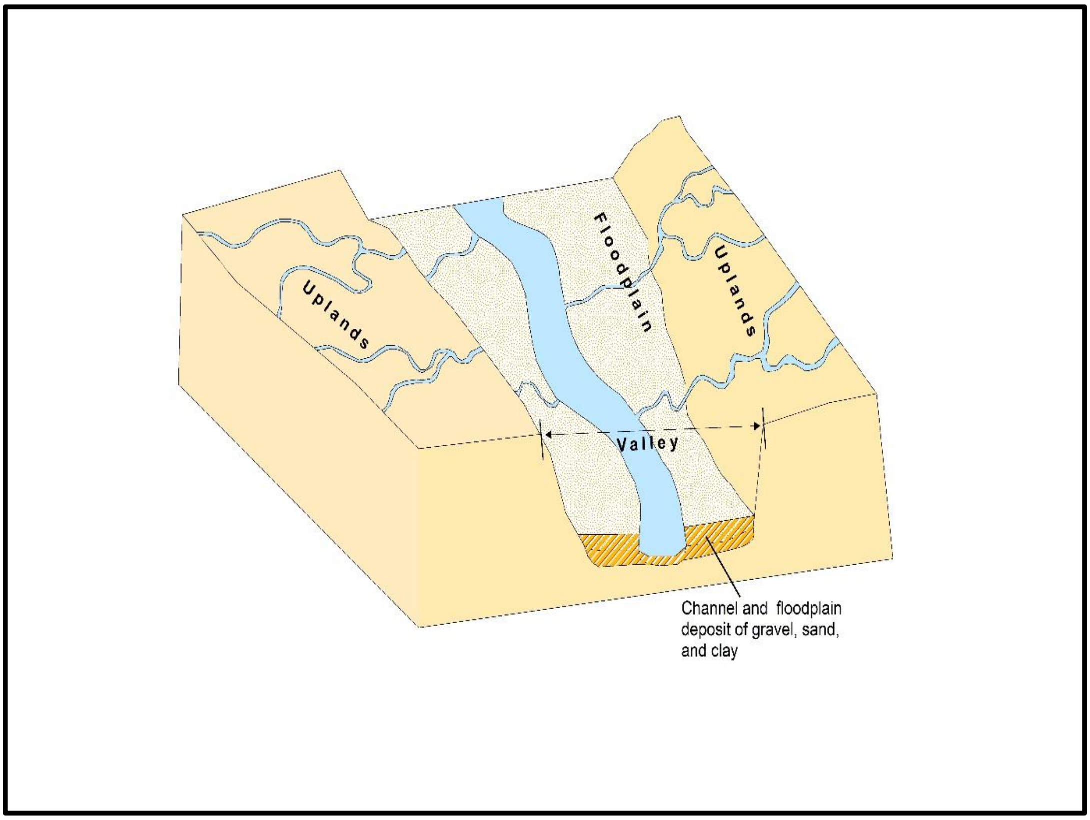

Figure 5

11. Replenishment of Sand and its Assessment

Based on the fundamentals of hydraulic, river flow has the ability to transport the debris as the resisting force is exerted on the water. The downstream of the river is based on the gravitational force acting as an inducing force while the friction resistance helps in the degrading process of the channel. The deposition on river bed is very pronounced during rainy season although the quantum of deposition varies from stream to stream depending on several factors like catchment, lithology, discharge, profile of river and geomorphology of the river course. In order to calculate the mineral deposits in the stream beds, the mineral constituents have been categorized as sand, gravel, silt and clay. Further, the Survey of India Topo-sheets should be used as base map to know the practical extent of river course. The sediment transportation is largely influenced by the grain size as the movement is influenced by the turbulence at the bed of the channel. The evaluation of sediment transport is important for appropriate management and policy implementation. The replenishment volume is determined by a 5-month dry period and as per River Sand Management Guidelines (2009).

11.1. Procedure for assessment of sediment replenishment :

The main objective of this study to assess the replenishment volume in order to calculate the optimum volume of sand to be extracted, supported by specific objectives in identifying the particle size in the river and determination of sediment transport during the low flow season. Regular replenishment study is mandatory and required to be carried out in order to keep a balance between deposition and extracted quantities.

Sediment load deposition in a river depends on catchment area, weathering index of the various minerals of that area, land-use pattern, rainfall data and grain-size distribution of the sediments.

Catchment Yield can be calculated using the following formula :

Catchment Yield (m^3) = Catchment Area (m^2) x Run-off Coefficient (%) x Rainfall (m)

Procedure :

Step no. 1 : Sampling stations to be identified as monitoring points within the study area. Sampling stations to be selected on the basis of active sand mining activity, the past sand mining area and the control stations. Control stations are to be used to represent the river reaches with no sand mining activity, so as to reflect the natural morphological characteristics without any human-made alterations. Such stations will represent the undisturbed condition for comparison with disturbed ones.

Step no. 2 : Following physical parameters are to be ascertained.

a) Channel width in meter (W)
b) Total cross-sectional area in m^2 (A)
c) Minimum and maximum velocity in m/s (V)
d) Water discharge in m/s (Q)
e) Total Dissolved Solid (TDS)

It may also be necessary to determine the channel slope and hydraulic radius, depending on the method of calculation followed.

All the above parameters are to be measured in-situ based on one water cycle (low-flow and high-flow). High-flow sampling period is preferred to be within November to January and low-flow sampling period may be during May-June.

Step no. 3 : It is desired that three samples are taken from each station from the upstream to the downstream. The samples are to be left to dry for 24 hours prior to obtaining bed material classification. Preferable sieve diameters are 2 mm, 1 mm, 0.5 mm, 0.25 mm,0.125 mm, 0.063 mm and 0.01 mm.

The changes in grain-size distribution determine the transport of sediment and sedimentation the river towards downstream. The result shall be represented as a cumulative distribution curve.

Step no. 4 : The total bed load can be calculated using the following equation :

$$T_j = \sum_{1}^{n} G_b \quad \text{where } G_b = \frac{W_i}{(T \times h_s)} \cdot \times b$$

Here, T_j is rate of bed load for the pre-defined cross-section in kilogram per second and G_b is rate of bed load for each section within the pre-defined cross-section in kilogram per second, W_i is weight of bed load sample in kg, T is duration of sampling in second, h_s nozzle width in meter, b = ratio between width of channel and number of se3ction within cross-section.

Other equations can also be used for calculation as shown below :

1) **Manning's Equation**

$Q = V.\ A. = (1.00 / n)\ .A.\ R^{2/3}\ .\sqrt{S}$ where
Q = Flow rate (m^3 /s) ; V = Velocity (m/s) ; A = Flow area (m^2) ;
R = Hydraulic Radius (m) : S = Channel Slope (m / m);
n = Manning's Roughness Co-efficient = $0.39\ S^{0.38}\ R^{-0.15}$

2) **Yang Equation (1972)**

$\log C_T = \{5.435 - 0.286 \log \log (W_s\, d_{50})\} / U - 0.475 \log U / W_S$ where

C_T = Total sand concentration in ppm
W_S = Terminal fall velocity (m / s)
d_{50} = Average particle diameter of granular material in mm
U = Shear Velocity in m / s = $(gRS_O)^{1/2}$
$R_e = U. d_{50} / v$; If $R_e < 70$, then $V_c / W_s = [2.5 / (\frac{\log U d_{50}}{v} - 0.06)] + 0.66$
If $R_e > 70$, then $V_c / W_s = 2.05$

3) **Dandy – Bolton Equation** :

Y = X . EK. CVF. PE. SL. ROKF

where Y - Sediment yield in tons per hectare
EK - Soil erodibility factor
CVF - Crop management factor considers prevention of soil loss

PE – Erosion control practice factor
SL - Slope length and steepness factor
ROKF – Coarse fragment factor
X is energy factor and equal to $1.586 \times (Q \times q)^{0.56} \times WSA^{0.12}$ where
Q =Runoff volume in mm, estimated using the SCS curve number method. ; q_p = Peak runoff rate in mm / hour ;
WSA = Watershed area in hectares ;
Peak flow q is calculated as per equation q = C x i x A where
C – runoff coefficient representing watershed characteristics
i - rainfall intensity for the watershed's time of concentration

4) Peak Flood Discharge calculation can be carried out using **Dicken's Formula**

$Q = CA^{3/4}$ where Q = Maximum flood discharge in a river (m^3/ hr)
A = Area of catchment in km^2
C = a constant varying widely between 2.8 to 5.6 for catchments in plains and 14 to 28 for catchments in hills.

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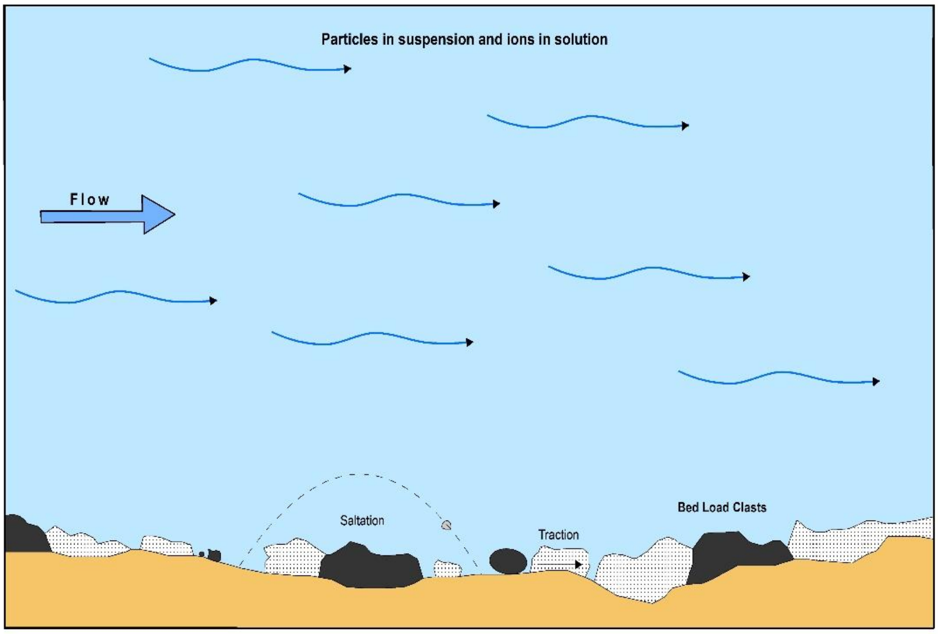

Figure 6

OR **Jarvis Formula** : $Q = CA^{1/2}$ where C = a constant varying between 1.77 as minimum to 177 as maximum. Flood of 100% chance is when C =177.

