केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

GOLAGHAT DISTRICT, ASSAM

उत्तर पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

CENTRAL GROUND WATER BOARD
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION
MINISTRY OF JAL SHAKTI
GOVERNMENT OF INDIA

REPORT
ON
"REPORT ON AQUIFER MAPPING AND MANAGEMENT PLAN OF GOLAGHAT DISTRICT, ASSAM"
(AAP 2022-23)

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CHAPTER -1

1.0 Introduction

Central Ground Water Board, North Eastern Region has carried out Aquifer mapping and management plan in Golaghat district, Assam during AAP 2020-21 covering **2262 sq.km** out of total geographical area of **3502** sq.km. Under National Aquifer Mapping and Management (NAQUIM) program, combination of geologic, geophysical, hydrologic and hydro chemical information is applied to characterize the quantity, quality and sustainability of ground water aquifers. Systematic aquifer mapping will improve our understanding of the geologic framework of aquifers, their hydrogeologic characteristics, quality and also quantifying the available ground water resources potential and proposing plans appropriate to the scale of demand and the institutional arrangements for management. Aquifer mapping at the appropriate scale can help prepare, implement and monitor the efficacy of various management interventions aimed at long-term sustainability of our precious ground water resources, which, in turn, will help achieve drinking water security, improved irrigation facilities and sustainability in water resources development.

1.1 Objectives

The objectives of this project are to understand the aquifer systems up to 200 m depth, to define the aquifer geometry, type of aquifers, ground water regime behaviours, hydraulic characteristics and to establish groundwater quantity, quality, and sustainability, and to estimate the dynamic and static resources accurately through a multidisciplinary scientific approach on 1:50,000 scale and finally formulate a complete, sustainable and effective management plan for ground water development.

1.2 Scope of the Study

The activities of the Aquifer Mapping and Management Program can be envisaged as follows:

a. Data Compilation & Data Gap Analysis: One of the important aspect of the aquifer mapping programme was the synthesis of the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data were assembled, analysed, examined, synthesized and interpreted from available sources. These sources were predominantly non computerized data, which was converted into computer based GIS data sets. On the basis of available data, Data Gaps were identified.

b. Data Generation: There was also a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping. This was achieved by multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, remote sensing, besides detailed hydrogeological surveys to delineate multi aquifer system; to bring out the efficacy of various geophysical techniques and a protocol for use of geophysical techniques for aquifer mapping in different hydrogeological environs.

c. Aquifer Map Preparation: On the basis of integration of data generated from various studies of hydrogeology & geophysics, aquifers have been delineated and characterized in

terms of quality and potential. Various maps have been prepared bringing out Characterization of Aquifers, which can be termed as Aquifer maps providing spatial variation (lateral & vertical) in reference aquifer extremities, quality, water level, potential and vulnerability (quality & quantity).

d. Aquifer Management Plan Formulation: Aquifer Maps and ground water regime scenario will be utilized to identify a suitable strategy for sustainable development of the aquifer in the area.

1.3 Approach and Methodology

Aquifer mapping has been carried out by adopting a multi-disciplinary approach:

(i) Geophysical Surveys through Vertical Electrical Sounding (VES),

(ii) Exploratory drilling and construction of tube wells tapping various groups of aquifers,

(iii) Ground Water Regime monitoring by establishing monitoring wells tapping different aquifers at different depths for long term monitoring of water level and quality,

(iv) Pumping test, soil infiltration test, specific yield determination, slug tests for determination of ground water recharge scope, intensity and potentials and also to determine the characteristics and performances of existing aquifers at various depths

(v) Collection of various relevant technical data from the field in Golaghat district and also from the concerned State Govt. Agencies and other Institutes dealing with ground water and incorporating these data along with CGWB data for final output.

(vi) Preparations of a micro level mapping of existing aquifers, their potentials depth wise and sideways in 2D and 3D forms viewed from different angles by various GIS Layers.

1.4 AreaDetails

Aquifer mapping and management programme has been taken up during Annual Action Plan 2020-21 in Golaghat District covering North Dev Block, Dergaon, Golaghat West Dev Block, Bokakhat , Kakodonga Dev Block, Sitalpathar , Morongi Dev Block, Morongi South Dev. Block, Sarupathar, Golaghat Central Dev. Block , Gomariguri Dev. Block, Gamariguri , East Dev. Block, Padumani blocks in order to delineate the available aquifers. The districts headquarter of Golaghat district is Golaghat. The district covers an area of **3502** Square Kilometer. As per Census 2011, the Golaghat district is having a total population of **1066888**out of which 523747 are female, **62298** are SC population and **111765** are ST population.

The district lies in the southern bank of the River Bramhaputra. **Golaghat** district is surrounded by the river Brahmaputra to the north, the state of Nagaland to the south, Jorhat district to the east and Karbi Anglong and Nagaon district to the weston the east and is confined within North Latitudes 25°45′ and 27°00′ and East Longitudes of 93°15′ and 94°15′. The area is falling mainly and partly in the Survey of India Toposheets bearing nos. 83F/5, 83F/6, 83F/9, 83F/10, 83F/10, 83F/13, 83F/14, 83F/15, 83F/16, 83G/13, 83J/1, 83J/2, 83J/3, 83J/ 4. Fig-1 depicts the base map of the NAQUIM area. The district is well connected with

rail, road and air. The District Head Quarter of Golaghat is located at Golaghat Town. The Head Quarter Golaghat is connected to NH-37 by PHG Path via Dergaon, connected to NH-37 (Komargaon) through Dhodar Ali and connected to NH-39 by Golaghat Dimapur Road. The total road length in the District is 3137.477 KM. Three major road passes through Golaghat District namely NH-37, NH-39 and Dhodar Ali (State Highway). The length of NH-37 that passes through Golaghat District is 80.00 KM i.e. from Bagori to Kakodonga river (Border of Golaghat and Jorhat District). NH-39 starts at Numaligarh and after traversing 47.00 KM through Golaghat District it enters into Karbi- Anglong at Garampani. Dhodhar Ali runs across Golaghat District from Komargaon to Kakodonga River. The nearest airport to Golaghat is Rowriah airport which is 37 km from Golaghati.

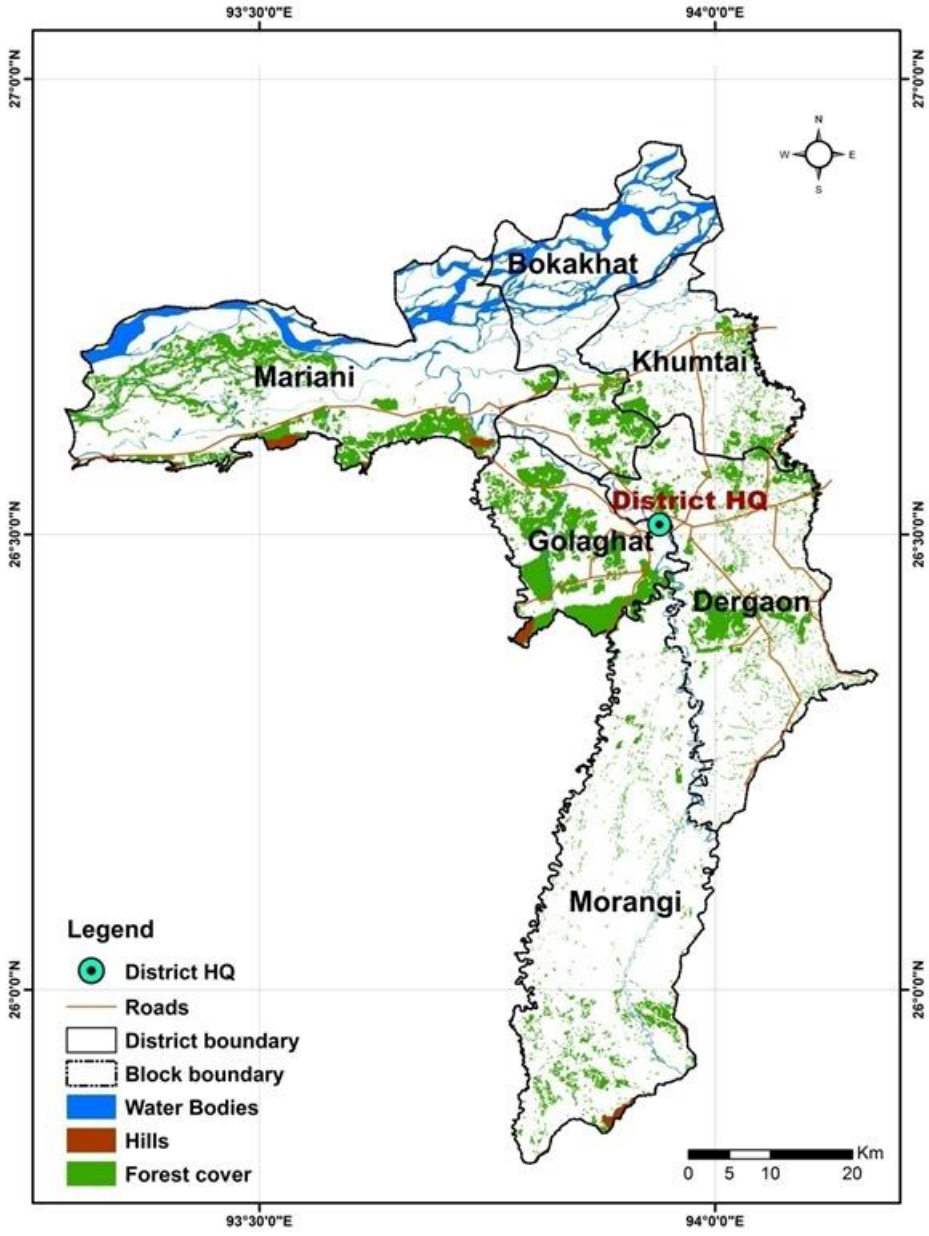

Fig 1: Base Map of Golaghat district, Assam

1.5 Data Availability & Data Adequacy before conducting Aquifer Mapping

After plotting the available data on the map prepared by Mapinfo it was found that there is not much data gap in the district. Hydrogeological, geophysical and ground water exploration data available in the district are as follows:

- **Exploration Data**: CGWB has constructed 10 (Ten) exploratory wells inGolaghat district. Details of drilling operation, aquifer parameters are furnished in Annexure – 4. State govt. has also drilled several wells.

