केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

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

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

DHEMAJI DISTRICT, ASSAM

उत्तर पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

AQUIFER MAPPING AND MANAGEMENT PLAN OF DHEMAJI DISTRICT, ASSAM

ANNUAL ACTION PLAN, 2022-23

By

EBADUR RAHMAN
SCIENTIST-B (HYDROGEOLOGY)

Central Ground Water Board
STATE UNIT OFFICE
NAHARLAGUN
ARUNACHAL PARADESH

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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 contaminated area and prepare an aquifer management plan.

1.2 Scope of the study

Dhemaji district has vast groundwater and surface water resources. However, the agro based economy of the area has negligible irrigation facility. Moreover, the groundwater of the area is contaminated with iron and arsenic which possesses serious health hazard to the general public. Proper hydrogeological knowledge of the area can be helpful to prepare a sustainable management plan for groundwater utilization.

1.3. Approach and methodology

The approach is to identify the principal aquifers and to conceptualize the aquifer system. This will help to formulate an aquifer management plan. Finally, the scientific knowledge will be disseminated to farmers, state government and other 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 (Arc-GIS 10.3.1 using Projection Coordinate system: UTM, Zone 47). 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 and 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 characteristics of aquifers, 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 and conceptual model a sustainable development plan of the aquifer is formulated

1.4 Area Details

The area chosen for aquifer mapping falls in part of Survey of India Toposheet No. 83I/6 and 83 I/07, 83I/10, 83I/11, 83I/14, 83M/01, 83M/02, 83M/05 and 83M/06 bounded by latitude 27^{O} 05’ 27”N to 27^{O} 57’ 16”N and longitude 94 ^{O} 12’ 18’’E to 95 ^{O} 41’ 32’’E. 550 Sq.km of the district is covered under NAQUIM study during AAP 2013-14. Rest of the district has been covered during AAP 2020-21 and during 2022-23 report of the mappable area of the entire district, i.e., 3152 sq.km. is prepared.

Administrative set up of the study area:

For the administrative purposes, the entire district is divided into two Sub-divisions viz Dhemaji and Jonai Sub-Division. There are five Community Development blocks namely Bordoloni, Dhemaji, Machkhowa, Sissiborgaon and Jonai Murkongselek. Total population of the district is 686,133 souls (as per 2011 census) with average population density of 212 persons/sq.km which is lower than the state average of 398. The decadal variation of population for 2001-2011 is 19.97 percent. Dhemaji district is connected with the rest of the State by NH 52 and by railways service.

Table 1.1 Administrative Divisions

No of Civil Subdivision	No of Blocks	No of Revenue Circles	No of Gram Panchayats	No of Villages (Inhabited)	No of Villages (Uninhabited)
2	5	6	149	1264	55

Data Source: Statistical Handbook, Assam

Table 1.2 Block Level Geographical Area and Population of Dhemaji District

District	Blocks	Area (sq.km)	No of Villages	Population
Dhemaji	Dhemaji	471	280	127104
	Murkongselek	339.58	381	169898
	Machkhowa	76.87	51	29575
	Bordoloni	463.82	28	112710
	Sissiborgaon	456	395	208368

Data source: Census Handbook 2011

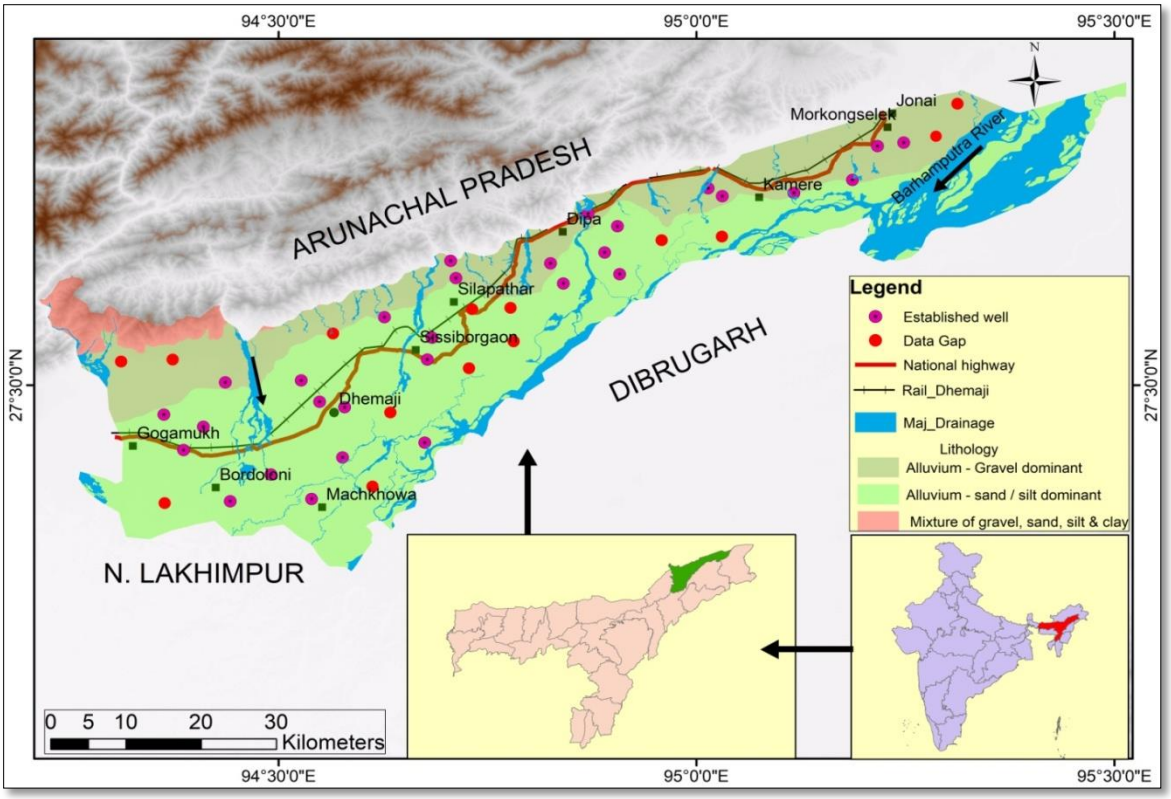


Fig.1.1: Index Map of the study area

Dhemaji district is basically agrarian, where more than 57 percent of the population is engaged in agriculture and allied activities and also works as agricultural labourers. 73.21% of total population is involved in agriculture as a main source of income and livelihood. Around 6% of the total population is agricultural labourers. 77.19% women are involved in agriculture and allied activities.

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 (Arc-GIS 10.3.1 using Projection Coordinate system: UTM, Zone 46). The available data, data gap and data generation work is tabulated in Table: 1.3

Table 1.3: Data availability, data gap and data generation in Dhemaji district, Assam

SN	Theme	Type	Data available	Data gap	Data generation	Total	Remarks
1	Borehole Lithology Data		4	7	Nil	4	Maximum depth of well is 60 mbgl only.
2	Geophysical data		14	24	Nil	14	
3	Groundwater level data	Dug well/ Hand pump	14	14	29	43	
		Piezometer Aquifer-I	4	7	Nil	4	
4	Groundwater quality data	Dug well-Aquifer-I	5	24	35	40	Post Monsson 30 water sample and pre monsoon 35.
		Piezometer Aquifer-I	4	7	Nil	4	
5	Specific Yield		Nil	7	Nil	Nil	
6	Soil Infiltration Test		Nil	00	04	04	

1.6 Rainfall-spatial, temporal and secular distribution

The average annual rainfall recorded from 2010 to 2019 in Dhemaji district is 2024 mm . Rainfall during January to April contributes nearly 9.45% to the total rainfall whereas the rainy season which commences from May and continues up to September contributes 86.69%. October to December rainfall makes up the rest. December receives least rainfall and maximum rainfall occurs during July. The average monthly rainfall from 2012 to 2019 are tabulated in Table- 1.4

Table- 1.4 Average monthly rainfall from 2012 to 2019

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total annual
2012	0		32	43	423	338	576	366	587	115	4	14	2498
2013	8		84	122	259	290	458	317	189	60	0	3	1782
2014	11	60	62	13	372	378	277	585	392	45	33	0	2157
2015	0	30	17	219	327	599	321	649	125	4	0	7	2268

2016	12		32	2		345	414	192	303	154	3	9	1454
2017	2	8.2	90	285	281	486	704	446	419	215	0	1	2927
2018	25	24	70	34	61	68	159	184	228	28	37	16	885
2019	14	59.7	70.2	100.9	498.4	324.3	607	156.1	333	117.4	9.3	4.1	2221

The average monthly rainfall from 2012 to 2019 and also yearly rainfall distribution of Dhemaji district are illustrated in Fig.1.2 and Fig 1.3

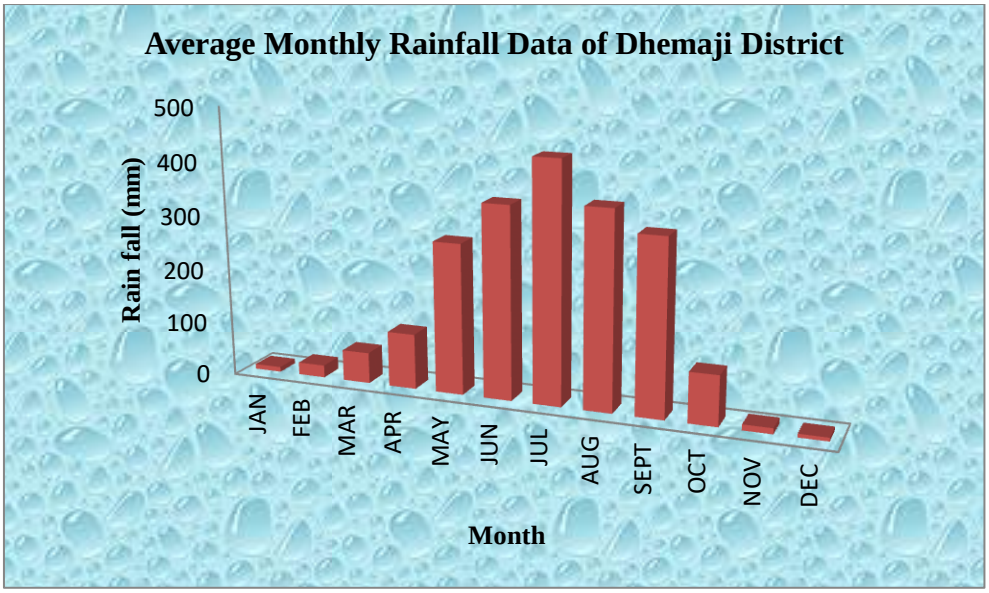


Fig. 1.2 Average monthly rainfall variations of Dhemaji district, Assam.

