केन्द्रीय 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

GOALPARA DISTRICT
ASSAM

उत्तर पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

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Central Ground Water Board

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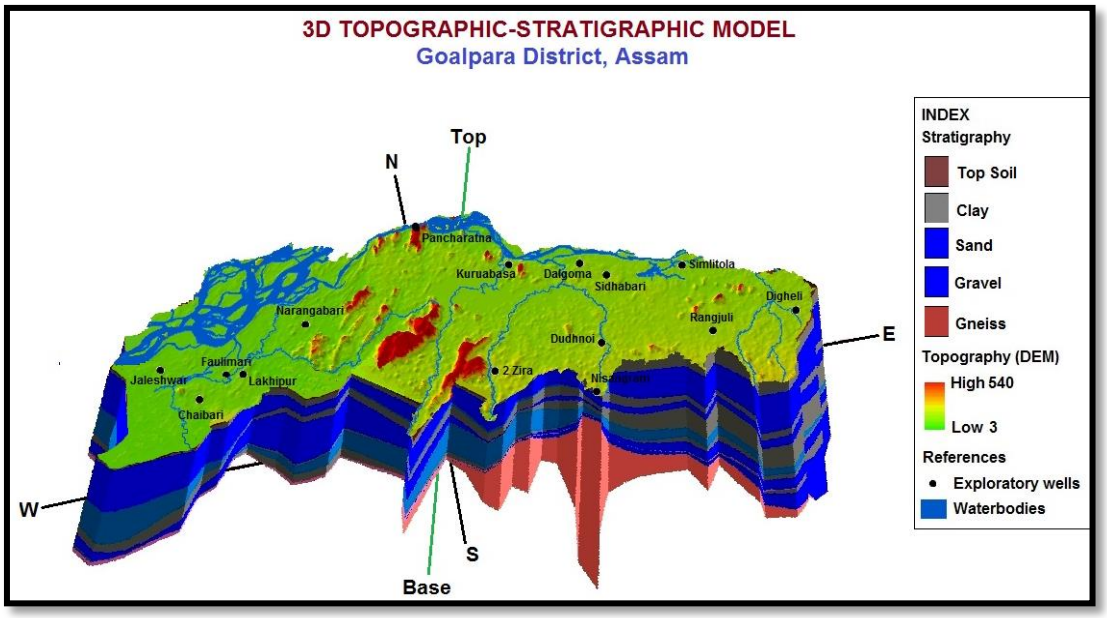
GOVERNMENT OF INDIA

भारतसरकार

REPORT ON AQUIFER MAPPING AND MANAGEMENT PLAN OF GOALPARA DISTRICT, ASSAM

ग्वालपारा जिला, असम के जलभृत मानचित्रण और प्रबंधन योजना पररिपोर्ट

(AAP2021-2022)



NORTH EASTERN REGION

उत्तरपूर्वीक्षेत्र

GUWAHATI

गुवाहाटी

JULY,2022

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 GOALPARA DISTRICT, ASSAM"

(AAP 2021-22)

By

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Sr. Tech. Asst. (Hydrogeology)

Central Ground Water Board

North Eastern Region

Guwahati

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INTRODUCTION

1.0 Introduction

1.1 Objectives

The objective of the study is to prepare aquifer map of the area in 1:50,000 scale, identify the groundwater related issues and prepare a groundwater management plan.

1.2 Scope of the study

Goalpara district has vast groundwater and surface water resources. The water resources of the district can be judiciously used for sustainable economic growth. Sustainable management plan of groundwater extraction warrants study on the occurrence of groundwater, its quantity and quality.

1.3. Approach and methodology

The approach is to identify the principal and major aquifers, quantify the resources and prepare a management plan. Finally the scientific knowledge will be disseminated to farmers, state government and stake holders.

The methodology can be illustrated as follows:

Data compilation and data gap analysis: The preliminary works consisted of collection and review of all existing hydrogeological and exploration data of CGWB, State Groundwater Departments. All data were plotted in base map on GIS Platform (ArcMap-10.8 using Projection category longitude/latitude (WGS 84-EPSG 4326). On the basis of available data, Data Gaps were identified.

Data Generation: Efforts were made to fill the data gaps by multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, besides detailed hydrogeological surveys.

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).

Aquifer Management Plan Formulation: Based on aquifer map a sustainable development plan of the aquifer is formulated

1.4 Area Details

Goalpara district is covered by Survey of India Toposheet No. 78 J/04, 78 J/08, 78 J/12, 78 J/16, 78 N/04, 78 O/01, 78 K/13, 78 K/13, 78 K/09, 78 K/05 & 78 K/01 and bounded by 25º 53′&26º 15′North Latitudes and 90º 07′&91º05′ East longitudes covering an area of 1842 sq. km (Fig.1.1).

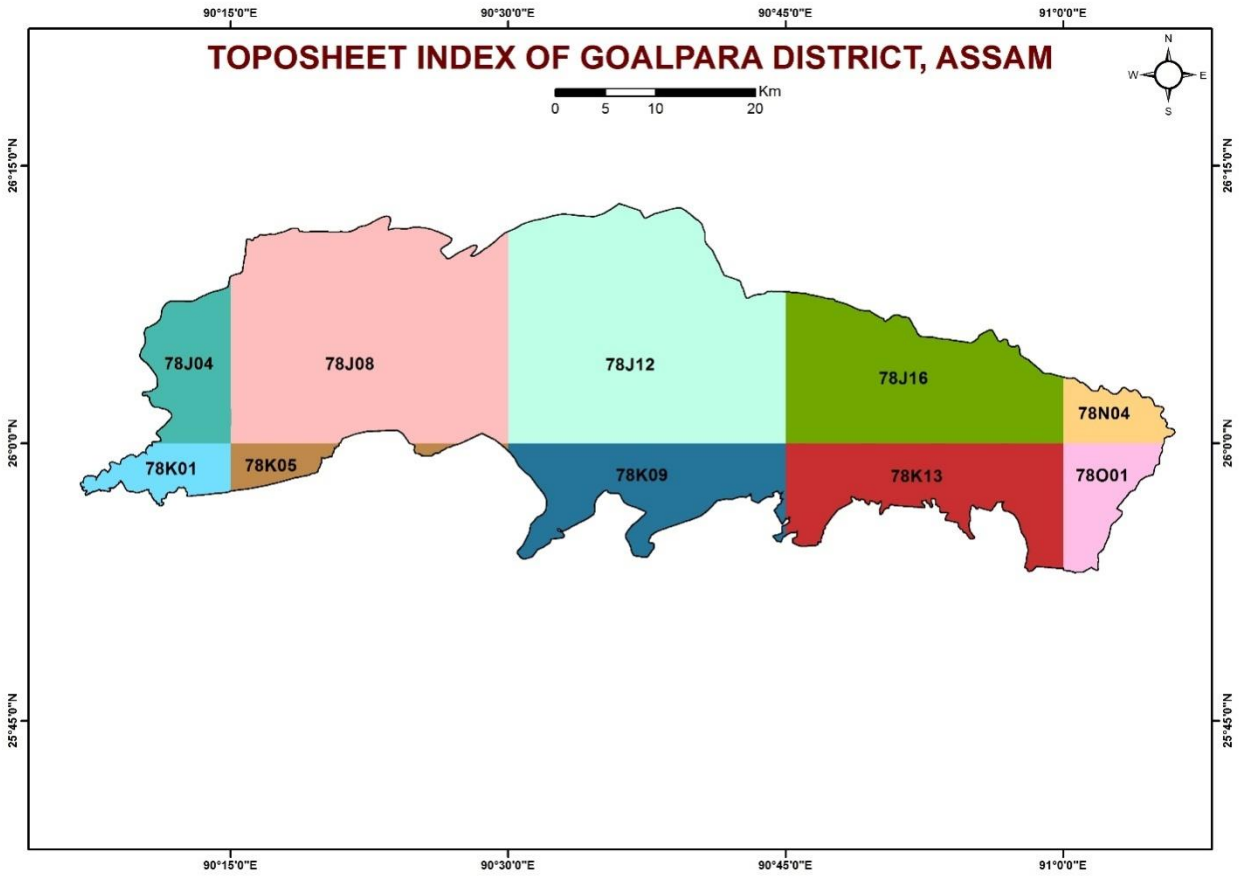

Fig: 1.1**:**Toposheet index of Goalpara district, Assam

The district is bounded on the east by the Kamrup, on the north by the district Dhubri, Bongaigaon and Barpeta, on the west by Dhubri and on the south by the state of Meghalaya. The district of Goalpara comprises of only Sadar sub-division. Goalpara has its headquarters at Goalpara and possess five revenue circles with eight Community Development Blocks encompassing 829 villages. The five revenue circles are Lakhipur, Balijana, Matia, Dudhnoi and Rongjuli. The district occupies 11 towns that includes one Municipal Board, one Town Committee and 9 census towns. Goalpara district covers an area of 1824 sq.km. (Rural: 1759.99 sq.km and Urban: 64.45 sq.km)

Table 1.1: Block wise population of Goalpara District as per 2011 census

Block	Male	Female
Balijana	57128	55299
Kharmuja	47594	45219
Lakhipur	57287	55084
Jaleswar	77551	73912
Matia	73892	70175
Rangjuli	56796	55418
Khuchdowa	45179	45288
Krishnai	56955	55137
Total	472382	455532

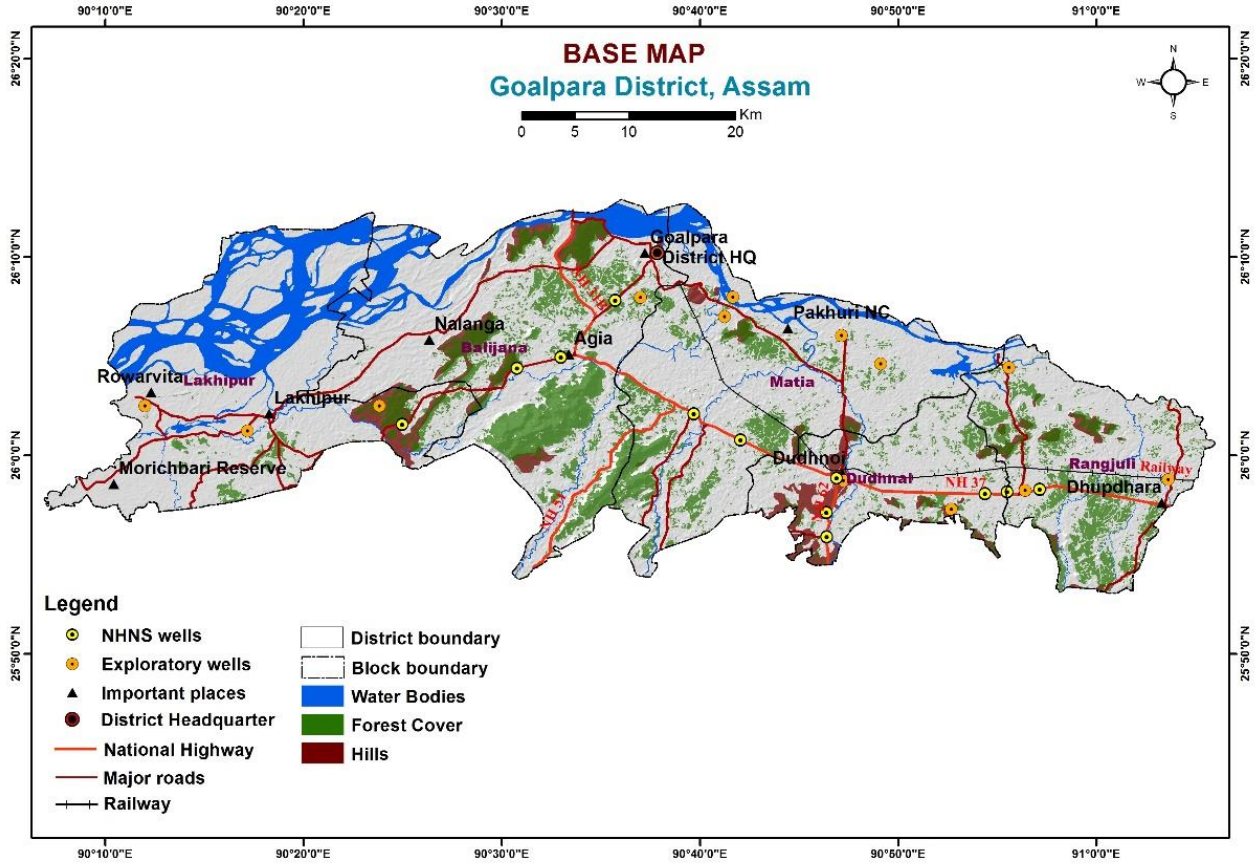

Fig.1.2: Base Map of Goalpara District, Assam

1.5 Data availability, data adequacy, data gap analysis and data generation

The preliminary works consisted of collection and review of all existing hydrogeological and exploration data of CGWB. All data were plotted in base map on GIS Platform (ArcMap-10.8 using Projection category longitude/latitude (WGS 84 EPSG 4326).The available data, data gap and data generation work is tabulated in Table: 1.3

Table 1.2: Data availability, data gap and data generation in Goalpara district, Assam

SN	Theme	Type	Data available	Data gap	Data generation	Total	Remarks
1	Borehole Lithology Data	Tube well	14	10	2	16	Maximum depth of well is 200mbgl only.
2	Geophysical data		13	7	Nil	13	
3	Groundwater level data	Dug well	13	16	48	61	
		Tubewell	Nil	Nil	Nil	Nil	
		Piezometer	1	3	0	1	
4	Soil Infiltration Test		Nil	3	3	3	

The available data and data generation points are shown in following figures.

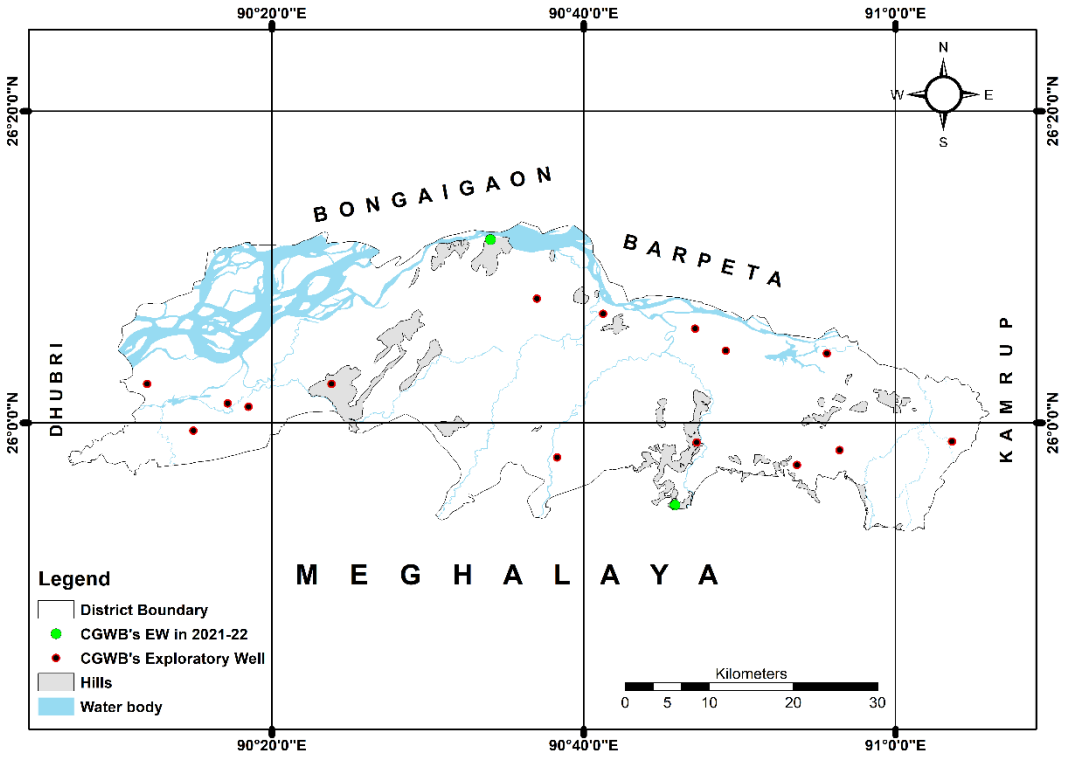

Fig. 1.3a: Available data and data generation of exploration in Goalpara district

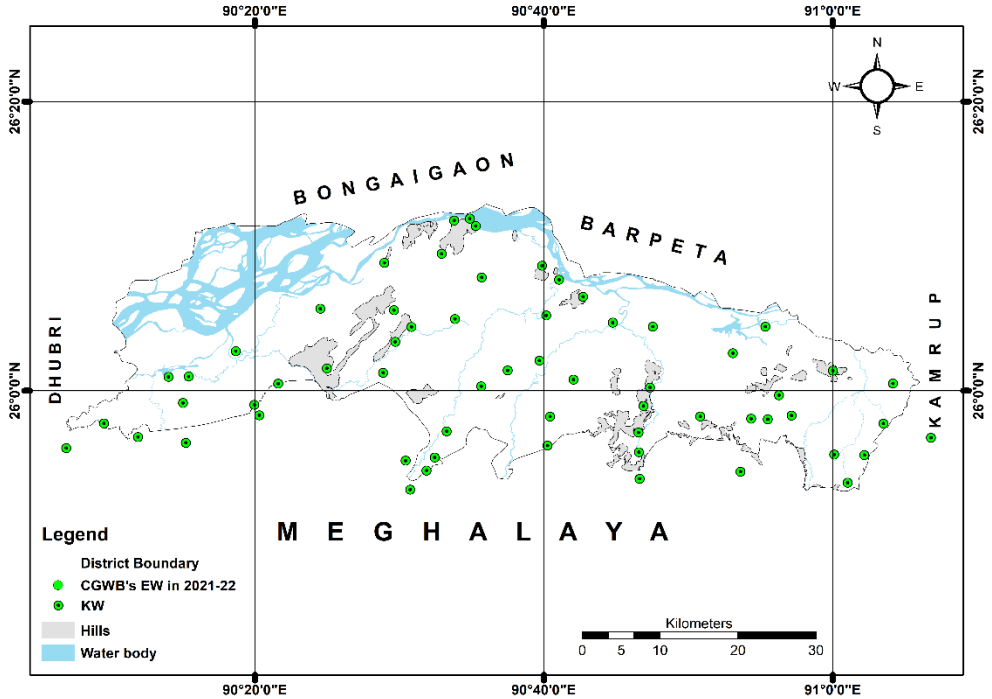

Fig. 1.3b: Available data and data generation of ground water level and quality monitoring Goalpara district

1.6 Rainfall-spatial, temporal and secular distribution

The average monthly actual rainfall and normal rainfall variations are graphically illustrated in Fig. 1.4. Based on Indian MeteorologicalDepartment (IMD) data set from Jan 2021 to Dec 2021, the annual rainfall of the district for the year 2021 found out to be 2197.75 mm.

Rainfall during January to April contributes nearly 8% to the total rainfall whereas the rainy season which commences from May and continues up to September contributes 70%. October to December rainfall makes up the rest. December receives least rainfall and maximum rainfall occurs during June.

The average monthly rainfall and monthly rainfall during 2021 and also yearly rainfall distribution are illustrated in Fig.1.3. There is deficit ofrainfall in both monsoon and non-monsoon period in 2021 when compared with normal rainfallexcept the October month of the year has received more rainfall than the normal rainfall.

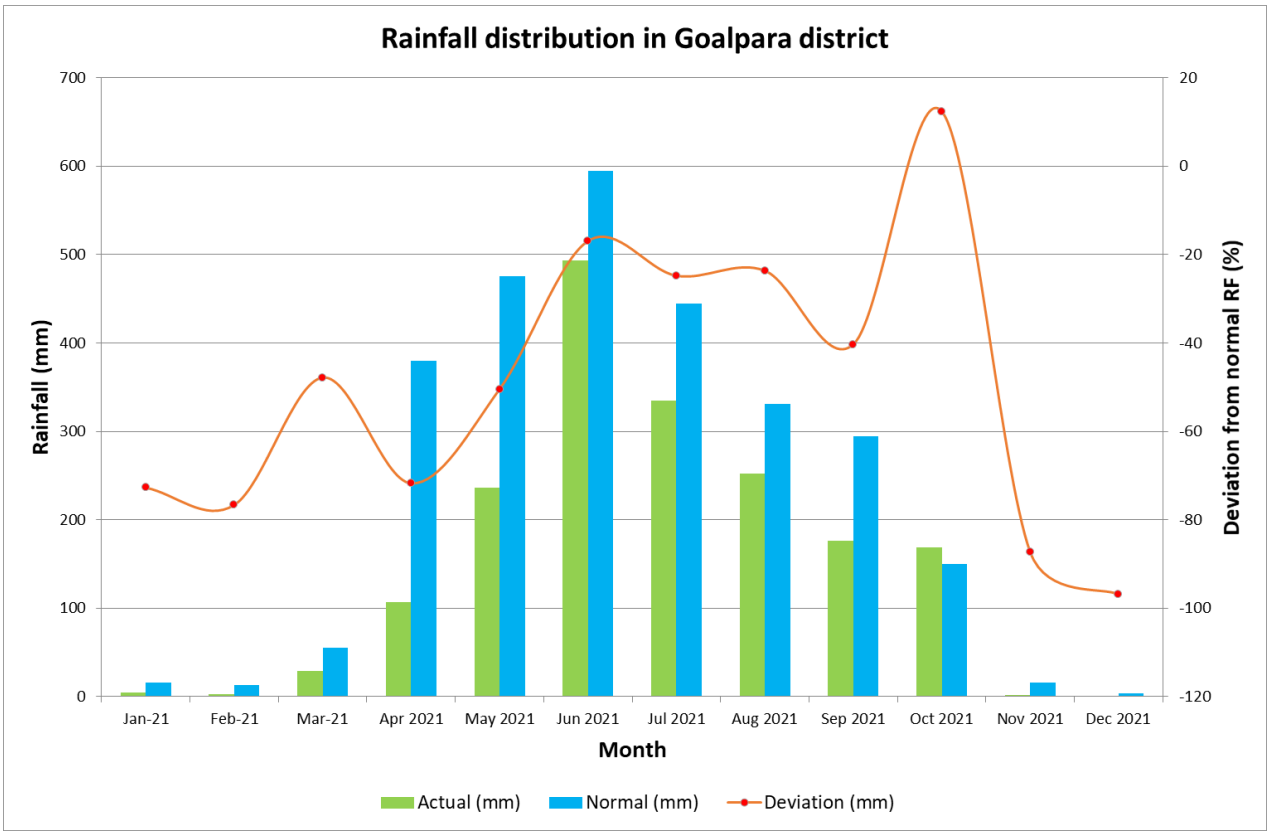

Fig. 1.4: Comparison of monthly-wise actual rainfall and normal rainfall data and their deviation

1.7 Physiographic set up

The topography of Goalpara district is generally characterized by an almost flat plain except for few low-forested hills that break the monotony of the terrain. The main hills are Pancharatna, Sri Surjya, Tukreswari, Nalanga&Paglartek with elevations ranging from 100 to 500 m.