- **Geophysical Survey (VES) Data**: 37 nos. of VES study conducted in the district earlier.

Ground Water Level Monitoring Data : CGWB has 7 (Seven) GWM wells the district. State ground water user departments like PHED, Irrigation department etc. do not have any ground water monitoring station.

- **Ground Water Quality Monitoring Data**: Chemical quality is also monitored in these 7 (Seven) GWMS once in a year.

1.6 Data Gap Analysis & Data Generation

1.6.1 Data Gap Analysis

The Data Gap is shown in Fig.1.2 and Data Requirement, Data Availability and Data Gap Analysis are presented in table 1.1

Table1.1 Data Availability and Data Gap Analysis in Aquifer Mapping Study Area

Sl. No.	Items	Data Requirement	Data Availability	Data Gap
1	Ground Water Exploration Data	02	10	10 No of EW
2	Geophysics	0	37	0
3	Ground Water Monitoring Regime	15	7	8 Nos.
4	Ground Water Quality	15	7	8 Nos.

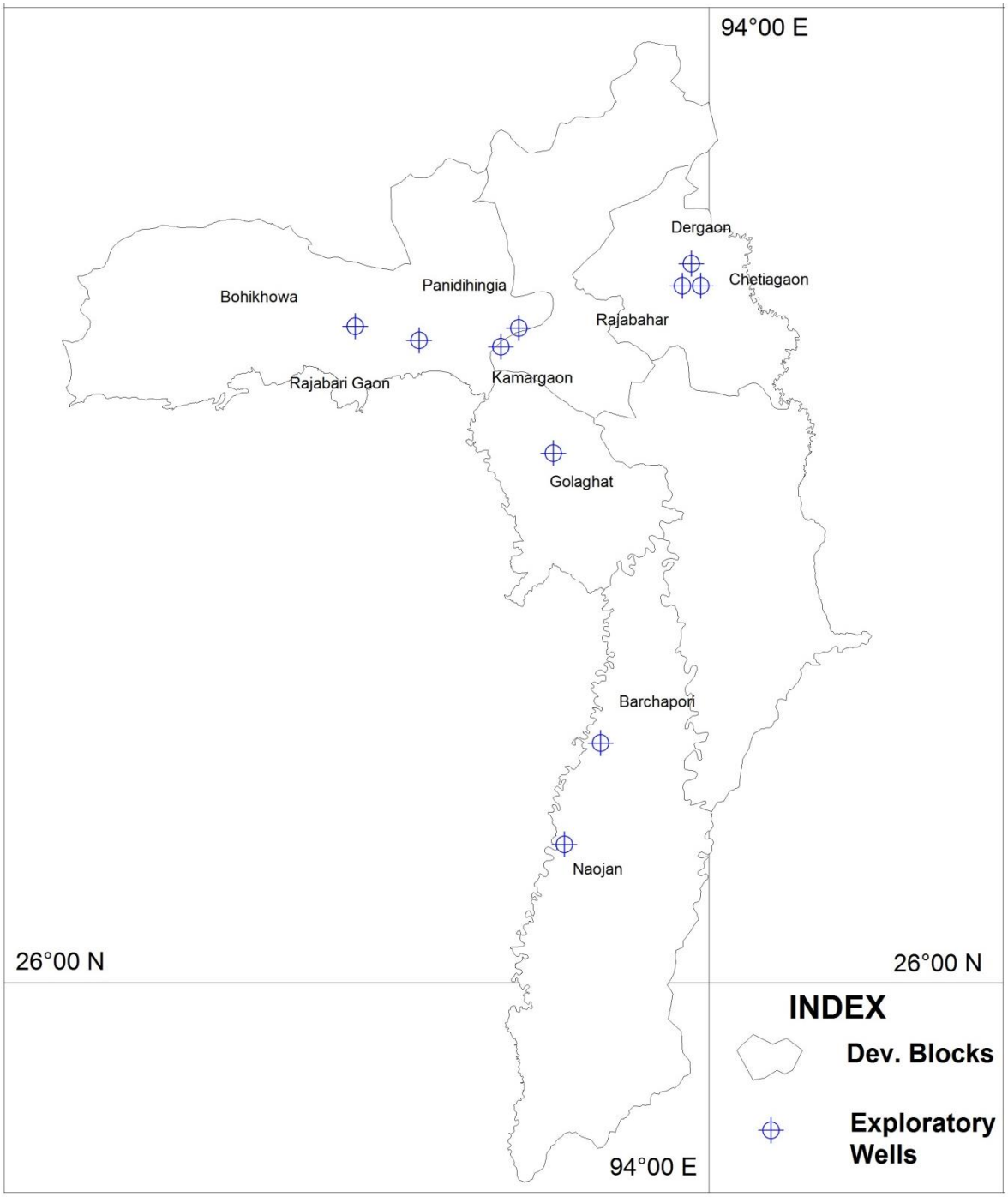

Fig 1.2: Data gap and Availability Map of Golaghat district

1.6 Rainfall and Climate

The district enjoys sub-tropical humid climate. Average annual rainfall in the district is 1543 mm. About 60 to 65% of the annual precipitation is received during south-west monsoon from June to September.

Table1.3: Rainfall Data of Last Five Years

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2014	4.9	31	32.8	43.7	138	149	406	253	193	21.6	2.6	2.1
2015	14	15	52.8	258	207	193	225	205	168	88.7	13.8	28
2016	22	1.7	48.4	280	258	263	388	156	239	39.6	35.7	3.1
2017	0	50	134	166	263	224	397	228	212	150	4.1	0
2018	4.4	31	79.8	79.2	195	323	184	245	181	26.9	28.4	31

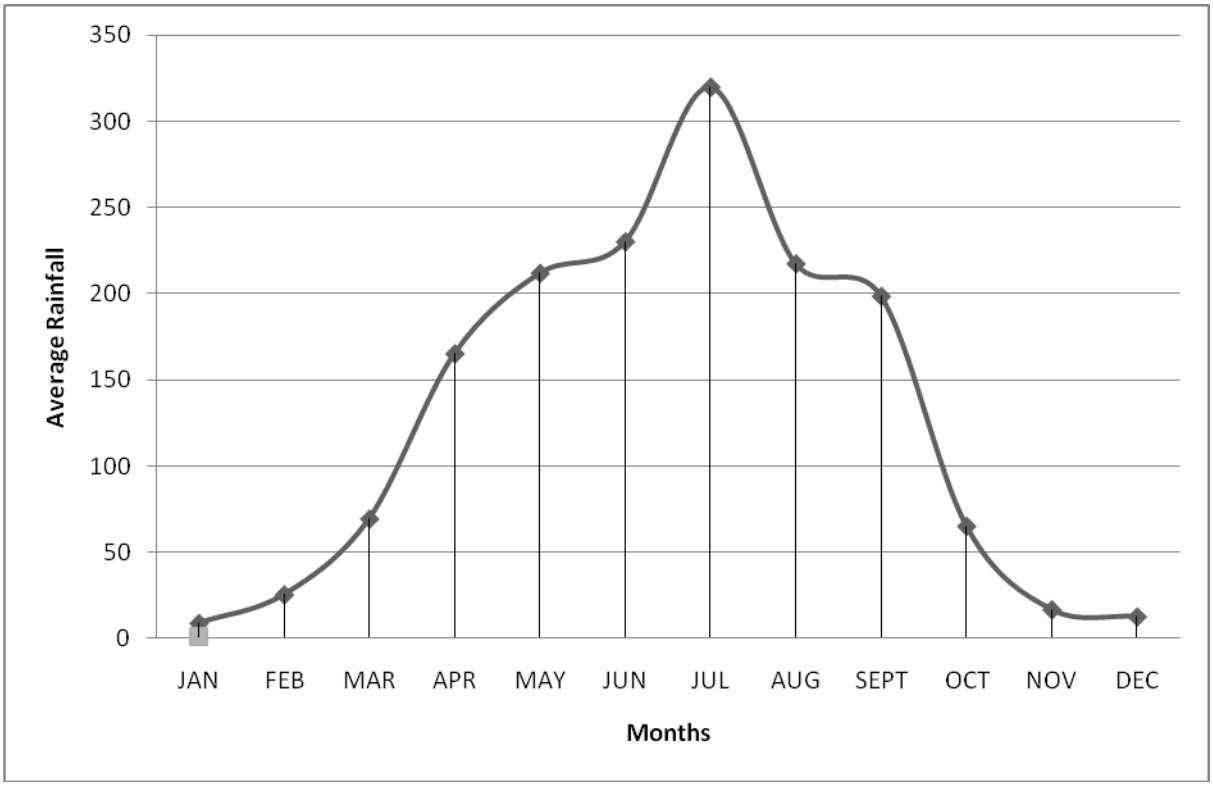

Fig 1.3: Rainfall Hydrograph of Golaghat district

Portion of the graph showing June to September represents monsoon season, January to May represents pre-monsoon season and September to December represents post monsoon season.

A bar diagram showing average annual rainfall in last 5 years has been shown in the **Fig 1.4** below.