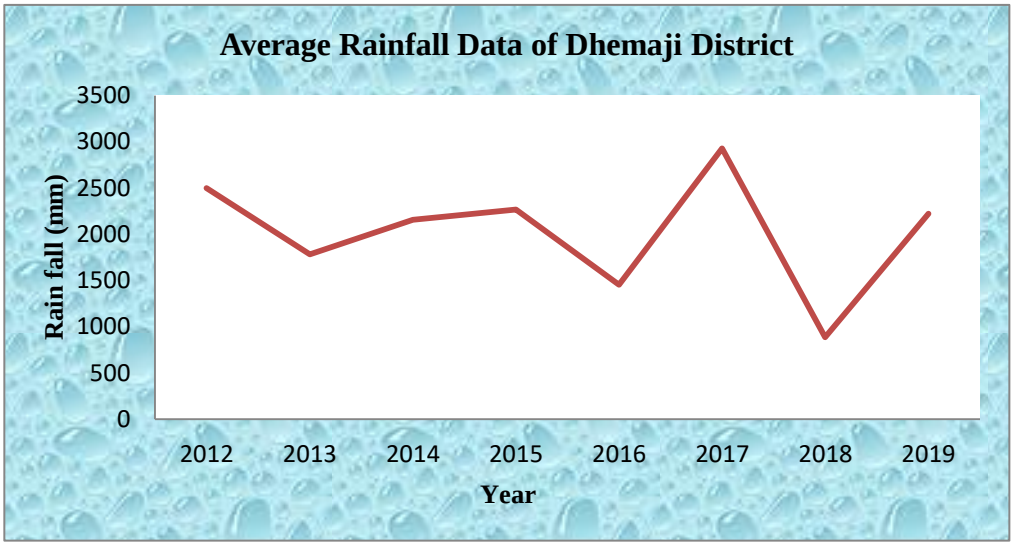


Fig.1.3: Annual variation of rainfall of Dhemaji district, Assam.

The maximum rainfall generally occurs during a period of 5 months starting from May to September. The drainage system is inadequate in the monsoon. Recurrence of flood during monsoon due to heavy rain falls in the district and neighbouring state Arunachal Pradesh and causes loss of crops and other properties almost every year. In recent years the district has experienced the heavy floods, to be precise, flash floods, due to heavy deforestation towards northern part. The people of the district, who mainly depend on rain water for their cultivation, are often badly affected by floods.

Temperature:

The temperature in the region begins to increase from the end of February and reaches the highest point during July and August. January is the coldest month of the year. The air is highly humid throughout the year and winds are light in the district. But some of the cyclonic storm and depressions from the Bay of Bengal occur in the monsoon and post monsoon periods accompanied by heavy rain. Thunderstorms occur during the period from March to May. Fog occurs in the winter months. The average minimum and maximum temperature in the summer is 23°C and 32°C respectively. However, the mean temperature in the summer is 28°C. The average temperature in the winter's ranges from slightly cold with 10°C to moderate temperature of 25°C.

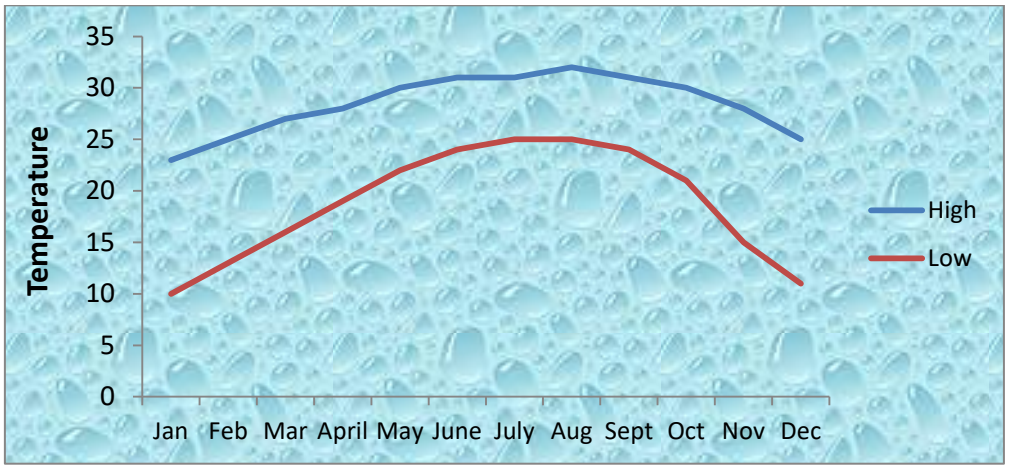


Fig.1.4: Annual variation of temperature of Dhemaji district, Assam.

1.7 Physiographic set up

Physiographically, the district of Dhemaji is a part of the Brahmaputra river valley. It is bounded on the north by Arunachal Paradesh and Brahmaputra river on the south (the proportional river Brahmaputra is included within the district). Physiographically the area can broadly be divided into three parts, i.e., the hilly tract, the piedmont alluvium and flood plain. The hilly tracts are characterized by low to moderate relief hills and corrugated landform and comprise of Siwalik sediments of lesser Himalayas. The slope of the area drops from northern towards south, 96.68% of area having slope less than 20 percent slope and remaining area having more than 20 percent slope. The southern part of the district parallel to the river Brahmaputra is low lying, representing a flood prone area with existence of abandoned river channels.

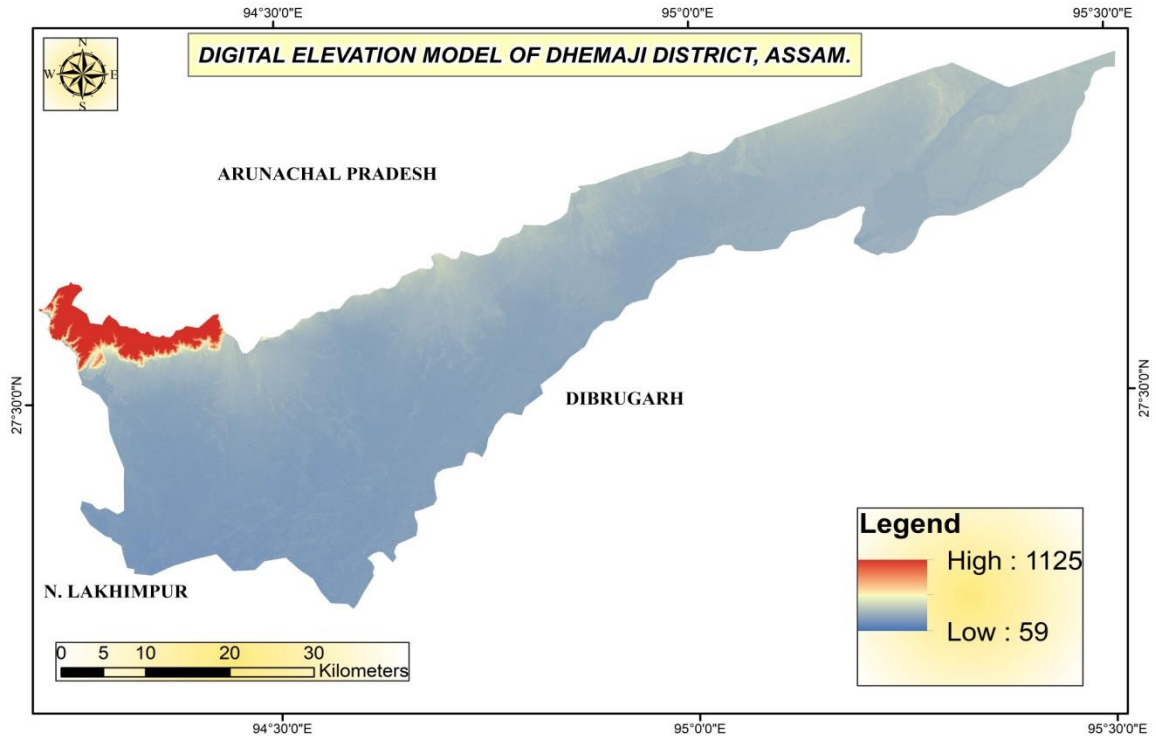


Fig 1.5: Digital Elevation Model (data source: USGS Earth Explorer, SRTM 30m resolution)