A significance of the district is the existence of a large number of Char (Riverine tracts and sandy river island) in the River Brahmaputra. The mighty River Brahmaputra flows east to west on the Northern boundary of district and the main tributaries are River Dudhnoi, Krishnai, Jinjiram and Jinary. Dudhnoi and Krishnai Rivers originate from hills of Meghalaya, then join each other in the Western part of Matia and flows as River Mornoi up to its confluence with the Brahmaputra. The Jinjiram originates from UrpadBeel flows parallel to the Brahmaputra and ultimately joins near South Salmara of DhubriDistrict. The Rivers are all perennial in nature. There are a few other minor streams in the District.

A number of Beels (natural reserve forests, lakes) such as UrapdBeel, HashilaBeel, KumriBeel and DhamarRisanBeel exist in the district and several other artificial ponds are also seen. Physiographic ally, the area is occupied by both the hills and plains. The alluvial land is flat with a gentle regional slope of less than 1 m/km towards Brahmaputra River.

The hills mostly occur as isolated inselberg whose areas vary from less than 1 sq km to almost 15 sq km (e.g. inselberg west of Goalpara town) with heights ranging between 60 to 300 m above MSL. The hills are veneered by lateritic mantle and are deeply forested with evergreen mixed open jungles. Tongue like projections of the main Shillong Plateau are also seen in the area around Agia (26°05′ / 90°33′), Krishnai (26°02′ / 90°39′), and southeast of Rangjuli (25°58′ / 90°04′). The height of the hills varies between 60 and 550 m above MSL.

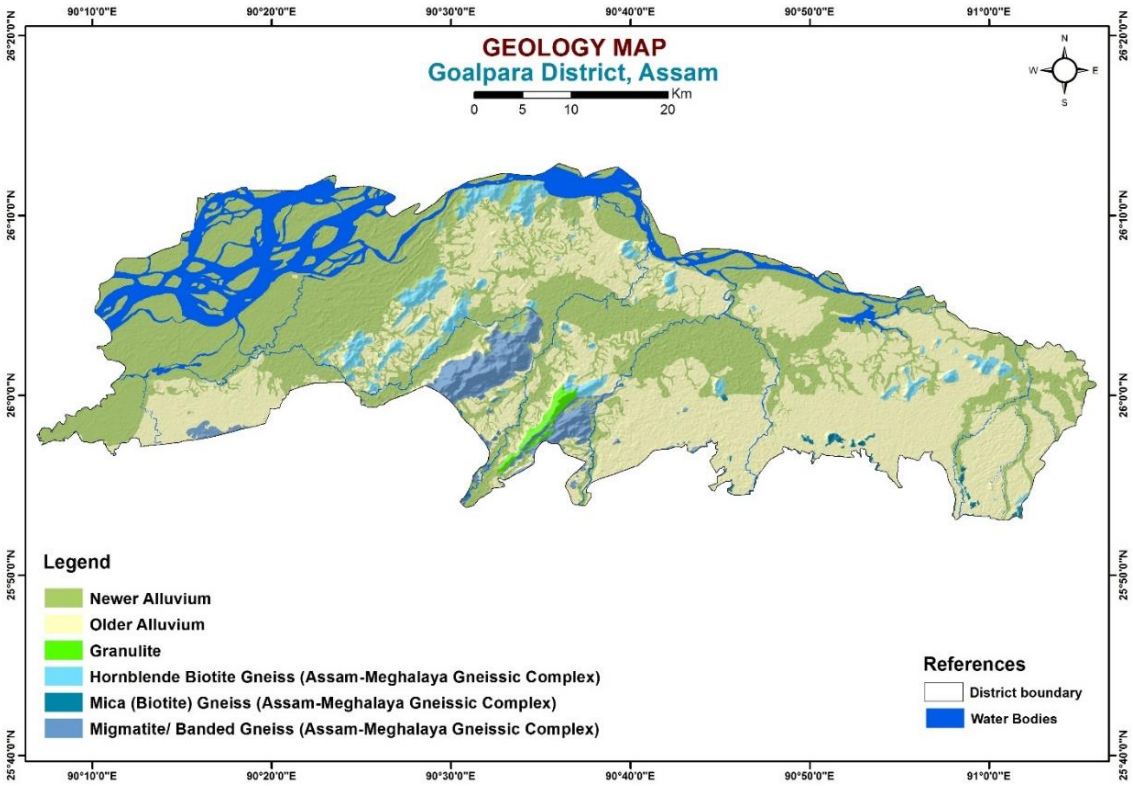

Fig. 1.5: Geological Map of Goalpara District, Assam

The main rock types of the Archean group comprise biotite gneiss, granite gneiss, quartzites, metabasites etc. the general strike of foliation of the rocks is ENE-WSW. Fractures and joints are common in the rocks.

1.8 Geomorphology

Geomorphologically the area can be classified mainly into four divisions: structural hills, piedmont zone, alluvial plan and flood plain. Piedmont zone is in the north eastern part of the study area. The piedmont zone is gravel dominated while alluvial plain and the flood plain are mixture of sand and silt with varying proportions. The alluvial flood plain consists of younger and older alluvial deposits. It represents various sub-features, viz., palaeochannel, swampy/marshy land, river terraces, flood plains, point bars, channel bar and river channel (Fig. 1.6).

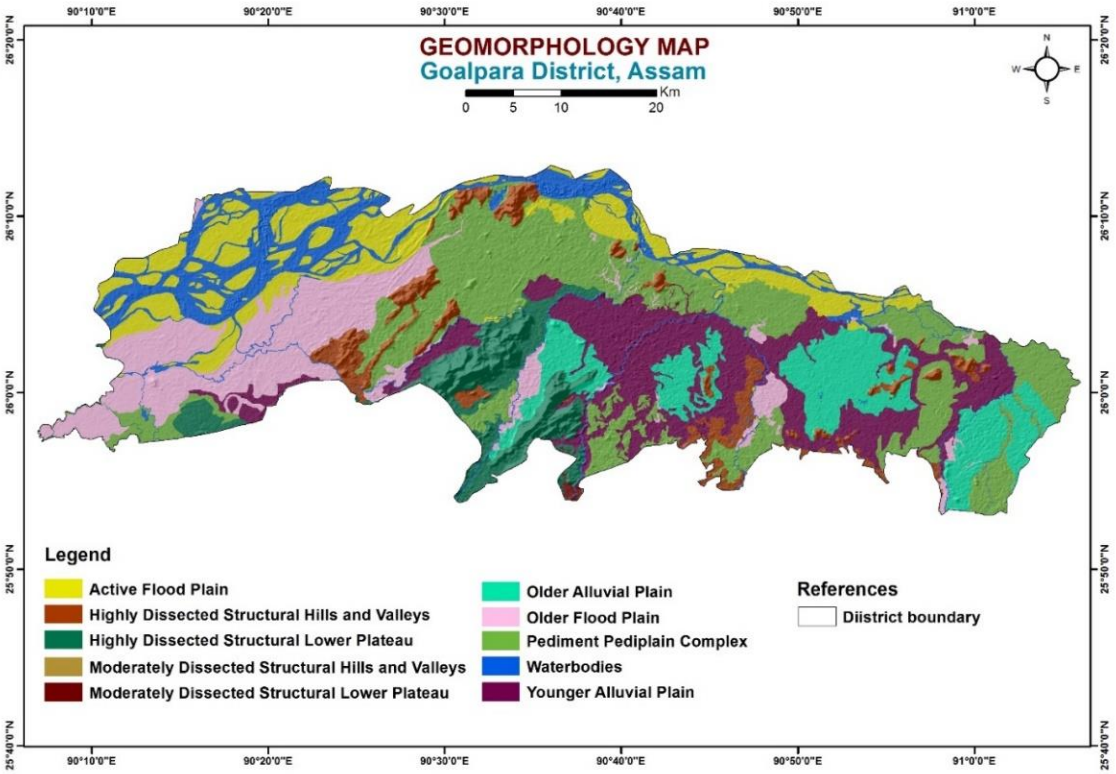

Fig. 1.6: Geomorphological Map of Goalpara District, Assam

Geomorphic Analysis: Geomorphology can also be defined as landforms description and classification. GIS based analysis of Digital Elevation Data helps to classify landform. In this study downloaded and processed DEM is classified into 10 classes based on Terrain Power Index (TPI) (Fig. 1.7).

Using TPI at different scales, plus slope, users can classify the landscape into both slope position (i.e. ridge top, valley bottom, mid-slope, etc.) and landform category (i.e. steep narrow canyons, gentle valleys, plains, open slopes, mesas, etc.). The TPI is the basis of the classification system and is simply the difference between a cell elevation value and the average elevation of the neighborhood around that cell. Positive values mean the cell is higher than its surroundings while negative values mean it is lower.

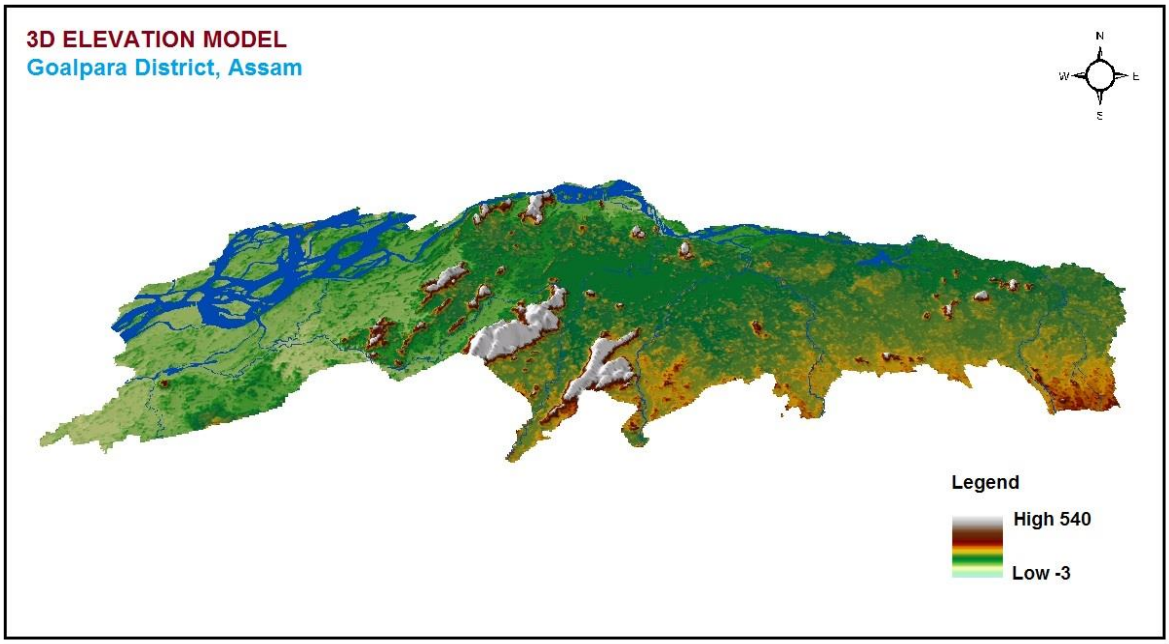

Fig.1.7: Digital Elevation Model of the study area based on 30m resolution JAXA data.

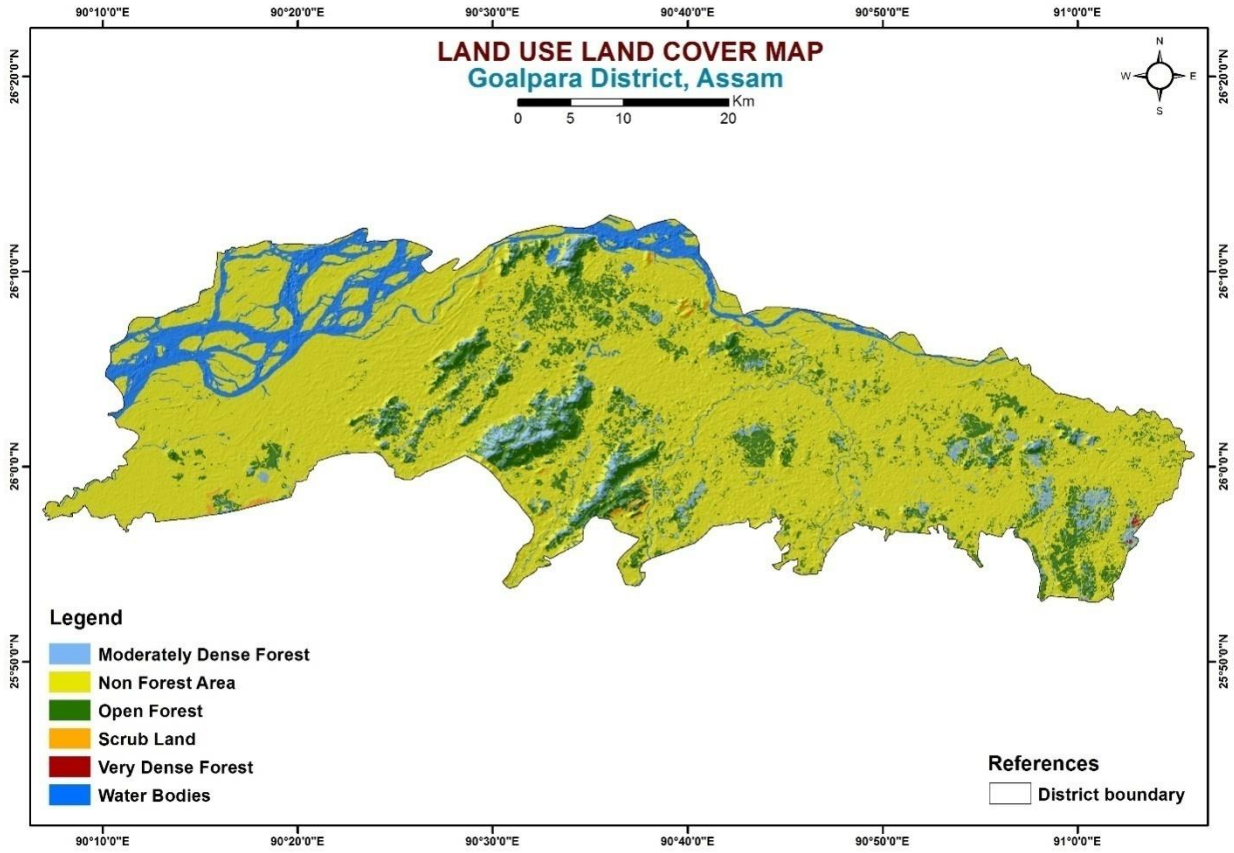

Fig. 1.8: Landform classification of Goalpara district

The degree to which it is higher or lower, plus the slope of the cell, can be used to classify the cell into slope position. If it is significantly higher than the surrounding neighbourhood, then it is likely to be at or near the top of a hill or ridge. Significantly low values suggest the cell is at or near the bottom of a valley. TPI values near zero could

mean either a flat area or a mid-slope area, so the cell slope can be used to distinguish the two.

Slope:

Slope having less than 20% area is mainly dominating throughout the district. Only a few scattered parts of the district occupying more than 20% area.

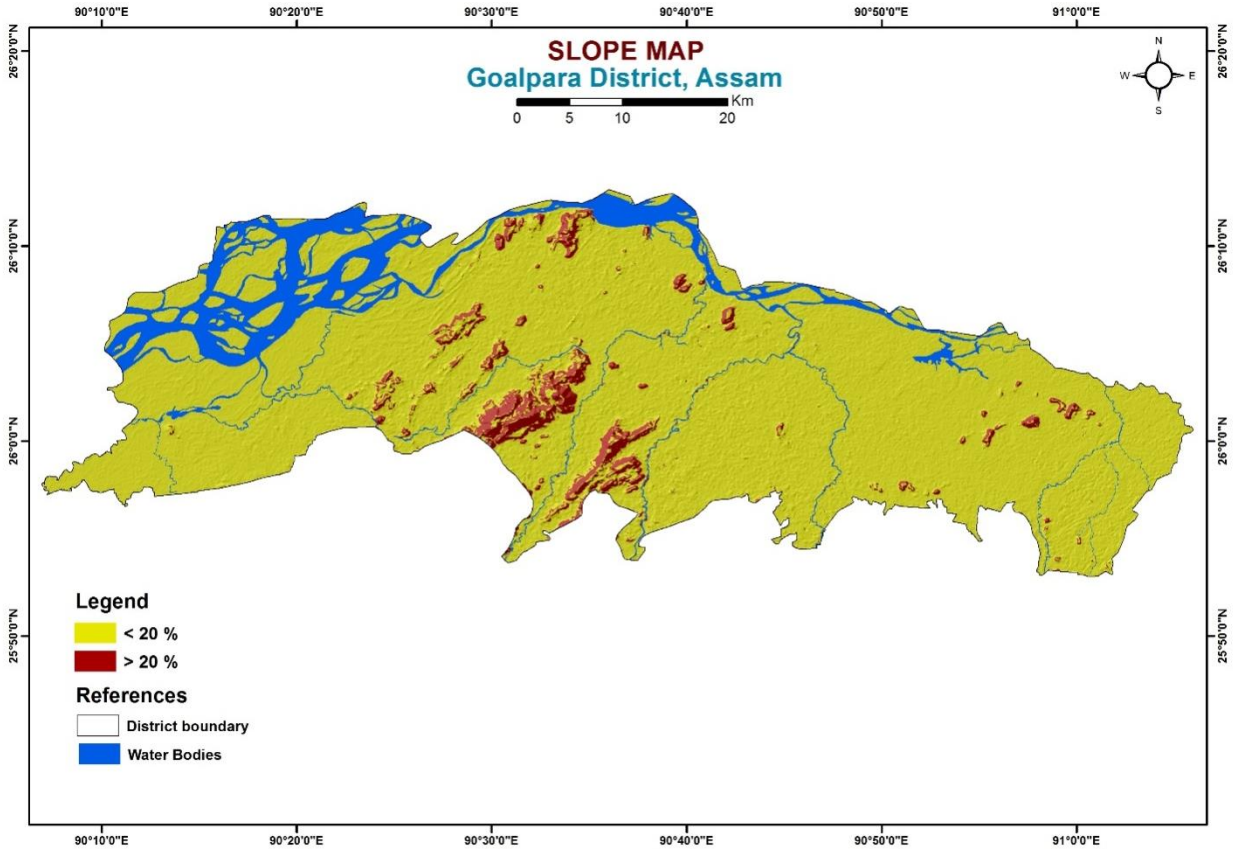

Fig. 1.9: Slope classification of Goalpara district

1.9**Land use Pattern**

Land use pattern of the villages in different blocks are given in the following table (Table: 1.3).

Table 1.3: Block-wise land use pattern in Goalpara

Block	Total Geographical Area	Net Sown Area	Area under Forest	Area under Wasteland
Rangjuli	30024.5	15225	6192.54	4948.81
Khuchdowa	17653.3	10607	2764.32	807.24
Krishnai	25808.6	13240	7377.01	4971
Matia	19486.3	14095	3877.14	2330
Balijana	28633.9	12747	10169.5	422
Kharmuja	18247.8	11594	1550.5	2795.85
Lakhipur	24312	12390	1984.52	5011.75
Jaleswar	18234	12750	2514.47	4971
(Source: District Irrigation Plan, Goalpara District, 2016-20, Assam)				

1.10 Soil

The plain areas bordering Brahmaputra River and in between the inselbergs are occupied by alluvial sediments belonging to Quaternary ages. Based on such criteria such as sedimentation, soil characteristics and geomorphic features, the Quaternary sediments can be grouped into two subdivisions, viz. (i) Older Alluvium, and (ii) Younger alluvium. The Older alluvium by virtue of its relative maturity is composed of somewhat oxidized sediments comprising yellow and the reddish brown colour sand, silt and clay in contrast to the light colour, less compact Younger alluvial sediment. The Older alluvium always occupies the higher grounds than the adjacent Younger alluvium but takes the proper stratigraphical position underlying the Younger alluvium sediments in the plain areas. A scarp as seen in the Krishnai River valley sometimes separates these two groups.

Table 1.4: Soil Profile in Goalpara

Soil Series	Area (ha)	Land Slope (% slope gradient)	Soil Taxon
Dudhnai	11,480	Very gently sloping (1-3%)	Fine , mixed, hyperthermic family of OxyaquicDystrudepts
Goalpara	7,223	Nearly level (0-1 %)	Fine, mixed, hyperthermic family of HumicEndoaquepts
Garopara	7,666	Moderately steep hill slopes (15-25%)	Fine loamy ,mixed, hyperthermic family of TypicHapludalfs
Jinjiram	17,866	Very gently sloping (1-3%)	Fine ,mixed, hyperthermic family of AericEndoaquepts
Jinjiram	17,866	Very gently sloping (1-3%)	Fine ,mixed, hyperthermic family of AericEndoaquepts
Krishnai	24,077	Very gently sloping (1-3%)	Fine ,mixed, hyperthermic family of AericEndoaquepts
Lakhipur	16,051	Gently Sloping	Fine -silty ,mixed, hyperthermic family of AericFluvaquents
Ranjauli	1,024	Steeply sloping hills (> 33%)	Loamy-skeletal, mixed, hyperthermic family of DystricEutrudepts
Source: ICAR – National Bureau of Soil Survey & Land Use Planning, Jorhat			

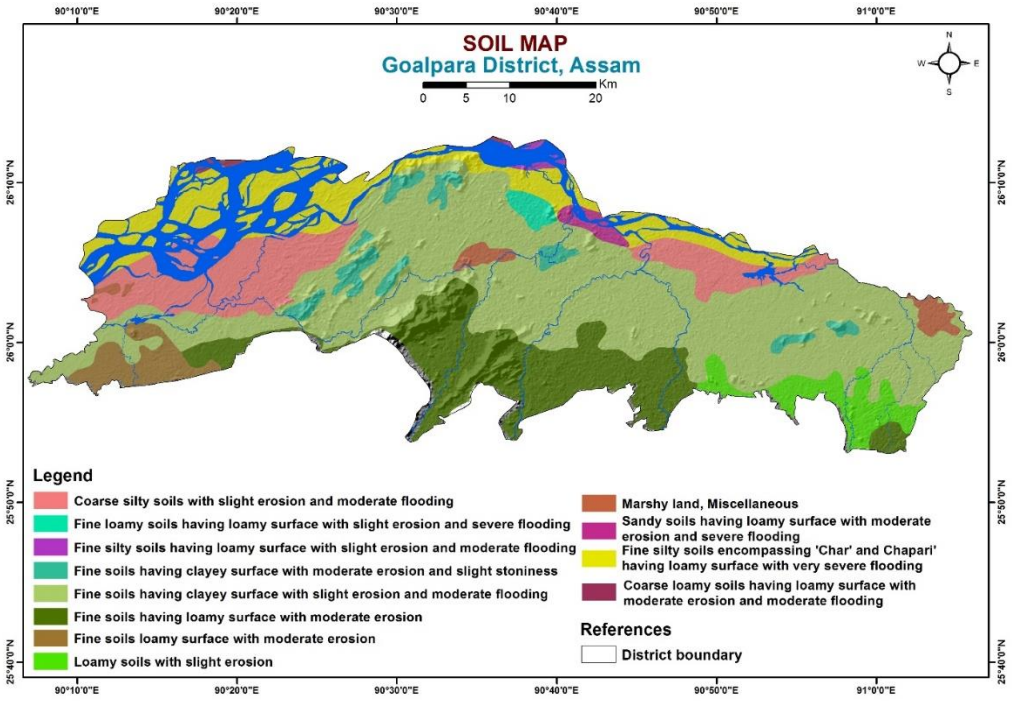

Fig. 1.10: Soil map of Goalpara district, Assam

1.11 Hydrology and surface water

The drainage of the entire area is controlled by two different systems of rivers. Towards the east, a northerly flowing river system drains the area, which consists of tributaries of the mighty Brahmaputra River. In the west of Agia, the drainage is controlled by Jinrana River, which flows in a westerly direction parallel to Brahmaputra River.