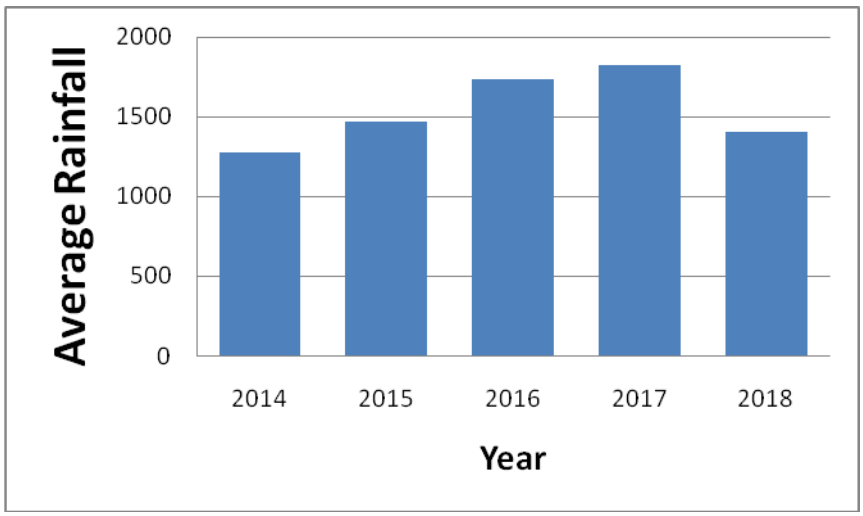

Fig 1.4 : Average annual rainfall from 2014 to 2018

Annual mean maximum and minimum temperature are 32ºC and 18ºC respectively. Annual average temperature during winter period varies from 6 to 14 ^{0}C and during summer, it varies from 29 to 36 ^{0}C. The relative humidity varies from 93 to 95% during morning hours and during afternoon hours it varies from 53 to 75%.

1.7 Physiography

Physiographically, it is an alluvial plain within the vast Brahmaputra Valley Alluvium with an altitude from 80 m at downstream to 160 m at upstream. The slope of the area is very gentle. Small hillocks having height from 213 m to 274 m covered with dense mixed jungle are also present in the study area (near the National Highway 39).

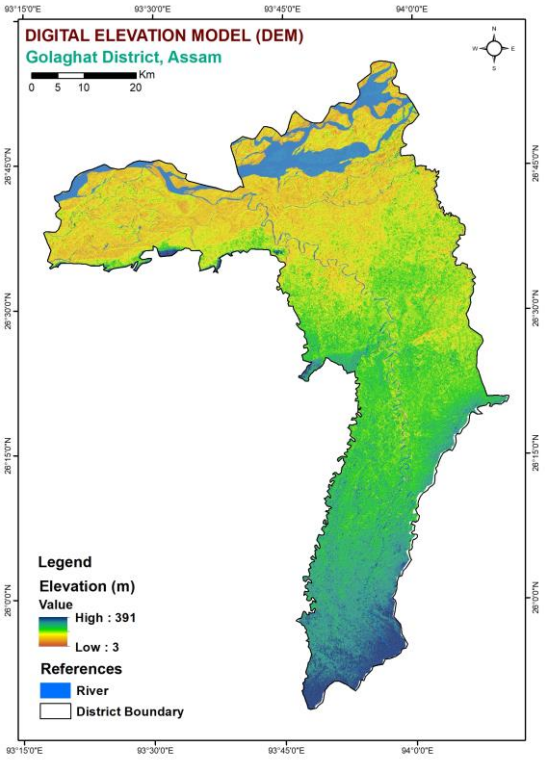

Fig 1.5: Digital Elevation Model of Golaghat District

1.8 Geomorphology

The district forms a part of the vast alluvial plains of Brahmaputra River system.Geomorphologically, the aquifer mapping area shows a monotonous plain topography towards north and southeast, while the south-western part of the area represents an undulating topography. The general elevation of the elevated area is around 100 meters above Mean Sea Level(MSL) and low lying areas show altitude about 80 m above MSL. Maximum height of about 128 m above MSL is observed in the southern parts of the study area, where it merges with the hills of the Nagaland as well as Karbi-Anglong district of Assam. The slope of the district is towards north (i.e. Brahmaputra River) east from south.

The Dhansiri River Basin is situated in a varied geomorphic setup. From the regional geomorphic viewpoints, two major geomorphic units (Plains & Hills) can be distinguished for the entire Dhansiri River Basin. Regional slope, geological formations, structure and topography are the criteria applied to divide the units. Plains and Hills are the major geomorphic units of the area, which can further be divided into different subgroups depending on their geochronological status, nature of occurrence and associated structures. The plains and hills can be differentiated into flood plain, younger alluvial plain, valley fills and older alluvial plain and denudation hills, inselberg and structural hills respectively.

Geomorphic Division: Geomorphologically the study area can be broadly divided into six units :

i. **Flood Plain:** Areas flooded seasonally by the River Brahmaputra, Dhansiri and Dayang. Old meanders, Palaeo-channels, natural levees, channel bars and ox-bow lakes are common and consist mainly of unconsolidated materials like pebbles, sand, silt and clay.

ii. **Younger Alluvial Plain:** Areas slightly higher than flood plain areas which occupies the major part of the study area. It is almost flat and gentle slope towards north. Palaeo-channels, old meanders etc. Are less developed and consist of sand, silt and clay.

iii. **Older Alluvial Plain:** Areas slightly higher than Younger Alluvial Plain areas, formed due to the earlier cycle of fluvial deposition. The materials comprise semi-consolidated fine sand, silt, clay etc. And occurs in the upper south western part closed to Karb iAnglong district and Central Western Part of the NAAQUIM area in Golaghat district.

iv. **Pediment:** Areas almost plain or slightly undulating, occurs in the south western part of the study area. The materials comprise boulders, pebbles etc.

v. **Inselberg:** Occupying the area as very small isolated hills, mostly comprise granite and granite gneisses and occurs near Numalligarh.

vi. **Denudational Hill:** this unit occurs in the north western part of the study area, close to the border of Karbi Anglong district. The area consists mainly of hard and compact gneissic rocks of Mikir Hills.

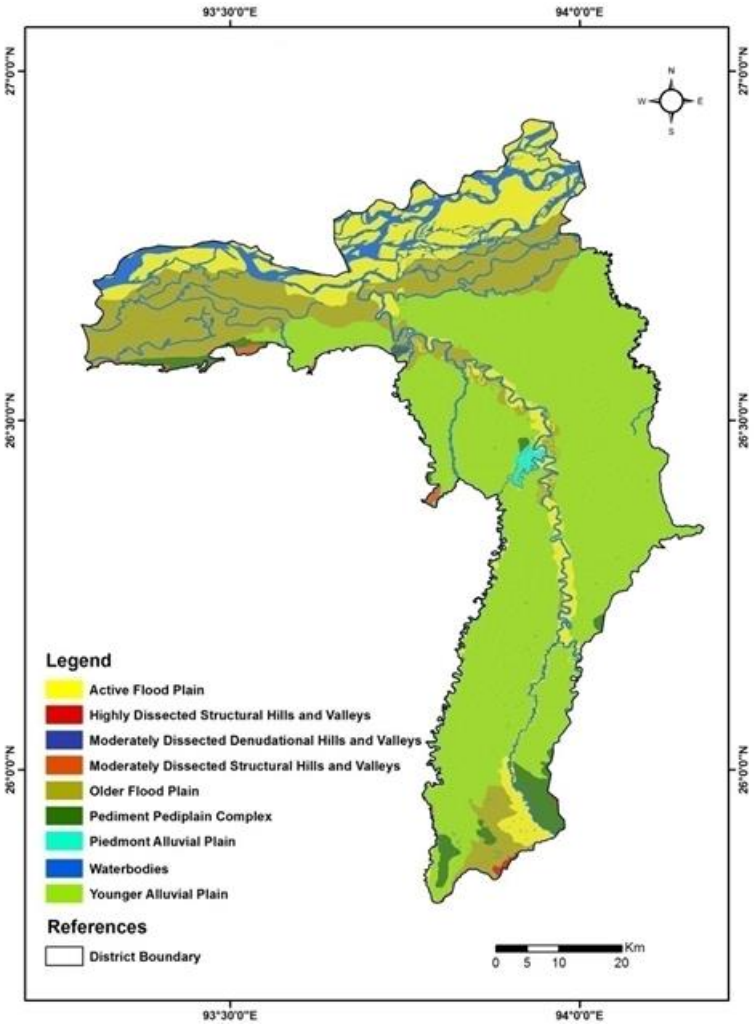

Fig 1.6 : Geomorphological Map of Golaghat District

1.9 Land Use

Based on the land utilization, the total area is divided into various types of landforms such as forest, cultivable land, fallows lands, crop area etc. which in turn reflects the degree of development of agricultural activities and cultivation potential.

Table1.3 : Land utilization of the Golaghat district (as on 2020)

Land use	**Area (ha)**
Geographical area	350200
Cultivable area	143790
Forest	136290
Land under nonagricultural use	29460
Permanent pastures	6300
Cultivable wasteland	3800
Land under Misc. tree crops and groves	13300
Barren and uncultivable	11000
Current fallows	3900
Other fallows	2300