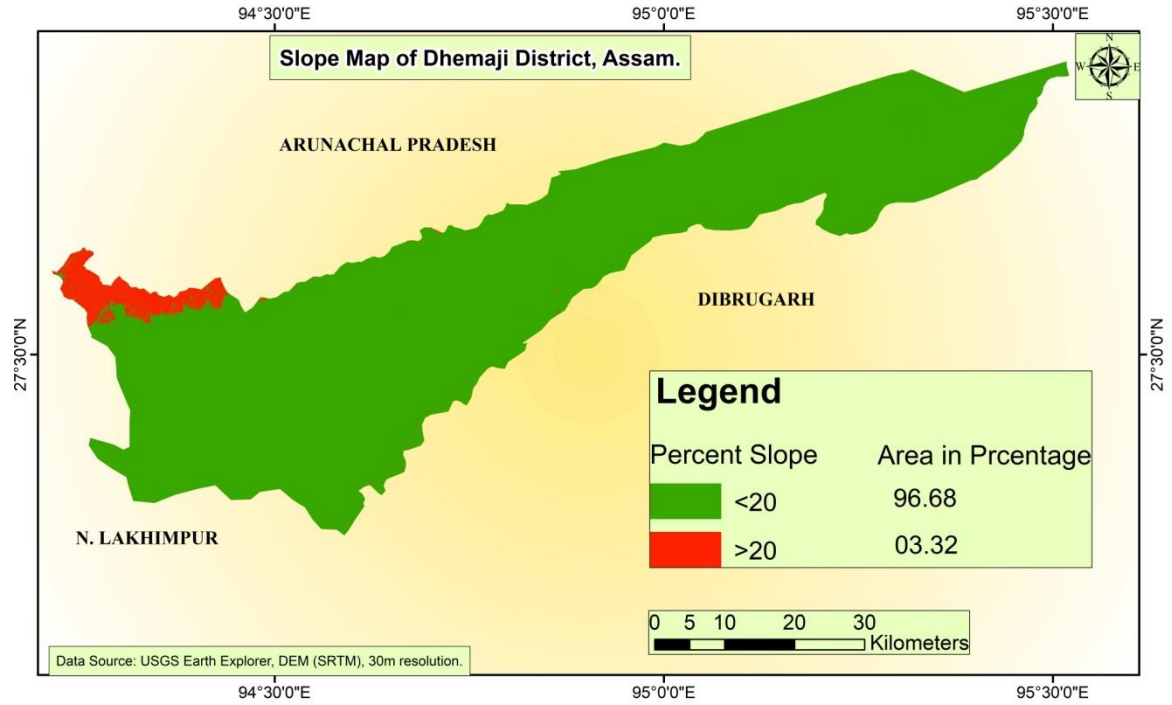


Fig.1.6: Slope map of the study area based on 30m resolution of SRTM data

1.8 Geology and Geomorphology

The Dhemaji district lies in the erstwhile foredeep region of the Eastern Himalaya which constitutes the Brahmaputra basin. Quaternary sediments of enormous thickness cover

up the older rocks in the northern part of the basin. The general geological succession of the area is given below:

Age	Formation/Group	Lithology
Pleistocene to Recent	Channel deposits	Sand, Silt, Clay and Gravel.
	Recent Alluvium	Clay, fine to medium grain sand.
	Younger Alluvium	Clay, Coarse to fine sand mix with Gravel and Pebble.
	Nonconformity	
Pleistocene	Older Alluvium	Gravel, Boulder with Sand and clay
	Unconformity	
Miocene	Tipam Group (?)	Sandstone

The Quaternary alluvial deposits are divided into two groups: Older alluvium and Younger alluvium. Older alluvium deposits are found in northern part of the district. The major part of the area of the district is occupied by the Younger alluvium formation.

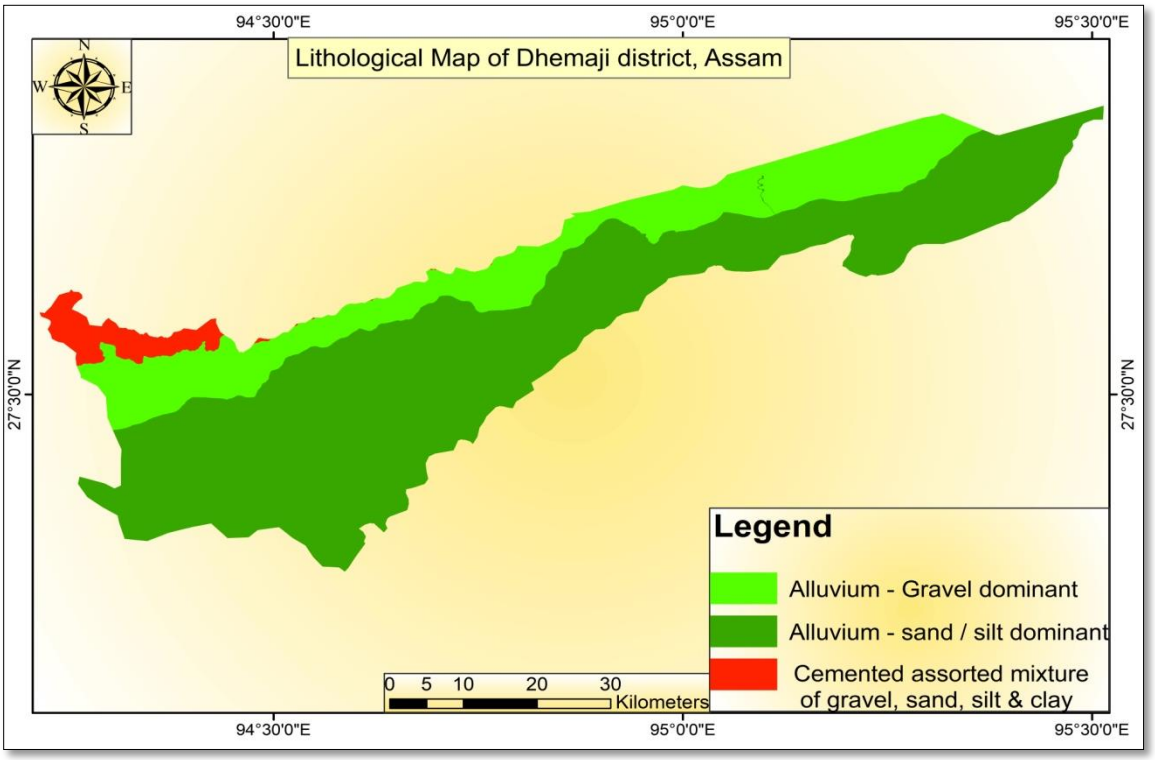


Fig. 1.7: Lithological Map of Dhemaji district, Assam

Geomorphologically the area can be classified mainly into four divisions: structural hills, piedmont zone, alluvial plan and flood plain. Piedmont zone is in the northern 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., palaeo channel, swampy/marshy land, river terraces, flood plains, point bars, natural levees, channel bar and river channel (Fig. 1.8).

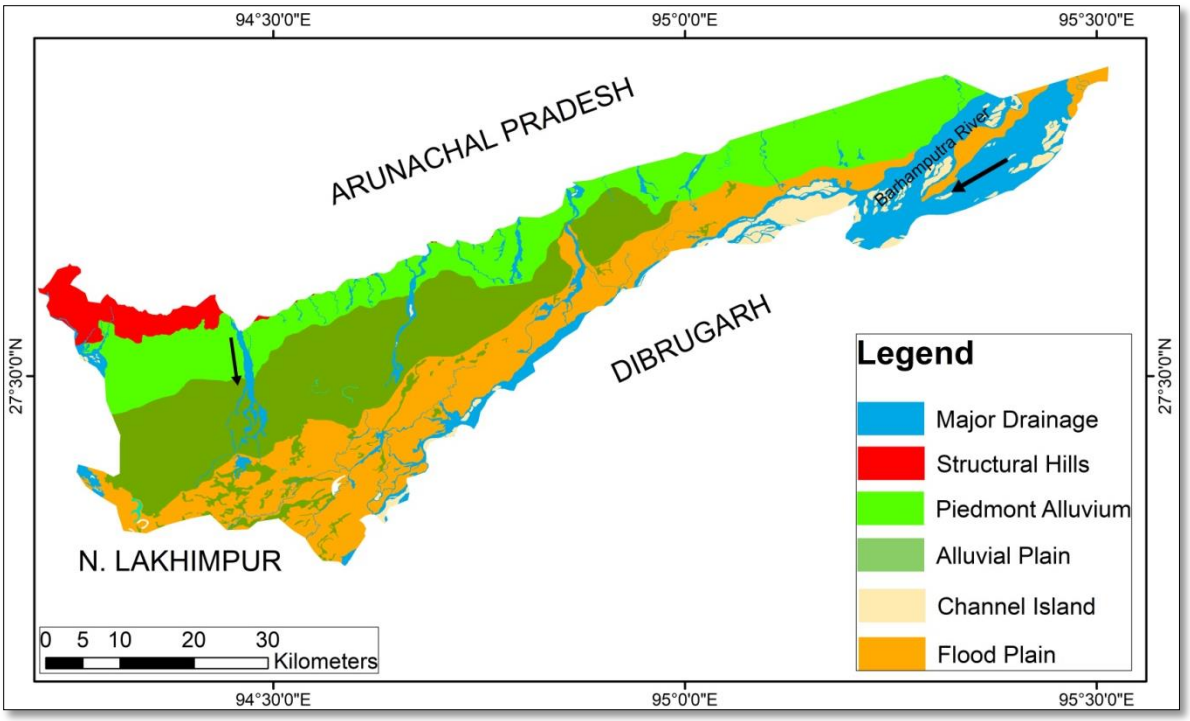


Fig. 1.8: Geomorphological Map of Dhemaji district, Assam

1.9 Land use Pattern

The net sown area of the district is 86703 ha which accounts for 26.78 percent of the geographical area of the district. The gross cropped area of the district is 95915 ha with cropping intensity of 110.6% percent. The farmer of the district is habituated in production of rice and is evident from the land use pattern. Rice is produced three times as autumn rice, winter rice and summer rice. Other cereal crops are pulses and maize. oil seeds like mustard, linseed, etc., rabi and kharif vegetables, jute, sugarcane and different horticulture crops are also produced in very small quantities.

Table 1.5 Land Use Pattern in Dhemaji District

Total Geographical Area (Ha)	Area under Agriculture (Ha)						Area under Agriculture (Ha)	
	Cultivable Area	Mono crop area	Double crop area	Triple crop area	Gross crop area	Cropping Intensity (%)	Irrigated area	non-irrigated area
323700	86703	NA	NA	nil	95915	110.6	137	95778

(Data Source: https://agcensus.dacnet.nic.in/DistCharacteristic.aspx)

1.10 Soil

The soils of this district can be broadly classified into three different types viz., the foothill/ piedmont zone soils, active flood plain soils near the river Brahmaputra and the low-lying marshy land soils. Commonly foothill/Piedmont zone soil is highly acidic. However, new alluvial soils formed due to inundation of land by river contain more percentages of fine

sand and fine silt and are less acidic. Such soils are often neutral and even alkaline. The rest large expanse of low-lying land is characterized by heavy clayish soil which shows high percentage of nitrogen. This soil is good for rice cultivation. The soil beside the Subansiri and Ranganadi rivers are sandy, coated with silt, which is good for cultivation of winter crops, such as raga, mustard, potato etc.