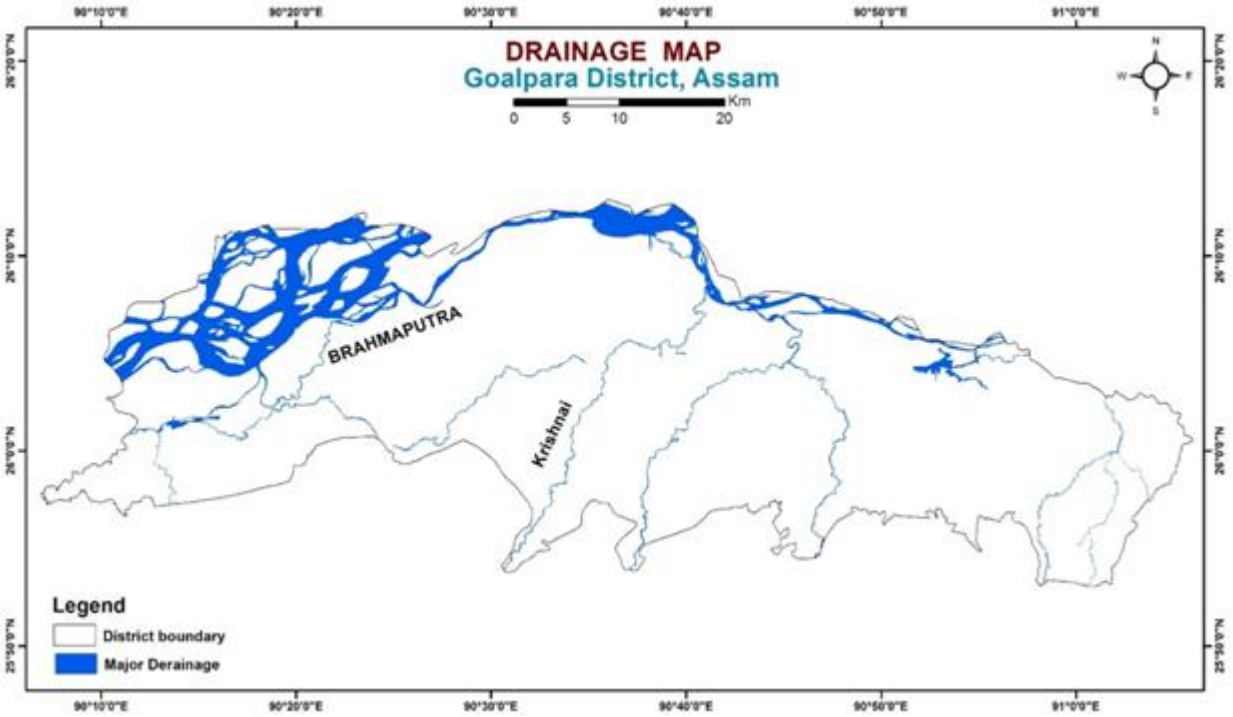

Fig. 1.11: Drainage map of Goalpara district, Assam

1.12 Agriculture

The economy of Goalpara district is primarily agrarian as 90 percent of the population depends for their livelihood on agriculture. Paddy is the major crop. Other important crops include wheat, maize, oil seeds, pulses, cash crop like jute, vegetables etc. The district is also known for its production of areca nut and banana. A big market of banana has come up at Darangiri to which businessmen from all over India come. The agro climatic conditions of the district are conducive for various agricultural activities. Agriculture in the district is characterized by over dependence on rainfall, predominance of seasonal crops and traditional methods of cultivation. Gross irrigated area in the district is 74174 ha and net irrigated area is 42157ha. Block wise distribution of irrigated lands are shown in Table 1.3.

Table 1.5: Block-wise land use pattern in Goalpara

Block	Total Geographical Area	Net Sown Area	Area under Forest	Area under Wasteland
Rangjuli	30024.5	15225	6192.54	4948.81
Khuchdowa	17653.3	10607	2764.32	807.24
Krishnai	25808.6	13240	7377.01	4971
Matia	19486.3	14095	3877.14	2330
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Lakhipur	24312	12390	1984.52	5011.75
Jaleswar	18234	12750	2514.47	4971
Source: Agriculture Department, Goalpara				

Surface and ground water resources are used in the district for irrigation purposes. As per District Irrigation Plan 2016-20, a total of 79 irrigation sources are operating in the district. Kuchdowa block has maximum command area under irrigation sources, i.e.2246 hectares out of 11051 hectares (20%). After Kuchdowa, Jaleswar and Matia have greater command area under irrigation sources. In Jaleswar, there are 11 irrigation sources with command area of 1965 ha while in Matia there are 14 irrigation sources with 1772 hectares of command area. Kharmuza is the block with least number of irrigation sources. In Kharmuza, there are only 12 irrigation sources with total command area of 575 ha.

Under surface irrigation, a total of 35 canal based irrigation sources exist with command area of 8391 ha. A total of 44 tube wells are operating in the district, with Matia block having the maximum number of tube-wells with 10 and command area of 675 ha.

In case of water extraction devices, there are 60 electricity pumps operating in district with a command area of 6671 ha. Out of total command area of 6671 ha under electricity pumps, Jaleswar block has 1675 ha (25%).

Table 1.6: Block wise share of surface and groundwater irrigation

Name of Tehsil	Surface Irrigation(1)		Ground Water (2)			Water Extraction Devices/ Lift			Total	
	Canal Based	T/P/ R	Tube Wells	Open Wells	Bore Wells	Elec. Pump	Diesel Pumps	Others	Irr. Sources	WEU
Matia	1097	-	675	-	-	1498	-	-	1772	1498
Balijana	563	-	210	-	-	397	-	-	773	397
Kharmuza	70	-	505	-	-	505	-	-	575	505
Krishnai	510	-	630	-	-	1024	-	-	1140	1024
Lakhipur	1010		30			283			1040	283
Jaleswar	1745		220			1675			1965	1675
Kuchdowa	2246		0			899			2246	899
Rongjuli	1150		390			390			1540	390
Source: Agriculture Department, Goalpara										

Table 1.7: Irrigation based classification

Sr. No.	Block	Gross Irrigated Area	Net Irrigated Area	Partially Irrigated/ Protective Irrigation	Un-Irrigated or Totally Rainfed
1	Rangjuli	4376	2909	-	18462
2	matia	7086	3054	-	17300
3	Balijana	3250	1866	-	15821
4	Kharmuja	7587	4966	-	11787
5	Lakhipur	7186	5055	-	11899
6	Jaleswar	6397	4119	-	15228
7	Kuchdowa	4280	2935	-	10831
8	Krishnai	2681	1607	-	17179

CHAPTER 2.0

Data Collection and Generation

2.1 Data collection

2.1.1 Hydrogeological data

The entire study area is covered by regular monitoring of 61 nos. of GWMS. Water level data were collected.

2.1.2 Exploration data

Central ground water board, North Eastern Region, Guwahati had undertaken exploration work in the district since 1977-78 and drilled 14 exploratory wells till 2013.

2.1.3 Meteorological Data

Meteorological data is collected from accessed free data of IMD.

2.1.4 Population and agriculture data

Population and groundwater dependency were collected from census 2011. All the data pertaining to agriculture were collected from District Irrigation Plan of Goalpara District for 2016-20 prepared by NABARD.

2.2 Data Generation

Water level data: 61 nos. of key wells have been established to fill up the data gap.

Table 2.1: Key wells location details

Location	Latitude	Longitude	RL (ma msl)	Total depth of Pz/DW (mbgl)	Type (DW/Pz/ Spring)	Aquifer group	Measuring point (magl)	Source/ Agency
Makri Bazar	26.157969	90.548748	48	7.63	DW	Alluvium	0.88	Private
Karmuja	26.147347	90.48266	40	6.05	DW	Alluvium	0.84	Private
KonachiparaMajid	26.094497	90.408742	38	7.80	DW	Alluvium	0.55	Private
Silapani	26.045563	90.311193	35	7.44	DW	Alluvium	0.60	Private
Kolabari	26.016358	90.256844	35	6.90	DW	Alluvium	0.86	Private
Bherbheri	25.962434	90.159125	36	5.45	DW	Alluvium	1.13	Private
Hatimura	26.015911	90.233582	39	6.12	DW	Alluvium	0.82	Private
KharaMedhipara	26.003614	90.789095	50	5.66	DW	Alluvium	0.87	Private
Pub Matia	26.073974	90.79242	40	6.85	DW	Alluvium	1.00	Private
Nepalikuti	26.078569	90.746331	47	8.77	DW	Alluvium	0.83	Private
Surya Pahar Temple	26.108367	90.711832	50	6.80	DW	Alluvium	0.68	Govt.
Dubapara	26.127993	90.684183	42	10.62	DW	Alluvium	0.89	Private
Dekdhowa	26.144103	90.664601	47	9.24	DW	Alluvium	0.86	Private
Hurkakuchi	26.189843	90.58805	37	6.58	DW	Alluvium	0.80	Private
Pancharatna I	26.198301	90.581271	29	7.97	DW	Alluvium	0.70	Govt.
Pancharatna II	26.196153	90.563229	43	4.14	DW	Alluvium	0.87	Govt.
Jiaguri	26.02343	90.624855	47	8.28	DW	Alluvium	0.83	Private
Chengmari	26.005096	90.594418	56	4.90	DW	Alluvium	0.92	Private
DarakonaRabha	25.908014	90.531178	70	9.62	DW	Alluvium	0.72	Private
Kukurkata	25.923115	90.54079	67	7.84	DW	Alluvium	0.69	Private
Hudakona	25.953252	90.554477	58	8.70	DW	Alluvium	0.70	Private

Hatogaon	26.008309	90.360184	42	4.67	DW	Alluvium	0.80	Private
Location	Latitude	Longitude	RL (ma msl)	Total depth of Pz/DW (mbgl)	Type (DW/Pz/ Spring)	Aquifer group	Measuring point (magl)	Source/ Agency
Borgobal	25.983794	90.332665	45	4.39	DW	Alluvium	0.88	Private
Amjonga	25.970478	90.847101	55	5.18	DW	Alluvium	0.72	Govt.
BudlungGarohita	25.994772	90.937995	58	6.60	DW	Alluvium	0.60	Govt.
Simlitola	26.073887	90.922292	52	12.40	DW	Alluvium	0.90	Private
Agia	26.082717	90.564122	32	7.43	DW	Alluvium	0.66	Govt.
Khamari	25.936888	90.670914	68	6.00	DW	Alluvium	0.80	Private
Chari Gaon Bazar	25.970322	90.673854	64	8.33	DW	Alluvium	0.76	Private
Bagdoba	26.008411	91.069433	64	5.37	DW	Alluvium	0.76	Private
Dhupdhara	25.962268	91.058532	49	5.43	DW	Alluvium	0.70	Private
Ambuk	25.925941	91.036562	42	5.34	DW	Alluvium	0.80	Private
Chekowari	25.893936	91.017238	65	12.63	DW	Alluvium	0.82	Private
Baida	26.025833	90.416389	65	5.00	DW	Alluvium	0.70	Govt.
Bhalukdubi	26.130556	90.595000	41	9.90	DW	Alluvium	0.80	Govt.
Damra	25.929167	90.776389	59	10.80	DW	Alluvium	0.90	Govt.
Dudhnoi	25.982500	90.781667	41	5.70	DW	Alluvium	0.75	Govt.
DudhnoiII	25.951944	90.775833	53	6.80	DW	Alluvium	0.75	Govt.
Dwarka	26.056389	90.495278	49	7.60	DW	Alluvium	0.9	Govt.
KrishnaiNew	26.034722	90.661667	57	9.70	DW	Alluvium	0.8	Govt.
Pattapara	25.967778	90.905833	44	5.50	DW	Alluvium	0.7	Govt.
Rongjuli	25.967222	90.925000	59	6.00	DW	Alluvium	0.3	Govt.
Salpara	26.012778	90.700833	52	8.10	DW	Alluvium	0.7	Govt.
Sarapara	25.971389	90.952500	57	4.65	DW	Alluvium	0.85	Govt.
Teuli	26.073611	90.513889	47	7.90	DW	Alluvium	0.60	Govt.
Thorkobazar	25.985923	90.250322	40	5.90	DW	Alluvium	0.69	Private
Ketkibari	26.020706	90.481228	42	9.63	DW	Alluvium	0.84	Private
Kheropara	26.043323	90.884836	42	11.00	DW	Alluvium	0.80	Private
Jyotigaon	25.926564	91.001666	54	8.32	DW	Alluvium	0.87	Private
Harimura	26.086886	90.669502	37	13.27	DW	Alluvium	0.95	Private
Dampara	26.092949	90.493693	40	5.44	DW	Alluvium	0.70	Private
Khopamara	26.023147	91.000206	42	4.92	DW	Alluvium	0.80	Private
Rajapara	25.945833	91.113333	64	12.50	DW	Alluvium	0.80	Private
Dainadubi	25.898611	90.777222	100	5.80	DW	Alluvium	0.80	Private
Kharkutta	25.906667	90.893611	43	7.20	DW	Alluvium	0.8	Private
Mendipathar	25.919444	90.507222	52	5.60	DW	Alluvium	0.72	Private
Bajengdoba New	25.886111	90.5125	61	7.50	DW	Alluvium	0.8	Private
Belguri	25.971667	90.338333	79	12.6	DW	Alluvium	0.7	Private
Nidanpur	25.933889	90.115556	33	4.6	DW	Alluvium	0.9	Private
Phutamati	25.940000	90.253611	40	5.6	DW	Alluvium	0.6	Private
Tikrikilla	25.946667	90.198333	36	6.1	DW	Alluvium	0.85	Private

Table 2.2: Water level measurement of key wells

Location	Month & depth-to-water level in mbgl	
	Nov-21	Mar-22
Makri Bazar	4.19	3.52
Karmuja	1.44	0.44
KonachiparaMajid	1.87	3.57
Silapani	3.09	5.00

Location	Month & depth-to-water level in mbgl	
	Nov-21	Mar-22
Kolabari	3.53	3.87
Bherbheri	1.88	4.30
Hatimura	3.02	3.66
KharaMedhipara	1.86	3.41
Pub Matia	3.72	6.08
Nepalikuti	4.44	6.67
Surya Pahar Temple	4.08	6.10
Dubapara	5.92	8.57
Dekdhowa	5.26	5.62
Hurkakuchi	4.93	5.91
Pancharatna I	4.51	5.81
Pancharatna II	0.63	1.11
Jiaguri	2.36	5.53
Chengmari	3.50	3.96
DarakonaRabha	6.38	8.82
Kukurkata	4.85	6.67
Hudakona	5.49	5.66
Hatogaon	2.61	3.21
Borgobal	2.03	2.51
Amjonga	2.37	2.78
BudlungGarohita	2.46	2.90
Simlitola	2.51	5.39
Agia	1.85	2.69
Khamari	1.32	2.82
Chari Gaon Bazar	1.34	3.10
Bagdoba	2.06	2.42
Dhupdhara	2.97	3.02
Ambuk	3.26	3.78
Chekowari	3.09	3.29
Baida	2.07	1.50
Bhalukdubi	3.27	7.04
Damra	4.49	6.79
Dudhnoi	1.80	2.03
Dudhnoi II	3.98	4.81
Dwarka	1.62	1.44
Krishnai New	1.80	2.40
Pattapara	1.44	3.53
Rongjuli	2.24	4.59
Salpara	2.00	2.07
Sarapara	1.35	2.25

Location	Month & depth-to-water level in mbgl	
	Nov-21	Mar-22
Teuli	4.24	4.90
Thorko bazar	3.16	3.64
Ketkibari	3.81	4.37
Kheropara	6.38	7.17
Jyotigaon	4.46	5.15
Harimura	5.70	7.99
Dampara	2.96	3.50
Khopamara	2.00	2.12
Rajapara	0.46	4.49
Dainadubi	1.1	5.3
Kharkutta	1.00	4.33
Mendipathar	2.38	4.67
Bajengdoba New	2.00	6.33
Belguri	2.80	10.76
Nidanpur	0.60	3.97
Phutamati	1.90	5.37
Tikrikilla	0.80	5.95

Soil Infiltration studies: Infiltration test

Salient features of the test sites are provided in Table 2.3 & 2.4. A perusal of the table shows that the tests have been conducted only in barren land and the soil types encountered in the sites are sand admixtures. The infiltration test was conducted for 140 mins.

Table 2.3: Salient features of the test sites

Site	Location	Land use	Soil type	RL (mamsl)	Latitude	Longitude
Jyotigaon	Jyotigaon ME School, Jyotigaon	Barren Land	Clay	54	25.926564	91.001666
Pub Matia	PWSS Nigam	Barren Land	Clay	46	26.076983	90.797705
Dudhnoi	94 No. Gerua AWC	Barren Land	Clay	44	26.074274	90.932491

Table 2.4: Summary of Infiltration Test

Site	Land use	Soil type	Infiltration rate (mm/hr)	Duration of test (min)	Total Quantum of water added (in m)	IF = (4) / (6) *100
Jyotigaon	Barren Land	Loam	15	140	245	6.12
Pub Matia	Barren Land	Loam	15	140	253	5.93
Dudhnoi	Barren Land	Clay	2	140	245	0.73

Water Quality: To understand the chemical quality of groundwater in the study area and its suitability for domestic, drinking and agricultural utilization, and existing quality data of CGWB were collected. Water samples were collected from monitoring wells/ key wells for detailed analysis of iron, heavy metals and arsenic etc.