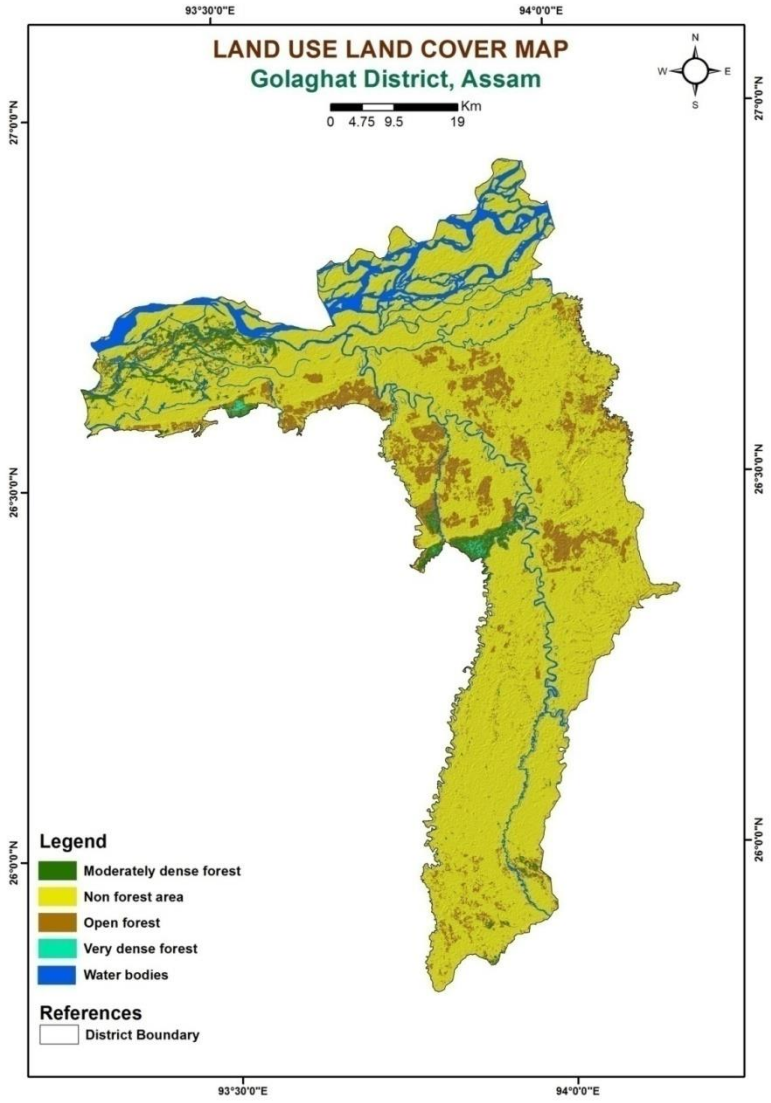

Fig 1.7 : Land use and land cover map of Golaghat District

1.10 Soil:

The soil of Golaghat district moistly of two types inceptisol (Old alluvial) and Entisol (recent alluvial).The texture of surface soil ranges from Fine loamy, coarse silty and fine soil. 58% of total are categorized under fine loamy soil under Inceptisol. The most typical characteristic of the soil of the district is its acidity. The major part of the soils of Golaghat district are acidic in nature. The organic matter content of soil is medium to high. The available N is medium and available P and K is low to medium owing to high rainfall in thedistrict.Red clayey soils covers 80% of the total area and lateritic soil covers 5% of total area.

1.11.1 Ponds, Tanks and other Water Conservation Structures

There are few numbers of small ponds available in the district. These ponds are used mainly for fish cultivation and also used for domestic purpose like washing, bathing, water for cattle's etc. Farmers rarely use these ponds for irrigation.

1.11.2 Drainage

The Brahmaputra is the principal river, which drains the area towards the northern extremity where its course is ENE-WSW. The other tributaries of Brahmaputra draining the study area are the Dhansiri, Gelabiland Disai. The streams have meandering courses and at several places abandoned channels are seen in the form of water -logged and marshy tracts or ox-bow lakes.

The River Brahmaputra flowing in east-west direction in the extreme northern parts of the district and its tributaries flowing in northerly direction, control the entire drainage system of the district and plays an important role in the ground water occurrence and control of the district. Important Rivers of the district are Dhansiri and Doyang. These rivers have meandering courses with abandoned channels in the form of bils and ox-bow lakes along their courses.

The ground observations along the studied stretch have revealed that in areas near Kuruabahi, fluvial erosion of the basal area of bank leads to severe undercutting and resulted subsequent cantilever failure. In these areas banks with slope approaching 90° and even more with overhangs are observed. This type of over steepening always enhances the failure of the bank. During the receding stage of the river, different types of shear failure also took place and observed around Kamargaon, Golaghat areas along the Dhansiri River channel (Dutta, 2007). As water level receded in the channel, saturated levee material lost support from the channel side. These resulted in shearing of blocks from the saturated bank due to its own weight.

In localities near Numaligarh-Butalikhowa areas fine grained over bank deposits with mud cracks are present along the banks. The process of formation of mud cracks can directly be attributed to sub-aerial erosion processes, which include wetting and drying of the soil (and associated desiccation). These preparatory processes help to weaken the surface of the bank prior to fluvial erosion, thus increasing the efficacy of erosion. The blocks are separated by mud cracks. The cumulative effect of blocks separation of fine-grained sediments enhances the activity of shearing, which may ultimately lead to large scale bank failure. The soil moisture content has a strong relationship with the interparticle forces within the material, which in turn related to pore-water pressure. The increase in soil moisture content act to decrease the ‘resistance’ of the bank to the shear forces associated with the flow. On the other hand, the decrease in soil moisture content also causes volumetric shrinkage resulting generation of ‘pad fabric’ with blocks separated by the desiccation cracks. This desiccation provides lines of weakness in the bank face, as cohesion is greater within the pads than between them. The affect of similar features enhancing the intensity of erosion along the studied stretch of the Dhansiri River channel is clearly visible around Kuruabahi, Butalikhowa and Golaghat areas.

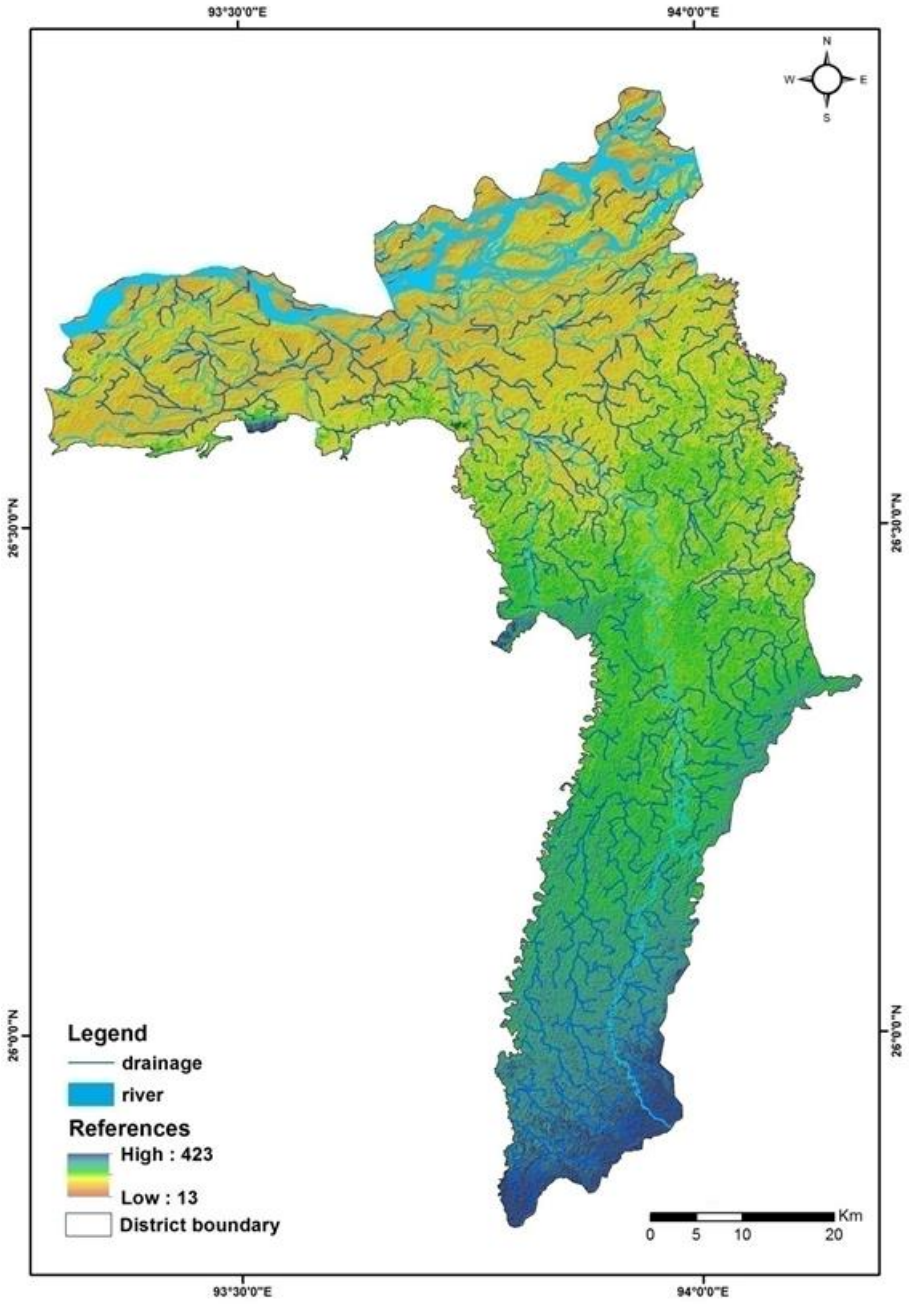

Fig 1.8: Drainage Map of Golaghat district, Assam

1.13 Agriculture

Agriculture in Golaghat district depends mainly on the timely monsoon. Fertile soils of the valleys and the abundant rainfall are very conducive to growagricultural and horticultural crops. Net area under agriculture (net area sown) is 132929ha, which is 47.16 % of total geographical area (350200 ha).

The economy of Golaghat district is agriculture-based. Rice is the most dominant crop followed by vegetables, pulses, oilseeds, tuber crops in the district. The productivity of all these crops are not satisfactory and below national average. Among the horticultural crops Banana, Citrus, Pineapple, Arecanut and Coconut are grown by the farmers in the extensive area. Apart from agricultural crops sericulture food plants also covering a sizable area. Generally Sali rice, Ginger, turmeric, sericulture fodder plants, sugarcane etc. are practiced in

monoculture in majority parts of the district. Nearly 10568 ha area is covered under Horticultural crops.

Table 1.4 :Production and Productivity of Major Crops

Sl. No.	Season	Crop Sown	Rainfed			Irrigated		
			Production (MT)	Productivity (Kg)	Cost of cultivation (Rs/ha)	Production (MT)	Productivity (Kg)	Cost of cultivation (Rs/ha)
1	Kharif	Paddy	384899.6	21930	203420	51862.82	20210	178384
		Maize	2382.63	21898	203574			
		Pulses	343.36	4640	183400			
2	Rabi	Pulses	1887.43	3946	159600	320.71	4080	166600
		Mastard	546.23	4800	111300	848.97	5315	118300
		Potato	16621.66	57603	756991			
3	Summer	Paddy				519	174009.9	25311

Cropping Pattern:

Paddy is the main cereal crop of the District during Kharif and summer season while maize is grown in both Kharif and summer season. Pulse crops like arahar, black gram are grown as secondary crop during Kharif while pulse crops like pea and lentil and oil seed crops such as mustard, sesame and linseed are major Rabi crops of the District. Major area in the Golaghat district is under rainfed condition. During summer some area is covered with summer paddy in irrigated condition. About 10568 ha area are covered with horticultural crops like Banana,Citrus,Pineapple, Arecanut, Coconut and vegetables.