OR **Rational Formula :** Q = C.I.A where C is Run-off coefficient depending on the characteristics of the catchment area, being a ratio of Runoff : Rainfall

I = Intensity of Rainfall m/sec ;

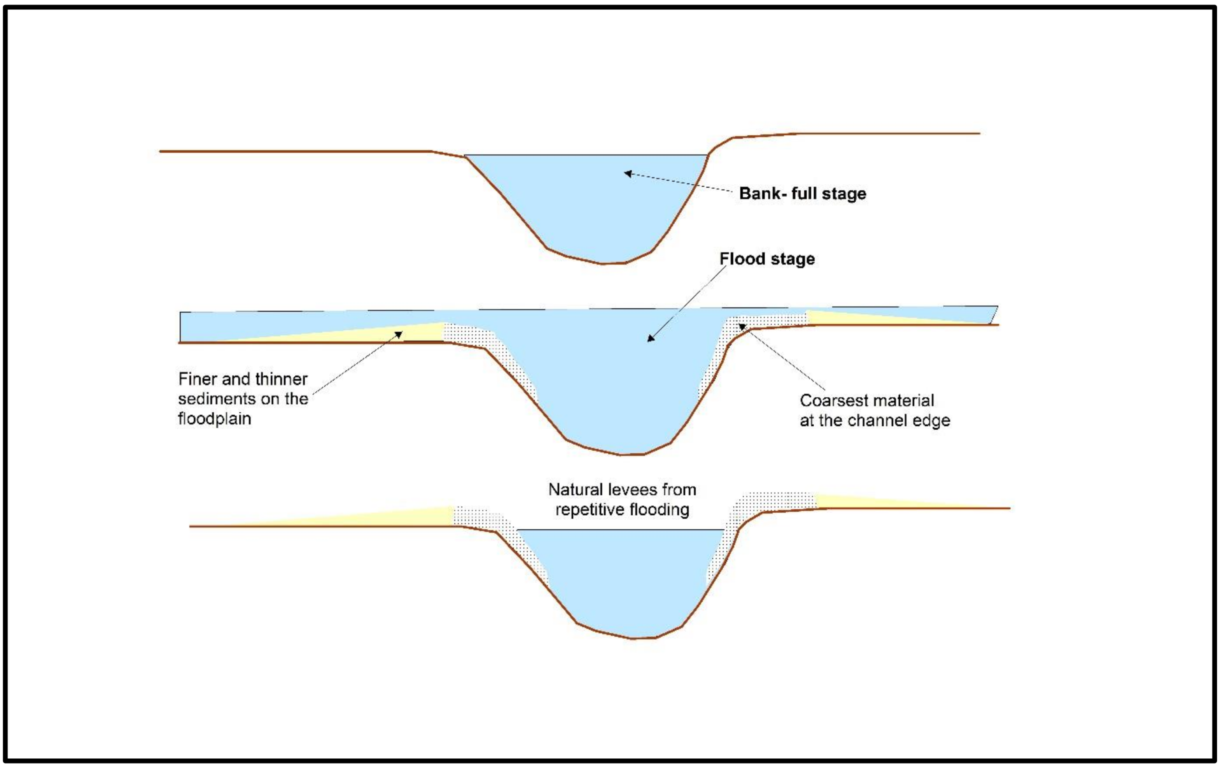

Figure 7

Bed Load Transport calculation is very difficult considering the fact three modes of transport may occur simultaneously i.e. rolling, sliding and saltation. There are a few equations in order to compute the total sediment load,most of which have both theoretical and empirical basis.

1) Ackers and White equation (1973) :

$C_t = C_s\, G_s\, (d_{50} / h)\, (v / U_*)^{n'} [F_{gr} – A_1) -1]^{m}$ where $F_{gr} = U\, n' / (G_s -1)\, g.d_{50}$

$x (V / \{ 5.66 \log(10h/ d_{50})\}^{1-n'}$

A_1 = Critical particle mobility factor
C_s = Concentration coefficient in the sediment transport function
C_t = Total sediment concentration
d_{50} = Medium grain size
d_{gr} = Dimensionless particle diameter = $d_{50} [g(G_s -1) /v^2]^{1/3}$

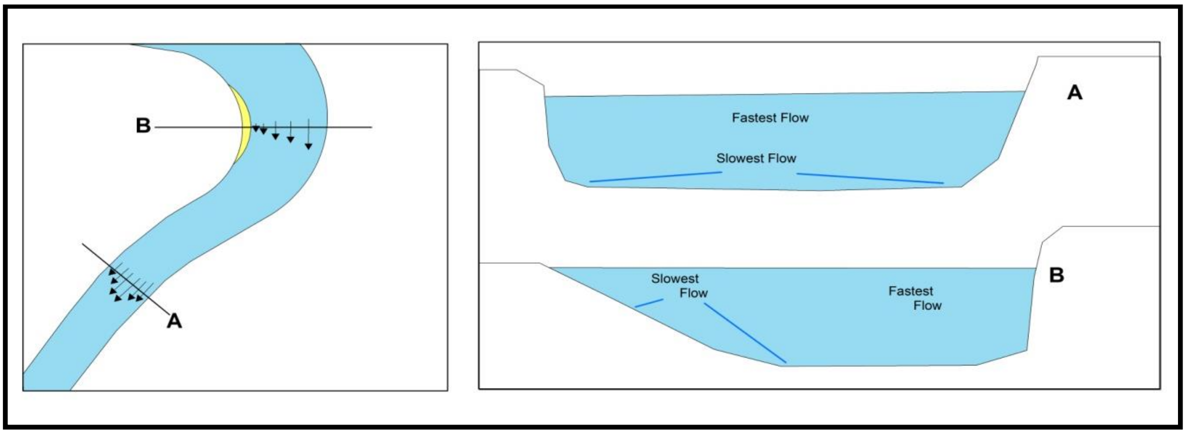

Figure 8

11.2. Deposition Process of Sediments in the River

Sediment is naturally occurring material, broken down by process of weathering and erosion and subsequently carried out or transported by the action of wind, tides, water and force of gravity acting upon the particles. Among these, water is the strongest agent for transportation of sediments and the degree of transportation depends on the strength and velocity of flow.

In general, there are three categories of river.

1) Youthful River
2) Mature River
3) Old Age River

A few characteristics of each of these are described below.

Youthful River

This river is the most dynamic of all the rivers. Such rivers are found at higher elevations, mainly in mountain areas where the slope of the land is steeper. Water moves very fast over such a landscape. These rivers can also be a tributary of a older and larger river, very far away. They also may be close to the beginning of the larger river.

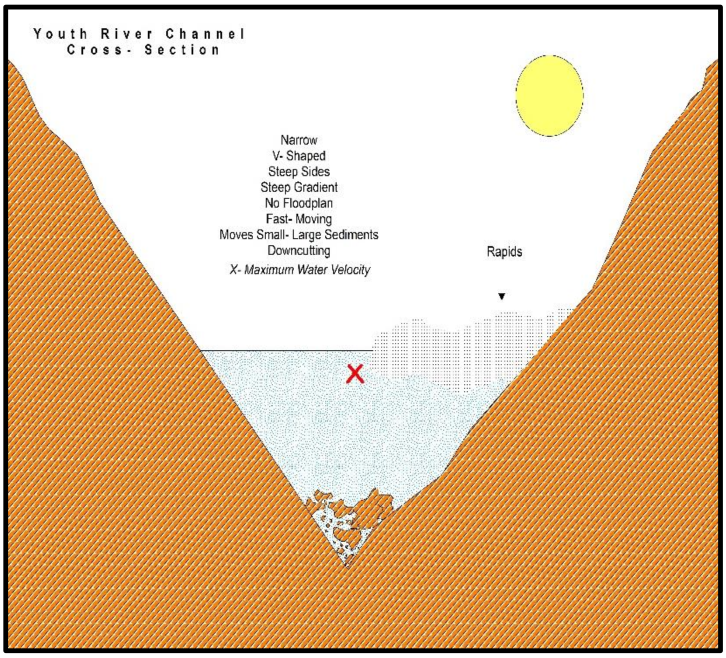

Figure 9

Mature River

Such Rivers down cuts to a much lesser degree than the Youthful Rivers does. They erode laterally but not as extensively as compared to Old Age River. They pass over enough steep landscape that slope of the river creates a velocity capable of moving not only the finer sedilen5ts but also larger pebbles and cobbles by way of rolling, bouncing and saltation along the river bed. They may flow through mountainous areas but not as high areas as in case of the Youthful River. The channel of a Mature River is U-shaped, more deep but less wide than Old Age River.

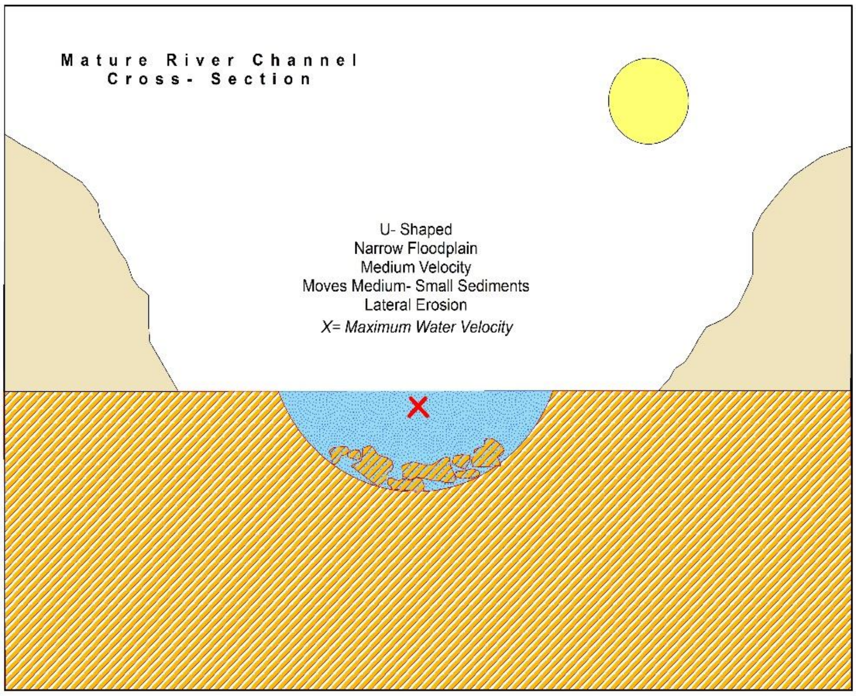

Figure 10

Old Age River :

An Old Age River rests in almost flat valley due to many years of erosion that took place over the years. Their course is not straight with widened flood plains. They are the slowest river with a high degree of sediments

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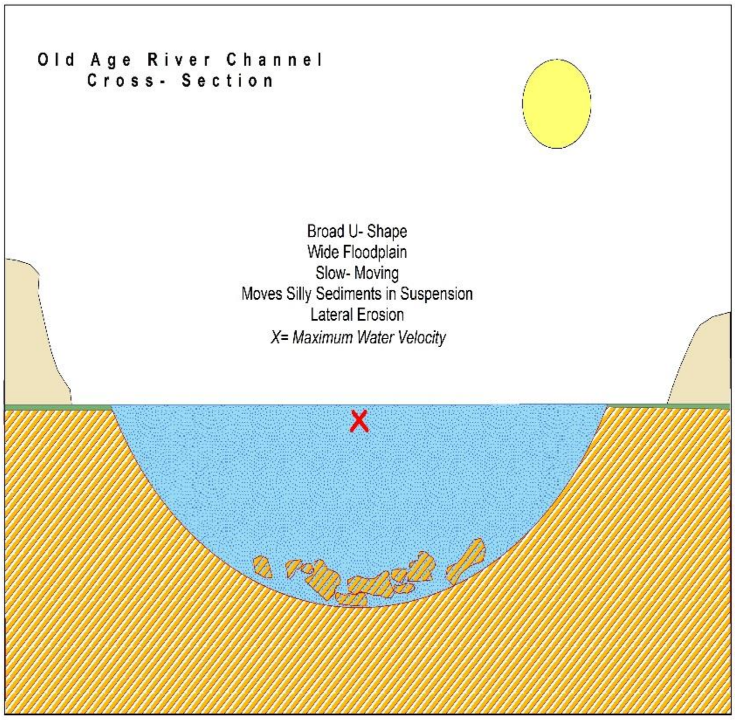