Table 1.6 Soil Profile of the district

S. N	Major Soil Classes	Area (ha)	Percent (%) of total geographical area
1	Sandy Loam	137500	42.47
2	Sandy	62100	19.18
3	Clay	27300	8.43
4	Clay Loam	60900	18.81
5	Alluvial	3300	1.20

Source: District Agriculture Officer, Dept. of Agriculture, Dhemaji.

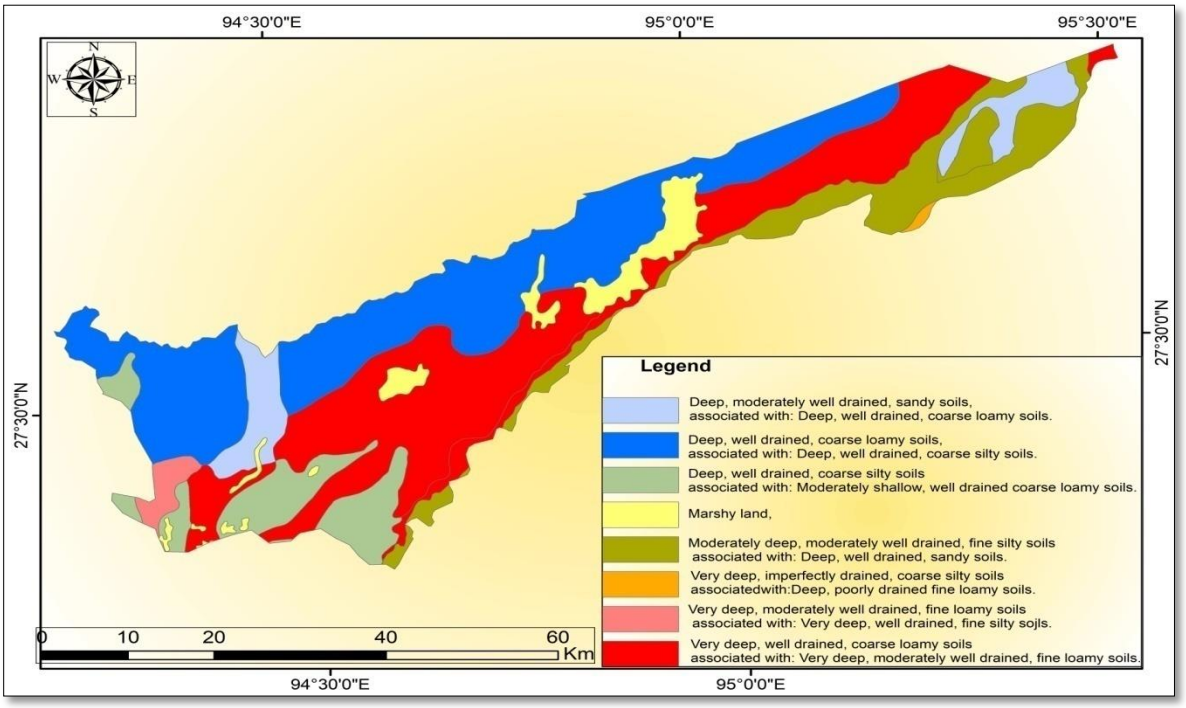


Fig. 1.9: Soil Map of Dhemaji district, Assam

1.11 Hydrology and Drainage

Surface water bodies are mainly observed in the flood plain area where south and south western flowing rivers loses its gradient. Water logged and marshy lands are observed. Kawaimari bill, Chumani bil, Chakamara bil, etc. are some of the surface water bodies in the area.

Dhemaji district has tremendous potential areas for the development of fishery and blessed with abundant water resources which consist of natural water bodies like rivers, beels,

ponds, community tanks and vast stretch of low-lying areas suitable for undertaking scientific fish farming. The approach of community fishery is also gaining momentum in the district.

The Subansiri River marks the western boundary of the district while the great Brahmaputra River marks the southern boundary. Numerous drainage originated from the hills of Arunachal Paradesh flow through this narrow valley and ending at the river Barahamputra. In general slope of the district drop from north eastern corner towards south western sides. After the confluence of three rivers Dihing, Dibang and Lohit from their hilly course to the valley exert tremendous impact of peak runoff at the eastern corner of Dhemaji district, making the district vulnerable to annual flooding. Gai Nadi, Moridhal, Jiadhal/Kumotia, Korha/Sila, Charikaria, Nonoi, Sampara Suti, Subansiri, etc. are important rivers in the district flowing toward southwest. Jiadhal River and Kumotia River create water logged and marshy areas in Bordoloni block. Kanibill which is called Laipulia in downstream side and Sisi are two important rivers draining the central part of the district after originating in the hills near Gohaingaon and Baligaon respectively.

Overall the drainage network of the area shows a dendritic drainage patterns. Collectively, the rivers after coming down from hills show a marked tendency to move towards south-westerly direction. This tendency may indicate influence of underlying fracture and slope direction pattern or this may due to paleochannels of the Brahmaputra River.

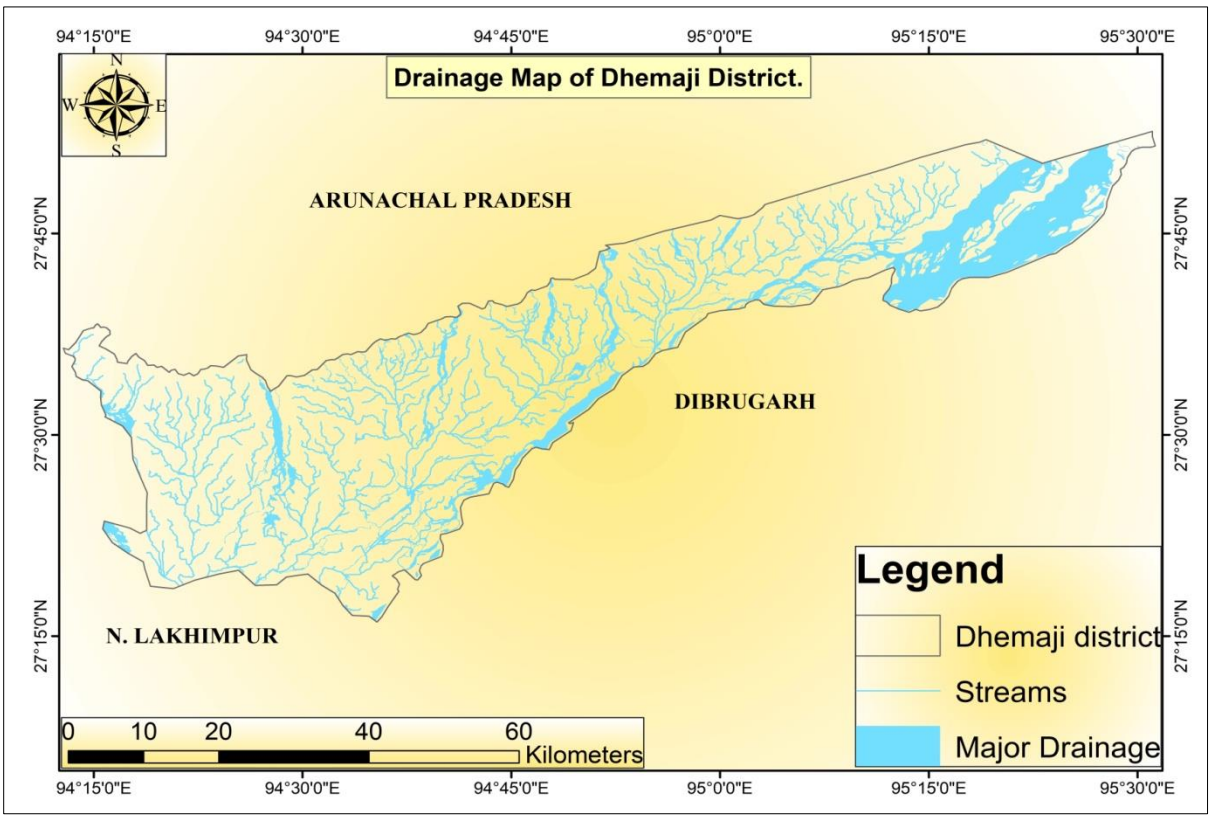


Fig. 1.10: Drainage Map of Dhemaji District, Assam

1.12 Agriculture

In the study area paddy is the principal crops. The agriculture is rain fed. Majority of the population depend on cultivation. Paddy is the dominant crop, however, double cropping pattern is very limited in this part mainly due to lack of irrigation facility. The fragmentation of holdings, causing low farm income and lack of financial resources is seen as the main reason for slow adoption of modern technologies and consequent poor agricultural yields and production and poverty.

The net sown area of the district is 87151 ha which accounts for 26.78 percent of the geographical area of the district & the land utilization pattern in the district

The gross cropped area of the district is 95915 ha with cropping intensity of 110.6 percent. Paddy is the principal crop grown in the district and autumn paddy, winter paddy and summer paddy are the three main types of paddy are grown in the district. Next to paddy, mustered, pulses, turmeric, Betelnuts and vegetables are the main agricultural produce.

Rice is of key importance to the district's economy and the people. It is the staple food of the District's people. The total area under rice cultivation during the year 2015-16 was 79357 ha. In the district summer rice cultivation practice may receive more attention to avoid flood and other natural calamities to make the district self-sufficient in rice production.

Dhemaji is traditionally rich in horticulture production due to diverse agro-climatic condition which is conducive for growing wide range of horticulture crop like vegetable, tuber, ginger, chilli etc., plantation crops- banana, Assam lemon, pineapple etc. horticulture crops more than 17.44 % of the gross cropped area of the district.

A large portion of the area in the Dhemaji district is mainly rain fed; the district has been blessed with heavy rainfall during kharif season.