1.14 Irrigation

The district is primarily rainfed. Out of the gross cropped area of 163214 ha, the extent of irrigated land is only 12469 ha, i.e. 7.6 % of total cropped area.

A total of 95640ha of area is under rainfed cultivation. Thedistricthasnetandgrosscroppedareasof1,32,929hectaresand1,63,214hectaresrespectively, the net cropped area being 47 percent of the total geographical area. Thepercentageoftherainfedareasoftheblockrangesfrom60% - 90 % in different blocks. The gross area under irrigation is 12469 Ha .

Irrigated area under different crops inGolaghat District (Area in Ha) is shown in Table 1.6

Table 1.6 :Irrigation basedclassification

Block	Irrigated (Area in ha)		Rainfed (Area in ha)	
	Gross Irrigated Area	Net Irrigated Area	Partially Irrigated/ProtectiveIrrigation	Un-Irrigated or Totally Rainfed
Bokakhat	3006	2004		18959
Dergaon	2485	1068		1292
Gomari	1083	396		12075
Kakodunga	2518	1156		1998
Kothalguri	634	423		7683.06
Morongi	677	454		5855
Podumoni	1033.426	547		23602.374
Dhansisri , Sarupather	1033	400		24176
Total	12469	6448	0	95640

Table 1.7: Area wise Crop wise Irrigation Status

Dev. Block	Kharif (area in Ha)		Rabi (Area In Ha)		Summer Crop (area in Ha)		Total Area In Ha		Horticulture & Plantation Crop (area in Ha)	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
Gomariguri	396	13288	180	527	327	0	903	13815	180	1317
East	547	12452	243	589	0	0	1216	13041	243	707
West	0.0	18826	501	4329	2004	0.0	2505	23155	501	890
South	290	38803	171	1705	400		861	40508	172	3117
North	589	7071	414	814	1068	0.0	2071	7885	414	38
Central	0.0	14930	105	1201	423.0	0.0	528	16131	106	600
Kakodonga	555	8429	380	721	1156	0.0	2091	9150	427	116
Morongi	0	16753	90	2195	454	0	544	18948	133	907
Total	2377	130552	2084	12081	5832	0	10719	142633	2176	7692

1.17 GENERAL GEOLOGY

The study area is occupied by unconsolidated alluvial sediments of Quaternary age and semi-consolidated formations of tertiary age. The unconsolidated quaternary alluvium is restricted to the area near the Brahmaputra river and the rest is occupied by tertiary formations of Mio-Pliocene age. The tertiary group is mainly represented byNamsang formation of the Diputila sub group and are characterized by the presence of mottled clay, and semi consolidated sandstones with layers and pockets of pebbles. The rocks belonging to the Pre-cambrian age are found in small portion in the western part of Golaghat district bordering Mikir hills in the south. These are mainly made up of quartzites. The generalized geological succession as per the Geological survey of India is as follows:

Table.5.1 Geological succession of the study area

Group	**Formation**	**Lithology**
Quaternary	Recent alluvium	Clay silt sand and shingle gravels and boulders
----------Unconformity----------		
Tertiary	Mio-Pliocene Namsang formation (Diputila group)	Clay and semi-consolidated sandstone with layers and pockets of pebbles beds
----------Unconformity----------		
Pre-cambrian	Shillong Group	Quartzites

CHAPTER -2

2. DATA COLLECTION & GENERATION

- **Exploration:**

Total 10 nos. of Tube Wells were constructed in the District. Details of these tube wells are used for technical analysis for aquifer mapping purpose.

- **VES :**

CGWB had carried out 37 nos. VES survey

- **Ground Water Quality :**

16 numbers of dug wells have been established for water quality monitoring in the district.

- **Water level monitoring**

16 nos. of dug wells were established as key wells to study the water level. Location of the key wells is shown in Fig 2.1

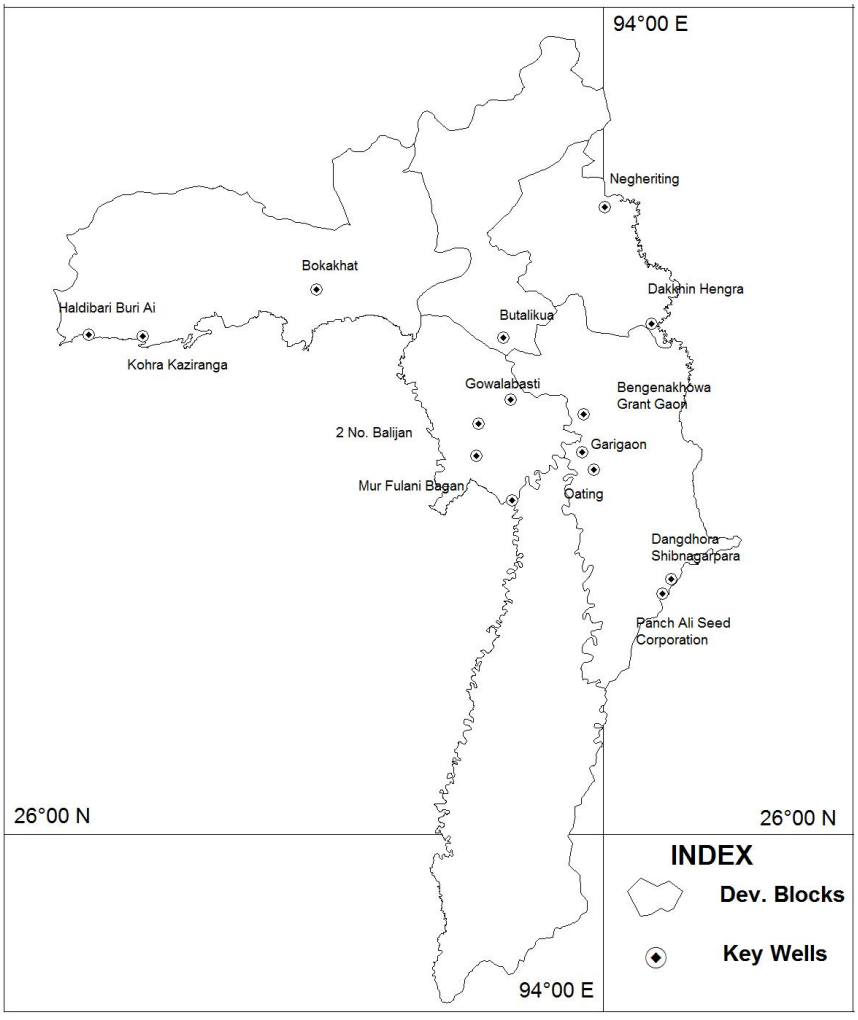

Fig 2.1: Key Well Location Map of Golaghat District

- Hydrochemistry

The quality of ground water is as important as that of the quantity. In order to study the chemical quality of ground water in the district, water samples from unconfined aquifer (dug wells) were collected during the course of field work. Ground water samples were analysed in

the regional chemical laboratory, Central Ground Water Board, North Eastern Region, Guwahati for 17 parameters.

- Exploratory drilling

CGWB has carried out GW exploration in10locations and explored down to a depth of 305.7 m bgl. Details of the same is given in Table-2.1

Table 2.1 :Details of exploratory wells

Sl No.	Location	Block	Toposheet No.	Latitude	Longitude	Drilled Depth/ Const. Depth	Diameter In mm
1	Kamargaon	Kakodanga	83F/14	26.63	93.77	204 / 121.2	Housing : 304.8 Casing: 152.4
2	Chetiagaon	Kakodanga	83F/14	26.69	93.99	305.7 / 55	Housing : 304.8 Casing: 152.4
3	Rajabahar	Kakodanga	83F/14	26.69	93.97	300 / 151	Housing : 304.8 Casing: 152.4
4	Dergaon	Kakodanga	83F/14	26.712	93.98	100 / 50	Housing : 304.8 Casing: 152.4
5	Naojan	Golaghat South	83F/16	26.14	93.84	205.10 /151	Housing : 304.8 Casing: 152.4
6	Panidihingia	Kakodanga	83F/14	26.649	93.79	200/ 170	Housing : 304.8 Casing: 152.4
7	Bohikhowa	Golaghat West	83F/10	26.65	93.61	200/ 154	Housing : 304.8 Casing: 152.4
8	RajabariGaon	Golaghat West	83F/14	26.636	93.68	117 / 45	Housing : 304.8 Casing: 152.4
9	Golaghat	Golaghat Central	83F/15	26.525	93.68	158/ 154	Housing : 304.8 Casing: 152.4
10	Barchapori	Golaghat South	83F/15	26.24	93.88	200/ 112	Housing : 304.8 Casing: 152.4

CHAPTER-3

3. DATA INTERPRETATION, INTEGRATION AND AQUIFERMAPPING

3.1.0 Aquifer Geometry

Central Ground Water Board, North Eastern Region, Guwahati has drilled 10 (Ten) exploratory wells in the area. From the examination of this lithologs it is observed that down to a maximum explored depth of 305 m the sequence is dominated by sand and clay.

Table 3.1: Summary result of Litholog Study

Depth (mbgl)	Lithology
0 to 5mbgl	Top soil: clays with Sands.
5 to 50mbgl	Saturated formation : mixture of sand, clay and silt
50 to 200mbgl	Saturated formation: fine to medium grained sand with intercalations of clay
200 to below 300 mbgl	Saturated formation: fine to medium grained sand with intercalations of clay

The aquifer in the study area represents a single or mono aquifer system. From the panel diagram it is clear that a very prominent gravelly bed is present in the southern side of the district i.e towards Naojan area. The variation of lithology and geomorphic set up of the study area has also influenced the ground water regime. Based on the hydrogeomorphic set up the area can broadly be classified into two zones. Thick gravelly layers is encountered between 18 m to 65 m indicate deposition of sediments in high energy conditions.