Figure 11

11.3. Stream Erosion and Deposition

Water flow in a stream largely depends on its gradient and also governed by the geometry of the stream channel. Velocity of water flow decreases with increase in friction along the stream bed. As a result, it is slowest at the bottom and edges and fastest near the surface and in the middle portion. On a curved section of a stream, flow velocity is highest on the extremes and slowest in the middle. An important factor that determine velocity of stream water is the size of sediments on the stream bed because large particles tend to slow down the flow more than the small particles. During a flood as the water level rises, there is more cross0-sectionalmarea available for the water to flow. But as long as the river remains confined, the velocity of water flow naturally increases. Small dimensional particles rest at the bottom for a

(Figure -12) while where they are moved by saltation and traction. These particles can also be held in suspension in the flowing water, at a time when the velocity is high. As we are aware of, stream water can also have dissolved load which may represent about 15% of the mass transported and consists of minerals like calcium (Ca^{2+}) and Chloride (Cl^{-}) in dissolved condition.

<u>Typical Particle-size (mm) Distribution Curve</u>:

A stream typically reaches the highest velocity as and when it is close to flooding over its banks (Bank-full Stage). As soon as the flooding stream flows over its banks and occupies the wide area in the flood plain, larger area becomes available and consequently the velocity comes down. At this juncture, sediment that was earlier being carried by high velocity of water gets deposited near the edge of the channel forming a natural bank or levee.

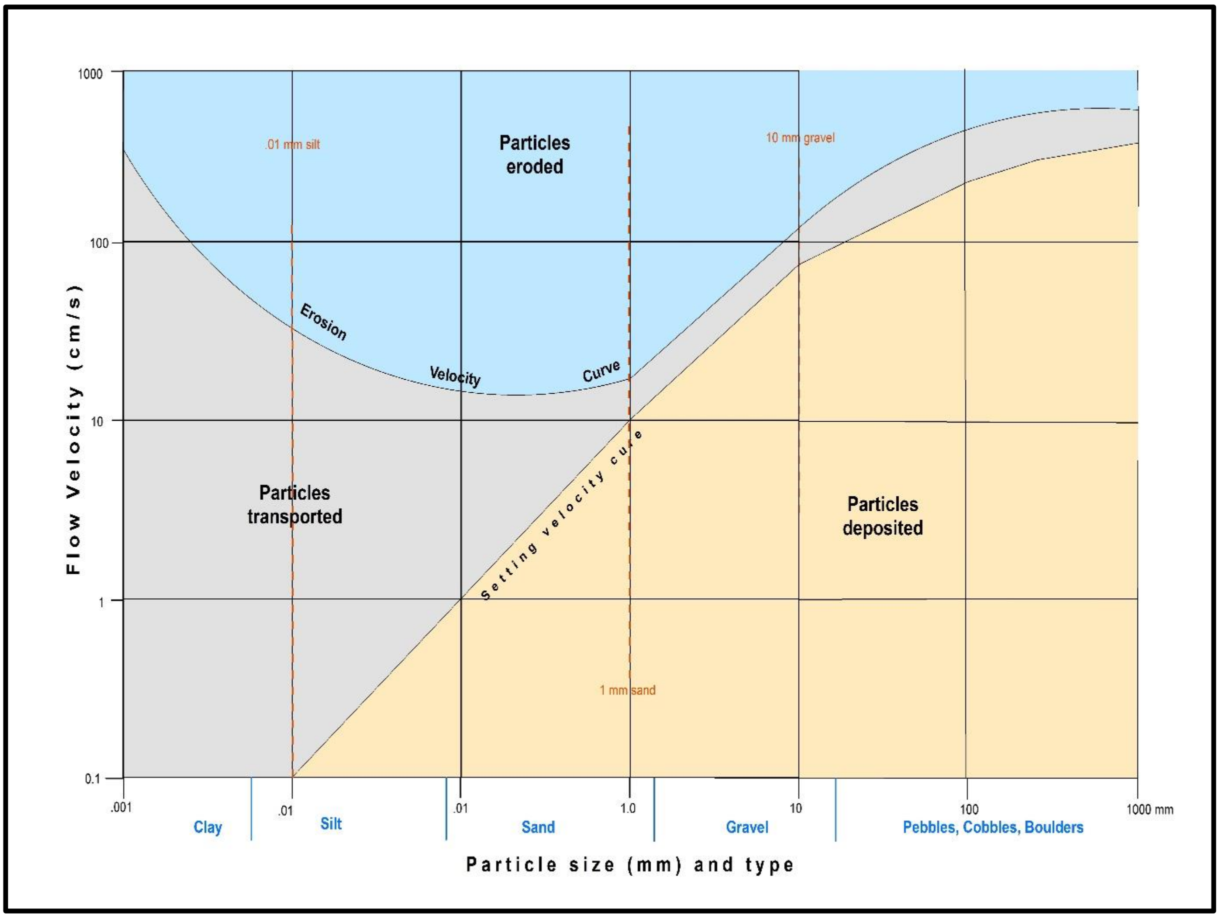

Figure 12

12. SAND MINING GUIDELINES

(Based on Sustainable Sand Management Guidelines, MoEF&CC, 2016)

In order to ensure sustainable and systematic sand mining with monitored protection of environment, the guidelines laid down in following documents are followed :

1) Sustainable Sand Mining Management Guidelines 2016 by MoEF&CC

2) Enforcement & Monitoring Guidelines for Sand Mining 2020 by MoEF&CC

3) Assam Minor Mineral Concession Rules, 2013

The above documents have been strictly adhered to during Preparation of Mining Plan and Progressive Mine Closure Plan under the guidance of a registered RQP. This will facilitate grant of any mineral concessions like "Mining Lease", "Mining Contract" or "Mining Permit" in respect of minor minerals for systematic, scientific and progressive development of all mines, quarries as well as river bed mining. As per guidelines prescribed in above said documents, special attention has been given on the following aspects :

1) The permanent boundary pillars need to be erected after identification of an area of aggradation and deposition outside the bank of the river at a safe location for future surveying. The distance between boundary pillars on both sides of the bank shall not be more than 100 meters.

2) Proper channelization of river is to be carried out so as to avoid the possibility of flooding and to maintain the flow of rivers.

3) The mining plan should include original ground level (OGL), available from District Survey Report (DSR) and to be recorded at an interval not more than 10 m x 10 m along and across the length of the river. Area of aggradation /deposition needs to be ascertained by comparing the level difference between the OGL and water level.

4) Riverbed sand mining shall be restricted within the central 3/4th width of the river/ rivulet or 7.5 meters(inward) from river banks but up to 10% of width of the river. Central 3/4th part of the river needs to be identified on a map, out of which the area of deposition / aggradation needs to be identified. Remaining 1/4th area needs to be marked as 'no mining zone'.

5) The sediment sampling should include the bed material and bed material load before, using and after the extraction period. The above exercise by DSR require four surveys i.e. 1st survey in the month of April, 2nd survey at the time of closing of mines for monsoon, 3rd survey needs to be carried out after monsoon to know the quantum of material deposited/replenished and the 4th survey to be carried out at the end of March to know the Quantum of material excavated. The above information will be available in District Survey Report (DSR).

6) The particle size distribution and bulk density of deposited material are required to be assessed by a NABL recognised laboratory.

7) Depth of mining should be restricted to 3 meters and distance from the bank should be 1/4th of the river width and should not be less than 7.5 meters. Alternatively, distance from the bank should be 3 meters or 10% of the river width, whichever is less.

8) Demarcation of mining area with pillars and geo-referencing should be done prior to of mining operation.

9) A buffer distance/ un-mined block of 50 meters after every block of 1000 meters over which mining is undertaken, shall be maintained.

10) Sand and gravel may be extracted across the entire active channel during the dry season only. No sand mining during monsoon session, as defined in DSR or IMD for each state.

11) Sand and gravel shall not be extracted up to a distance of 1 km from major bridges and highways on both sides, or five (5) times span of a bridge/public civil structure (including water intake points) on up-stream side and ten(10) times the span of such bridge on down- stream side, subjected to a minimum of 250 meters on the upstream side and 500 meters on the downstream side.

12) Sand and gravel shall not be allowed to be extracted where erosion may occur, such as, at the concave bank.

13) River mining from outside should not affect rivers. No mining shall be permitted in an area up to a width of 100 meters from the active edge of the embankments or distance prescribed by irrigation department. The mining from area outside river bed

shall be permitted subject to a condition that a safety margin of two (2) meters shall be maintained above the groundwater level while undertaking mining operation.

14) Sand and gravel shall not be extracted within 200 to 500 meters from any crucial hydraulic structure such as pumping station, water intakes.

15) All sand carrying vehicle (from source to destination) to be tracked through GPS or RFID. There should be one entry and exit point for trucks / dumpers. Project Proponent should carry out effective monitoring of the same. In case of vehicle break-down, the validity of transport permit can be extended by State Authority, if so required.

13 Details of Mining Permit Areas

List of Govt. Land lmining of Darrang District under North Kamrup Division, Rangia.