Table 2.5: Water quality data of samples collected during Post-monsoon

Well Number	State	Location	District	Block	Lat DD	Long DD	Type of sample (EW or DW)	NHNS/Exploratory/Aquifer mapping	Date of collection	Temp ºC	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS	CO3-2	HCO3-1	TA (as CaCO3)	Cl-	SO4-2	NO3-1	F-	Ca+2	Mg+2	TH (as CaCO3)	Na	K	Fe	As	U
NQGP01	Assam	Agia	Goalpara	Balijana	26.083	90.564	DW	Aquifer mapping	12.11.2021	25.5	8.35	170.60	BDL	113	9.00	146.52	156	14	BDL	BDL	BDL	16	9.70	80.00	22.57	12.53	2.38	BDL	BDL
NQGP02	Assam	Ambuk	Goalpara	Rongjuli	25.926	91.037	DW	Aquifer mapping	09.11.2021	25.5	6.02	42.27	BDL	28	BDL	48.84	49	14	0.4	BDL	2.03	6	6.07	40.00	10.83	3.36	0.26	0.25	BDL
NQGP03	Assam	Amjonga	Goalpara	Dudhnoi	25.97	90.847	DW	Aquifer mapping	14.11.2021	25.9	7.34	35.06	BDL	23	BDL	30.52	31	14	BDL	BDL	BDL	6	2.42	25.00	5.48	3.06	0.25	BDL	1.06
NQGP04	Assam	Bagdoba	Goalpara	Rongjuli	26.008	91.069	DW	Aquifer mapping	09.11.2021	25.1	6.54	86.46	0.10	57	BDL	91.57	92	14	0.4	BDL	BDL	10	3.64	40.00	24.23	6.85	0.45	0.13	0.01
NQGP05	Assam	Baida	Goalpara	Balijana	26.026	90.416	DW	Aquifer mapping	11.11.2021	26.8	6.33	47.67	BDL	31	BDL	30.52	31	28	BDL	6.31	BDL	10	7.28	55.00	5.35	3.40	0.52	0.13	0.09
NQGP06	Assam	Bhalukdubi	Goalpara	Balijana	25.131	90.595	DW	Aquifer mapping	15.11.2021	25.5	7.51	73.48	BDL	48	BDL	42.73	43	14	BDL	0.50	BDL	14	2.42	45.00	3.63	2.48	0.19	0.14	0.03
NQGP07	Meghalaya	Borgobal	West Garo Hills	Tikrikila	25.984	90.333	DW	Aquifer mapping	11.11.2021	25.8		57.61	0.30	38	BDL	61.05	61	18	BDL	BDL	BDL	10	1.21	30.00	20.02	2.51	0.44	0.02	0.10
NQGP08	Assam	Budlung Garohita	Goalpara	Rongjuli	25.995	90.938	DW	Aquifer mapping	14.11.2021	26.1	6.62	87.35	BDL	58	BDL	36.63	37	32	BDL	BDL	0.31	6	6.07	40.00	9.45	12.70	0.87	0.64	0.07
NQGP09	Assam	Chari Gaon Bazar	Goalpara	Krishnai	25.97	90.674	DW	Aquifer mapping	13.11.2021	26.6	7.45	63.07	0.10	42	BDL	48.84	49	14	BDL	BDL	BDL	10	4.85	45.00	7.23	3.63	0.23	BDL	0.03
NQGP10	Assam	Chekowari	Goalpara	Rongjuli	25.894	91.017	DW	Aquifer mapping	09.11.2021	26.1	8.47	337.90	BDL	223	18.00	177.04	195	28	8.2	BDL	1.31	36	7.26	120.00	23.45	26.83	0.32	0.48	BDL
NQGP11	Assam	Dampara	Goalpara	Balijana	26.093	90.494	DW	Aquifer mapping	15.11.2021	25.2	6.94	38.41	0.10	25	BDL	24.42	24	25	BDL	0.50	BDL	6	7.28	45.00	4.26	3.19	0.15	0.01	BDL
NQGP12	Assam	Damra	Goalpara	Dudhnoi	25.929	90.776	DW	Aquifer mapping	15.11.2021	25.9	7.70	131.10	0.10	87	BDL	73.26	73	35	1.0	BDL	BDL	14	13.34	90.00	7.36	7.34	0.32	0.14	0.06
NQGP13	Meghalaya	Darakona Rabha	North Garo Hills	Resubelpara	25.908	90.531	DW	Aquifer mapping	13.11.2021	25.1	7.34	43.20	BDL	29	BDL	30.52	31	14	BDL	BDL	BDL	4	2.43	20.00	3.75	10.55	0.23	BDL	0.06
NQGP14	Assam	Darranggiri	Goalpara	Dudhnoi	25.969	90.888	TW	Aquifer mapping	14.11.2021	26.3	8.32	1520.00	BDL	1003	9.00	97.68	107	170	196.1	BDL	0.36	180	8.41	485.00	45.78	2.82	0.35	0.26	10.52
NQGP15	Assam	Dekdhowa	Goalpara	Balijana	26.144	90.665	DW	Aquifer mapping	10.11.2021	25.8	6.60	82.53	BDL	54	BDL	67.15	67	14	0.0	BDL	BDL	8	4.85	40.00	11.07	4.56	1.64	0.13	0.08
NQGP16	Assam	Dhubapara	Goalpara	Matia	26.128	90.684	DW	Aquifer mapping	10.11.2021	25.9	7.03	117.00	BDL	77	BDL	103.78	104	21	2.4	BDL	BDL	14	6.06	60.00	18.82	8.16	0.59	0.25	0.08
NQGP17	Assam	Dhupdhara	Goalpara	Rongjuli	25.962	91.059	DW	Aquifer mapping	09.11.2021	25.3	6.52	174.40	BDL	115	BDL	54.94	55	32	0.4	13.21	BDL	12	2.42	40.00	25.63	9.90	0.18	0.13	0.07
NQGP18	Assam	Dudhnoi I	Goalpara	Dudhnoi	25.983	90.782	DW	Aquifer mapping	15.11.2021	25.2	8.31	364.20	BDL	240	12.00	91.57	104	53	7.3	BDL	BDL	28	1.20	75.00	37.39	26.02	0.35	0.14	0.07
NQGP19	Assam	Dudhnoi II	Goalpara	Dudhnoi	25.952	90.776	DW	Aquifer mapping	15.11.2021	25.1	6.92	43.02	0.30	28	BDL	24.42	24	32	BDL	BDL	BDL	6	10.92	60.00	3.84	1.54	0.22	0.01	0.23
NQGP20	Assam	Dwarka	Goalpara	Balijana	26.056	90.495	DW	Aquifer mapping	11.11.2021	25	7.02	182.20	BDL	120	BDL	140.41	140	18	BDL	BDL	0.84	16	1.21	45.00	23.97	15.79	12.75	8.86	0.19
NQGP21	Assam	Harimura	Goalpara	Matia	26.087	90.67	DW	Aquifer mapping	15.11.2021	25.9	7.27	75.88	BDL	50	BDL	36.63	37	46	BDL	1.81	BDL	6	18.20	90.00	3.29	2.88	0.15	0.01	0.03
NQGP22	Assam	Harimura	Goalpara	Matia	26.086	90.672	TW	Aquifer mapping	15.11.2021	24.9	8.36	235.20	BDL	155	9.00	158.73	168	11	BDL	BDL	0.44	20	1.20	55.00	34.66	12.86	0.20	0.14	0.03
NQGP23	Assam	Hatimura	Goalpara	Jaleshwar	26.016	90.234	DW	Aquifer mapping	11.11.2021	25.4	8.44	404.00	BDL	267	60.00	158.73	219	78	2.9	2.84	BDL	30	15.76	140.00	58.54	39.87	0.11	BDL	0.43
NQGP24	Meghalaya	Hatogaon	West Garo	Tikrikila	26.008	90.36	DW	Aquifer mapping	11.11.2021	24.9	7.48	106.30	BDL	70	BDL	91.57	92	18	BDL	2.05	BDL	14	1.21	40.00	25.92	3.51	0.18	0.02	0.04
NQGP25	Assam	Hudakona	Goalpara	Krishnai	25.953	90.554	DW	Aquifer mapping	13.11.2021	24.9	6.20	54.56	0.20	36	BDL	48.84	49	14	BDL	BDL	BDL	6	4.85	35.00	10.68	4.54	1.10	BDL	0.03
NQGP26	Assam	Hurkakuchi	Goalpara	Balijana	26.19	90.588	DW	Aquifer mapping	10.11.2021	25.1	6.89	138.60	BDL	91	BDL	91.57	92	21	1.5	BDL	0.00	14	3.63	50.00	20.78	3.49	0.22	0.13	0.33
NQGP27	Assam	Jiagrui	Goalpara	Balijana	26.023	90.625	DW	Aquifer mapping	13.11.2021	26	7.29	116.50	BDL	77	BDL	85.47	85	14	BDL	8.32	BDL	24	4.84	80.00	3.93	3.76	0.17	BDL	BDL
NQGP28	Assam	Jyotigaon	Goalpara	Rongjuli	25.927	91.002	DW	Aquifer mapping	14.11.2021	25.5	7.46	106.90	0.20	71	BDL	42.73	43	28	BDL	2.11	BDL	14	4.85	55.00	6.19	5.10	0.15	0.01	0.00
NQGP29	Assam	Karmuja	Goalpara	Kharmuja	26.147	90.483	DW	Aquifer mapping	12.11.2021	26.7	8.42	320.70	BDL	212	6.00	140.41	146	35	1.9	1.66	BDL	38	6.05	120.00	21.67	11.62	0.50	0.25	0.44
NQGP30	Assam	Ketkibari	Goalpara	Balijana	26.021	90.481	DW	Aquifer mapping	12.11.2021	25.9	8.31	158.30	BDL	104	15.00	115.99	131	18	BDL	1.67	BDL	24	4.84	80.00	26.53	4.89	4.46	0.25	0.08
NQGP31	Assam	Khamari	Goalpara	Krishnai	25.937	90.671	DW	Aquifer mapping	13.11.2021	25.8	7.03	108.30	0.10	71	BDL	73.26	73	14	0.5	BDL	BDL	20	4.84	70.00	4.35	3.83	0.46	BDL	0.04
NQGP32	Assam	Khara Medhipara	Goalpara	Dudhnoi	26.004	90.789	DW	Aquifer mapping	10.11.2021	25.5	6.81	98.93	BDL	65	BDL	79.36	79	18	0.4	BDL	BDL	20	1.20	55.00	10.78	10.46	0.34	0.02	0.07
NQGP33	Assam	Khopamara	Goalpara	Rongjuli	26.023	91	DW	Aquifer mapping	14.11.2021	25.2	7.01	38.82	0.20	26	BDL	24.42	24	28	BDL	BDL	BDL	6	7.28	45.00	4.85	3.07	0.23	0.26	BDL
NQGP34	Assam	Kolabari	Goalpara	Jaleshwar	26.016	90.257	DW	Aquifer mapping	11.11.2021	25.7	7.15	198.60	BDL	131	BDL	97.68	98	39	BDL	8.52	BDL	12	14.56	90.00	18.86	4.52	0.19	0.13	0.00
NQGP35	Assam	Konachipara Majid	Goalpara	Kharmuja	26.094	90.409	DW	Aquifer mapping	12.11.2021	25.4	7.75	535.50	0.40	353	BDL	91.57	92	92	4.1	22.13	BDL	48	16.97	190.00	11.85	8.79	0.18	BDL	0.44
NQGP36	Assam	Krishnai	Goalpara	Krishnai	26.034	90.67	TW	Aquifer mapping	13.11.2021	26.3	8.35	242.80	BDL	160	12.00	158.73	171	18	0.1	4.78	BDL	22	7.27	85.00	36.66	6.95	0.23	BDL	0.07
NQGP37	Assam	Krishnai New	Goalpara	Krishnai	26.035	90.662	DW	Aquifer mapping	13.11.2021	25.5	8.36	187.60	BDL	124	21.00	97.68	119	18	0.2	BDL	BDL	24	2.42	70.00	22.82	6.41	0.24	BDL	0.01
NQGP38	Assam	Kukurkata	Goalpara	Krishnai	25.923	90.541	DW	Aquifer mapping	13.11.2021	24.7	8.31	179.20	BDL	118	9.00	103.78	113	11	3.4	8.65	BDL	28	2.41	80.00	4.12	27.95	0.56	BDL	0.11
NQGP39	Assam	Makri Bazar	Goalpara	Balijana	26.158	90.549	DW	Aquifer mapping	12.11.2021	25.1	8.36	236.30	BDL	156	12.00	140.41	152	18	BDL	3.26	BDL	24	12.12	110.00	20.16	4.39	2.77	0.95	0.11
NQGP40	Assam	Markula Garopara	Goalpara	Balijana	26.07	90.436	TW	Aquifer mapping	12.11.2021	26.7	8.39	242.40	BDL	160	21.00	177.04	198	14	BDL	BDL	0.67	20	10.91	95.00	36.48	8.75	0.44	0.83	0.24

Well Number	State	Location	District	Block	Lat DD	Long DD	Type of sample (EW or DW)	NHNS/Exploratory/Aquifer mapping	Date of collection	TempºC	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS	CO3-2	HCO3-1	TA (as CaCO3)	Cl-	SO4-2	NO3-1	F-	Ca+2	Mg+2	TH (as CaCO3)	Na	K	Fe	As	U
NQGP41	Assam	Mornai I	Goalpara	Matia	26.09226	90.74489	TW	Aquifer ma	15.11.2021	24.9	7.58	96.80	0.20	64	BDL	73.26	73	25	BDL	BDL	BDL	6	10.92	60.00	14.78	6.44	0.17	0.01	BDL
NQGP42	Assam	Mornai II	Goalpara	Matia	26.09527	90.74102	TW	Aquifer ma	15.11.2021	26	7.59	102.30	BDL	68	BDL	67.15	67	21	BDL	BDL	BDL	10	6.06	50.00	13.60	7.44	1.00	0.14	BDL
NQGP43	Assam	Nepalikuti	Goalpara	Matia	26.07857	90.74633	DW	Aquifer ma	10.11.2021	25.6	6.88	85.46	BDL	56	BDL	67.15	67	28	0.4	BDL	BDL	10	3.64	40.00	10.91	2.83	11.62	1.18	BDL
NQGP44	Assam	Pancharatn	Goalpara	Balijana	26.19778	90.58574	Spring	Aquifer ma	10.11.2021	25	6.51	42.63	BDL	28	BDL	61.05	61	28	2.7	1.68	BDL	6	15.77	80.00	7.28	2.09	0.13	0.13	0.32
NQGP45	Assam	Pancharatn	Goalpara	Balijana	26.19615	90.56323	DW	Aquifer ma	10.11.2021	24.8	6.81	85.53	0.20	56	BDL	61.05	61	28	0.3	BDL	BDL	16	8.49	75.00	8.70	3.38	0.54	0.25	0.04
NQGP46	Assam	Pub Matia	Goalpara	Matia	26.07397	90.79242	DW	Aquifer ma	10.11.2021	24.9	6.61	86.38	0.10	57	BDL	85.47	85	14	0.4	BDL	BDL	6	8.49	50.00	12.96	6.31	0.54	0.02	0.08
NQGP47	Assam	Rongjuli	Goalpara	Rongjuli	25.97559	90.95971	TW	Aquifer ma	14.11.2021	25.9	8.38	379.70	BDL	251	15.00	195.36	210	53	1.1	2.11	0.89	24	33.97	200.00	37.26	6.27	0.29	0.14	0.96
NQGP48	Assam	Salpara	Goalpara	Krishnai	26.01278	90.70083	DW	Aquifer ma	13.11.2021	25.3	7.22	80.51	BDL	53	BDL	48.84	49	35	BDL	BDL	BDL	10	14.56	85.00	3.19	2.74	0.37	BDL	BDL
NQGP49	Assam	Sarapara	Goalpara	Rongjuli	25.97139	90.9525	DW	Aquifer ma	14.11.2021	26.3	8.60	301.80	BDL	199	9.00	201.46	210	11	BDL	BDL	0.30	32	1.20	85.00	41.87	3.96	5.42	13.02	0.02
NQGP50	Assam	Silapani	Goalpara	Lakhimpur	26.04556	90.31119	DW	Aquifer ma	12.11.2021	26.9	7.56	276.20	BDL	182	BDL	128.20	128	28	6.2	3.70	0.03	20	20.62	135.00	7.76	3.24	0.37	0.48	0.09
NQGP51	Assam	Simlitola	Goalpara	Rongjuli	26.07314	90.07391	DW	Aquifer ma	14.11.2021	26.2	7.71	177.60	BDL	117	BDL	54.94	55	32	0.2	4.77	BDL	24	1.20	65.00	9.50	8.22	0.24	0.26	BDL
NQGP52	Assam	Teuli	Goalpara	Rongjuli	26.07361	90.51389	DW	Aquifer ma	11.11.2021	25.8	6.95	111.00	BDL	73	BDL	85.47	85	35	1.0	2.05	BDL	22	12.13	105.00	8.47	4.15	0.96	0.37	0.09
NQGP53	Assam	Thorko baz	Goalpara	Lakhipur	25.98592	90.25032	DW	Aquifer ma	11.11.2021	25.6	7.76	186.60	BDL	123	BDL	97.68	98	14	BDL	BDL	BDL	12	8.49	65.00	18.01	3.15	0.69	BDL	0.91
NQGP54	Assam	Tinikoniapa	Goalpara	Matia	26.10127	90.72841	TW	Aquifer ma	15.11.2021	25.3	7.66	101.40	BDL	67	BDL	73.26	73	11	BDL	BDL	BDL	10	6.06	50.00	9.33	7.19	0.55	BDL	BDL
NQGP55	Assam	Chengmari	Goalpara	Balijana	26.0051	90.59442	DW	Aquifer ma	13.11.2021	24.4	6.38	48.30	BDL	32	BDL	36.63	37	18	BDL	6.20	BDL	6	2.42	25.00	8.04	13.66	0.78	BDL	0.13
NQGP56	Assam	Dakparbhit	Goalpara	Jaleshwar	25.98211	90.17164	HP	Aquifer ma	11.11.2021	27.2	8.39	219.90	0.10	145	27.00	134.31	161	28	5.1	BDL	BDL	12	19.41	110.00	25.61	13.83	0.65	BDL	BDL
NQGP57	Assam	Kheropara	Goalpara	Kuchdhowa	26.04332	90.88484	DW	Aquifer ma	14.11.2021	24.9	6.95	206.30	BDL	136	BDL	61.05	61	32	0.5	14.63	BDL	10	12.13	75.00	7.92	4.62	0.54	0.76	BDL
NQGP58	Assam	Pattapara	Goalpara	Dudhnoi	25.96778	90.90583	DW	Aquifer ma	14.11.2021	25.9	7.62	106.30	BDL	70	BDL	61.05	61	14	2.3	3.23	BDL	12	2.42	40.00	11.52	9.40	0.62	0.26	0.09
NQGP59	Assam	Rongjuli	Goalpara	Rongjuli	25.96722	90.925	DW	Aquifer ma	14.11.2021	29.5	7.76	104.10	BDL	69	BDL	67.15	67	14	BDL	BDL	BDL	12	3.63	45.00	8.53	3.89	6.11	0.76	0.02

Table 2.6: Water quality data of samples collected during Pre-monsoon

Well Number	State	Location	District	Block	Lat DD	Long DD	Type of sample (EW or DW)	NHNS/Exploratory/Aquifer mapping	Date of collection	Temp ºC	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS	CO3-2	HCO3-1	TA (as CaCO3)	Cl-	SO4-2	NO3-1	F-	Ca+2	Mg+2	TH (as CaCO3)	Na	K	Fe	As
NQGP01	Assam	Agia	Goalpara	Balijana	26.082717	90.564122	DW	Aquifer mapping	29.01.22	25.6	8.30	239.60	BDL	158.14	9.00	128.20	137.20	10.64	3.38	1.16	0.29	20.02	13.34	105.00	15.67	3.57	2.16	0.21
NQGP02	Assam	Ambuk	Goalpara	Rongjuli	25.925941	91.036562	DW	Aquifer mapping	06.02.22	20.5	6.84	47.44	BDL	31.31	BDL	24.42	24.42	14.18	40.16	BDL	0.06	6.00	2.42	25.00	24.31	2.27	0.44	BDL
NQGP03	Assam	Amjonga	Goalpara	Dudhnoi	25.970478	90.847101	DW	Aquifer mapping	04.02.22	24.8	6.82	40.23	BDL	26.55	BDL	24.42	24.42	10.64	0.32	BDL	BDL	6.00	3.64	30.00	2.89	1.44	0.41	0.41
NQGP04	Assam	Bagdoba	Goalpara	Rongjuli	26.008411	91.069433	DW	Aquifer mapping	05.02.22	22.1	7.07	61.40	BDL	40.52	BDL	36.63	36.63	14.18	36.15	3.15	BDL	10.01	2.42	35.00	20.88	1.64	0.12	BDL
NQGP05	Assam	Baida	Goalpara	Balijana	26.025833	90.416389	DW	Aquifer mapping	02.02.22	23.2	6.70	49.65	BDL	32.77	BDL	30.52	30.52	10.64	10.16	1.90	0.04	6.00	2.42	25.00	12.71	1.8	0.36	BDL
NQGP06	Assam	Bhalukdubi	Goalpara	Balijana	26.130556	90.595000	DW	Aquifer mapping	30.01.22	22.9	6.98	116.70	BDL	77.02	BDL	67.15	67.15	7.09	BDL	4.54	0.04	18.01	2.42	55.00	3.35	1.9	0.52	BDL
NQGP07	Meghalaya	Borgobal	West Garo Hills	Tikrikila	25.983794	90.332665	DW	Aquifer mapping	02.02.22	20.4	6.70	63.27	0.30	41.76	BDL	48.84	48.84	7.09	18.16	1.57	BDL	14.01	3.63	50.00	8.12	0.97	0.44	BDL
NQGP08	Assam	Budlung Garohita	Goalpara	Rongjuli	25.994772	90.937995	DW	Aquifer mapping	08.02.22	21.2	6.27	80.54	BDL	53.16	BDL	42.73	42.73	14.18	10.23	6.51	BDL	8.01	3.64	35.00	9.08	#####	0.83	0.83
NQGP09	Assam	Chari Gaon Bazar	Goalpara	Krishnai	25.970322	90.673854	DW	Aquifer mapping	08.02.22	23.1	6.70	71.14	0.40	46.95	BDL	42.73	42.73	14.18	2.69	8.33	0.73	12.01	3.63	45.00	5.85	2.71	0.08	BDL
NQGP10	Assam	Chekowari	Goalpara	Rongjuli	25.893936	91.017238	DW	Aquifer mapping	06.02.22	22.7	7.56	321.80	0.10	212.39	BDL	158.73	158.73	14.18	0.01	0.25	0.07	26.02	15.76	130.00	6.19	12.3	0.44	BDL
NQGP11	Assam	Dampara	Goalpara	Balijana	26.092949	90.493693	DW	Aquifer mapping	01.02.22	20	6.04	33.47	0.10	22.09	BDL	12.21	12.21	17.73	25.05	0.60	0.44	2.00	3.64	20.00	18.12	3.75	0.06	11.64
NQGP12	Assam	Damra	Goalpara	Dudhnoi	25.929167	90.776389	DW	Aquifer mapping	31.01.22	23.9	8.35	145.20	BDL	95.83	6.00	54.94	60.94	14.18	0.13	5.46	0.18	16.01	7.27	70.00	4.52	2.75	0.47	BDL
NQGP13	Meghalaya	Darakona Rabha	North Garo Hills	Resubelpara	25.908014	90.531178	DW	Aquifer mapping	05.02.22	21.7	7.03	143.00	BDL	94.38	BDL	30.52	30.52	24.82	15.15	0.32	0.04	6.00	6.07	40.00	8.21	12.8	0.51	BDL
NQGP14	Assam	Darrangiri	Goalpara	Dudhnoi	25.968780	90.888070	TW	Aquifer mapping	04.02.22	26.1	7.47	436.30	BDL	287.96	BDL	146.52	146.52	46.09	3.16	BDL	0.29	38.03	12.12	145.00	20.36	2.38	8.98	0.82
NQGP15	Assam	Dekdhowa	Goalpara	Balijana	26.144103	90.664601	DW	Aquifer mapping	30.01.22	22.3	6.52	71.80	BDL	47.39	BDL	48.84	48.84	14.18	3.65	BDL	0.14	6.00	2.42	25.00	14.97	2.38	0.11	BDL
NQGP16	Assam	Dhubapara	Goalpara	Matia	26.127993	90.684183	DW	Aquifer mapping	30.01.22	22.8	8.38	140.90	BDL	92.99	6.00	97.68	103.68	10.64	0.22	3.89	0.18	14.01	6.06	60.00	13.32	10.1	0.63	BDL
NQGP17	Assam	Dhupdhara	Goalpara	Rongjuli	25.962268	91.058532	DW	Aquifer mapping	05.02.22	63.3	7.00	153.20	BDL	101.11	BDL	36.63	36.63	28.36	27.15	BDL	BDL	8.01	3.64	35.00	25.55	2.49	0.16	BDL
NQGP18	Assam	Dudhnoi I	Goalpara	Dudhnoi	25.982500	90.781667	DW	Aquifer mapping	31.01.22	21.8	6.45	388.50	BDL	256.41	BDL	109.89	109.89	56.72	12.36	0.55	0.57	32.03	7.27	110.00	19.91	10.4	0.54	0.53
NQGP19	Assam	Dudhnoi II	Goalpara	Dudhnoi	25.951944	90.775833	DW	Aquifer mapping	31.01.22	22.1	8.41	25.59	0.10	16.89	9.00	42.73	51.73	14.18	0.64	0.80	0.45	6.00	1.21	20.00	21.22	4.74	0.11	13.69
NQGP20	Assam	Dwarka	Goalpara	Balijana	26.056389	90.495278	DW	Aquifer mapping	02.02.22	21.5	7.05	140.20	BDL	92.53	BDL	85.47	85.47	14.18	19.24	0.37	0.11	20.02	2.42	60.00	22.84	3.19	0.23	BDL
NQGP21	Assam	Harimura	Goalpara	Matia	26.086312	90.672325	TW	Aquifer mapping	03.02.22	19.4	7.32	232.90	BDL	153.71	BDL	152.62	152.62	10.64	0.15	8.15	0.15	20.02	8.49	85.00	22.25	1.45	0.15	BDL
NQGP22	Assam	Harimura	Goalpara	Matia	26.086887	90.669502	DW	Aquifer mapping	03.02.22	16.7	7.10	123.50	0.10	81.51	BDL	61.05	61.05	10.63	0.02	0.05	BDL	18.01	2.42	55.00	4.44	1.69	0.10	BDL
NQGP23	Assam	Hatimura	Goalpara	Jaleshwar	26.015911	90.233582	DW	Aquifer mapping	03.02.22	22.3	7.37	505.40	0.20	333.56	BDL	177.04	177.04	74.45	23.26	BDL	0.24	54.04	9.68	175.00	32.54	2.67	0.19	BDL
NQGP24	Meghalaya	Hatogaon	West Gar	Tikrikila	26.008309	90.360184	DW	Aquifer mapping	02.02.22	19.1	7.97	161.80	BDL	106.79	BDL	91.57	91.57	21.27	0.15	0.15	BDL	24.02	9.70	100.00	3.21	1.98	0.16	BDL
NQGP25	Assam	Hudakona	Goalpara	Krishnai	25.953252	90.554477	DW	Aquifer mapping	05.02.22	21.9	7.37	95.35	BDL	62.93	BDL	48.84	48.84	7.09	2.05	BDL	0.12	14.01	2.42	45.00	2.69	2.42	0.16	BDL
NQGP26	Assam	Hurkakuchi	Goalpara	Balijana	26.189843	90.588050	DW	Aquifer mapping	07.02.22	23.9	6.35	141.50	BDL	93.39	BDL	67.15	67.15	21.27	5.35	12.95	0.50	24.02	1.20	65.00	19.38	2.95	0.19	BDL
NQGP27	Assam	Jiaguri	Goalpara	Balijana	26.023430	90.624855	DW	Aquifer mapping	04.02.22	22.7	7.15	134.00	BDL	88.44	BDL	79.36	79.36	10.64	8.15	0.15	0.66	24.02	1.20	65.00	7.36	2.21	0.17	BDL
NQGP28	Assam	Jyotigaon	Goalpara	Rongjuli	25.926564	91.001666	DW	Aquifer mapping	06.02.22	22.3	6.72	91.11	BDL	60.13	BDL	30.52	30.52	17.73	2.99	11.95	0.25	18.01	1.20	50.00	4.81	3.51	0.33	BDL
NQGP29	Assam	Karmuja	Goalpara	Kharmuja	26.147347	90.482660	DW	Aquifer mapping	03.02.22	22.8	8.47	366.10	BDL	241.63	9.00	183.15	192.15	31.91	12.15	11.16	BDL	46.04	7.26	145.00	27.86	8.89	0.29	BDL
NQGP30	Assam	Ketkibari	Goalpara	Balijana	26.020706	90.481228	DW	Aquifer mapping	01.02.22	23.2	8.40	147.60	BDL	97.42	9.00	103.78	112.78	10.64	0.16	0.94	0.04	28.02	2.41	80.00	10.73	1.53	0.70	BDL
NQGP31	Assam	Khamari	Goalpara	Krishnai	25.936888	90.670914	DW	Aquifer mapping	08.02.22	22.4	6.82	107.00	BDL	70.62	BDL	73.26	73.26	10.64	10.52	5.59	BDL	22.02	1.20	60.00	10.12	2.98	1.20	BDL
NQGP32	Assam	Khara Medhipara	Goalpara	Dudhnoi	26.003614	90.789095	DW	Aquifer mapping	31.01.22	22.8	6.71	71.71	BDL	47.33	BDL	61.05	61.05	3.54	0.01	6.11	BDL	6.00	2.42	25.00	14.88	3.9	0.69	0.72
NQGP33	Assam	Khopamara	Goalpara	Rongjuli	26.023147	91.000206	DW	Aquifer mapping	06.02.22	20.7	5.91	27.73	0.20	18.30	BDL	30.52	30.52	21.27	1.40	6.70	0.09	14.01	2.42	45.00	8.84	1.96	0.10	BDL
NQGP34	Assam	Kolabari	Goalpara	Jaleshwar	26.016358	90.256844	DW	Aquifer mapping	02.02.22	22.5	6.85	176.00	BDL	116.16	BDL	61.05	61.05	28.36	0.15	1.16	0.36	16.01	4.85	60.00	11.82	1.87	0.08	BDL
NQGP35	Assam	Konachipara Maj	Goalpara	Kharmuja	26.094497	90.408742	DW	Aquifer mapping	03.02.22	21.6	8.48	183.40	BDL	121.04	6.00	103.78	109.78	7.09	0.01	3.89	BDL	20.02	7.27	80.00	6.12	2.3	1.55	1.55
NQGP36	Assam	Krishnai	Goalpara	Krishnai	26.034430	90.669930	TW	Aquifer mapping	01.02.22	25	8.35	243.40	0.20	160.64	12.00	146.52	158.52	17.73	41.56	1.36	0.09	20.02	7.27	80.00	43.25	12.7	0.16	BDL
NQGP37	Assam	Krishnai New	Goalpara	Krishnai	26.034722	90.661667	DW	Aquifer mapping	29.01.22	22.6	8.40	168.80	BDL	111.41	3.00	115.99	118.99	21.27	BDL	23.15	0.55	20.02	2.42	60.00	33.55	6.36	0.14	0.32
NQGP38	Assam	Kukurkata	Goalpara	Krishnai	25.923115	90.540790	DW	Aquifer mapping	05.02.22	22.3	7.35	177.30	BDL	117.02	BDL	85.47	85.47	14.18	11.13	2.18	0.23	18.01	3.63	60.00	12.52	18.7	1.47	BDL
NQGP39	Assam	Makri Bazar	Goalpara	Balijana	26.157969	90.548748	DW	Aquifer mapping	07.02.22	21.4	8.33	301.40	BDL	198.92	3.00	134.31	137.31	31.91	5.61	13.69	0.29	36.03	8.48	125.00	22.82	4.72	0.10	BDL
NQGP40	Assam	Markula Garopar	Goalpara	Balijana	26.070292	90.435797	TW	Aquifer mapping	02.02.22	24.7	8.36	369.70	BDL	244.00	15.00	225.88	240.88	10.64	0.13	0.15	BDL	38.03	2.41	105.00	43.89	2.35	0.39	0.25