The aquifer disposition of the area in panel diagram indicates existence of a single aquifer in the area. The confining layers are not continuous throughout the area.

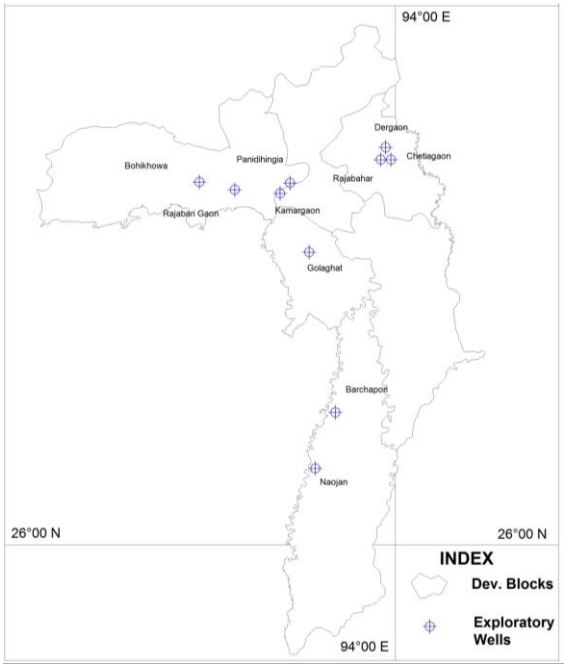

Fig 3.2.1: Location of Exploratory Wells constructed by CGWB

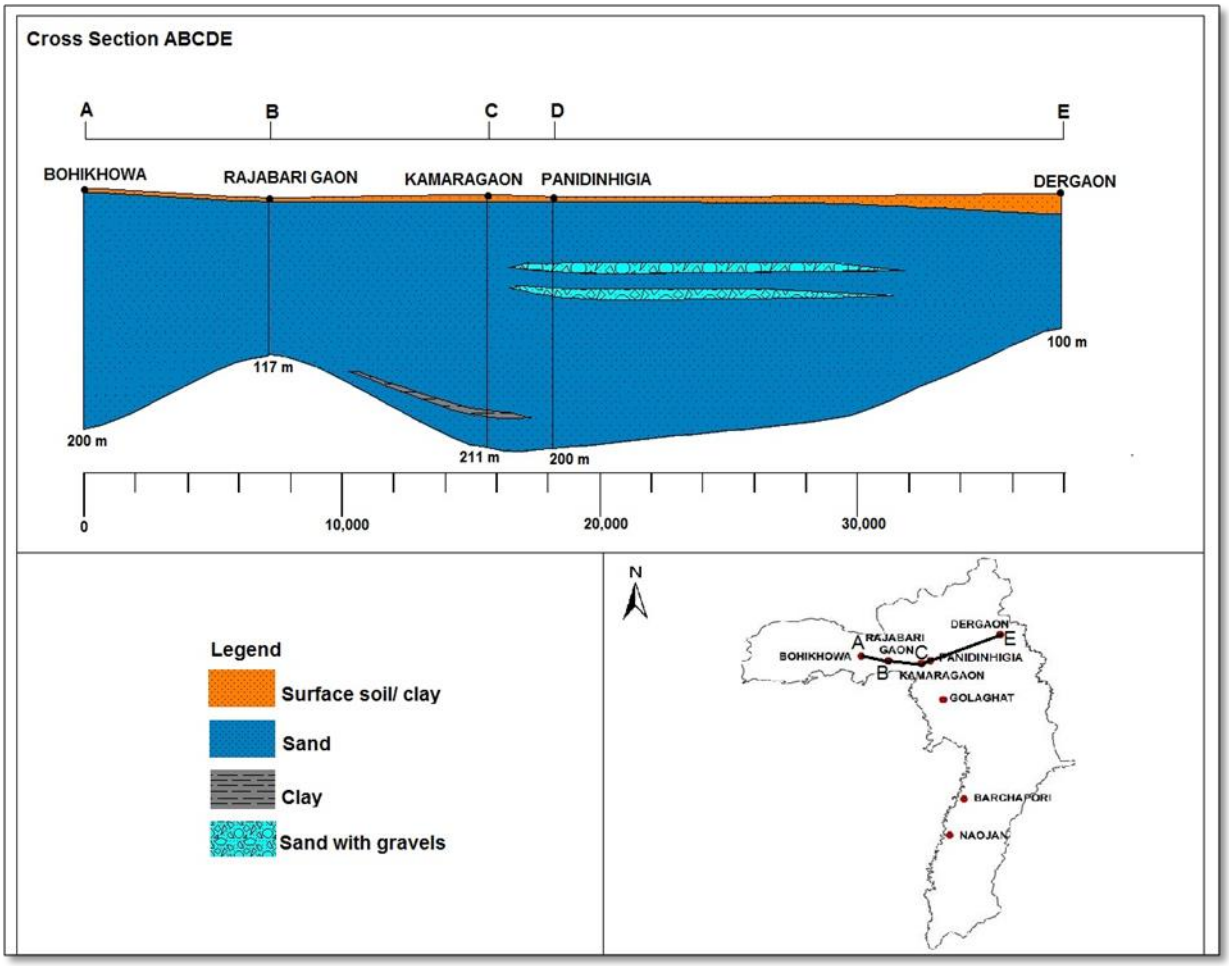

Fig 3.1.2 : Section Diagram of Bohikhowa- Dergaon Section

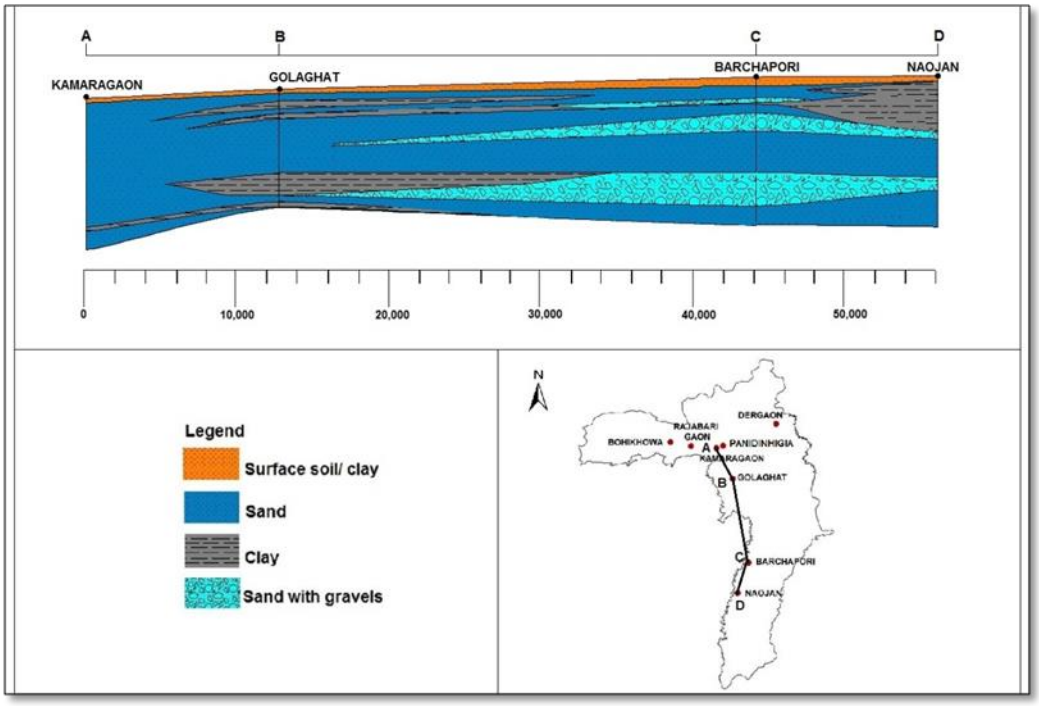

Fig 3.1.3 : Section of Komargaon- NaojanSection

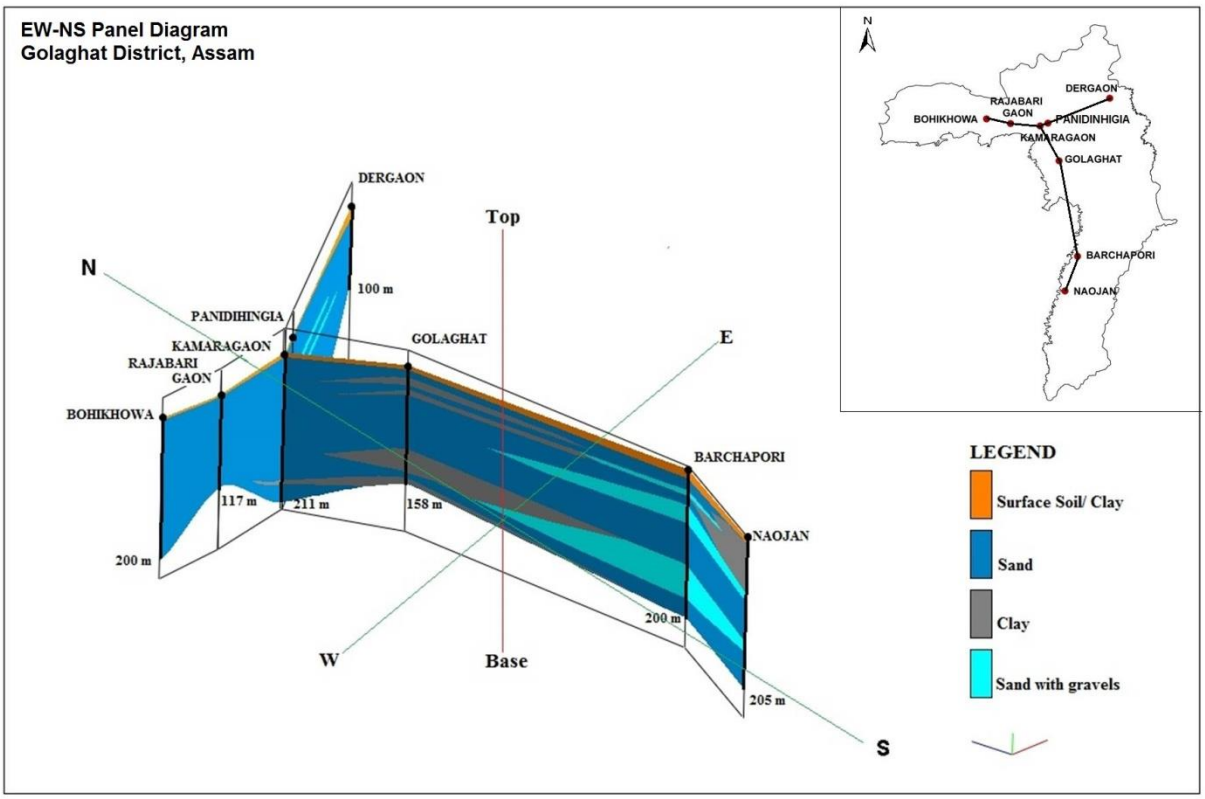

Fig 3.1.5 : Panel Diagram of Bohikhowa- Dergaon-Naojan

3.1.2.Depth to water level

Depth to water level of shallow aquifer during November, 2020 ranges from 1.01 m to 5.29 mbgl(post- monsoon)while in March, 2021 (pre- monsoon)it ranges from 1.11m to 5.92 m bgl. Depth to Water Level Map of Golaghat district during pre- monsoon and Post-Most Monsoon seasons are shown in the Fig 3.1.1 and Fig 3.1.2 respectively. Fluctuation of water level ranges from 0.10 to 2.53 mbgl.

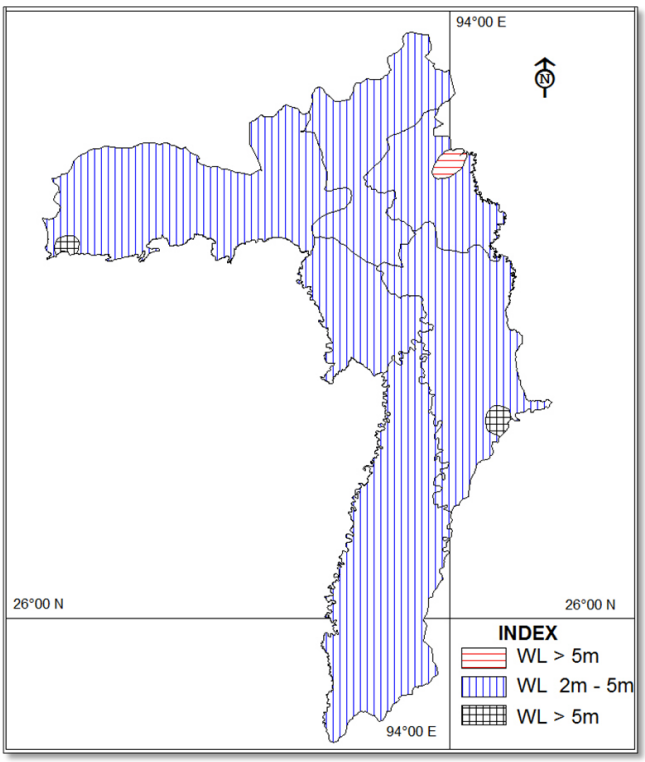

Fig 3.1.6: Pre Monsoon Depth to Water Level Map of Golaghat District

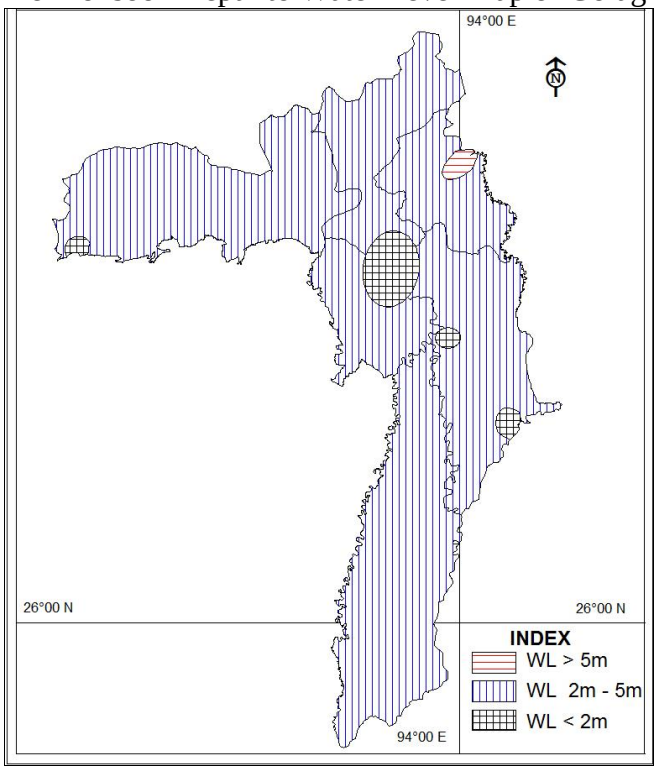

Fig 3.1.7 : Post- Monsoon Depth to Water Level Map of Golaghat District

3.1.3. Ground water quality

The pH value in ground water ranges from 7.5 to 8.43 , while the EC and TDS varies from 173 to 1030 µmhos/cm and 114.18 to 679.80 mg/l respectively. The concentration of Cl ranges from 17.73 to 180.80 mg/l and that of SO_4ranges from 0 to 86.30 mg/l. Ca and Mg concentration ranges from 4 to 50.04 mg/l and 2.41 to 24.26 mg/l respectively with a total hardness of 30 to 165 mg/l. All chemical parameters in the shallow aquifer are within permissible limit for drinking, agricultural and industrial use as per BIS (2012) barring high

iron (Fe) concentration in some places. Thus, ground water quality is suitable for domestic, irrigation and industrial purposes.

Table.3.2: Summary result of water quality

Water Quality Parameters	
pH	7.5 - 8.43
Ec (µS/cm)	173 -1030
HCO_3	48.84 – 293.03
Cl	17.73 - 180.80
SO_4^{-2}	0 - 86.30
F^-	0 -1
Ca^{+2}	4 – 50.04
Mg^{+2}	2.41 - 24.26
Na^+	11.47-84.21
K^+	1.22-72.93
Fe	0.30-13.01

CHAPTER-4

GROUNDWATERRESOURCES

Estimation of Ground Water Resources in theGolaghat district has been carried out based on the revised recommendations of Ground Water Resource Estimation Committee – 2015 (GEC'15), the revised methodology GEC 2015 recommends aquifer wise ground water resource assessment. Ground water resources have two components – Replenishable ground water resources or Dynamic ground water resources and In-storage resources or Static resources. GEC 2015 recommends estimation of Replenishable and in-storage ground water resources for both unconfined and confined aquifers. Wherever the aquifer geometry has not been firmly established for the unconfined aquifer, the in-storage ground water resources have to be assessed in the alluvial areas up to the depth of bed rock or 300 m whichever is less. In case of hard rock aquifers, the depth of assessment would be limited to 100 m. In case of confined aquifers, if it is known that ground water extraction is being taken place from this aquifer, the dynamic as well as in-storage resources are to be