Sl no.	Name of District	Name of Range	Name of Govt land Permit area	GPS coordinates		Remarks
				Latitude N.	Longitude E.	
	Darrang	Kuruwa Range	Dumunichowki Govt. Land Ordinary earth MPA	$26^{0}21.026^{/}$	$91^{0}48.980^{/}$	
				$26^{0}21.021^{/}$	$91^{0}48.957^{/}$	
				$26^{0}20.982^{/}$	$91^{0}48.960^{/}$	
				$26^{0}20.986^{/}$	$91^{0}48.982^{/}$	
	Darrang	Mangaldai Beat	BaghbariChapari Govt. Land Ordinary earth MPA	$26^{0}25^{/}8.36^{//}$	$92^{0}2^{/}22.17^{//}$	
				$26^{0}25^{/}2.68^{//}$	$92^{0}2^{/}25.70^{//}$	
				$26^{0}25^{/}9.69^{//}$	$92^{0}2^{/}32.59^{//}$	
				$26^{0}25^{/}20.92^{//}$	$92^{0}2^{/}26.25^{//}$	
	Darrang	Mangaldai Beat	BaghbariChapari Govt. Land Ordinary earth MPA	$26^{0}25^{/}32.21^{//}$	$92^{0}2^{/}30.10^{//}$	
				$26^{0}25^{/}23.20^{//}$	$92^{0}2^{/}39.08^{//}$	
				$26^{0}25^{/}34.00^{//}$	$92^{0}2^{/}53.28^{//}$	
				$26^{0}25^{/}40.19^{//}$	$92^{0}2^{/}50.13^{//}$	
	Darrang	Mangaldai Beat	GerimariChapari Govt. Land	$26^{0}24^{/}40.100^{//}$	$92^{0}01^{/}00.00^{//}$	

			Ordinary earth MPA	$26^{0}24^{/}31.00^{//}$	$92^{0}010^{/}02.00^{//}$	
				$26^{0}24^{/}38.86^{//}$	$92^{0}00^{/}55.78^{//}$	
				$26^{0}24^{/}47.00^{//}$	$92^{0}01^{/}03.00^{//}$	
	Darrang	Mangaldai Beat	GerimariChapari Govt. Land Ordinary earth MPA	$26^{0}24^{/}26.06^{//}$	$92^{0}00^{/}42.34^{//}$	
				$26^{0}24^{/}34.00^{//}$	$92^{0}00^{/}51.00^{//}$	
				$26^{0}24^{/}26.63^{//}$	$92^{0}01^{/}03.27^{//}$	
				$26^{0}24^{/}19.52^{//}$	$92^{0}00^{/}49.95^{//}$	
	Darrang	Mangaldai Beat	Naorasisakash Govt. Land Sand & Clay MPA	$26^{0}36^{/}37.720^{//}$	$92^{0}16^{/}9.270^{//}$	
				$26^{0}36^{/}41.130^{//}$	$92^{0}16^{/}3.730^{//}$	
				$26^{0}36^{/}46.790^{//}$	$92^{0}16^{/}6.030^{//}$	
				$26^{0}36^{/}39.352^{//}$	$92^{0}16^{/}10.999^{//}$	
				$26^{0}36^{/}38.110^{//}$	$92^{0}16^{/}15.110^{//}$	
				$26^{0}36^{/}44.040^{//}$	$92^{0}16^{/}9.310^{//}$	
				$26^{0}36^{/}45.550^{//}$	$92^{0}16^{/}12.390^{//}$	
				$26^{0}36^{/}37.580^{//}$	$92^{0}16^{/}12.540^{//}$	
	Darrang	Mangaldai Beat	Mowamari Govt. Land Ordinary earth MPA	$26^{0}24^{/}45.519^{//}$	$92^{0}1^{/}32.940^{//}$	
				$26^{0}24^{/}46.106^{//}$	$92^{0}1^{/}28.641^{//}$	
				$26^{0}24^{/}43.592^{//}$	$92^{0}1^{/}27.177^{//}$	
				$26^{0}24^{/}44.088^{//}$	$92^{0}1^{/}32.605^{//}$	
				$26^{0}24^{/}45.193^{//}$	$92^{0}1^{/}35.327^{//}$	

				$26^{0}24^{/}43.291^{//}$	$92^{0}1^{/}32.418^{//}$	
				$26^{0}24^{/}41.588^{//}$	$92^{0}1^{/}32.020^{//}$	
				$26^{0}24^{/}41.081^{//}$	$92^{0}1^{/}36.433^{//}$	
				$26^{0}24^{/}44.918^{//}$	$92^{0}1^{/}37.346^{//}$	
				$26^{0}24^{/}44.082^{//}$	$92^{0}1^{/}43.463^{//}$	
				$26^{0}24^{/}44.799^{//}$	$92^{0}1^{/}38.218^{//}$	
				$26^{0}24^{/}41.421^{//}$	$92^{0}1^{/}$ $37.861^{//}$	
				$26^{0}24^{/}41.599^{//}$	$92^{0}1^{/}40.631^{//}$	
				$26^{0}24^{/}42.524^{//}$	$92^{0}1^{/}43.112^{//}$	
	Darrang	Mangaldai Beat	Mowamari Govt. Land Ordinary earth MPA	$26^{0}24^{/}47.545^{//}$	$92^{0}1^{/}29.475^{//}$	
				$26^{0}24^{/}45.620^{//}$	$92^{0}1^{/}43.810^{//}$	
				$26^{0}24^{/}54.210^{//}$	$92^{0}1^{/}34.030^{//}$	
				$26^{0}24^{/}54.423^{//}$	$92^{0}1^{/}33.487^{//}$	
	Darrang	Mangaldai Beat	Mowamari Govt. Land Ordinary earth MPA	$26^{0}24^{/}36.05^{//}$	$92^{0}1^{/}22.17^{//}$	
				$26^{0}24^{/}40.72^{//}$	$92^{0}1^{/}24.66^{//}$	
				$26^{0}24^{/}38.87^{//}$	$92^{0}1^{/}33.11^{//}$	
				$26^{0}24^{/}31.87^{//}$	$92^{0}1^{/}30.69^{//}$	

List of PP land mining of Darrang District under North Kamrup Division, Rangia.

Sl no.	Name of District	Name of Range	Name of PP land Permit area	GPS coordinates		Remarks
				Latitude N.	Longitude E.	
	Darrang	Kuruwa Range	Chutiakata Narikali PP Land Ordinary Earth MPA	$26^{0}20^{/}36.8^{//}$	$91^{0}51^{/}45.9^{//}$	
				$26^{0}20^{/}36.7^{//}$	$91^{0}51^{/}45.0^{//}$	
				$26^{0}20^{/}33.9^{//}$	$91^{0}51^{/}45.4^{//}$	
				$26^{0}20^{/}34.1^{//}$	$91^{0}51^{/}46.5^{//}$	
				$26^{0}21^{/}35.25^{//}$	$91^{0}51^{/}$ $38.95^{//}$	
				$26^{0}21^{/}31.48^{//}$	$91^{0}51^{/}$ $39.67^{//}$	
				$26^{0}21^{/}31.16^{//}$	$91^{0}51^{/}44.61^{//}$	
				$26^{0}21^{/}36.85^{//}$	$91^{0}51^{/}46.11^{//}$	
				$26^{0}21^{/}13.67^{//}$	$91^{0}51^{/}27.77^{//}$	
				$26^{0}21^{/}14.68^{//}$	91^{0} $51^{/}38.48^{//}$	
				$26^{0}21^{/}21.87^{//}$	91^{0} $51^{/}36.40^{//}$	
				$26^{0}21^{/}18.93^{//}$	91^{0} $51^{/}28.72^{//}$	
				$26^{0}21^{/}$ $13.67^{//}$	91^{0} $51^{/}$ $27.77^{//}$	
				$26^{0}21^{/}$ $13.67^{//}$	91^{0} $51^{/}$ $27.77^{//}$	
				$26^{0}21^{/}$ $13.67^{//}$	91^{0} $51^{/}$ $27.77^{//}$	
				$26^{0}21^{/}$ $13.67^{//}$	91^{0} $51^{/}$ $27.77^{//}$	
				$26^{0}21^{/}$ $13.67^{//}$	91^{0} $51^{/}$ $27.77^{//}$	

List of mines already granted EC of Darrang District under North Kamrup Division, Rangia.

Sl no.	Name of District	Name of Range	Name of MCA/MPA	GPS coordinates		Remarks
				Latitude N.	Longitude E.	
	Darrang	Mangaldai Beat	NKD-M-14 Mangaldai River MCA	26^{0} $30^{/}$ $21.6^{//}$	92^{0} $01^{/}$ $28.1^{//}$	
				26^{0} $27^{/}$ $52.0^{//}$	92^{0} $01^{/}$ $04.2^{//}$	
	Darrang	Mangaldai Beat	NKD-M-16 Koupati MPA	26^{0} $35^{/}$ $41.04^{//}$	92^{0} $16^{/}$ $21.81^{//}$	
				26^{0} $35^{/}$ $30.57^{//}$	92^{0} $16^{/}$ $31.37^{//}$	

List of proposed mining quarries of Darrang District under North Kamrup Division, Rangia.

Sl no.	Name of District	Name of Range	Name of MCA	GPS coordinates		Remarks
				Latitude N.	Longitude E.	
	Darrang	Mangaldai Beat	NKD-M-16 Koupati Mining Contract Area	$26^{0}36^{/}54.500^{//}$N	92^{0} $15^{/}$ $56.900^{//}$E	
				$26^{0}36^{/}51.300^{//}$N	92^{0} $15^{/}$ $58.800^{//}$E	
				$26^{0}36^{/}52.000^{//}$N	92^{0} $16^{/}$ $6.900^{//}$E	
				26^{0} $37^{/}$ $9.000^{//}$N	92^{0} $16^{/}$ $4.300^{//}$E	
				26^{0} $37^{/}$ $0.200^{//}$N	92^{0} $16^{/}$ $2.800^{//}$E	
				$26^{0}37^{/}05.700^{//}$N	92^{0} $16^{/}$ $0.800^{//}$E	

				$26^{0}37^{/}09.000^{//}N$	92^{0} $15^{/}$ $59.500^{//}E$	
				$26^{0}37^{/}11.479^{//}N$	92^{0} $15^{/}$ $58.133^{//}E$	
				$26^{0}37^{/}08.938^{//}N$	92^{0} $15^{/}$ $50.601^{//}E$	
				$26^{0}36^{/}59.670^{//}N$	92^{0} $15^{/}$ $54.592^{//}E$	
				$26^{0}36^{/}57.020^{//}N$	92^{0} $15^{/}$ $55.872^{//}E$	

14. Revenue Collection for the last Five (5) years;

Sl. No.	Year	Revenue received from minor minerals (in Rs.)
1	2019-20	19406242.00
2	2020-21	16088325.00
3	2021-22	15764566.00
4	2022-23	69729460.00
5	2023-24	99394931.00
	Total	**220383524.00**

15. Remedial measures in order to mitigate the impact of sand mining

Air Environment :

The only source of air pollution during mining is excavation, transportation, loading and handling of minerals. Following measures are suggested to mitigate the negative impact of the mining activities to control the spreading of pollutants by plantation of trees along the haul roads, especially near settlements, planning transportation routes of mined mineral by shortest routes and regular water sprinkling on unpaved roads.

A. Air Emmissions :

Probable Impact	Mitigation Suggested
1) Dust and air emission particularly due to excavation, construction and movement of vehicles leading to air pollution	1) Provision for spraying water to reduce dust emission on unpaved roads, particularly near existing settlements, (> 2 L per m^2) 2) Excavated topsoil to be preserved and reused for landscaping 3) Amount of exposed ground stockpiles to be minimized so that re-suspension due to wind and following dust fall may be prevented. 4) Care should be taken in making arrangement of the soil in such a manner such that the existing drainage pattern, even if altered, will still ensure that runoff does not carry away topsoil but reaches the water bodies with which it is connected. 5) To ensure that all generators, vehicles,

	compressors are regularly serviced and well maintained.

Other measures to be adapted:

** Transportation of material must be carried out during day time only.

** To plan multiple transportation routes in different direction to minimize the dust generation. Planned paved roads outside the mining lease area will minimize dust generation. in order to minimize transportation over unpaved roads, it is advised to plan transportation so as to each the nearest paved road by shortest route.