Well Number	State	Location	District	Block	Lat DD	Long DD	Type of sample (EW or DW)	NHNS/Exploratory/Aquifer mapping	Date of collection	TempºC	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS	CO3-2	HCO3-1	TA (as CaCO3)	Cl-	SO4-2	NO3-1	F-	Ca+2	Mg+2	TH (as CaCO3)	Na	K	Fe	As
NQGP41	Assam	Mornai I	Goalpara	Matia	26.092260	90.744890	TW	Aquifer ma	30.01.22	25.7	6.46	90.91	BDL	60.00	BDL	73.26	73.26	7.09	7.27	BDL	BDL	10.01	1.21	30.00	19.45	2.87	0.04	BDL
NQGP42	Assam	Mornai II	Goalpara	Matia	26.095270	90.741020	TW	Aquifer ma	30.01.22	24.3	6.69	102.00	BDL	67.32	BDL	79.36	79.36	3.55	12.56	6.27	BDL	14.01	1.21	40.00	17.23	2.91	0.44	17.20
NQGP43	Assam	Nepalikuti	Goalpara	Matia	26.078569	90.746331	DW	Aquifer ma	31.01.22	21.7	6.86	82.02	BDL	54.13	BDL	67.15	67.15	7.09	10.27	2.06	0.06	4.00	3.64	25.00	18.97	5.84	2.92	BDL
NQGP44	Assam	Pancharatr	Goalpara	Balijana	26.197776	90.585737	Spring	Aquifer ma	07.02.22	18.1	6.51	71.95	BDL	47.49	BDL	36.63	36.63	7.09	9.67	3.97	BDL	8.01	1.21	25.00	12.50	2.11	0.07	BDL
NQGP45	Assam	Pancharatr	Goalpara	Balijana	26.196153	90.563229	DW	Aquifer ma	07.02.22	20.1	6.44	78.65	BDL	51.91	BDL	54.94	54.94	24.82	5.98	2.75	BDL	26.02	1.20	70.00	9.14	1.79	0.21	BDL
NQGP46	Assam	Pub Matia	Goalpara	Matia	26.073974	90.792420	DW	Aquifer ma	31.01.22	22.2	6.60	81.18	0.40	53.58	BDL	67.15	67.15	10.64	9.54	1.82	0.14	8.01	2.42	30.00	17.77	2.89	1.52	11.83
NQGP47	Assam	Rongjuli	Goalpara	Rongjuli	25.975590	90.959710	TW	Aquifer ma	09.02.22	24.9	8.35	359.50	BDL	237.27	6.00	195.36	201.36	17.73	31.12	0.12	1.93	24.02	4.84	80.00	75.10	4.80	0.20	BDL
NQGP48	Assam	Salpara	Goalpara	Krishnai	26.012778	90.700833	DW	Aquifer ma	01.02.22	21.8	6.48	70.57	BDL	46.58	BDL	30.52	30.52	21.27	15.15	0.07	0.60	8.01	2.42	30.00	13.9	6.6	0.20	BDL
NQGP49	Assam	Sarapara	Goalpara	Rongjuli	25.971389	90.952500	DW	Aquifer ma	09.02.22	21.6	8.45	283.20	BDL	186.91	15.00	207.57	222.57	14.18	0.81	3.98	0.87	30.02	10.91	120.00	37.04	2.84	2.35	5.27
NQGP50	Assam	Silapani	Goalpara	Lakhimpur	26.045563	90.311193	DW	Aquifer ma	03.02.22	20.7	8.37	430.90	BDL	284.39	18.00	231.99	249.99	24.82	16.25	0.00	0.14	54.04	14.54	195.00	31.74	3.51	0.25	0.44
NQGP51	Assam	Simlitola	Goalpara	Rongjuli	26.073140	90.073914	DW	Aquifer ma	08.02.22	22.7	7.11	169.90	BDL	112.13	BDL	122.10	122.10	14.18	0.66	0.57	0.40	20.02	10.91	95.00	11.85	2.15	2.30	BDL
NQGP52	Assam	Teuli	Goalpara	Rongjuli	26.073611	90.513889	DW	Aquifer ma	01.02.22	21	8.41	138.90	BDL	91.67	6.00	91.57	97.57	10.64	18.49	0.27	0.21	22.02	2.42	65.00	15.87	2.28	3.81	0.25
NQGP53	Assam	Thorko Baz	Goalpara	Lakhipur	25.985923	90.250322	DW	Aquifer ma	02.02.22	22.1	6.98	113.20	BDL	74.71	BDL	67.15	67.15	10.64	6.02	12.30	BDL	14.01	3.63	50.00	12.4	1.09	0.47	BDL
NQGP54	Assam	Tinikonipar	Goalpara	Matia	26.101270	90.728410	TW	Aquifer ma	30.01.22	22.1	6.83	97.50	0.50	64.35	BDL	79.36	79.36	7.09	5.13	BDL	0.24	12.01	3.63	45.00	11.83	3.03	0.36	BDL

Geophysical survey: Geophysical survey was carried out at 13 locations in the district in the year of 2012-13.

Table 2.7: Geophysical data survey in Goalpara district in 2012-13 & 2021-22

Sr. No.	District	Location/	Depth (m)	Hard rock/ Soft Rock	Year	Latitude	Longitude
1	Goalpara	Dulehaparyanpura	19	soft rock	2012-13	26.0317	90.7606
2	Goalpara	Dalgoma	87	soft rock	2012-13	26.1011	90.7875
3	Goalpara	Sidhabari	187	soft rock	2012-13	26.075	90.8322
4	Goalpara	Simlitola	108	soft rock	2012-13	26.0631	90.9164
5	Goalpara	Digheli	272	soft rock	2012-13	25.9836	91.0531
6	Goalpara	Uparthala	32	soft rock	2012-13	26.035	90.7889
7	Goalpara	Sonapur	38	soft rock	2012-13	26.0358	90.7025
8	Goalpara	Domani	28	soft rock	2012-13	26.0769	90.7603
9	Goalpara	Matia	89	soft rock	2012-13	26.0414	90.7836
10	Goalpara	Bakrapara	59	soft rock	2012-13	26.0239	90.9356
11	Goalpara	Kalubari	82	soft rock	2012-13	26.1042	90.9822
12	Goalpara	Rabhapara	132	soft rock	2012-13	25.9703	90.9283
13	Goalpara	Darranggiri	110	soft rock	2012-13	25.9711	90.7242
14	Goalpara	Nisangram	45	Hard rock	2021-22	25.91809	90.76208

Under AAP 2021-22, One Surface Geophysical studies was carried out to assess the feasibility of exploratory tubewell at Nisangram EW site in Kuchdhowa (Dudhnoi) block of Golpara district.

The VES observed can be located on toposheets (78K/13) with the co-ordinates given along with results. QH type VES curve was obtained. The following table describes the interpreted results of VES and inferences with respect to possible sub-surface geology.

(VES-1): District: Golpara , Block: Dudhnoi, Village: Nisangram, , Assam (Latitude: 25.91809 N, Latitude: 90.76208 E)

Table 2.8: Geophysical data survey in Goalpara district in 2021-22

Depth range (m)	Thickness	Interpreted layer resistivity (ohm m)	Inferences
G.L.-3.43	3	1482	Topsoil with Boulders
3.43-8.59	6	57.6	Sandy clay
8.59-30.3	24	32.1	Clay formation
>30.3		176	Sand formation

Exploratory Drilling: Central Ground Water Board, North Eastern Region, Guwahati had began exploration in the district since 1977 and drilled 14 exploratory wells till 2013.During AAP 2021-22 exploration activity initiated in the district focussing mainly to

cover unexplored hard rock terrain of the district, two exploratory wells were constructed in the area.

A list of wells constructed in the area was prepared incorporating location, well designs, etc.

Table 2.8: Details of exploratory wells in Goalpara District, Assam

Location	Longitude	Latitude	Type of well	Formation	Depth Drilled (mbgl)	Depth of constr. (mbgl)	Source/ Agency
Faulimari-EW	90.286111	26.020833	TW	Alluvium. Hard rock at 71.6 m	71.66	55.00	CGWB
Jaleswar-EW	90.200000	26.041667	TW	Alluvium. Hard rock at 90.4 m	90.40	85.50	CGWB
Narangbari-EW	90.397222	26.041667	TW	Alluvium. Hard rock at 81.9 m	81.91	70.00	CGWB
Rangjuli-EW	90.940278	25.970833	TW	Alluvium. Hard rock at 101 m	101.00	100.00	CGWB
Paharsingpara-EW	90.694444	26.133333	TW	Alluvium. Hard rock at 90.85 m	90.85	90.00	CGWB
Doodhnoi-EW	90.787500	25.979167	TW	Alluvium. Hard rock at 81.0 m	81.50	77.00	CGWB
Kuruabhasa-EW	90.687500	26.116667	TW	Alluvium. Hard rock at 81.5 m	81.50	77.00	CGWB
Goalpara Civil Hospital-I-EW	90.616667	26.132778	TW	Granite Gniess	201.70		CGWB
Goalpara Civil Hospital-II-EW	90.616667	26.132778	TW	Granite Gniess	184.04		CGWB
Darangiri-EW	90.878056	25.955000	TW	Granite Gniess	194.30		CGWB
Dighali-EW	91.060556	25.980000	TW	Alluvium	183.00	153.00	CGWB
Sidhabari-EW	90.818611	26.077222	TW	Alluvium	103.30	95.00	CGWB
Simlitola-EW	90.926667	26.074167	TW	Alluvium	136.10	108.00	CGWB
Dalgoma-EW	90.785833	26.100833	TW	Alluvium	107.00	99.00	CGWB
Nisangram-EW	90.764	25.912	TW	Granite Gniess	200.0		CGWB
Pancharatna-EW	90.566875	26.195969	TW	Granite Gniess	179.3		CGWB

CHAPTER 3.0

Data Interpretation, Integration and Aquifer Mapping

3.1 Data Interpretation

Data Interpretation

The subsurface geology of Goalpara District is interpreted based on exploration data of CGWB.

The drilled depth of CGWB's exploratory well ranges from 71.6 to 201.70 mbgl. Distribution of well as per drilling depth indicates that 35% of exploratory wells depth ranges from 50 to 100mbgl (Table 3.1).

Table 3.1: Distribution of EW based on drilled depth.

Depth	within 50m	50-100m	100-150m	150-200m	200-250m	250-300m	Total
No. of wells	0	6	4	5	2	0	17
% of well	0	35	24	29	12	0	100

Plotting of EW locations in the geomorphologic map indicate that two of the wells were constructed in piedmont area. Majority of wells were constructed older alluvial plain and rest were located in younger alluvial plain.

From the available data two principal aquifers can be identified in the district, viz., alluvium of unconsolidated nature of Quaternary age and gneissic aquifer of Archean age.

Data Integration: To know the aquifer geometry of the district, lithologs of CGWB's exploratory wells and lithologsof state government are compiled

A. 2D disposition

Three sections are constructed to visualize the aquifer disposition

(i) An East-West section from 2 Zira to Dighelialong the southern boundary of the district (Fig. 3.1)

(ii) An almosteast-west section from Chaibari to Narangabarialong the Brahmaputra River (Fig. 3.2).

(iii) A North-West to South-East section from Kuruabasa to Digheli (Fig. 3.3).

The easy-west section along the southern boundary of the district from 2 Zira to Digheli shows presence of three regionally extensive confining layers. Generally clay thickness is more towards eastern direction. Thicknesses of granular zones are also increasing towards the east. However, grain size of aquifer materials are decreasing towards east. (Fig 3.1).

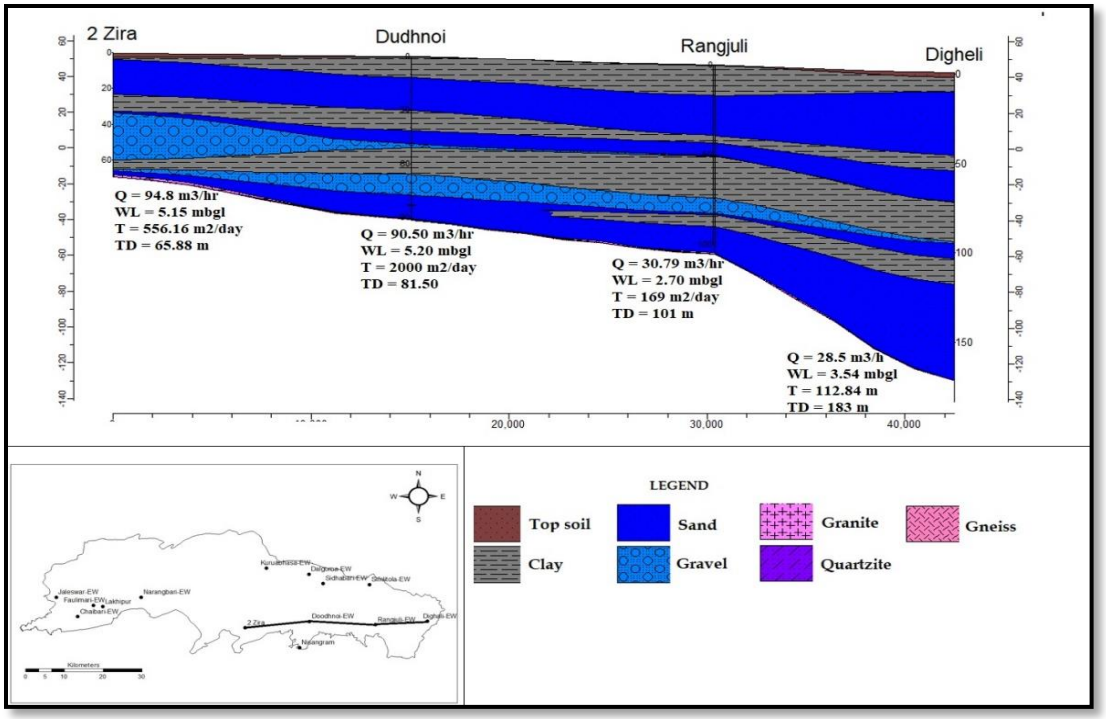


Figure 3.1. 2D disposition along East-West direction.

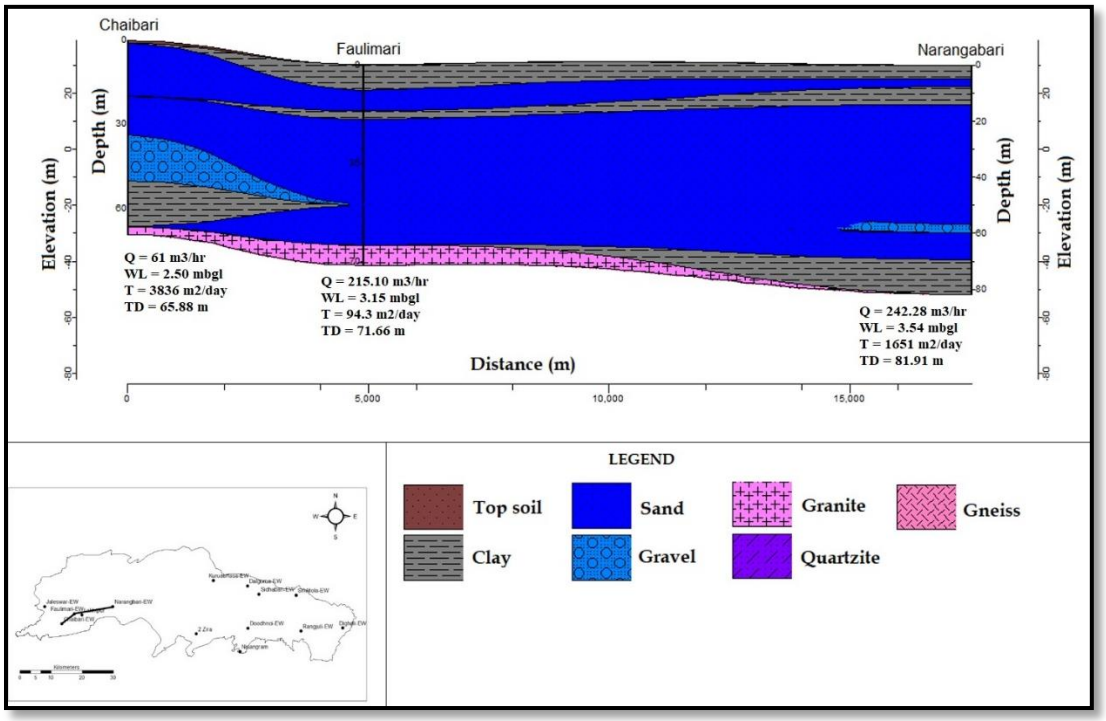


Figure 3.2. 2D disposition along the river Brahmaputra.

Section showing 2D disposition of aquifer along river Brahmaputra indicates presence of gneissic aquifer at around 62m depth.The alluvial aquifer is sand dominated and clay occurs as lenses (Fig. 3.2)..

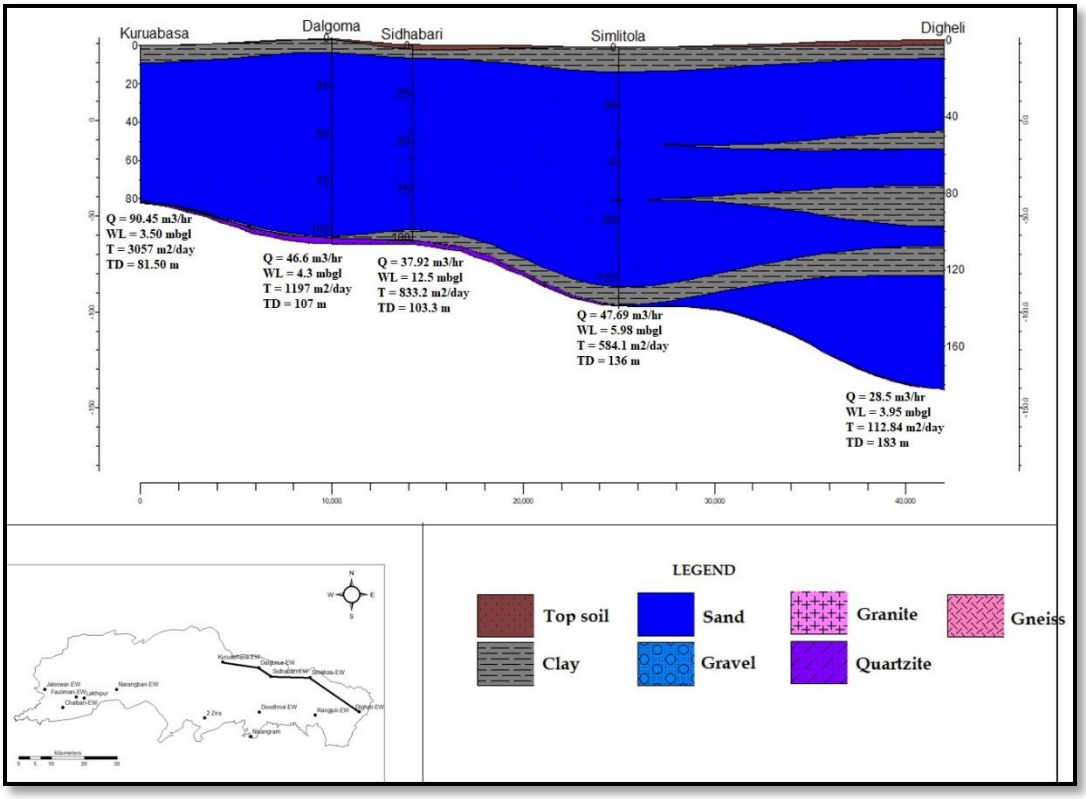


Figure 3.3.2D disposition along Brahmaputra River towards North-West to South-East direction.