estimated. If it is firmly established that there is no ground water extraction from this confined aquifer, then only in storage resources of that aquifer has to be estimated. The dynamic resources has been calculated by considering entire district as a single unit, because block-wise hydrological data was not available. Area with more than 20% slope has been excluded for the recharge computation. The dynamic reserve which is seasonally renewable in response to monsoon recharge has been assessed based on the seasonal fluctuation of water table and specific yield of shallow aquifer materials and also based on rainfall recharge by infiltration. Dynamic resources of ground water, extent of current utilization, balance available for further development have been calculated in this procedure. There is no saline/brackish water aquifer or any other poor ground water quality area. There is no major or medium canal irrigation scheme and thus the whole Golaghat district has been considered as a non-command area.

Table 4.1: Net ground water availability (ham)

Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water (ham)
Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge		
Recharge from rainfall	Recharge from other sources	Recharge from rainfall	Recharge from other sources			
81020.51	2,696.94	35,463.84	1019.26	120200.55	16897	103303.55

Table 4.2: Categorization of ground water resources (ham)

Annual Extractable GW Resources	Annual GW extraction				Annual allocation for Domestic uses upto 2025	Ground water availability for future use	Stage of ground water extraction (%)
	Irrigation	Domestic extraction	Industrial extraction	Total			
103303.55	3677.52	1647.87	12.77	108641.71	1786.15	97827.12	5.16

Groundwater Resources – Recharge for VariousSeasons

Recharge from Rainfall has been computed separately for monsoon and non-monsoon periods for the entire district. The recharge from rainfall during monsoon season has not been

computed using water level fluctuation method (WLFM) as Ground Water Monitoring Wells (GWMW) in the district is very few.

Recharge from All Sources: Total recharge to groundwater has several components, rainfall being the major one. The other components include seepage from canals, return flow from surface water irrigation, return flow from groundwater irrigation, seepage from tanks/ ponds etc. Recharge from various sources has been calculated for monsoon as well as non-monsoon periods and details have been shown in table 4.3

Table 4.3: Recharge from various sources (ham).

District	Recharge from Rainfall during monsoon season	Recharge from Other Sources-Monsoon Season	Recharge from rainfall during non-monsoon season	Recharge from other sources during non-monsoon Season	Total Annual Ground Water Recharge	Annual Extractable GW Resources
Golaghat	81020.51	2696.94	35463.84	1019.26	120200.55	103303.55

Recharge from rainfall in the district is 116484.35 hams. Comparison of monsoon & non-monsoon rainfall recharge shows that monsoon recharge accounts for 67 %. Recharge from other sources is 3716.2 ham. Comparison of recharge from rainfall, to recharge from sources other than rainfall shows that the later accounts for only about 0.03 % of the total recharge.