Fig 1.11: Field photograph showing rice cultivation in and around Phatakalia and Bhekeli Kardong during October month

CHAPTER 2.0

Data Collection and Generation

2.1 Data collection

Data collection includes collection of rainfall data from state government, compilation of CGWB's earlier survey data, GWMS data, chemical data, exploration data and geophysical data. Population data is collected from Census of India website (2011). Agriculture data are taken from District Irrigation Plan, 2016-2020, Dhemaji, Assam prepared by NABARD. CGWB had constructed 05 exploratory wells in this area earlier and during current annual action plan 7 exploratory well was purposed but due to outsourcing work yet to complete from CHQ level none of exploratory well has been constructed during AAP 2020-21.

2.2 Data Generation

2.2.1 Geophysical survey

During AAP 2020-21, there was no VES conducted in the area. CGWB old record were collected and examined. VES survey was with current electrodes spreading in the range of 200 and 500m in the area as part of data generation activity. The location details of these VES survey is shown in Table 2.1

Table 2.1: Location details of VES survey

SN	Name of the site	Latitude	Longitude	RL (mamsl)	Agency	VES/TEM	Depth of interpretation
1	Padmapur	27.54333	94.55889	109	CGWB	VES	169
2	GoalChapori	27.50694	94.58861	101	CGWB	VES	98
3	Maridhol	27.54639	94.62833	104	CGWB	VES	188
4	Siripani	27.57444	94.64306	110	CGWB	VES	96
5	Sisi Borgaon	27.53806	94.68722	106	CGWB	VES	100
6	Akojan	27.54917	94.74056	111	CGWB	VES	157
7	Pichala	27.525	94.3025	114	CGWB	VES	69.9
8	Borola Mirigaon	27.5275	94.32444	115	CGWB	VES	209
9	Govindpur	27.53889	94.43917	124	CGWB	VES	180
10	Panbari	27.53889	94.43917	126	CGWB	VES	201
11	Lekhabali	27.65194	94.71472	134	CGWB	VES	190
12	Nilakhpurgaon	27.62528	94.64556	129	CGWB	VES	250
13	Jairampur	27.51417	94.42944	113	CGWB	VES	92
14	Bakulbari	27.43194	94.43	99	CGWB	VES	94
15	Bishnupur	27.5275	94.51083	113	CGWB	VES	209
16	Silapathar	27.5975	94.73778	116	CGWB	VES	111

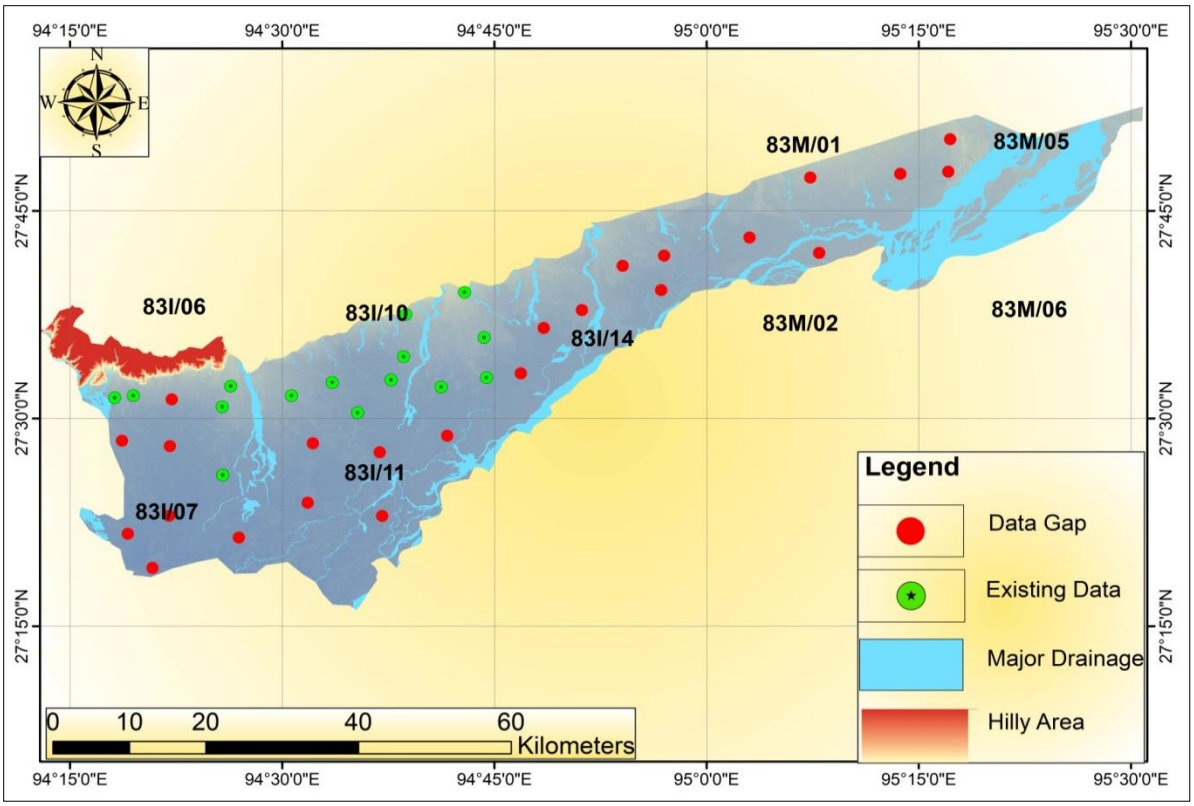


Fig. 2.1: Available data and data generation of VES

2.2.2 Soil Infiltration studies

Salient features of the soil infiltration test are provided in Table 2.2. A perusal of the table shows that the test has been conducted only in barren land and the soil types encountered in the sites are sand/ Silt/Clay admixtures. The infiltration test was conducted for 135 to 160 minutes.

Table 2.2: Summary of soil infiltration test

S N	Site	Latitude	Longitude	RL (m)	Land use	Soil type	Infiltration rate (cm/hr)	Total Quantum of water added in cm	Total quantum of water recharged in m	Infiltration Factor
1	Bokalgaon	94.5790	27.4727	51	Barren Land	Silty Clay	0.12	18	0.00456	2.53
2	Jone karang	95.1665	27.78900	61	Barren Land	Silty Sand	4.0	45.4	0.06352	13.99
3	Atakpur	94.8736	27.70082	53	Barren Land	Sand	36.3	106.9	0.162368	15.17

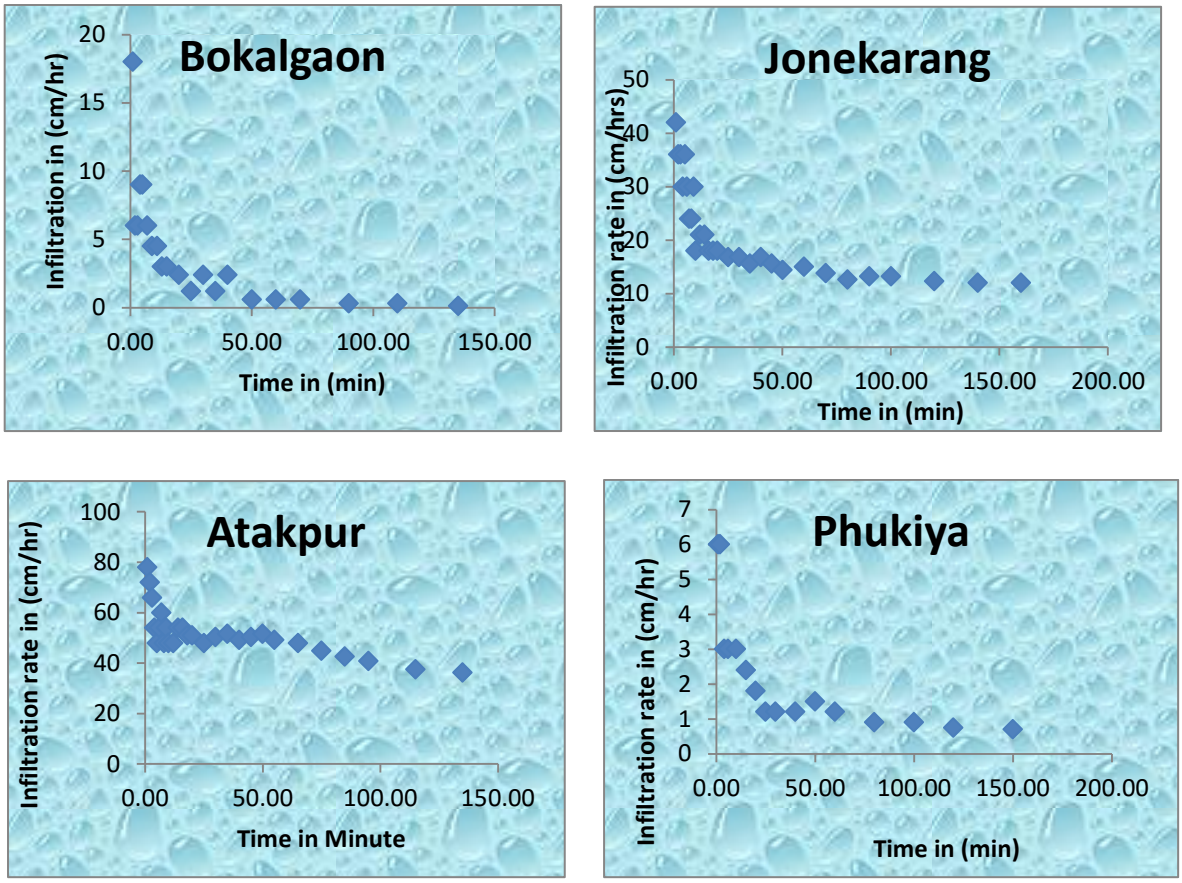


Fig. 2.2: Time Vs Soil infiltration rate plot.

2.2.3 Water Quality

To understand the chemical quality of groundwater in the study area and its suitability for domestic, drinking and agricultural utilization. 30 and 35 nos of Water samples were collected from monitoring wells for analysis of basic elements, iron, heavy metals and arsenic during post monsoon and pre monsoon respectively and submitted to Regional Chemical Laboratory CGWB NER Guwahati for chemical analysis. However, pre-monsoon water analysis data are yet to be received.