In the northwest-southeast section quartzite encounters at 104m depth towards the northwestern direction. The alluvial aquifer in this section is sand dominated and clay occurs as lenses towards the eastern part (Fig 3.3).

3D disposition of aquifer: The aquifer disposition of the area in the 3D block diagram indicates presence of multi-aquifer system in the district. The banded gneiss aquifer encounters at shallow depth towards the southern part of the district bordering Meghalaya and also in the north near the inselberg at Pancharatna. In the eastern and western parts of the district the alluvial aquifer thickness is increasing and gneissic aquifer is expected to encounter at deeper depth (Fig.3.4).

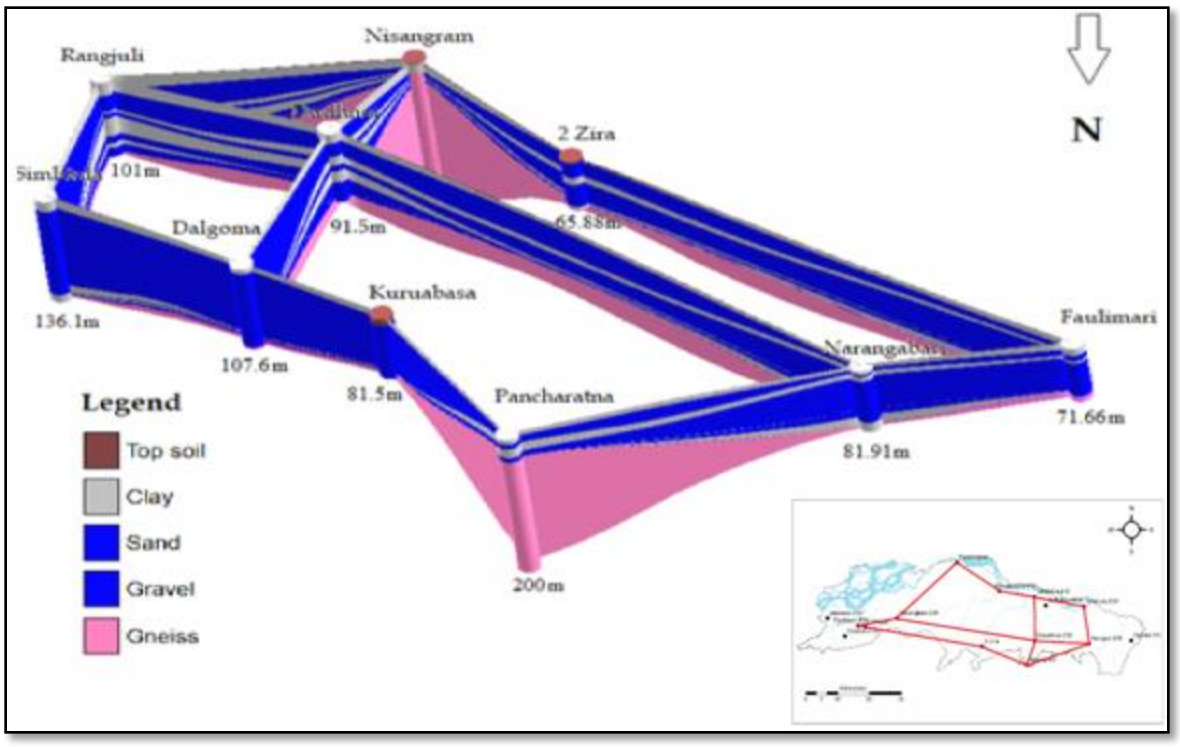


Fig. 3.4: 3D disposition of aquifer in the study area

Aquifer characteristics

Two major aquifers are identified in the area, viz., younger alluvium and banded gneissic aquifers. Gneissic aquifer is explored during AAP 2021-22. Unconsolidated alluvial aquifer consists of older and younger alluvium. The alluvial aquifer is characterized by coarse grained materials ranging in size from sand to gravel. Broadly the aquifer in the district can be classified into two groups for ground water extraction purposes, viz., shallow aquifer and deeper aquifer. Shallow aquifer depth limit is 50m and below which deeper aquifer exists. The cumulative thicknesses of both shallow and deeper aquifers are given in Table 3.2.

i) Shallow aquifer system

Shallow aquifer system is considered to be within 50 m below ground level. Within this depth cumulative thickness of aquifer ranging from 31 to 50 m in the alluvial aquifer. Ground water structures contains in flood plain, younger and older alluvium in shallow aquifer zones can give yield varies from 110 to 320 m^3/hr.

ii) Deeper Aquifer System:

Deeper aquifer system in the depth ranges 50 to more than 200 m having cumulative thickness of more than 40 m. These tube wells are giving yield of 30 to 90 m^3/hr. The discharge capacity however observed to be lesser in case of deep

tubewellconstructed at Granitic gneiss formation at Nisangram, which is found 8 m^3/hr for higher draw down.

3D model of aquifer: The aquifer disposition of the district in the 3D modelhas been extrapolated throughout the district taking into consideration of the lithologs of the constructed exploratory wells. The disposition of granite gneiss aquifer can be seen through model, however, still some places of hard rock terrain are yet to be explored.

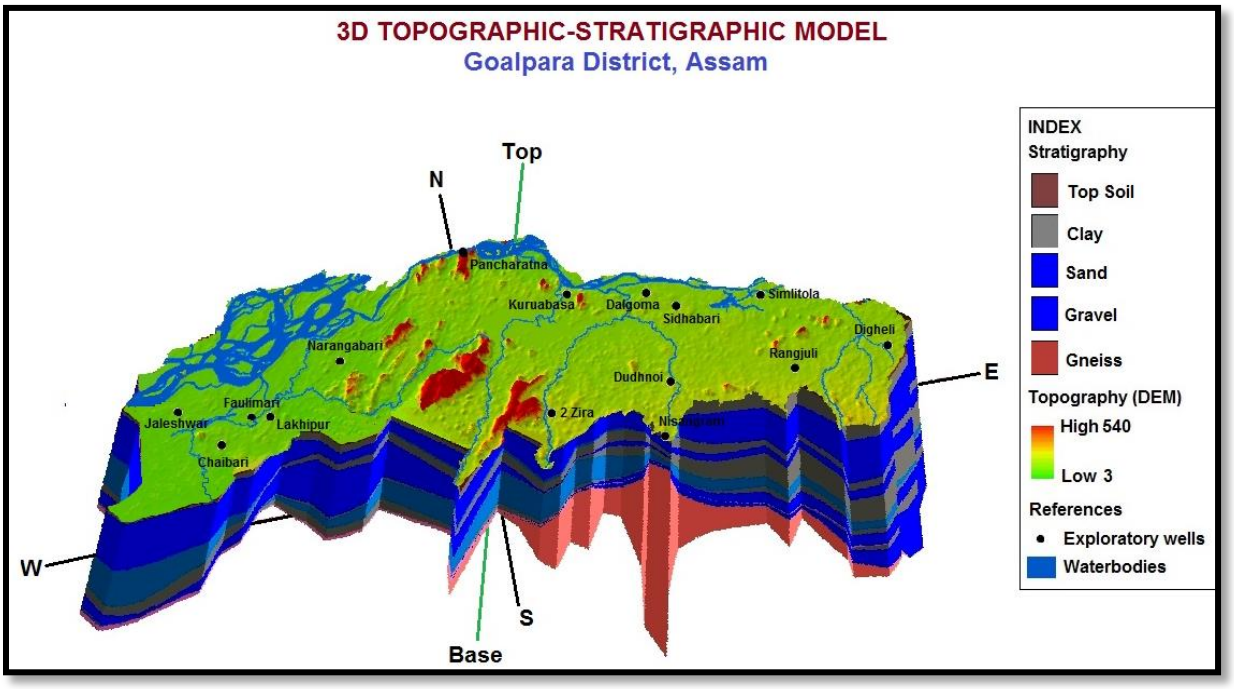


Fig. 3.5: 3 D aquifer model of Goalpara District, Assam

Table 3.2: Aquifer characteristicsin the Goalpara district

Aquifer	Zones / Fractured encountered	Static Water level (mbgl)	Discharge (m3/hr)	Draw Down (m)	Transmissivity (m2/ day)
Alluvium	30-50, 50-84, 92-105, 126-151	2.70-12.50	8.43-242.70	2.10-19.16	113-15431
Granite Gneiss	46-46.5, 71-86, 111-114, 123-131, 165-174	0.33-10.00	7.92-30	12.6-33.77	2.84-11.74

Ground water level

CGWB, NER has 13 nos. of groundwater monitoring stations in the district. During NAQUIM study 61 nos. of key wells were established covering most of the blocks of the district. During AAP 2021-22, water level of the GWMS was measured four times in a groundwater year. The key wells were established in Aug 2021 and the water levels of the key wells were monitored during November 2021 and March 2022. Water level data of the district were summarized in Table 3.3.

Table 3.3: Pre- and post-monsoon depth-to-water level and fluctuation of water level

Sr. No.	Block	Pre-monsoon DTW (mbgl)	Post-monsoon DTW (mbgl)	Fluctuation(m)
1	Kuchdhowa (Dudhnoi)	2.03 to 7.17	1.44 to 6.30	0.59 to 0.87
2	Jaleshwar	3.66 to 3.87	3.02 to 3.53	0.34 to 0.64
3	Kharmuja	0.44 to 3.57	1.44 to 1.87	1.00 to 1.70
4	Krishnai	2.07 to 6.67	1.32 to 5.49	0.75 to 1.18
5	Lakhipur	3.64 to 5.00	1.88 to 3.16	1.76 to 1.84
6	Matia	6.08 to 8.57	3.72 to 5.92	2.36 to 2.65
7	Rongjuli	2.12 to 5.39	1.35 to 4.46	0.77 to 0.93

The pre-monsoon water level in the piedmont varies from 1.68 to 10.37 mbgl, in the older alluvium it varies from 1.87 to 5mbgl and in the younger alluvium it varies between 1.15 to 4.62mbgl. In the structural valley and weathered pediplain pre-monsoon DTW varies from is 4.27 to 7.34 mbgl and 2.42 to 5.04 mbgl respectively. (Table 3.2).

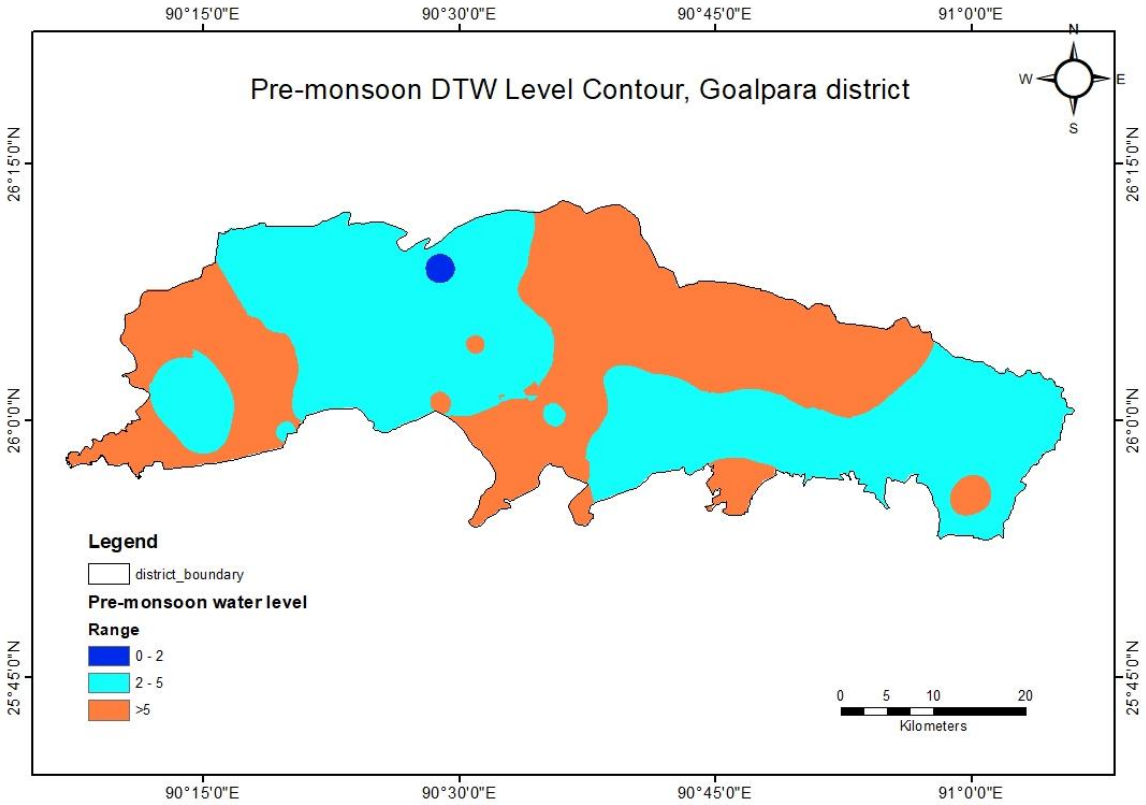


Fig. 3.5: Pre-monsoon DTW level contour of phreatic aquifer of Goalpara District, Assam

The post-monsoon water level in piedmont zone varies from 1.36 to 15.82 mbgl, in older alluvium it varies from 1.64 to 7.40mbgl and in the younger alluvium 0.66 to 4.18mbgl. In the structural valley pre- and post-monsoon DTW is 7.34 and 2.35mbgl respectively. In the structural valley and weathered pediplain post-monsoon DTW is 8.74 mbgl and 4.67mbgl respectively (Table 3.3 & Fig.3.5).

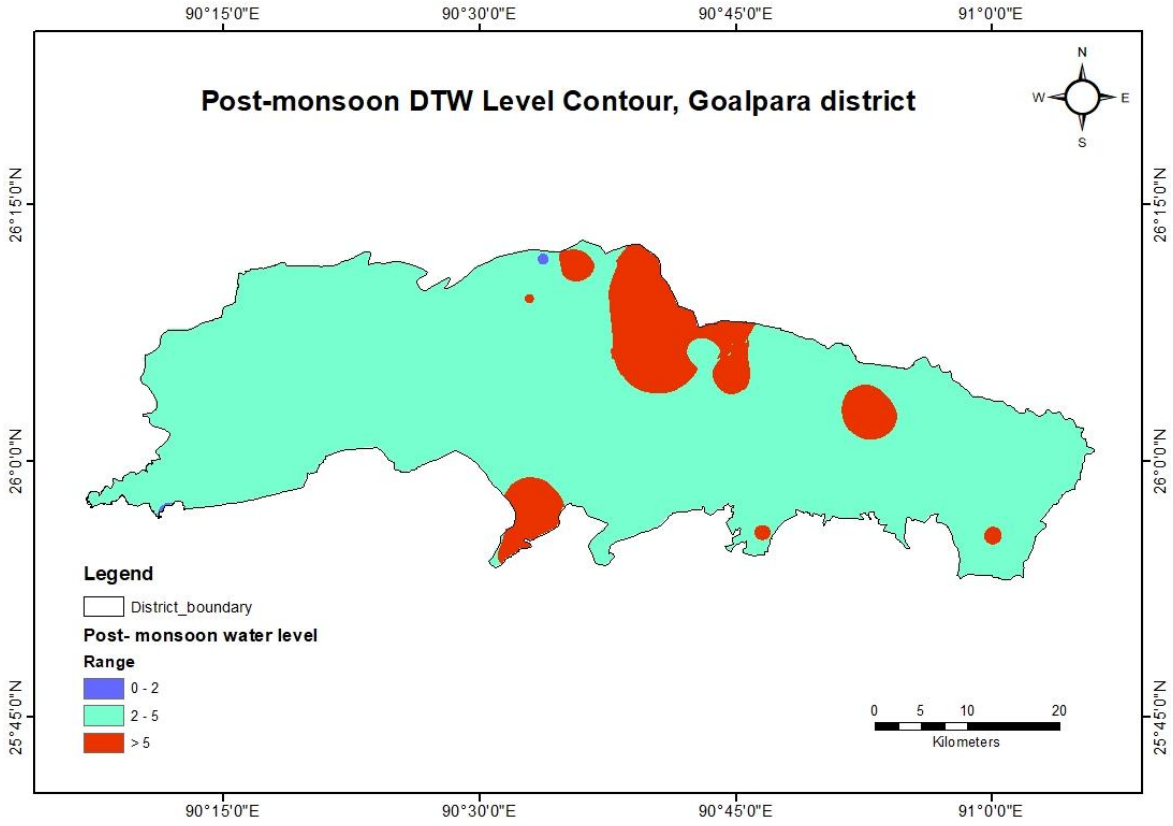


Fig. 3.6: Post-monsoon DTW level contour of phreatic aquifer of Goalpara District, Assam

Fluctuation of water level in the piedmont zone is 0.87 to 1.51m while in older alluvium water level fluctuates between 0.24 to 6.12m. In younger alluvium post-monsoon water level differ from pre- monsoon water level by 0.56 to 1.73 mbgl. The water level fluctuation in the structural valley and in the weathered pediplain is 4.64 and 3.96mbgl respectively (Table 3.3 and Fig.3.6).

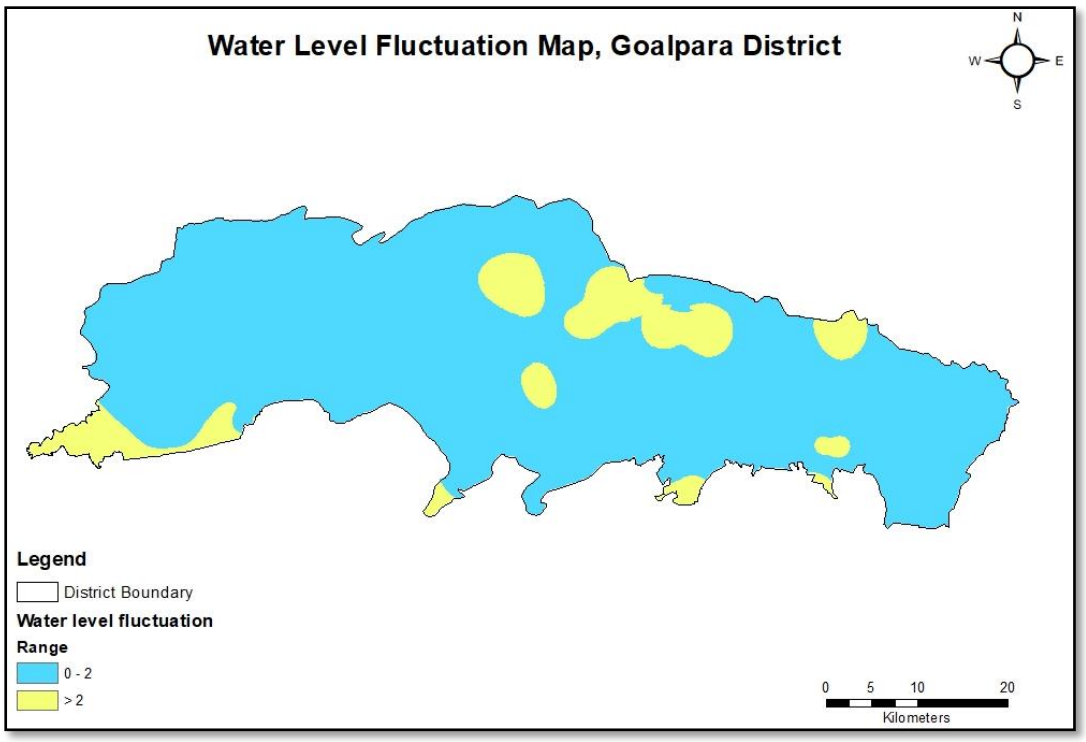


Fig.3.7: Water level fluctuation of phreatic aquifer of Goalpara District, Assam

Ground Water Movement

The water table contour of phreatic aquifer has been prepared based on water level data with respect to elevation of ground water monitoring stations from mean sea level (Fig. 3.8). The contour map shows that water table contour of Goalpara district varies from 25m to 60m above mean sea level (Fig.3.8). In general groundwater movement is towards north, i.e., toward the river Brahmaputra and conforms to the general topography of the district.