** All the workers are to be provided with Dust mask at points like excavation and loading.

** Plantation of trees along haul roads.

** Speed of trucks to be limited to 20km/hr.

** The loaded material should be covered with tarpaulin during transportation.

B   Movement of Traffic :

Probable Impact	Mitigation Suggested
1) Due to mining activity, number of vehicles per hour will increase in the existing traffic leading to undesired sound resulting in impact in human health.	1) Truck drivers to be instructed to make minimum use of horns in the village area and sensitive zones. It is advisable to plant local species of trees (fruit bearing and medicinal) along the haul road, in consultation with Forest Department.
2) Increase in number of vehicle movement will lead to air pollution affecting the health of local villagers with respiratory system, asthma, breathing problems etc.	2) All vehicles must possess proper ad up-to-date PUC Certificate. Plantation of trees, as stated earlier will minimize the effect f air pollution. Moreover, Regular health check-up camps should be organized.
3)Vehicles moving with over-speed can lead to accidents.	3) Vehicle speed should be limited to 20 km/hr. Nearby medical facilities must be available in case of any mishap.

C. Noise Pollutioin

Probable Impact	Mitigation Suggested
1).Impact of noise due to mining activities	1) Noise generated from the equipment like generators must be within prescribed limit of 75 dB. The noise must not be continuous.
2) Prolonged exposure of noise from the machinery can cause hypertension, hearing loss, sleep disturbances etc.	2) Noise measurement should be done at specified intervals and the data must adhere to permissible limits as per National Ambient Noise Quality Standards.
3) Increase in number of transports will lead to more noise and discomfort.	3) Truck drivers to be instructed to make minimum use of horns. Plantations along the approach roads will minimize noise propagation.

D, Water Environment:

Probable Impact	Mitigation Suggested
1). Flow pattern might get changed due to river bed mining.	1) Diversion of flow pattern should be avoided. Thus there will be no change in flow pattern, surface hydrology and ground water regime.
2) Increase in mining depth will result in increase in flow velocity	2) Mining activities must be restricted to 3m depth which will not affect the flow pattern.
3). Change in qualities of ground water and surface water.	3) Mining should not be done below the water levels. Water samples should be tested at regular basis as a precautionary measure. Mining will be done as per approved Mining Plan and approved Rules and Regulations e.g. mining should be restricted to central $3/4^{th}$ width of the river and should not be less than 7.5 meters etc.
4) Mode of waste water discharge	4) It is advised to use portable bio-toilets so that no sewage or liquid effluent will contaminate the ground water due to percolation.

E. Soil Environment:

Probable Impact	Mitigation Suggested
1) Mining activity may lead to increase of soil erosion and degradation which results in adverse impact in soil quality.	1) Plantation of local species trees on regular basis along the haul roads, outer periphery within the mining area will help to enhance the binding property of the soil and check erosion. Water to be sprinkled on unpaved roads.
2) Extraction of top soil from outside riverbed may affect the soil fertility and productivity	2) Of course, if it is a river bed, then top soil will not be generated.
3) Soil erosion takes place during the flood.	3) To construct dams for protection of river banks. No bank cutting is permitted.

F. Land Use

Probable Impact	Mitigation Suggested
1) In case mining activity is carried out outside riverbed, a pit will be formed which will cause soil erosion. 2) Mining in riverbed may lead to a change in complete land use pattern and even land geometry, sediment transportation capacity, bed elevation etc. leading to a change in flow pattern of the river and erosion in the downstream.	1) In such a case, proper reclamation to be implemented either by planting of trees or converting the pit into a fishery project. 2) Mining should be carried out only during non-monsoon seasons so that the excavated area is replenished naturally during the subsequent rainy season. Pre and post-monsoon survey for sedimentation in the riverbed should be carried out regularly. Dams to be constructed at required places for protection of banks. Safety distance from the bank inwards to be maintained not to disturb the channel geometry.

G. Hydrogeology :

Probable Impact	Mitigation Suggested
1) Ground water contamination is very much susceptible for mining in river beds, due to intersection with water table. 2) Any change in topography will divert the river flow.	1) Proper analysis and monitoring must be done so that intersection with water table is avoided. Moreover, depth of mining should not exceed 3 m. 2) Mining activity should not involve any diversion or modification of topography.

3) Any change in slope of mining area will lead to soil erosion and rain water run-off channel may get diverted.	3) Maximum depth permissible for riverbed mining is 3 m, which must be adhered to.

H. Biological Environment:

Probable Impact	Mitigation Suggested
1) Transportation of minerals in trucks or dumpers will hamper the movement of wild animals like jungle ca, jackal and other reptiles. Moreover, Fugitive emission from vehicle movement will form a layer on plant leaves leading to reduction in gaseous exchange process. This will ultimately affect the growth of plants (stomatal index may get minimized) There is also a possibility of collision with wildlife as and when they attempt to cross the road.	1) Movement of vehicles should be limited during day time only. Access roads should never encroach into the riparian zone. Water to be sprinkled on unpaved roads which will minimize dust generation.

2) Human settlement in the mining area will destroy the vegetation cover and disturb the reptiles. 3) Adverse effects on benthic fauna which inhabits the bottom sandy substratum in case indiscriminate mining is carried out. Extraction of excessive sand from riverbed will affect the eco-biology of many terrestrial insects whose initial life begins in aquatic environments.	2) Human settlement not to be permitted in the mining lease area or nearby. 3) Mining should be carried out as per principles laid down by the authorities. As such, there will be no impact on benthic fauna.

I. Socio-economical effect :

Probable Impacts	Mitigation Suggested
1. Mining and t5ransportation activities will generate small shops, dhabas, garage, restaurants, vegetable shops etc. along the roads creating direct employment.	1. Positive impact, welcome
2. Local people will get employment in the mining activities.	2. Positive impact, welcome.
3. There will be generation of solid wastes along the roads due the shops opened.	3. Garbage bins to be provided at proper places.

4. Deep pits created in the channel can lead to accidents for villagers who goes to collect river water for their own domestic purposes.	4. Proper reclamation procedure to be adapted in the mined out areas. Mining must be carried out in non-monsoon period so the excavated portion gets replenished during the subsequent rainy season.
5. There is huge possibility of accidents due to rash driving of dumpers carrying the materials through the village roads.	5. Shortest and safe roads to be used to reach the nearest paved roads. It will be better if graveled roads are constructed between mine lease area and the nearest paved road.
6. Generation of dust due to traffic movement will be injurious to health for the villagers.	6. Water to be sprinkled regularly on unpaved roads to minimize dust generation. Speed of vehicles carrying the material to be controlled within limit. Moreover, materials being carried to be covered properly with tarpaulin.

15.1. Remedial Measures for Land Environment

1) The Mining activities must be carried out within the lease area only.

2) The surface run-off from the lease area should be retained within the lease area and to be used for plantation, dust suppression etc. so that there is no erosion of soil from the lease area and surroundings on account of mining activity.

3) Retaining wall and garland drains for the proposed waste dump to be constructed to arrest wash offs from the dumps. The dump must have inner slope with catch drains at inward side of the terrace and the catch drain of the individual terrace is to be connected to the garland drain outside to periphery of the dump.

4) The waste materials are to be used for construction of road.

5) Maintenance and repair work of vehicles and machineries should be carried out outside the mining area.

15.2 Remedial Measures for Waste Management

1) Solid waste to be dumped systematically with proper repose angle.

2) Solid waste is to be stabilized in the following manner:

a) Stabilization of dump with top soil and tree plantation shall make the dump stable.

b) Dump should be terraced for every 5 m height.

c) Gradation of the dump should be done automatically as coarse materials go down to the bottom at finer at the top. As such the drain of rain water will flow freely to the bottom without hampering the stability of the dump

d) ! m height parapet should be constructed for dumps more than 6 m height.

16.0 Risk Assessment and Disaster Management

Most of the accidents occur during transportation by trucks / dumpers and movement of mining equipment. Following mitigation matters to be adapted :

a) Regular training of all vehicle / machinery drivers / operators to be ensured.

b) Regular maintenance and testing of all mining equipment according to manufacturer's guidelines.

c) All safety precautions and provisions of MMR 1961 shall be strictly followed.

d) Broad sign to be provided at each and every turning point of vehicles.

e) All transportation activities within the main working area should be carried out under direct supervision and control of the management.

f) At the embankment and tripping points, reversing lorries should be made man-free, have proper indication lamps and warning horns.

17. Hazard Identification and Risk Assessment (HIRA)

Hazard Identification and risk Assessment are two processes necessary for maintaining a high level of safety and efficiency in the workplace. These processes aim to identify potential risks and hazards, assess their severity, and put the management team in a better position to put controls and take preventive and corrective actions.

It is desired that the entire mining operation is carried out under the supervision of the Mining Engineer or Mines Manager having second class mine's manager's certificate of competency to take adequate measure during following circumstances :

1) Slope failure at mine faces
2) Accident due to sliding of dumps

3) Accident due to storage of fuel
4) Accident due to fly-rock generation
5) Accident due to transportation or movement of heavy machineries
6) Accident due to use of explosives
7) Mishandling of mining equipment

It is advisable that a 5 x 5 risk assessment Matrix is prepared on day-to-day basis.

In this matter, Likelihood (Probability) is put along the x-axis and pertains to the extent how likely the risk may occur. The 5 risk rating levels under this component are…. **Rare** – unlikely to happen and/or have minor or negligible consequences

Unlikely – possible to happen and/or will have moderate consequences.

Moderate – likely to happen and/or have moderate consequences

Likely – almost sure to happen and/or to have major consequences

Almost certain – sure to happen and have major consequences.

Impact which is also called severity, is placed along the y-axis to determine the level of effects that the hazard can cause to workplace, health and safety.

The levels are

Insignificant – won't cause serious injuries or illness

Minor – can cause injuries or illness only to a mild extent.

Significant – can cause injuries that may require medical treatment but limited one.

Major -- can cause irreversible injuries that require constant medical attention

Severe – can cause fatality

17.1. Risk and Mitigation Measures

A. Over Burden Risk : The overburden dumps is susceptible to landslides. If the dump is very high, It may slide down at the quarry edge or may cause failure of the pit slope due to excessive loading. This may lead to loss of life and property. Siltation of surface water may also cause run-off from overburden dumps.

Mitigation: I) Height of overburden dump should be restricted.

2) Proper garland drain and bund to be constructed around the dump. This will prevent slippage

3) No loose rock or stone or loose tree to be allowed within 3 meters of the edge of the quarry

4) In order to prevent siltation of surface water, it is necessary to construct retaining wall on the downside of each overburden dump

B Fuel Storage: Major storage of fuel in the mining lease area is strictly prohibited.

C Water Logging: in case mine pit gets filled up with rainwater, adequate number of pumps of proper capacity should be arranged well in advance Garland drainage should be properly maintained to prevent inflow of rain water into the pit.

17.2 Disaster Management

. Disaster is an event, natural or manmade, sudden or progressive which impacts with such severity that the affected community or workers must respond by taking exceptional measures. It is a sudden or progressive occurrence of such magnitude as to effect normal working conditions or pattern of life.