Fig 2.3 Field photograph a and b showing water level measurment and soil infiltration study.

2.2.4 Exploratory Drilling

During AAP 2020-21, non of exploratory drilling cmpleted by CGWB in study area. Exploratory wells drilled by CGWB before NAQUIM, were collected and examined.

Table 2.3: Details of exploratory wells in the study area

Sl No	Location	Block	Toposheet No	Long	Lat	Type of Well (DW/ BW/ TW)	Depth	Depth of construction (m)	Source
1	Bokabil	Dhemaji	83I/10	27.5	94.54	TW	37.7	37.7	CGWB
2	Moridhol	Dhemaji	83I/10	27.54	94.62	TW	34.1m	34.1m	CGWB
3	Barala Miri Gaon	Bordoloni	83I/06	27.52	94.32	TW	61.5	61.5	CGWB
4	Tarajan Mohori	Bordoloni	83I/06	27.5	94.32	TW	59.5	59.5	CGWB
5	Chengaki patthar	Dhemaji	83I/10	27.34	94.52	TW			CGWB

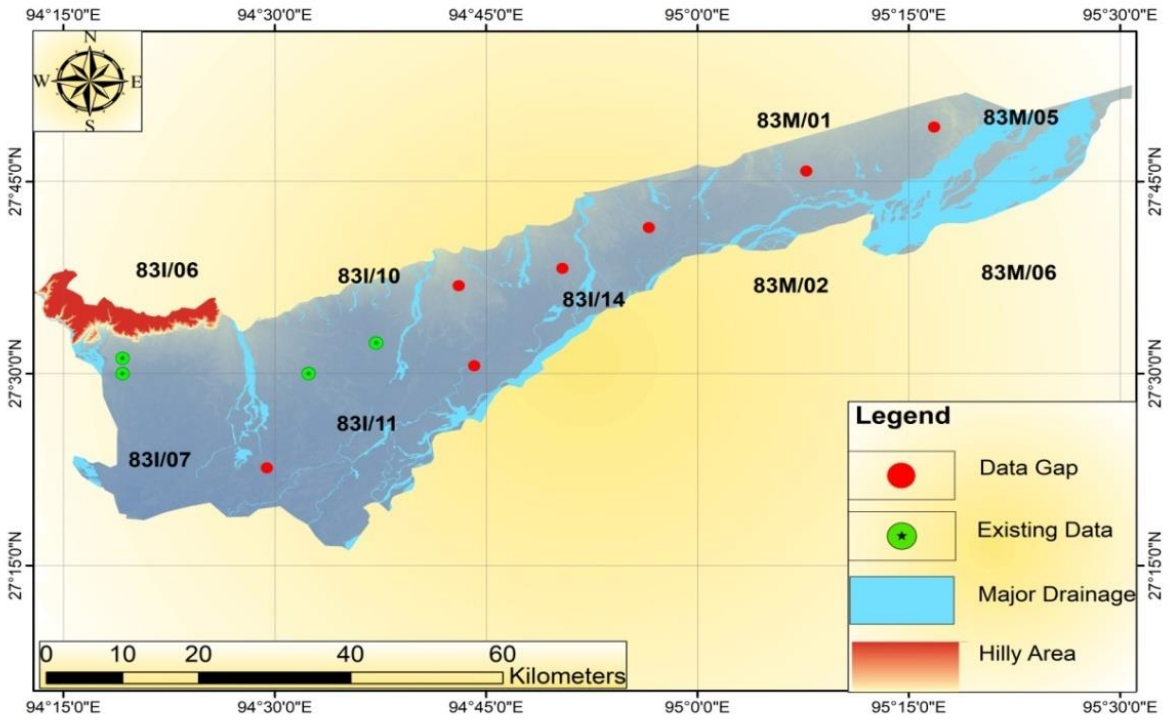


Fig. 2.4: Available data and data generation of exploration in the study area

2.2.5 Hydrogeological data

The entire study area is covered by regular monitoring of existing GWMS and another 29 key wells have been established. All these wells are under monitoring after establishment.

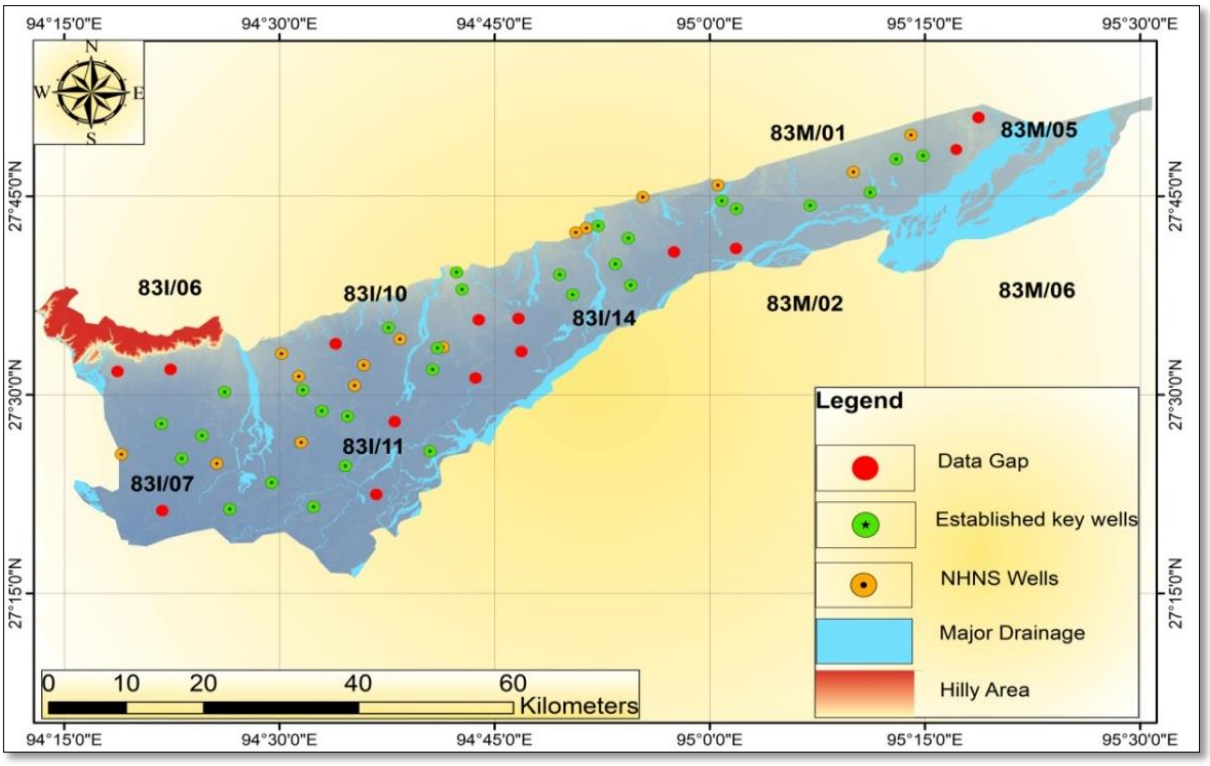


Fig. 2.5: Available data and data generation for ground water level monitoring

Table 2.4: GWMS and Key wells details

Sr. No	Village	Lat*	Long*	Well* Type	MP*	RL*	Depth*	Aquifer group	WL (mbmp), Nov-2020	WL (mbgl), Nov-2020	WL (mbmp) March-2021	WL (mbgl), March-2021
1	Naunandi	27.419594	94.386383	DUG	0.78	95.3	3.75	**Unconsolidated (1st aquifer)**	1.77	0.99	3.02	2.24
2	Ghotapathar Bali deori.	27.448425	94.409967	DUG	0.85	101.3	3.82		1.75	0.9	2.26	1.41
3	2 no Joyrampur Bihari gaon	27.503497	94.436268	DUG	0.97	114.1	3.52		1.82	0.85	3.02	2.05
4	Siker Selok	27.74406	95.013902	DUG	0.85	117.1	3.4		2.47	1.62	3.91	3.06
5	Kamre	27.734307	95.03075	DUG	0.7	113.7	2.94		1.34	0.64	2.5	1.8
6	Gali Mormi	27.738317	95.116553	DUG	0.94	116.2	3.45		1.97	1.03	3.35	2.41
7	Namoni Bali Gaon	27.75457	95.186441	DUG	0.85	120.5	3.34		1.06	0.21	3.43	2.58
8	Jonai Charali	27.800774	95.247751	DUG	0.87	121	3.05		1.11	0.24	1.8	0.93
9	No 2 Rayeng kuli	27.7965	95.216528	DUG	0.6	124	3.25		1	0.4	2.92	2.32
10	Likabali	27.632636	94.712205	DUG	0.96	129.4	4.42		2.24	1.28	3.42	2.46
11	HQ Likabali	27.654161	94.705781	DUG	0.12	139.9	_		6.96	6.84	9.5	9.38
12	Shilahuti	27.558767	94.683602	DUG	1.17	111.3	5.72		2.67	1.5	4.07	2.9
13	Phukiya	27.569309	94.639658	DUG	1.1	108	5.42		2.59	1.49	3.47	2.37
14	Siripani	27.531779	94.67795	DUG	0.75	108.2	3.63		1.78	1.03	3.12	2.37
15	Sisibargaon	27.428742	94.674853	DUG	1.02	103.2	5.04		3.79	2.77	5.41	4.39
16	Mersapuri	27.713893	94.851628	DUG	0.91	115	10.95		8.36	7.45	10.7	9.79
17	Ranga hari	27.651095	94.825454	DUG	1	118.9	5		2.4	1.4	4.26	3.26
18	Siemen Alimur	27.626105	94.840632	DUG	0.75	112.2	3.09		1.53	0.78	2.87	2.12
19	Siemen Chapari	27.712632	94.870301	DUG	0.91	130.3	8.04		2.82	1.91	4.91	4
20	Jorhatia	27.697045	94.905336	DUG	0.94	119.9	4.34		2.84	1.9	Dry	Dry
21	Somkong	27.664559	94.89018	DUG	1.04	118.8	6.41		2.26	1.22	5.4	4.36
22	Jamuguri	27.505915	94.527182	DUG	1.03	109.8	4.25		2.06	1.03	4.05	3.02
23	Kalapathar	27.479417	94.549161	DUG	0.9	106.3	4.7		2.53	1.63	4.46	3.56