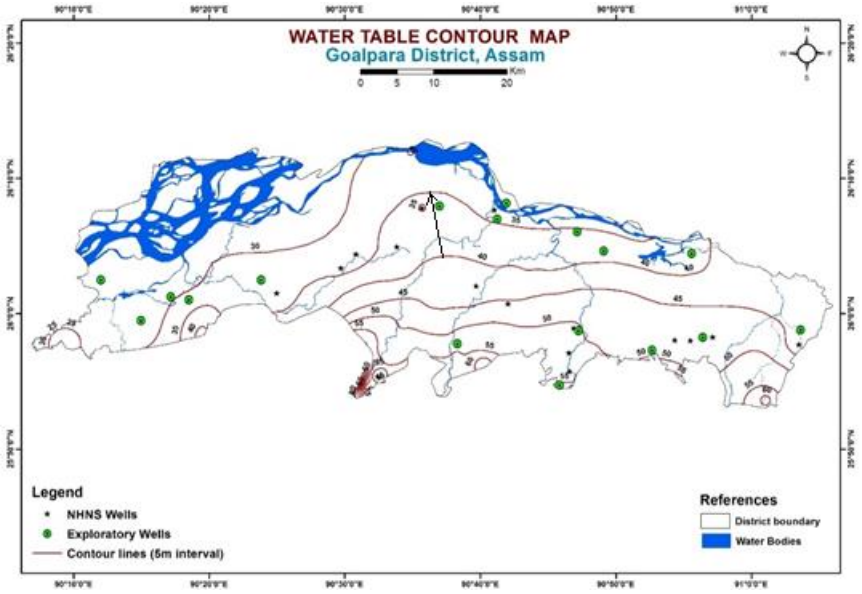


Fig. 3.8: Water table contour of Goalpara District, Assam

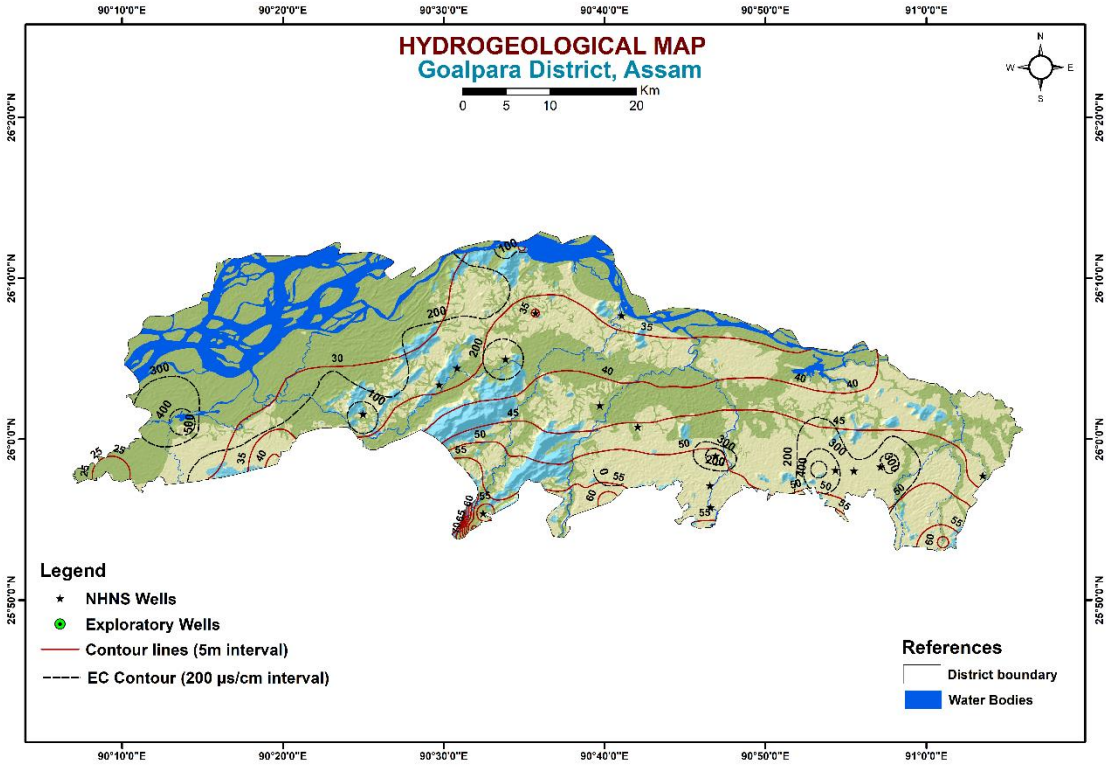


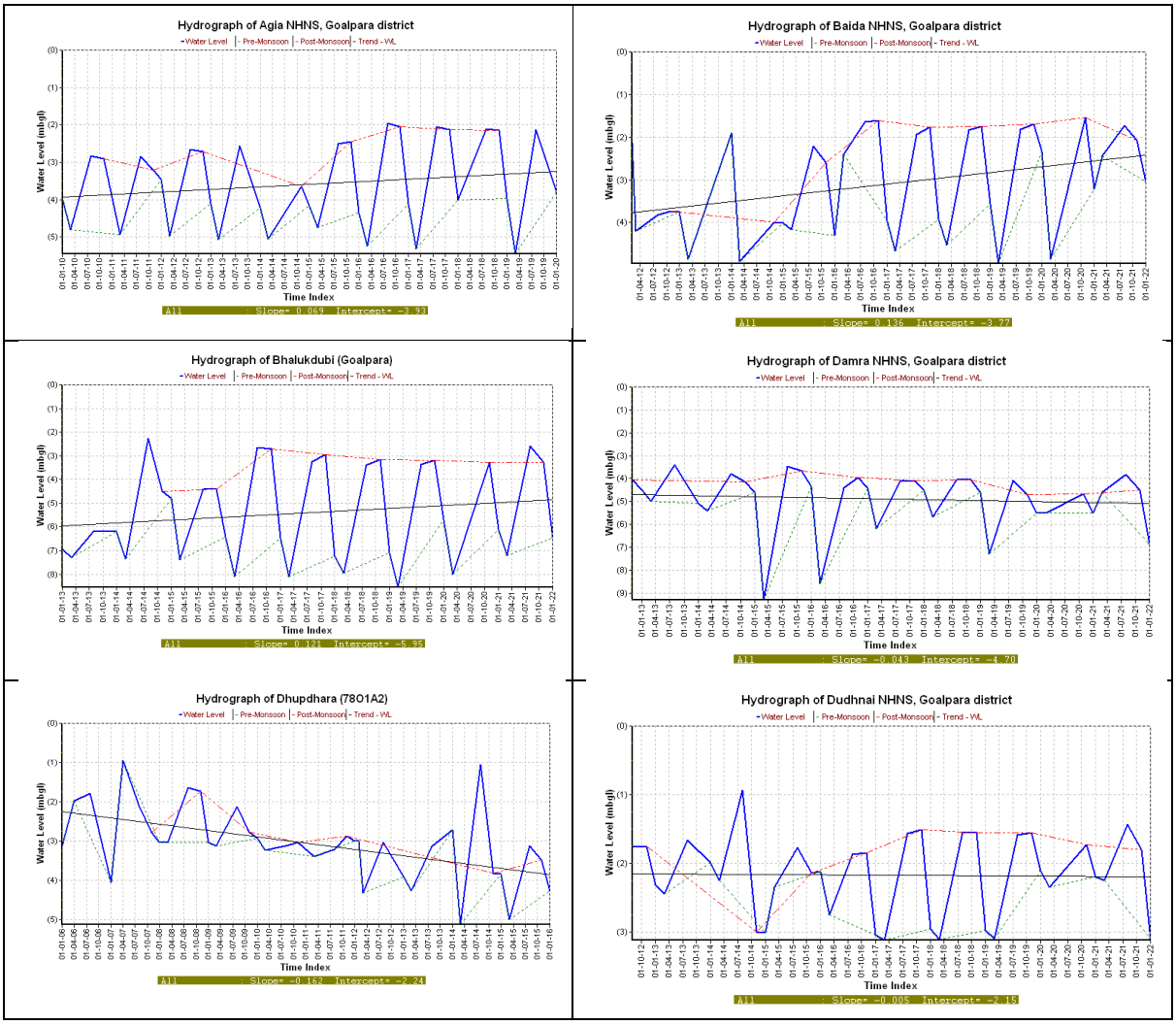
Fig. 3.9: Hydrogeological map of Goalpara District, Assam

Water level trend analysis

For analysis of long-term behaviour of ground water level, data from Ground Water Monitoring Stations (GWMS) are utilized. Historical depth-to-water level data (in mbgl) are plotted as individual hydrographs and are shown in Figure 3.8 and Table 3.4.

Table 3.4 Trend of Water levels in GWMS Wells

Sr. no.	Well No	Locality/Name	No. of years	Water Level Trend	
				Slope	Remark
1		Agia	11	0.069	Rise
2	78J4B3	Baida	11	0.136	Rise
3	ASGP15	Bhalukdubi	10	0.121	Rise
4	78K1D8	Damra	10	-0.043	Fall
5	78O1A2	Dhupdhara	11	-0.162	Fall
6	78K1D1	Dudhnoi	11	-0.005	Fall
7	ASGP17	Dudhnoi II	10	-0.042	Fall
8	ASGP19	Dwarka	10	0.142	Rise
9	ASGP14	Krishnai New	4	0.373	Rise
10	ASGP22	Pattapara	10	0.068	Rise
11	78K1D2	Rongjuli	11	0.010	Rise
12	ASGP16	Salpara	10	0.033	Rise
13	ASGP23	Sarapara	10	0.031	Rise
14	ASGP20	Teuli	10	0.151	Rise



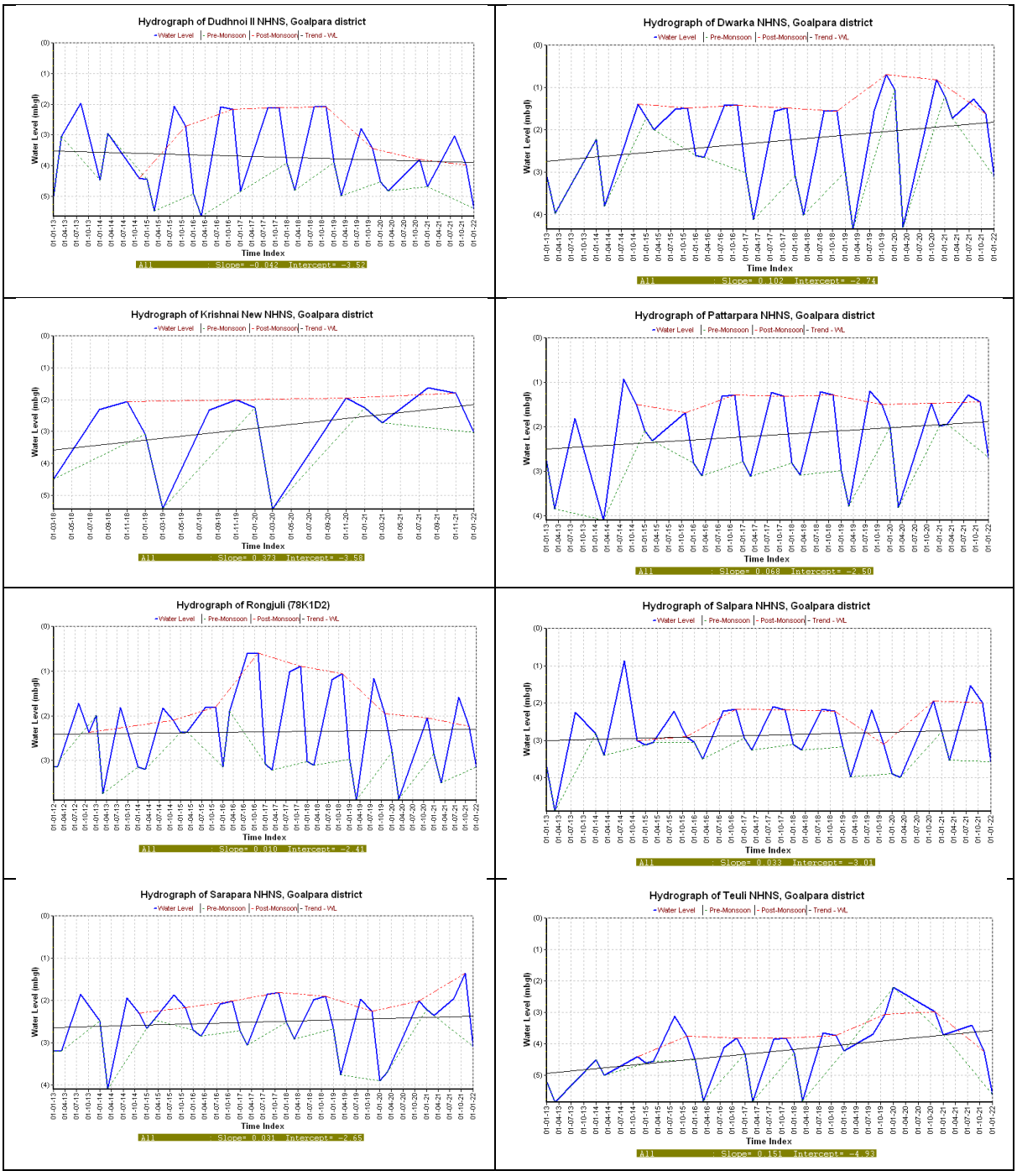


Fig.3.10: Hydrograph of Ground Water Monitoring Stations in Goalpara District, Assam

Ground water quality

Chemical analysis of ground water samples collected during pre-monsoon and post-monsoon are carried out by NABL accredited regional chemical laboratory of Central Ground Water Board, North Eastern Region, Guwahati.

Pre-monsoon pH value ranges from 5.91 to 8.48 and in the post-monsoon pH value ranges from 6.02 to 8.60. Pre-monsoon water sample mostly acidic while post-monsoon samples are mostly alkaline in nature. Pre-monsoon iron concentration range is 0.043 to 8.976 mg/l. Post-monsoon iron concentration is found to be increased in all the blocks. It is observed that in both pre- and post-monsoon groundwater samples concentration of Ca, Mg, Cl, SO_4, TDS and hardness as $CaCO_3$ are within desirable limit. Block wise concentration range of different chemical elements in groundwater during pre- and post- monsoon in Goalpara district is shown in Table 3.4 and 3.5

Table 3.5. Summarized chemical quality of water samples collected during Pre-monsoon.

Sl. No.	Chemical constituents	Unit	Maximum	Minimum
1	pH		8.48	5.91
2	EC	**(µs/cm) 25°C**	505	25.59
3	Turbidity	**NTU**	0.5	BDL
4	TDS	**mg/l**	333.56	16.89
5	CO3-2		18	BDL
6	HCO3-1		231.99	24.42
7	TA (as CaCO3)		249.99	12.21
8	Cl-		74.45	3.55
9	SO4-2		41.56	BDL
10	NO3-1		23.15	BDL
11	F-		1.93	0.04
12	Ca+2		54.04	2.00
13	Mg+2		15.76	1.20
14	TH (as CaCO3)		195	20
15	Na		75.1	2.69
16	K		18.72	0.97
17	Fe		8.976	0.043
19	As	**µg/l**	17.196	BDL

Table 3.6. Summarized chemical quality of water samples collected during Pre-monsoon.

Sl. No.	Chemical constituents	Unit	Maximum	Minimum
1	pH		8.32	6.02
2	EC	**(µs/cm) 25°C**	1520	35.06
3	Turbidity	**NTU**	0.4	BDL
4	TDS	**mg/l**	1003	23.14
5	CO3-2		60	BDL
6	HCO3-1		201.46	24.42
7	TA (as CaCO3)		218.73	24.42
8	Cl-		170.16	10.63
9	SO4-2		196.12	BDL
10	NO3-1		22.13	BDL
11	F-		2.03	BDL
12	Ca+2		180.14	4.00
13	Mg+2		33.97	1.20
14	TH (as CaCO3)		485	20
15	Na		58.54	3.19
16	K		39.87	1.54
17	Fe		12.75	0.11

Table 3.7: Summarized chemical quality of water samples collected during Pre-monsoon.

Type of Structure	No. of Sample analysed	Conc. Of Iron(mg/l)		pH value	
		< 1	> 1	<6.5	6.5 to 8.7
Dug wells	45	36	9	7	38
Deep Tube Well	8	7	1	0	8
Spring	1	1	0	0	1

Table 3.8. Summarized chemical quality of water samples collected during Post-monsoon.

Type of Structure	No. of Sample analysed	Conc. Of Iron(mg/l)		pH value	
		< 1	> 1	<6.5	6.5 to 8.7
Dug wells	45	36	9	4	41
Deep Tube Well	8	7	1	0	8
Spring	1	1	0	0	1

Ground Water quality assessment

Various chemical diagrams like Piper diagram, Wilcox diagram are prepared by using the Aquachem software to assess the quality of ground water of Goalpara district.

A. Piper Diagram

Piper trilinear diagram is an effective graphical procedure to segregate the analytical data to understand the sources of the dissolved constituent in water. In chemical equilibrium cations and anions are present in the water. The analyzed sample for pre-monsoon period falls under the magnesium bicarbonate type & mixed type mainly and only few samples fall under sodium chloride type. For post-monsoon period, everything is the same except the fact that no sample falls within the category of sodium chloride type. From the plot in the cation triangle, we can see most of the samples from post monsoon are falling under no dominant type, calcium type & magnesium type and few only under sodium and potassium type whereas same exists for pre monsoon samples also except the fact no sample falls under magnesium type. In the anion triangle for post-monsoon period, samples are falling on the bicarbonate-chloride axis only and only one sample falling in no dominant type whereas for pre-monsoon period samples are falling bicarbonate type to no dominant type only and only one sample falling within chloride type. By the extrapolation of cations and anions in to the diamond field represents the hydro-chemical facies of groundwater samples. The facies reflect the response of chemical processes operation within the lithologic framework and flow pattern. This diagram represents for both pre monsoon and post monsoon most of the samples are falling under Magnesium bicarbonate type to mixed type. Only 16 % samples are under calcium type.

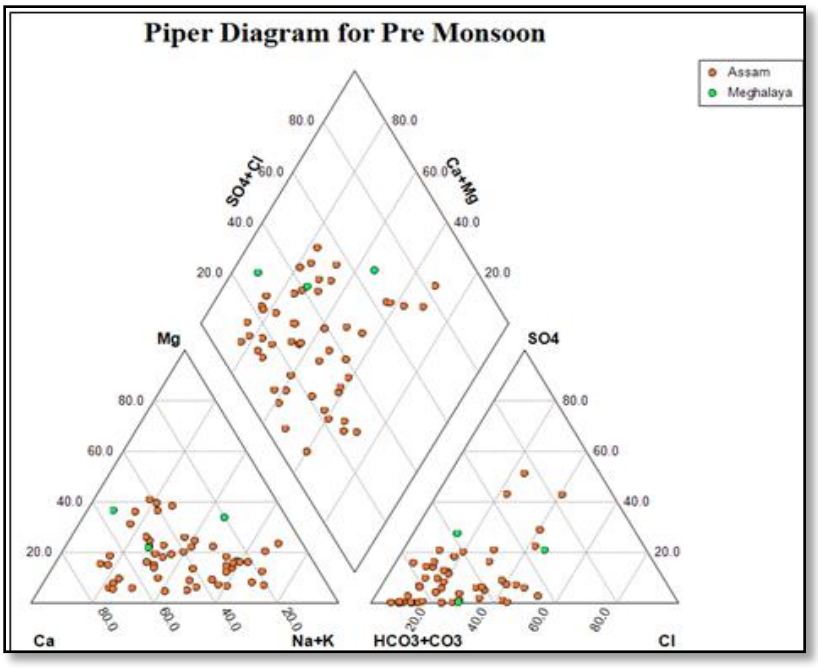


Fig. 3.11: Piper trilinear Diagram for pre-monsoon

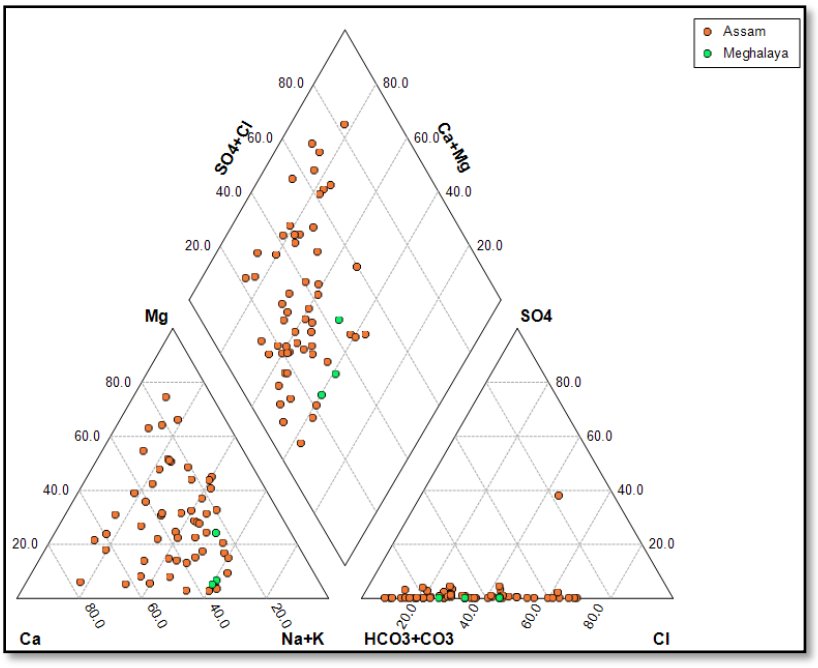


Fig.: 3.12. Piper trilinear Diagram for pre-monsoon

CHAPTER 4.0

Ground water Resources

The rechargeable area of Goalpara district with slope ≤20% is identified by downloading 30m resolution DEM of Shuttle Radar Topography Mission (SRTM) from http://earthexplorer.com.

The rechargeable area is found to be 171983 ha. As block boundary is not available, it was not possible to carry out block wise resource calculation. Here district wise resource calculation is presented.

The computation of ground water resources available in the district has been done using GEC 2015 methodology.

Data and assumptions used in the assessment: Following data and assumptions are used in the assessment:

1) Rainfall recharge has been computed by both RIF and WLF methods. Rainfall infiltration factor of 22% for valley fill as per norms is taken for calculation. In WLF method, specific yield has been taken as 0.16 for valley fill deposit following the norms recommended by GEC'2015. The rainfall of Goalpara district is 2208.6 mm.
2) Water level data has been considered for 2019-20. Water level fluctuation based on data of March (Pre monsoon) and November (post monsoon) has been considered. The average pre- and post-monsoon water level of Goalpara district is 5.03 mbgl and 2.39 mbgl. The average water level fluctuation is 2.64 m
3) The population figures were collected from Census, 2011 and projected to 2022. The per capita domestic requirement is considered as 60 lpcd.
4) Recharge from other sources includes recharge from minor surface and ground water irrigation.

Recharge: The aquifers of the study area are recharged by rainfall. The area experiences south-east monsoon. Monsoon rainfall contributes approximately 70 percent of total rainfall (June, July, August, September) while share of post and pre monsoon rainfall are approximately 30 percent each.

Previous records show that the rainfall occurs almost in every month of a year. The month November to December has the minimum number of rainy days in any year and the period June to September has maximum number of rainy days.

The monsoon recharge of the 171983 ha of recharge worthy area is 45009.2 ham while non-monsoon recharge is 22991.96 ham. Recharge from other sources is 6379.64 ham. Total ground water recharge is 74380.8 ham.

Extraction: The agriculture in the area generally rainfed. 28% of cropped area has irrigation facilities and groundwater irrigation is nearly 16% of total irrigation. Total groundwater extraction for irrigation purpose is 9866.64 ham. Total industrial extraction is 8.817 ham. So ground water is extracted only for domestic use. Total groundwater extraction of Goalparadistrict is 11909.56 ham

Allocation of resources up to 2025: The net ground water resource is allocated for domestic use 2337.15 ham. Net available resource for future use is 52270.66 ham.

Stage of groundwater development: Groundwater is mainly utilized for domestic purposes. The stage of groundwater extraction in the district is 18.46%.

Table 4.1: Net groundwater availability, existing extraction and stage of extraction for the year 2020.

Recharge worthy area Ha	Total annual GW recharge Ham	Environmental flow Ham	Annual extractable GW resource Ham (2-3)	Existing gross GW extraction for all uses Ham	Stage of GW extraction [(5/4)*100%]
1	2	3	4	5	6
171983	74380.80	9897.53	64483.27	11909.56	18.46%

Extraction from unconfined aquifer/deeper aquifer: Groundwater in the district is utilized for (a) irrigation, (b) drinking or domestic purposes and (c) industrial purpose.