Types of Disaster : Fire and explosion, Large oil spillage, Toxic gas release, Flood, Cyclone, Equipment failure, Transportation of hazardous material, improper storage of debris etc. etc.

Phases of Disaster : 1) Warning Phase : Many disasters are preceded by some sort of warning. During any industrial operation, a detection and alarm system to be installed in such cases.

2) Impact phase – This is the period when the disaster actually strikes and very little can be done in order to lessen the effects of it.

3) Rescue phase : This phase starts after the impact phase and to be continued till the situation becomes under control.

4) Relief and Rehabilitation phase.

As such, during mining activities, the workforce must be made aware of all the above factors and proper responsibilities to be assigned to each individual or coordinators in the organization about each phases of disaster and make preparatory work before the emergency, implement operational plan during the emergency and carry out investigation of the causes of disaster after the emergency.

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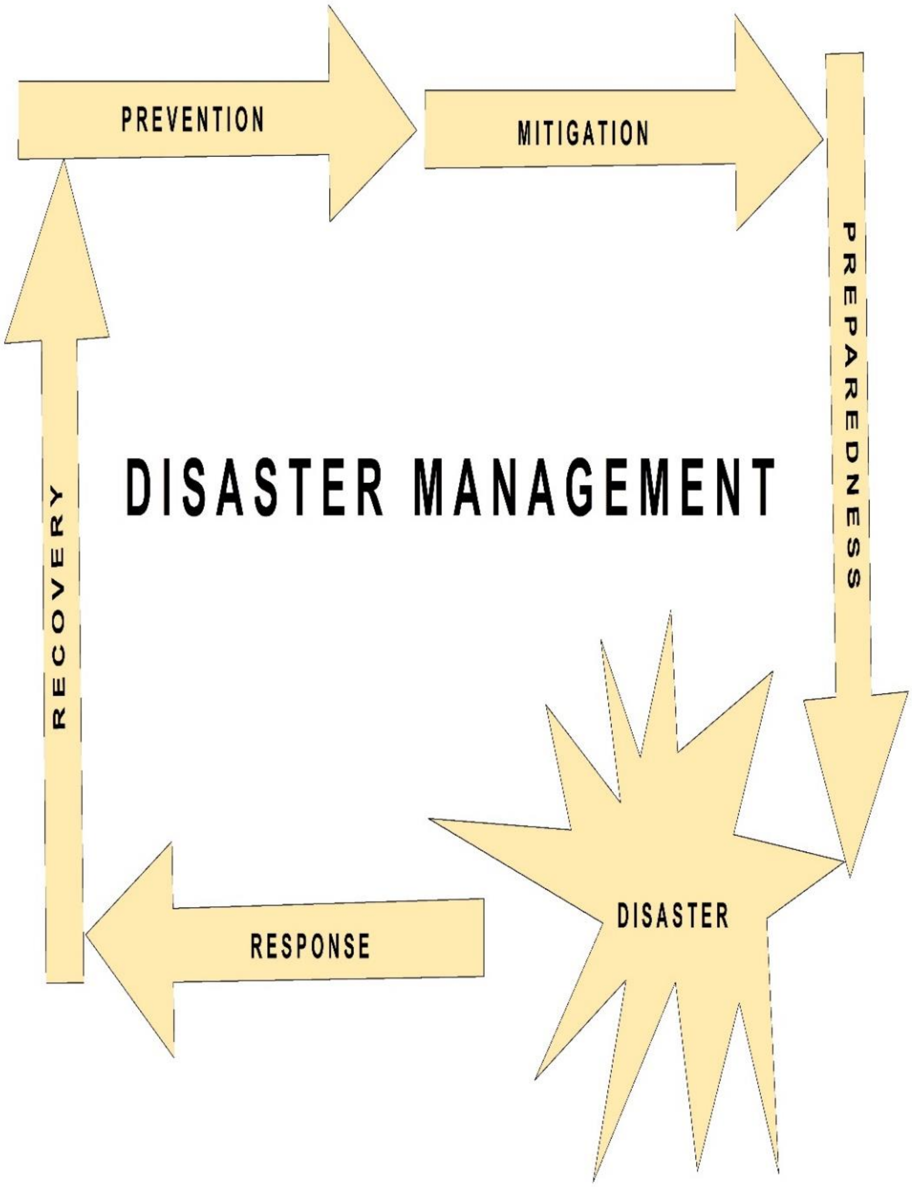
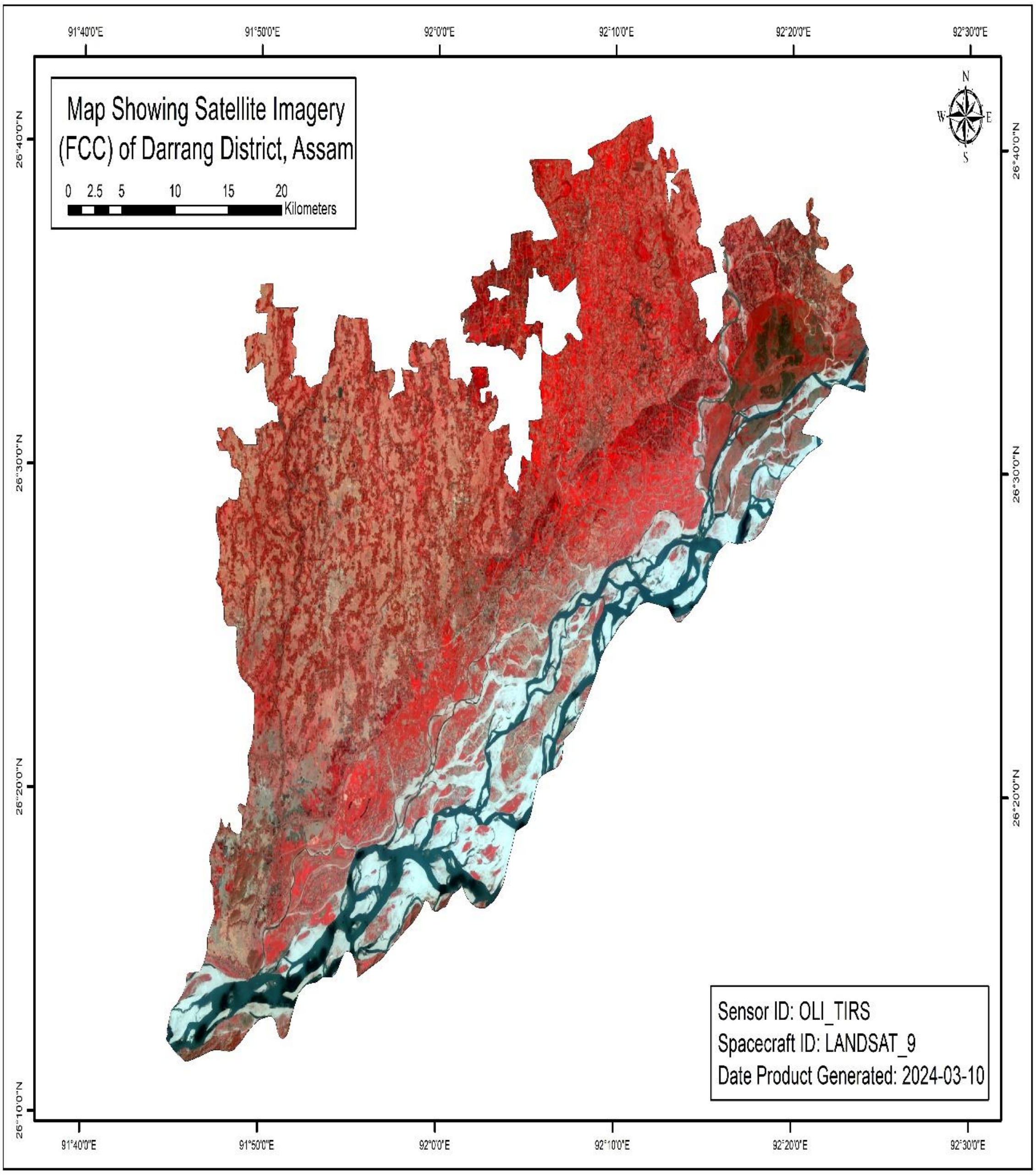

PREVENTION
MITIGATION
PREPAREDNESS
DISASTER MANAGEMENT
RECOVERY
DISASTER
RESPONSE


Map Showing Satellite Imagery
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92°0'0"E
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92°20'0"E
92°30'0"E
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26°30'0"N
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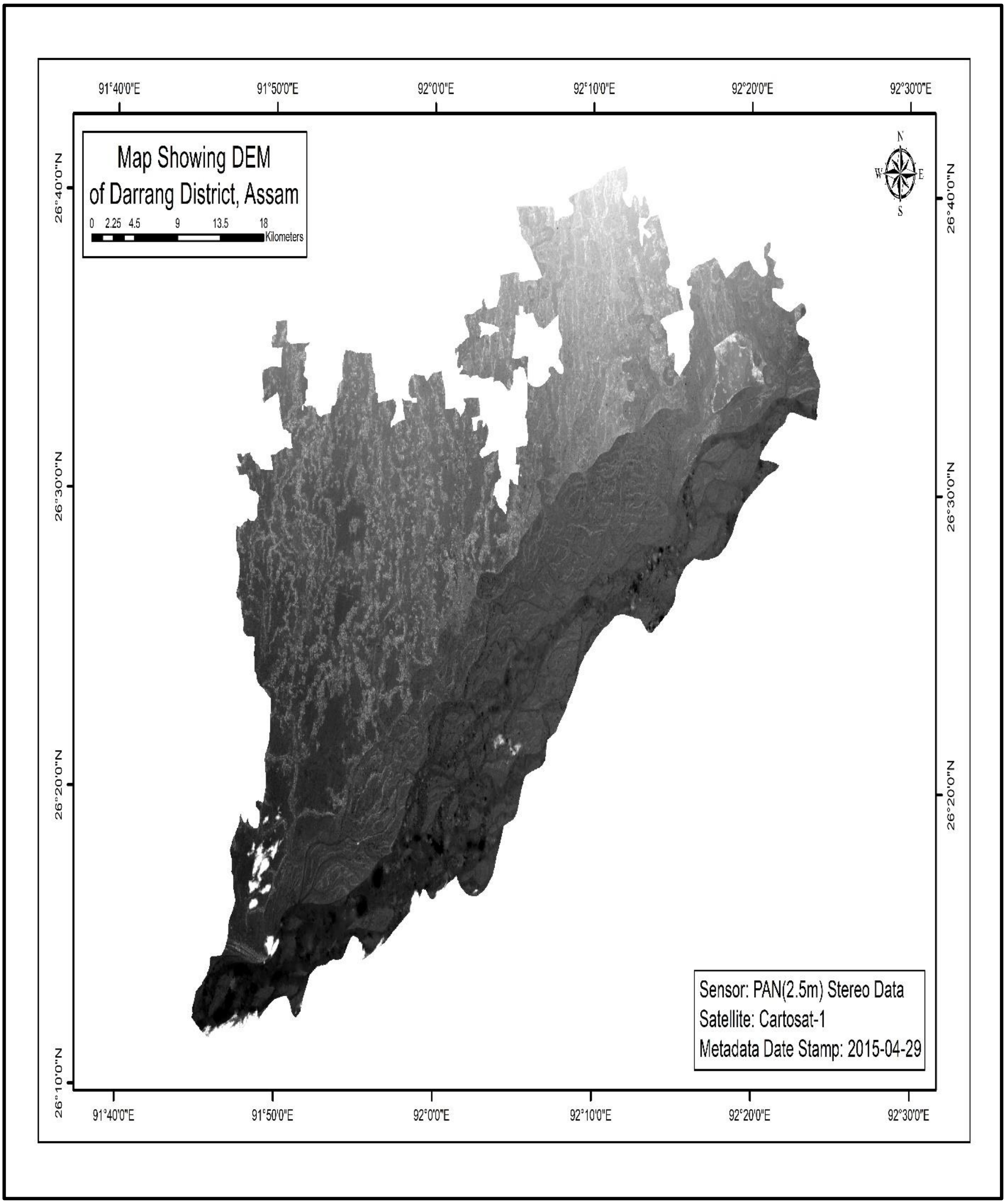
Map- 1