Sr. No	Village	Lat*	Long*	Well* Type	MP*	RL*	Depth*	Aquifer group	WL (mbmp), Nov-2020	WL (mbgl), Nov-2020	WL (mbmp) March-2021	WL (mbgl), March-2021
24	Dhemaji	27.472726	94.579025	DUG	1.1	107	5.22		3.63	2.53	5.28	4.18
25		27.41033	94.576642	HP	0.29	102	7.62		3.61	3.32	Demolished	Demolished
26	Bemgenagarh	27.358868	94.539567	DUG	1.12	99.5	5.36		3.24	2.12	4.47	3.35
27	Parsai kiya Gaon	27.38922	94.490876	DUG	1.1	102	6.72		2.47	1.37	3.97	2.87
28	Khikusi	27.356058	94.442318	DUG	0.85	97.8	3.2		2.43	1.58	Dry	
29	Betbari	27.46348	94.362799	DUG	0.96	101.3	4.6		2.12	1.16	3.03	2.07
30	Bhagaban charali	27.70981	94.85664	DUG	0.9	115	10.9		8.33	7.43	10.6	9.7
31	Bijoypur	27.78039	95.16678	DUG	0.79	112	6.57		1.33	0.54	3.39	2.6
32	Bokabil	27.52311	94.52244	OW	0.8	100			2.76	1.96	4.1	3.3
33	Bordoloni	27.41336	94.42719	DUG	1.25	89			1.2	-0.05	2.1	0.85
34	Chengaki Pather	27.43983	94.52525	OW	0.76	88		**Unconsolidated (1st aquifer)**	1.71	0.95	3.09	2.33
35	Dhemaji	27.51158	94.58731	DUG	1.21	74	5.09		1.61	0.4	2.77	1.56
36	Dipa	27.70428	94.84422	DUG	0.7	117	7.55		4.52	3.82		
37	Gogamukh High. sec.School	27.42506	94.31619	OW	0.76	96			2.4	1.64	4.2	3.44
38	Jonai Murkongselek	27.82694	95.23386	DUG	0.8	124	5.06		1.83	1.03	3.37	2.57
39	Moridhol	27.53708	94.59786	DUG	0.97	110	4.98		2.18	1.21	3.61	2.64
40	Santipur	27.55158	94.50236	DUG	0.60	109	4.87		2.3	1.70	3.75	3.15
41	Sisibargaon	27.56000	94.69000	DUG	0.97	110	3.75		1.79	0.82	2.04	1.07
42	Telem	27.76397	95.00953	DUG	1.01	111	6.21		2.4	1.39	5.13	4.12
43	Ghilamara	27.32107	94.42060	OW	0.8						5.34	4.54
44	Siripani	27.57000	94.64000	DUG	0.78	108						

CHAPTER 3.0

Data Interpretation, Integration and Aquifer Mapping

3.1 Aquifer Characterization

The interpreted results of VES data has shown that top soil of the district has resistivity value within 500 Ωm being approximately 5m thick comprises clays with boulders of compact nature. The layer below the top soil in the depth range of 5m and 50m with resistivity in the range of 100 Ωm and 250 Ωm is indicative of saturated formation comprising sands, clays with pebbles etc. The consecutive layer below 50m and 250m with resistivity more than 150 Ωm is indicative of the probably the saturated formation comprising pebbles with sands and clays occasionally with boulders. Comparatively lesser resistivity within 70-80 Ωm is indicative of clays predominance intercalated with thin bands of sands etc. The summary result of resistivity survey is shown in Table: 3.1

Table 3.1: Summary result of VES study

Resistivity section	Resistivity value Ωm	Depth (mbgl)	Inferred Lithology
	500	0 to 5mbgl	Top soil: clays with boulders of compact nature
	100 to 250	5 to 50mbgl	Saturated formation : Sands, clays with pebbles etc.
	>150	50 to below 250mbgl	Saturated formation: Pebbles with sands and clays occasionally with boulders
	70-80	clays predominance intercalated with thin bands of sands	

The result of VES survey has shown that the subsurface formation is sand or gravel dominated and clay occur as intercalations with sand. Moreover, saturated formation is extended below 250m.

Central Ground Water Board, North Eastern Region, Guwahati has drilled five exploratory wells in the area. From the examination of this litholog it is observed that down to a maximum explored depth of 61.5 m, the sequence is dominated by gravel, sand, clay and boulders. The lithologs and the lithology identified in VES survey are used to understand 2D and 3D disposition of aquifer.

2D disposition: Sections are prepared along north east-south west direction to know disposition of sediments along the piedmont zone and normal to the piedmont. It is observed that the sediments of piedmont zone deposited in high energy conditions as coarser grain materials are dominated in sub surface formation close to the foothill. Two gravelly formations are encountered and identified in the VES and in drilling. Resistivity value of the first gravel zone ranges from 267 to 7080 Ωm and perusal of litholog of Borola Miri Gaon, Tarajan Mohori Camp, Bokabil and Moridhol EW shows that the zone is dominantly gravelly

mixed with sand. 2D disposition of this zone in the subsurface along the strike of piedmont is lens shaped with continuously thinning and thickening (Fig. 3.1). Towards the Brahmaputra flood plain this gravel layer is pinched out (Fig. 3.2).

The resistivity value of the second gravel zone ranges from 250 to 2644 Ωm. The highest resistivity value is found near Arunachal foot hill at Likabali and Borola Miri Gaon, etc., indicating coarseness and dryness of the zone. This zone is pinched out towards the alluvial plain/flood plain. In the piedmont zone also this zone is pinched out and reappear depending the proximity of the area to Arunachal foothill.

In the study area three clay layers encountered. The first clay layer is pinching out at Bishnupur and near Pichola. The second clay layer is pinched out towards northwestern part while third clay layer is completely absent in some locations. That is both these layers are not present throughout the area. Resistivity value of the first clay layer ranges from 53 to 97 Ωm and resistivity of the second clay layer ranges from 67 to 130 Ωm. Second clay layer is absent in the piedmont zone and after emerging in the alluvial plain its presence can be detected towards the flood plain.

The aquifer zone is an admixture of sand and gravel in various proportions. However, towards the flood plain, i.e., in the area around Bakulbari, Dhemaji area the gravel percentage may be less.

A perusal of the 2D and 3D disposition of the aquifer, it can be summarized that the aquifer system of Dhemaji district belong to alluvial aquifer which consists of both younger and older alluvial sediments (Fig. 3.3). The aquifer property identified by CGWB are given in Table