As per District Irrigation Plan 2016-2020, a total of 79 irrigation sources are operating in the district. Kuchdowa block has maximum command area under irrigation sources, i.e.2246 hectares out of 11051 hectares (20%). After Kuchdowa, Jaleswar and Matia have greater command area under irrigation sources. In Jaleswar, there are 11 irrigation sources with command area of 1965 ha while in Matia there are 14 irrigation sources with 1772 hectares of command area. Kharmuza is the block with least number of irrigation sources. In Kharmuza, there are only 12 irrigation sources with total command area of 575 ha.

Under surface irrigation, a total of 35 canal based irrigation sources exist with command area of 8391 ha. A total of 44 tube wells are operating in the district, with Matia block having the maximum number of tube-wells with 10 and command area of 675 ha.

In case of water extraction devices, there are 60 electricity pumps operating in district with a command area of 6671 ha. Out of total command area of 6671 ha under electricity pumps, Jaleswar block has 1675 ha (25%).

In domestic sector, dug wells and hand pumps are main source of groundwater extraction. Public health Engineering Dept. supplies water through groundwater and also by surface water. Generally the groundwater extracted from shallow aquifer.

Potential resource:

(i) Shallow water table areas: Potential resource due to shallow water table areas was estimated from aquifer area where depth-to-water level was within 5mbgl. The area within depth-to-water level of 5mbgl is 1045 sq.km which is 57% of total area of the district. The potential resource of shallow water table areas is 15675.41 ham.

(ii) Flood prone area: As per GWRE 2020, the flood prone area of the district is 76987 ha and it is considered that flood water remained in the area for at least 30 days. Potential resource in flood prone area is 3233.45 ham.

(iii) Total potential resource of Goalpara district is 18908.86 ham.

Static resource: Here also the administrative district has been considered as the assessment unit due to paucity of block-wise data. Hilly areas having slope more than 20% are deleted from the total area to get the area suitable for recharge. The average thickness of saturated unconfined aquifer below ground level as obtained from dug wells / bore wells in the district has been considered.

The Pre-monsoon (month of March) Water Level from Monitoring Wells of CGWB in Goalpara district has been considered as the maximum depth below ground level up to which the zone of water level fluctuation occurs. Since the north eastern states receives pre-monsoon showers, which commences from the first week of April, resulting in rise in water levels in the phreatic zones, the deepest water levels are recorded during the month of March. Specific yield value of 0.12 is considered for the district.

Finally the Static Ground Water Resource is computed from the data as obtained:

$$Y = A^* (Z_1 - Z_2)^* Sy$$

Where, Y = Static ground water resources,

A = Area of ground water assessment unit

Z_1 = Thickness of saturated unconfined aquifer below ground level

Z_2 = Pre-monsoon water level

Sy = Specific yield of the unconfined aquifer

Table 4.2: Salient information of static resource of Goalpara district, Assam

Type of rock formation	Alluvium
Total Geographical Area (Ha)	182400
Assessment Area (Ha)	171983
Bottom of the unconfined aquifer (m)	50
Average Pre- monsoon Water Level (m)	5.03
Thickness of the saturated zone of the un-confined aquifer below WLF zone (m) [(5)-(6)]	44.97
Volume of Saturated zone of the unconfined aquifer below WLF zone (ham)	7734075.51

Static/In-storage Ground Water Resources (ham): Volume of saturated zone X specific yield

= 7734075.51 X 0.12= 928089.06 ham

CHAPTER 5.0

Groundwater Related Issues

Identification of issues: The main groundwater issues identified in the area are-low rainfall, low stage of groundwater extraction, areas under flood as well as high iron concentration, arsenic and uranium detection.

Low rainfall: Except October month, all the months of year 2021 have precipitation deficit of actual rainfall in comparison to normal rainfall. Monsoon period (June to September) of 2021 have 75% of normal rainfall and Non-monsoon period (Jan to May & October to December) occupies only 48% of normal rainfall.

Low stage of groundwater extraction: Compared to vast dynamic groundwater resource of Goalpara district, groundwater extraction for domestic, irrigation and industrial purposes is low. Vast tract of agricultural land remain fallow after harvesting of paddy only due to lack of irrigation facility. The stage of groundwater extraction is only 18 %.

Flood-affected area: Flood-affected areas are observed mostly in Matia and Lakhipur block. Flood-affected area of the district is 76987 ha. Flood-affected areas are found in the alluvial plain and flood plain. Occurrence of flood conditions in the region is due to high rainfall, shallow water level and a meagre ground water draft in vast flood plains of the Brahmaputra and Krishnai river system. (Fig. 5.1)

Area vulnerable to arsenic pollution: Arsenic is detected in some groundwater samples. Only 4 out of 54 water samples in pre-monsoon have more than permissible limit. However, in most of the samples, arsenic concentration is within permissible limit.

Area vulnerable to uranium pollution: Uranium is detected in some groundwater samples. However, in all the samples uranium concentration is within permissible limit.

Area vulnerable to iron pollution: Iron content in ground water, above permissible limit is found in some areas.

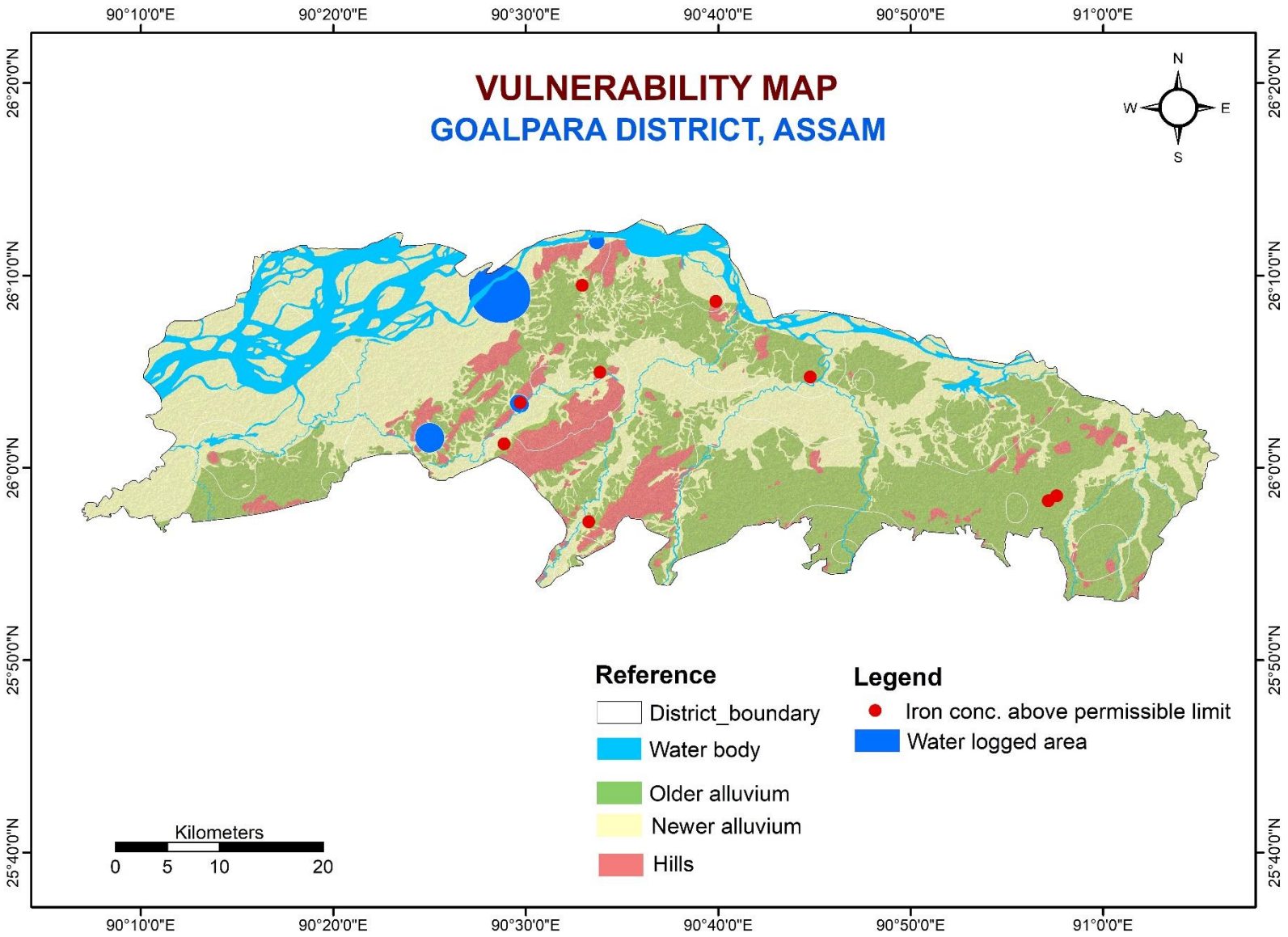


Fig. 5.1: Vulnerability Map of GOALPARA District, Assam

Future demand: Future demand of ground water is analyzed for domestic purpose and for irrigation purpose

Domestic purpose: The domestic requirement is worked out for projected district population and requirement is considered as 60 litre per person per day. The water requirement for domestic purpose up to 2025 is worked out and tabulated (Table 5.1)

Table 5.1: Projected population and water demand for domestic purpose of the area

District	Census 2011 Population	Decadal growth	Projected Population		Projected water demand (ham)	
			2020	2025	2020	2025
Goalpara	112427	22.64	1008183	1148478	2034	2317

Future demand for agriculture: Future Water demand of the district for agricultural sector is assessed by projecting cropping intensity to 200% through assured irrigation in agricultural field. As per District Irrigation Plan, 2016-20, Goalpara, the net sown area of the district is 102648 ha and area sown more than once is 58702 ha. The gross cropped area of the district is 161350 ha and the cropping intensity is nearly 158%. The rainfed or un-irrigated area of the district is 76137ha and net irrigated area is 26511ha.

The crop water requirement for unirrigated area of the district is estimated based on soil condition, flooding and geomorphic classification using FAO's Cropwat 8.0 software following guidance of Assam Agriculture University.

Stress Aspects of aquifer

Table 5.2: Total water requirement for the district

District	Drinking water requirement up to 2025 Ham	Water requirement to increase cropping intensity to 200% (Ham)	Water allocated for drinking and domestic purposes up to 2025 (Ham)	Water allocated for future use Ham
Goalpara	2317	24913	2337	52270

Supply and demand gap: It is observed that drinking water allocation is sufficient to meet the future demand and it will not give additional stress in the aquifer.

The demand of groundwater in irrigation sector can sufficiently be met from future allocation of resources.

Table 5.3: Supply and demand gap in drinking water sector

District	Drinking water demand up to 2025 (in Ham)	Water allocated for drinking and domestic purposes up to 2025 Ham	Gap between supply and demandHam
Goalpara	2317	2337	20

Table 5.4: Supply and demand gap in irrigation

District	Total irrigation demand (in Ham)	Water allocated for future use (in Ham)	Gap between supply and demand(in Ham)
Goalpara	36822	52270	67741

CHAPTER 6.0

Management Strategy

The groundwater regime of Goalpara district is influenced by lithological variation and geomorphologic set up. The district can be divided into two slope classes, viz., slope >20% and slope <=20%. Areas with slope more than 20% are found in southern and northern extremities of the central part of the district. Geomorphologically, these areas include structural hills in southern-central, northern-central and eastern-most side. Areas with slope less or equal to 20% slope include younger alluvial plain and older flood plain. Water logged areas are found in alluvial plain.

Sustainable Management Plan of Resource: Some important points have to be taken into consideration during preparation of aquifer management plan.

- From flood zonation map it becomes clear that barring the structural hills most of the area of the district is ravaged by flood.
- Stage of groundwater development in the district is 18.47 % leaving vast scope for groundwater development.
- Irrigated area is still 25 % only and requires boasting for agricultural purpose.

Management of resources for agricultural sector: The crop water requirement for unirrigated area of the district is estimated based on soil condition, amount of rainfall, flooding and geomorphic classification and the estimation is carried out in accordance to the suggestion of Assam Agriculture University. AAU has identified characteristics cropping sequence for different geomorphologic conditions. The cropping pattern suitable for un-irrigated area is shown below:

Table 6.1: Cropping pattern of un-irrigated areas of Goalpara district

SN	Crop	Planting date	Area (%)	Actual area (ha)
1	Winter Rice	04-Jun	10	5150
2	Winter Rice	15-Jun	15	7725
3	Winter Rice	20-Jun	25	12875
4	Winter Rice	30-Jun	20	10300
5	Winter Rice	10-Jul	20	10300
6	Winter Rice	15-Jul	10	5150
7	1. Potato	15-Oct	5	2575
8	2. Pulses	05-Jan	10	5150
9	3. Mustard	30-Oct	5	2575
10	4. Mustard	05-Nov	10	5150
11	5. Mustard	20-Nov	10	5150
12	6. Small Vegetables	10-Oct	5	2575
13	7. Small Vegetables	25-Oct	5	2575
14	8. Small Vegetables	25-Nov	5	2575
15	9. Small Vegetables	15-Dec	5	2575
16	10. Potato	10-Nov	10	5150
17	11. Winter Wheat	10-Nov	10	5150
18	12. MAIZE (Grain)	04-Dec	10	5150
19	13. MAIZE (Grain)	25-Nov	10	5150

The water demand of agricultural sector to provide assured irrigation potentiality to un-irrigated areas will be calculated using Cropwat 8.0 software of FAO. AAU suggested cropping sequence can be followed which will provide flood affected people assured irrigation facility.

As per information, Net sown area of the district is 102648 ha and out of which 26511 ha only is under irrigation (District Irrigation Plan 2016-20). It is observed that un-irrigated area associated with kharif paddy (winter rice) is 51500 ha which is sown during summer time from May-July. For further utilization of groundwater seeing the vast scope for ground water development in the area, other crops like maize, pulses, rapeseed, potato, winter vegetables will be used in the 100% of the area of kharif paddy with in area of 51500 ha.

A management plan has been prepared for un-irrigated crop land based on cropping pattern suggested by Assam Agriculture University (Table 6.2)

Table 6.2: Water requirement for un-irrigated areas of Goalpara district

Cropping pattern (s)				
Early Summer Rice-Late Winter Rice	Present Cultivated area	Area to be cultivated	Area to be cultivated (**ha**)	Irrigation requirement (**ham**)
Summer vegetables- Late Winter Rice	(**ha**)	(**%**)		
Pulses-Late Winter Rice-Potato/Vegetables/Wheat				
Net cultivated area	**51500**			
	1	2 (= % of 1)	3	4
Rice (main crop)	51500		51500	
Winter Rice (main crop)	51500	50	51500	8084.2125
Potato		8	8240	1736.58
Pulses		5	5150	522.21
Mustard		12	12360	2573.1975
Winter vegetables		5	5150	827.09
Summer vegetables		5	5150	876.7875
Wheat		5	5150	1041.845
Maize		10	10300	1777.265
Gross cultivated area (Paddy/+Maize/+Wheat+Pulses+Vegetables)			**103000**	17439
Total irrigation requirement (70% irrigation efficiency)				**24913**
Cropping intensity			**200% (Intended)**	

Sowing season of winter rice is October-November and can be harvested during summer season. Winter rice sowing month is fixed as May-July depending upon cessation of flood water from the crop land. If flood water retains in paddy field during July and August then the winter rice may not be cultivated, instead other crops like vegetables, wheat, pulses and potato can be cultivated with assured irrigation facilities provided by construction of tube wells.

Table 6.3: Precipitation deficiency

Precipitation deficit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Rice	0	0	0	0	147.1	62.9	0	0	0	3	0	0
2. Rice	0	0	0	0	49	98	0	0	0	5.9	0	0
3. Rice	0	0	0	0	48.4	95.8	0	0	0	0	0	0
4. Rice	0	0	0	0	0.5	146.5	0	0	0	0	0	0
5. Rice	0	0	0	0	0	147.1	0	0	0	0	2.6	0
6. Rice	0	0	0	0	0	49.1	98	0	0	0	26.4	0
7. Potato	66.5	47.4	0	0	0	0	0	0	0	0	48.5	69
8. Pulses	20.4	68.6	10.9	1.5	0	0	0	0	0	0	0	0
9. Mustard	55	68.5	0	0	0	1.5	0	0	0	2.4	38.8	56.5
10. Mustard	55	68.5	0	0	0	0	0	0	0	0	30.7	54.2
11. Mustard	55	68.5	0	0	0	0	3.1	0	0	0	10.5	42.8
12. Small Vegetables	21.8	0	0	0	0	0	0	0	0	2.3	64.9	64
13. Small Vegetables	50.7	0	0	0	0	0	0	0	0	0	55.2	62.3
14. Small Vegetables	59.9	70.8	0	0	0	0	0	0	0	0	9.9	47
15. Small Vegetables	50.3	76.4	2.9	0	0	0	0	0	0	0	0	23.3
16. Potato	67.7	81.3	0	0	0	0	0	0	0	0	26	46.5
17. Winter Wheat f.f.	48	66.6	0.6	5.6	0	0	0	0	0	0	36.3	45.2
18. MAIZE (Grain)	52.7	86.4	7.8	0	0	0	0	0	0	0	0	18
19. MAIZE (Grain)	62.4	86.3	1.7	0	0	0	0	0	0	0	4.3	25.5

Table 6.4: Actual monthly water requirement for different crops in Flood Prone Areas of Goalpara district, Assam

Crop	Net sown area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Cropwise Total IWR (Ham)
Winter Rice	5150	0	0	0	0	757.565	323.935	0	0	0	15.45	0	0	1096.95
Winter Rice	7725	0	0	0	0	378.525	757.05	0	0	0	45.5775	0	0	1181.1525
Winter Rice	12875	0	0	0	0	623.15	1233.425	0	0	0	0	0	0	1856.575
Winter Rice	10300	0	0	0	0	5.15	1508.95	0	0	0	0	0	0	1514.1
Winter Rice	10300	0	0	0	0	0	1515.13	0	0	0	0	26.78	0	1541.91
Winter Rice	5150	0	0	0	0	0	252.865	504.7	0	0	0	135.96	0	893.525
Potato	2575	171.2375	122.055	0	0	0	0	0	0	0	0	124.8875	177.675	595.855
Pulses	5150	105.06	353.29	56.135	7.725	0	0	0	0	0	0	0	0	522.21
Mustard	2575	141.625	176.3875	0	0	0	3.8625	0	0	0	6.18	99.91	145.4875	573.4525
Mustard	5150	283.25	352.775	0	0	0	0	0	0	0	0	158.105	279.13	1073.26
Mustard	5150	283.25	352.775	0	0	0	0	15.965	0	0	0	54.075	220.42	926.485
Small Vegetables	2575	56.135	0	0	0	0	0	0	0	0	5.9225	167.1175	164.8	393.975
Small Vegetables	2575	130.5525	0	0	0	0	0	0	0	0	0	142.14	160.4225	433.115
Small Vegetables	2575	154.2425	182.31	0	0	0	0	0	0	0	0	25.4925	121.025	483.07
Small Vegetables	2575	129.5225	196.73	7.4675	0	0	0	0	0	0	0	0	59.9975	393.7175
Potato	5150	348.655	418.695	0	0	0	0	0	0	0	0	133.9	239.475	1140.725
Winter Wheat f.f.	5150	247.2	342.99	3.09	28.84	0	0	0	0	0	0	186.945	232.78	1041.845
MAIZE (Grain)	5150	271.405	444.96	40.17	0	0	0	0	0	0	0	0	92.7	849.235
MAIZE (Grain)	5150	321.36	444.445	8.755	0	0	0	0	0	0	0	22.145	131.325	928.03

Total unirrigated area of the district is 76137 ha and out of which 51500 ha is kharif paddy. Total water requirement to bring the un-irrigated area of the district and water availability for future use are summarized in Table: 6.5

Table 6.5: Summarised results of water requirement to bring the un-irrigated area of Goalpara district, Assam

Area	Net Cultivated area (Ha)	Irrigation water requirement (Ham)	Water allocated for future use (Ham)
Kharif paddy	51500	24913	52270

No. of days requiring irrigation has been determined on the basis of precipitation deficit in respective months, summarised in Table 6.6

Table 6.6: Rainfall deficit and Irrigation requirement in the months of Nov-Dec and Jan-March

Month Interval	Area to be cultivated (Ha)	Rainfall deficit (in mm)	Irrigation Requirement (in ham)
Nov- Dec	36050	908	3303
Jan -March	5150	1478	6147

Based on available groundwater resource and subsurface condition, the approximate numbers of tube wells that can be constructed in the district are worked out.

Discharge of the tube wells constructed by CGWB tapping 20 to 40m of the sub unit 1 of the older alluvial aquifer varies from 15 to 242 m3/hr. It is expected that tube wells of 50 m depth tapping 20 to 40 m of granular zones of the sub unit 1 of the older alluvial aquifer can yield 15 to 21 m3/hr. If the well is allowed to run 8 hrs a day for 120 days then a tube well having discharge of 19 m3/hr will extract 1.8 ham groundwater annually.

Total numbers of shallow tube wells require to construct in the district to fulfil the irrigation requirement of 24913 ham, is found to be 13658 nos. On the other hand consideration of safe distance of 200m permits to construct 12875 nos.

Extraction of 24913 ham of groundwater will increase the stage of groundwater extraction to 57 %. Potential resource of the district is 18908.86 ham.

Arsenic Pollution: Arsenic above permissible limit is detected in four samples. In these areas alternate source of water may be searched.

6.3 Demand side management

Demand side management implies sustainable management of water. In irrigation and in drinking water supply also sufficient quantity of water loss occurs.

Water use efficiency should be high in all sectors particularly in the irrigation sector. Loss in irrigation water will increase water logged area.

Irrigation efficiency can be increased by

- reducing convenience loss
- improving water application efficiency

Following demand side interventions will increase water use efficiency

- Use of water efficient irrigation method: Drip and sprinkler irrigation methods are very useful in saving water. Both of them save conveyance losses and improve water application efficiency by applying water near the root-zone of the plant.Drip irrigation can increase crop yield per hectare and also saves water up to 70% than conventional irrigation.
- Water loss through supply canals can be minimized by proper lining in the canals.
- Adopting water saving rice irrigation: In this method instead of submerging the paddy field for longer duration, the rice field have to provide water through irrigation only after a certain number of days when the ponded water disappears. This technology is known as alternate wetting and drying (AWD) irrigation. With the optimal management, this technology reduces the amount of water required by about 25% without reduction in yields.

Therefore, groundwater resource of the district is sufficient to meet drinking water demand and also irrigation and other industrial demands under different condition.

Following recommendations are suggested:

- Water distribution mechanism should minimize water loss by using lining distribution canals. Locally available materials are to be preferred as these materials are cheap and eco-friendly.
- Conservation of rain water in the up dip of cultivated field. During rabi season the conserved water can be drained to paddy field through gravity.
- In some pockets iron content is very high. The sources of iron pollution in deeper aquifer can be attributed to geogenic origin. It needs removal before human consumption.
- Roof top rain water harvesting may be practiced by the individual households. .