Groundwater Extraction for VariousPurposes

Groundwater extraction for domestic use has been estimated on projected population for 2025, based 2011 Census data of number of households using groundwater as "Main source of drinking water". Groundwater extraction for irrigation is 3677.52 whereas for domestic and industrial supply it is 1647.87 ham in the district. Hence, groundwater extraction for all uses in the district is108641.71 ham. Provision for domesticrequirement supply to 2025 is 1786.15ham.Net Ground Water Availability for future development in the district is 97827.12ham.

Stage of Groundwater Extraction & Categorization:

The stage of Ground Water development is defined as the ratio between the existing gross ground water drafts for all uses by net annual ground water availability multiplied by 100. The various units of assessment are categorized based on the stages of Ground Water development and long term trend of pre and post monsoon water level. The stage of ground water development for Golaghat district is 5.16 %. Based on the stages of extraction and long-term water level trend analysis the district can be categorized under **safe category**.

CHAPTER-5

5.0 Groundwater Issues

Water Quality

As deciphered from water quality analysis of deep tube wells drilled by CGWB during NAQUIM, higher concentration of iron is reported in groundwater in some places.

Low Stage of Ground WaterExtraction

As per ground water resource estimation, the stage of ground water development is just 5.16 % and there is utilization of ground water for irrigation in the area is very low. Therefore, there is enough scope for future development of ground water in the study area to bring more area under irrigation practice.

CHAPTER-6

6.0 GROUND WATER MANAGEMENT STRATEGY

As per dynamic ground water resource estimation of Golaghat district for 2020-21, net ground water availability is 97827.12 ham and stage of development is only 5.16 %. The district is having balance net ground water availability for future use in the tune of 97827.12ham. If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available, then 58696.27 ham of groundwater resources is available in the district for the future irrigation uses. From this available resource (planned for future development) 24456nos. of shallow tube wells (considering a unit draft of 2.4 ham/year) can be constructed. Therefore, there is enough scope for future development of ground water in the district to bring more area under irrigation practice.

During Kharif season, land under cultivation (field crops only) in the district is **95640** ha. Land use data for 2020-21 shows that cropping intensity in the district is 123%.

After Kharif crops are over, 77 % of this cultivable area remains fallow during Rabi season. Gap between area cultivated during Kharif season and Rabi season is 73643ha. The intention of this plan is to utilize this fallow land of about 73643 ha under assured irrigation during Rabi season which will help to increase gross cropped area to 191280ha. This will help to increase gross cropped area and thereby increase cropping intensity up to 200%. Since stage of extraction of dynamic ground water is only about5.16 %, this area of 191280ha can easily be covered by constructing ground water based irrigation projects. To use the groundwater for irrigation purpose a cropping plan has been designed for the district by using CROPWAT model developed by FAO. A suitable cropping plan for the district was prepared and is presented in Table 6.1

Table 6.1: Cropping Pattern Data of Golaghat District

CROPPING PATTERN DATA

(File: C:\ProgramData\CROPWAT\data\sessions\Baksa_rice_crop plan.PAT)

Cropping pattern name: Baksa_Rice

No.	Crop file	Crop name	Planting date	Harvest date	Area %
1	...Data\CROPWAT\data	Rice	05/06	02/10	20
2	...Data\CROPWAT\data	Rice	10/06	07/10	20
3	...Data\CROPWAT\data	Rice	20/06	17/10	20
4	...Data\CROPWAT\data	Rice	25/06	22/10	20
5	...Data\CROPWAT\data	Rice	30/06	27/10	10
6	...Data\CROPWAT\data	Rice	10/07	06/11	10

Source: CROPWAT

In rice fallow, potato, oil seeds, winter vegetables, summer vegetables, wheat, millet and rabi vegetables can be grown with the support of irrigation. Present cropping pattern, proposed cropping pattern, targeted increase in cropping intensity were shown in table 6.2

Table 6.2: Proposed cropping pattern of Vegetables in Golaghat district

Cropping pattern (s)				
Rice-Pulse-Potato Rice-Wheat-Vegetables Rice-Pulses	Present Cultivated area (**ha**)	Area to be cultivated (**%**)	Area to be cultivated (**ha**)	Irrigation requirement (**ha m**)
Rice-Millet				
Rice-Rapseed Mustard				
	1	2 (= % of 1)	3	4
Rice (main crop)	95640	100	95640	**14959.6**
Pulses		20	19128	1335.1
Oilseed		20	19128	2877.8
Winter vegetables		15	14346	1661.5
Summer vegetables		15	14346	129.3
Potato		10	9564	1367.7
Wheat		5	4782	501.2
Milllet		5	4782	149.7
Maize		10	9564	1160.6
Net cultivated area	95640			**24142.4**
Gross cultivated area (Paddy/+Maize/+Wheat+Pulses+Millet)	191280		**191280**	
Total irrigation requirement				**24142.4**
With 70% irrigation efficiency				**34489.1**
Cropping intensity			**200% (Intended)**	

Crop-wise and month-wise irrigation water requirement (Precipitation deficit) has been estimated from CROPWAT after giving necessary meteorological, soil, crop plan inputs and the same has been shown in Table 6.3. Crop-wise and month-wise Irrigation water requirement in ham has been further calculated in Table 6.5.

The total area of rice cultivation is comprised of **95640**ha. During Kharif season, rice is cultivated from June to mid-July. Since this huge area cannot be cultivated in a single day (one planting date), so it is considered/ planned to cultivate rice in two to four stages during this period. It is planned to utilize rice fallow of **95640**ha for the cultivation of potato, oil seeds, winter vegetables, summer vegetables, wheat, millet and Rabi vegetables. It is considered to cultivate the proposed crops 19128ha each for pulses and oil seeds, 14346 ha each for winter-summer vegetables, 9564 ha each for Potato-Maize and 4782 ha each for Wheat-Millet.The peak water requirement for irrigation for rice is in the months of May-June,

for mustard and pulses it is in the month of January, for potato it is in the month of March and for vegetables it is during February.

Under ground water exploration programme, of CGWB has drilled 10 DTWs (including observation wells) down to the depth of 305 m bgl. It is observed that tubewells constructed down to a depth from 100 to 305 m and tapping zones between 31-52 m bgl(21m Thick), 56-70 m bgl (14 m), 142- 148 m bgl (6 m thick) and below 200 m bgl with a zone of 30 m thickness and capable to yield 33 to 206 m^3/hr for a maximum drawdown 1.34 – 10.12 m. The Transmissivity of the aquifer is calculated as 451 to 5178 m^2/day and can be sustainably developed and use for irrigation purpose. Shallow tube wells within 50 m of depth can be constructed through 150/100mm diameter well assembly tapping 31–55 m granular zones having 25m housing and 15-18 m slotted portion. The annular space between the borehole and the well assembly should be shrouded preferably with 100 mm thick zone of pea gravels.

A shallow tube well in the district is expected to yield 30 m^3/hr. If such a tube well runs for 8 hrs/day for 120 days, then it will create a draft of 2.88 ham.

Annual irrigation water requirement is **24142.4** ham. However, proportionate dynamic groundwater resources available for future irrigation use in the district is**97827.12** ham. Therefore, this rice fallow area can be irrigated by constructing ground water abstraction structures and can bring under double cropped area. This amount of groundwater resources can be harnessed by constructing **8382** tube wells. It is also proposed to construct water harvesting structures at suitable places. As per available ground water resources (60% availability) **20381** nos. of tube wells can be constructed. Based on CGWB exploration data shallow and deeper aquifer zones are shown in Table 7.1

Table:7.1: Potential zones in Golaghat District, Assam

District	Major Aquifer Delineated	No. of Wells Drilled/ Available in each aquifer	Depth Range	Zones encountered	Zones Tapped	Discharge (m^3/hr)
Golaghat	Alluvium	10 Nos.	100-305.7	<u>Shallow</u> 31-52	<u>Shallow</u> 9-15 31-40	<u>Shallow</u> 13.68- 31.104
				<u>Deeper</u> 69-76 106-123 165-191 227-240 243-270 273-292	<u>Deeper</u> 70-75 110-116 227-233 242-265 282-285	<u>Deeper</u> 16.32- 151.68

Groundwater in some areas is infested with iron, therefore before consumption aeration/ filtering/ installation of Iron Removal Plant is necessary.

Table 6.4: Crop-wise and month-wise precipitation deficit (mm) using CROPWAT 8 for Golaghat district.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
1. Rice	0	0	0	0	146.9	0	0	0	0	5.7	0	0
2. Rice	0	0	0	0	49.4	98	0	0	0	0	0	0
3. Rice	0	0	0	0	48.4	98	0	0	0	0	0	0
4. Rice	0	0	0	0	0	146.9	0	0	0	11.5	0	0
5. Rice	0	0	0	0	0.4	146.4	0	0	0	8.5	0	0
6. Rice	0	0	0	0	0	48.8	98	0	0	21.9	9.5	0
7. Pulses	11.5	30.1	42.3	0	0	0	0	0	0	0	0	0
8. Pulses	4.3	10.8	39.4	1.2	0	0	0	0	0	0	0	0
9. Mustard	37.9	30.3	24.2	0	0	2.5	0	0	0	0	13.7	31.9
10. Mustard	37.9	30.3	24.2	0	0	1.3	0	0	0	1.1	28.6	37
11. Small Vegetables	29.8	0	0	0	0	0	0	0	0	5.3	35	41.5
12. Small Vegetables	42.8	16.9	0	0	0	0	0	0	0	0	24.7	35.1
13. Small Vegetables	0	0	4.8	0	0	5.6	0	0	0	0	0	0
14. Small Vegetables	0	0	2.2	0	0	5.6	0	0	0	0	0	0
15. Potato	47.7	39.9	11.3	0	0	0	0	0	0	0	15.9	28.2
16. Spring Wheat	36.6	41.4	18.4	0	0	0	0	0	0	0	2	6.4
17. MILLET	2.2	2.1	22.8	0	2.1	0	0	0	0	0	0	0
18. MAIZE (Grain)	17.2	0	0	0	0	0	0	0	0.9	3	52.1	46.6
19. MAIZE (Grain)	40.3	4.5	0	0	0	0	0	0	0	0.9	29.2	48