Map Showing DEM
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Kilometers
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91°40'0"E
91°50'0"E
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26°40'0"N
26°30'0"N
26°20'0"N
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Satellite: Cartosat-1
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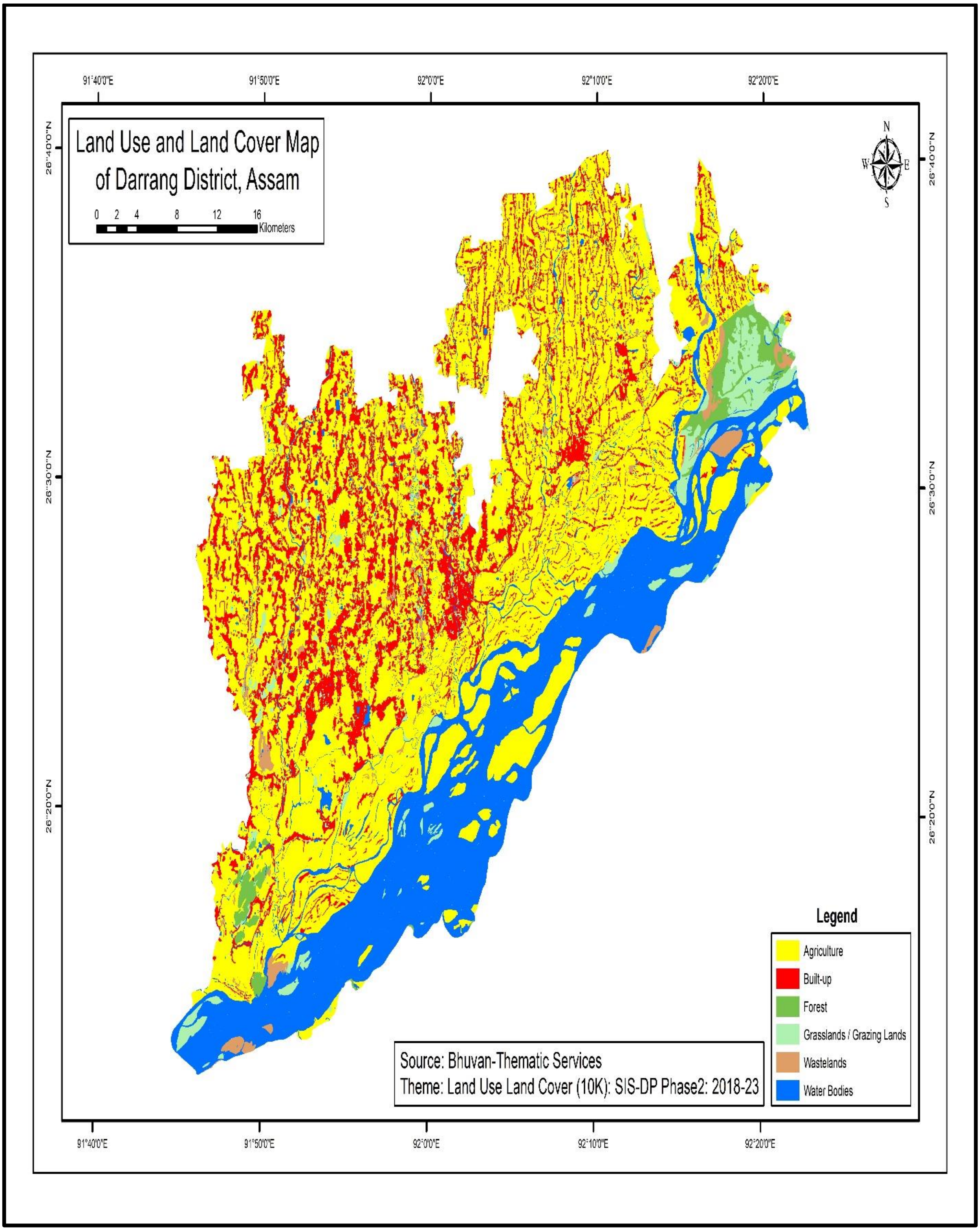
Map- 2


Land Use and Land Cover Map
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91°50'0"E
92°0'0"E
92°10'0"E
92°20'0"E
26°40'0"N
26°30'0"N
26°20'0"N
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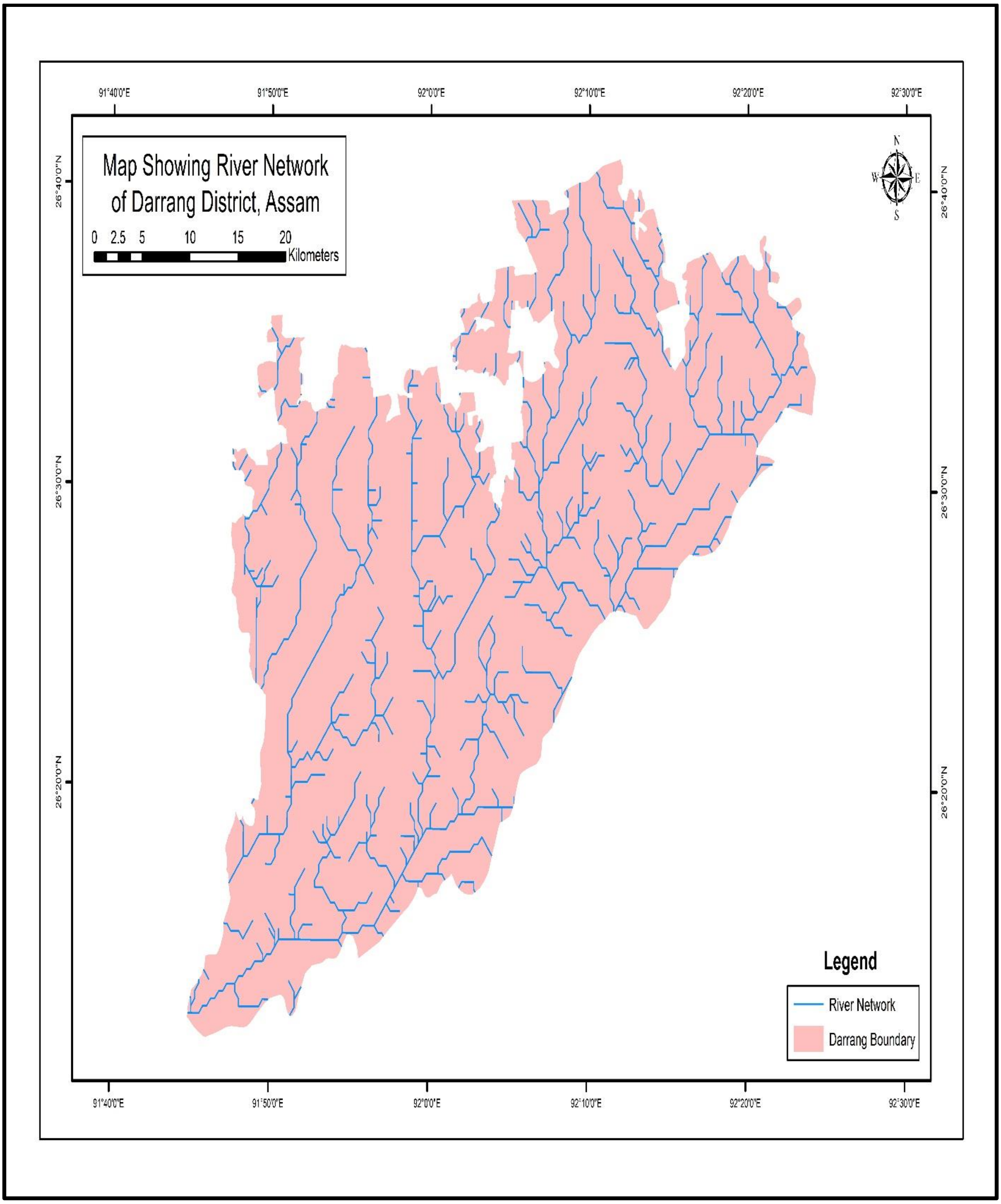
Legend
Agriculture
Built-up
Forest
Grasslands / Grazing Lands
Wastelands
Water Bodies
Source: Bhuvan-Thematic Services
Theme: Land Use Land Cover (10K): SIS-DP Phase2: 2018-23

Map- 3


Map Showing River Network
of Darrang District, Assam
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Kilometers
91°40'0"E
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92°10'0"E
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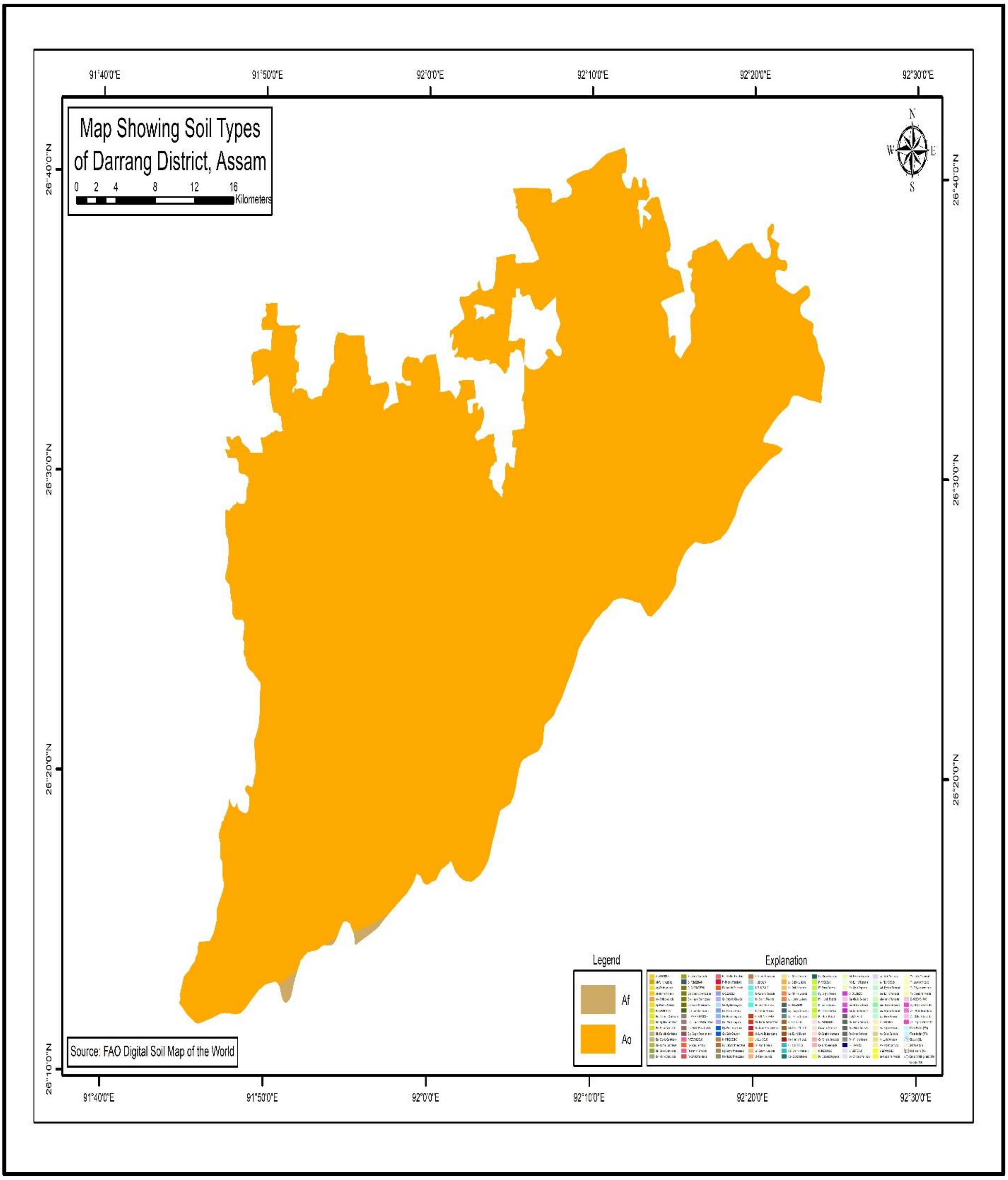
Legend
River Network
Darrang Boundary

Map- 4


Map Showing Soil Types
of Darrang District, Assam
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Kilometers
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91°50'0"E
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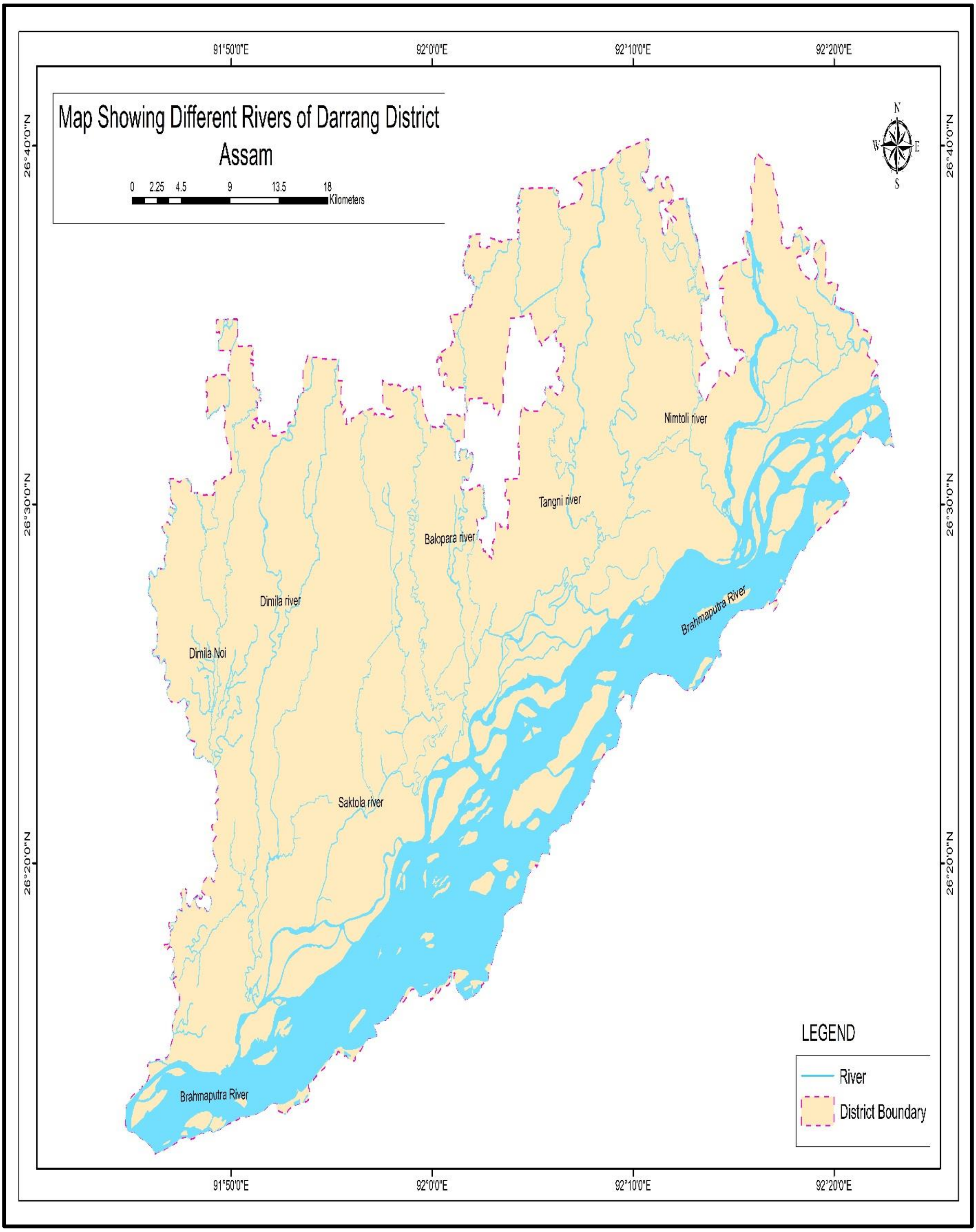
Explanation
Source: FAO Digital Soil Map of the World

Map- 5


Map Showing Different Rivers of Darrang District
Assam
0 2.25 4.5 9 13.5 18
Kilometers
91°50'0"E
92°0'0"E
92°10'0"E
92°20'0"E
26°40'0"N
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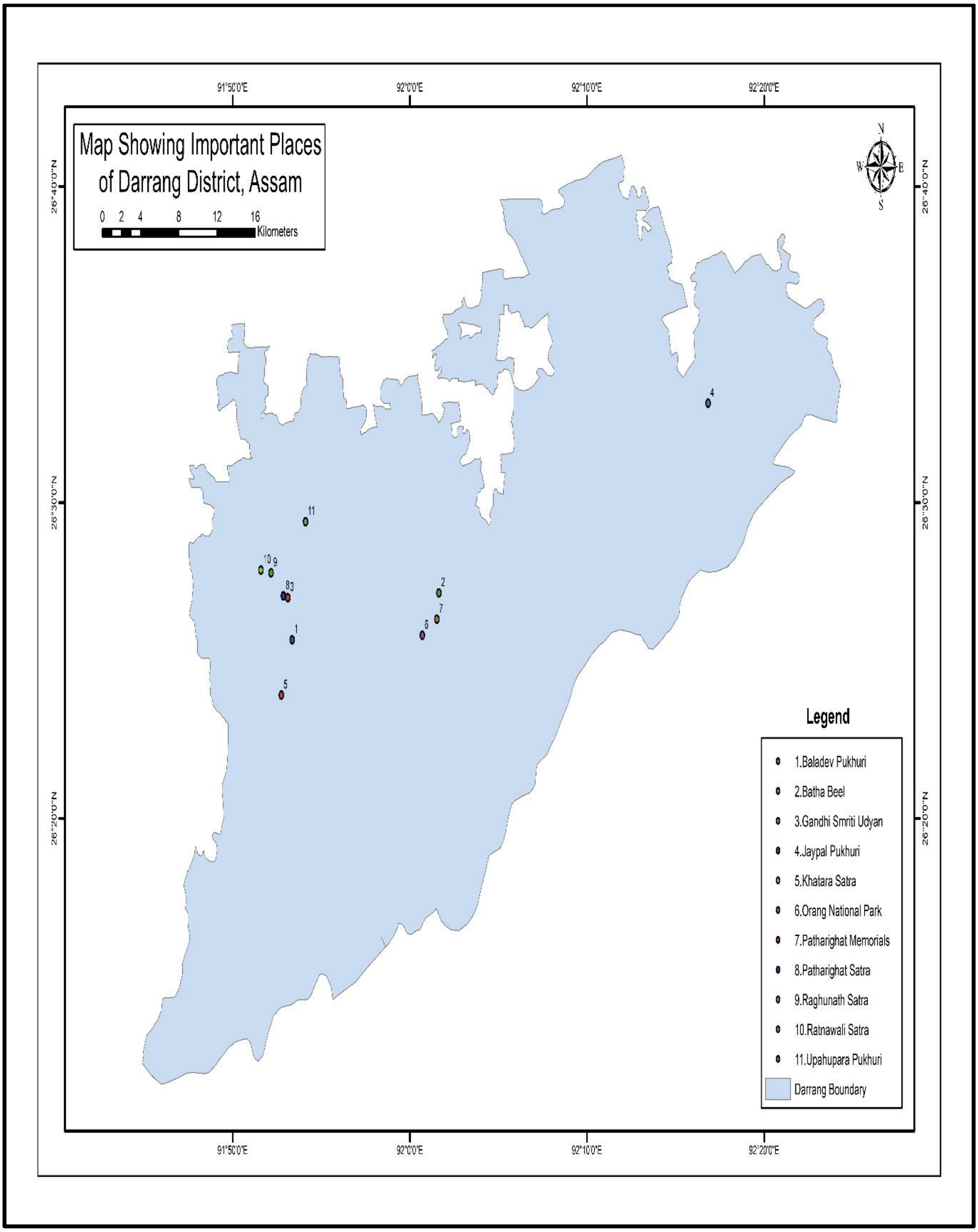
Nimtoli river
Tangni river
Balopara river
Dimila river
Dimila Noi
Saktola river
Brahmaputra River
Brahmaputra River
LEGEND
River
District Boundary

Map- 6



Map Showing Important Places
of Darrang District, Assam
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Kilometers
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92°20'0"E
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26°20'0"N
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Legend
1.Baladev Pukhuri
2.Batha Beel
3.Gandhi Smriti Udyan
4.Jaypal Pukhuri
5.Khatara Satra
6.Orang National Park
7.Patharighat Memorials
8.Patharighat Satra
9.Raghunath Satra
10.Ratnawali Satra
11.Upahupara Pukhuri
Darrang Boundary

Map- 7

Joint Inspection Photographs by Office of The District Commissioner, Darrang and Office of The Divisional Forest Officer, North Kamrup Division

Image 1: Kaworighat Mangaldoi River MPA

Image 2: Kaworighat Mangaldoi River North Side