2D Disposition of Aquifer

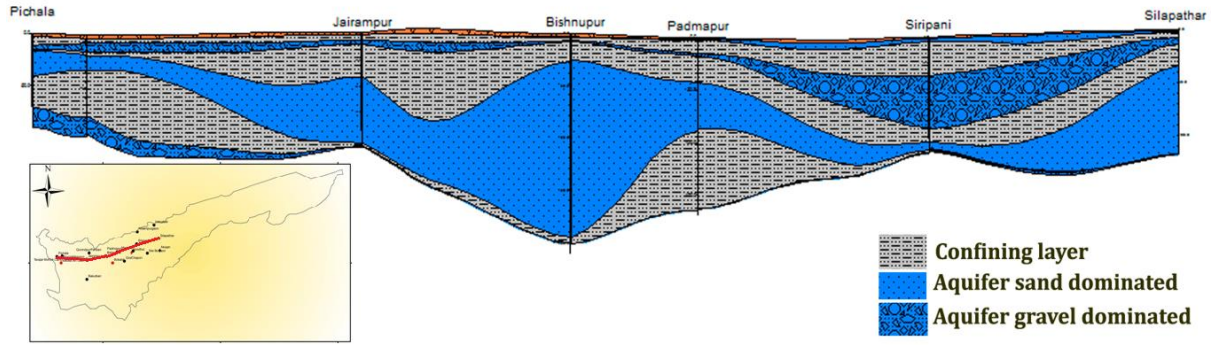


Fig. 3.1: NE-SW SECTION PARALLEL TO PIEDMONT ZONE

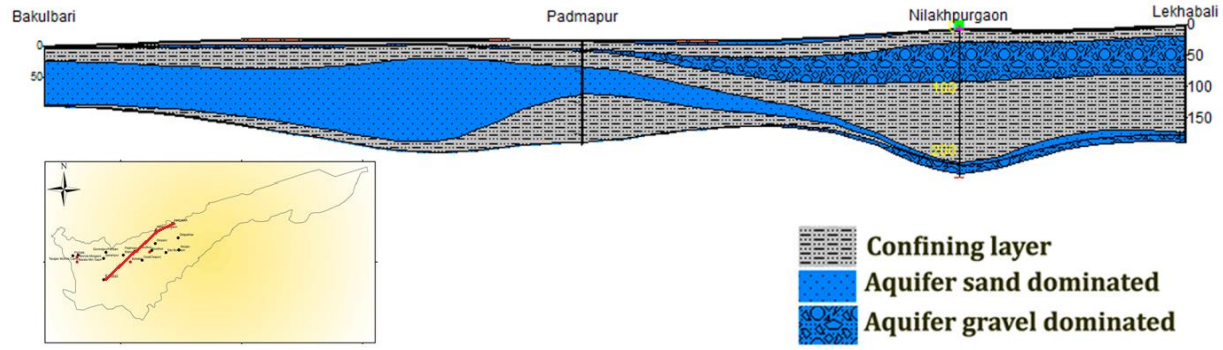


Fig. 3.2: NNE-SSW SECTION NORMAL TO PIEDMONT

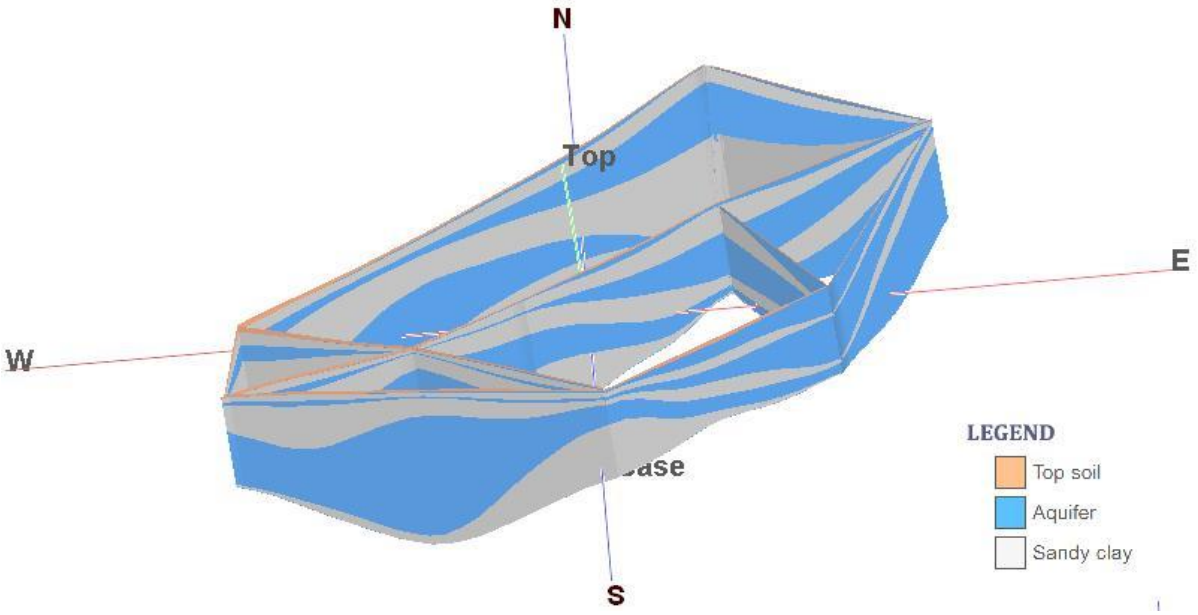


Fig. 3.3: 3D Aquifer Disposition

Table 3.2: Aquifer property

Village/ Location	Taluka/ Block	Lat	Long	Type of well	Depth (m)	Draw down (m)	Transmissivity (m^2/day)	Storativity/ S.Yield	Specific Capacity (lpm/m of dd)	Source/ Agency
Barala Miri Gaon	Bordoloni	27.52	94.32	TW	61.5	0.855	3283.2	NA	947.36	CGWB
Tarajan Mohori Camp		27.50	94.32	TW	59.5	2.08	9831	NA	358.5	CGWB
Bokabil	Dhemaji	27.50	94.54	TW	37.4	2.41	5466.0	NA	175.56	CGWB
Moridhol		27.54	94.62	TW	34.1	4.92	2032.4	NA	137.4	CGWB

3.2 Ground water level

To study ground water regime, depth to water level from 44 monitoring stations (GWMS 15, Key well 29) are measured seasonally. Block wise variation of water level can be discussed as below.

Pre-monsoon (March 2021) depth-to-water level of the key wells in Bordoloni Block (Excluding hilly area) is 0.85 to 2.24 mbgl, Dhemaji Block 2.87 to 4.18 mbgl, Sisibargaon block 2.12 to 9.79 mbgl, Murkongselek block is 0.69 to 9.7 mbgl and Machkhowa block depth-to-water level 3.35 mbgl. (Fig. 3.4)

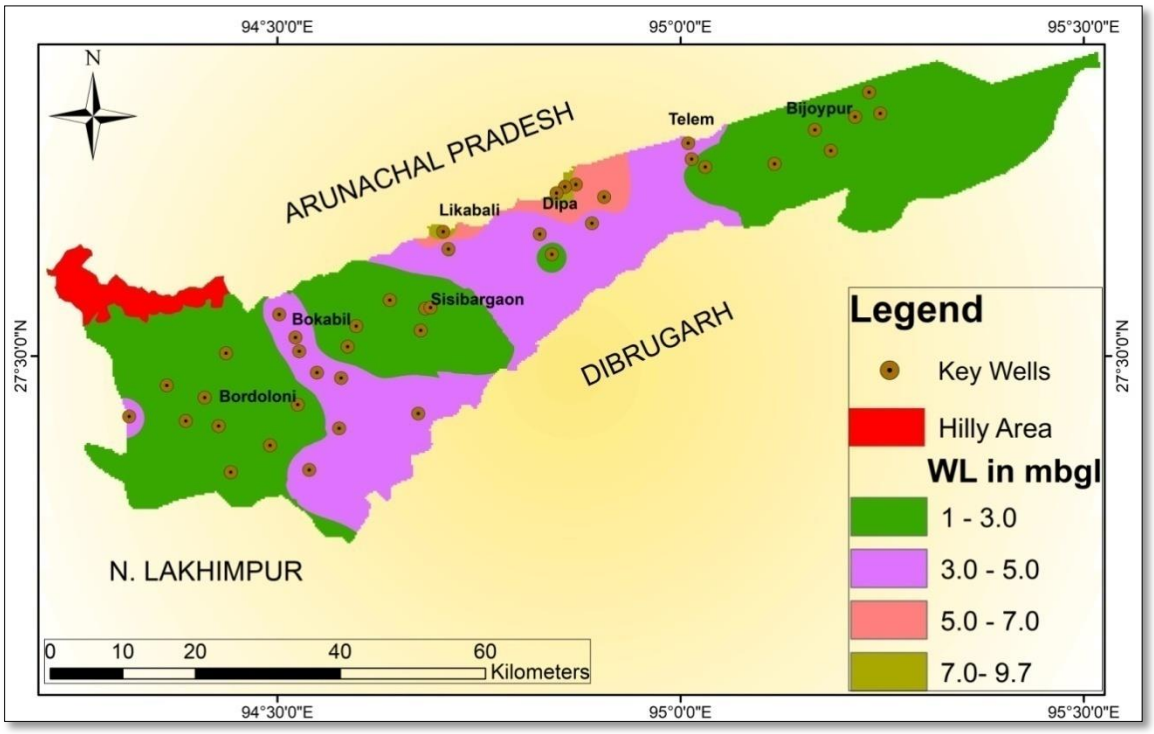


Fig. 3.4: Pre-monsoon groundwater level of the study area

Post-monsoon (November 2020) depth-to-water level of the key wells in Bordoloni Block (Excluding hilly area) is -0.05 to 1.58 mbgl, Dhemaji Block 1.37 to 3.32 mbgl, Sisibargaon block 1.03 to 7.37 mbgl, Murkongselek block is 0.21 to 7.43 mbgl and Machkhowa block depth-to-water level 2.12 mbgl. (Fig. 3.5).

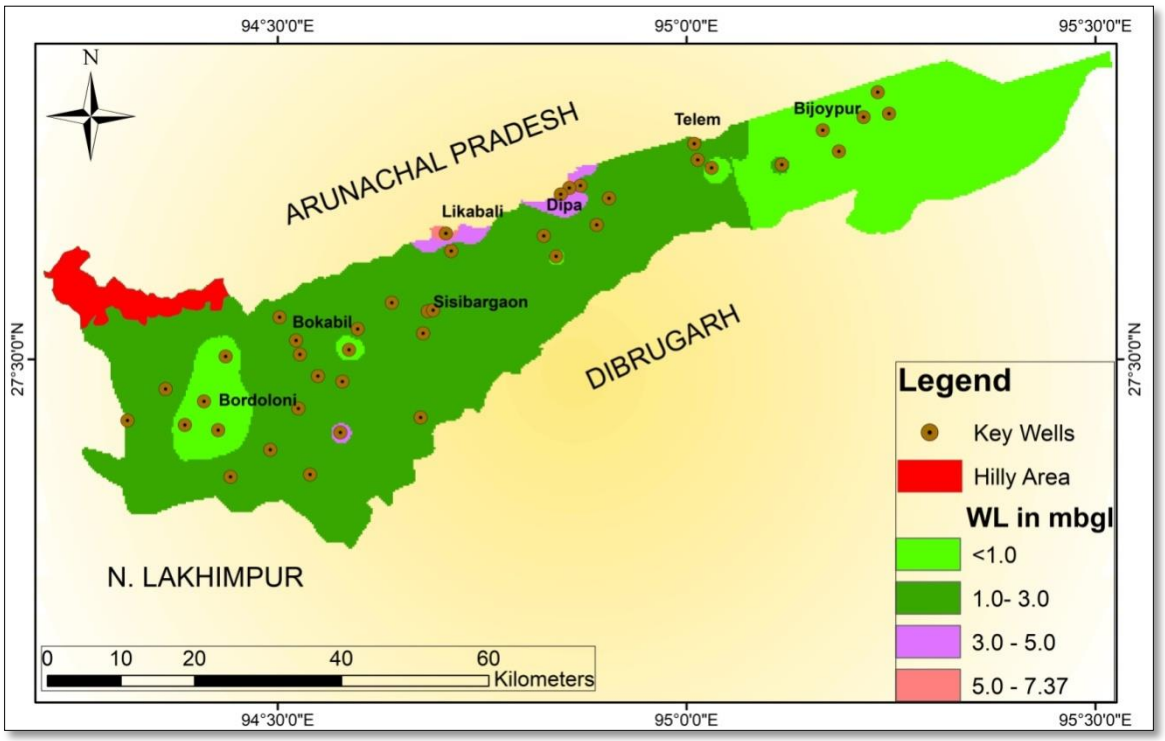


Fig. 3.5: Post-monsoon groundwater level of the study area

Fluctuation of water level pre- and post-monsoon water level difference ranges from 0.51 to 3.13 mbgl. Highest fluctuation observed in western part of Murkongselek block and

northern hilly tract of Sisibargaon block from 2.0 to 3.13, remaining district shown less than 2.0 m fluctuation. (Fig. 3.6).

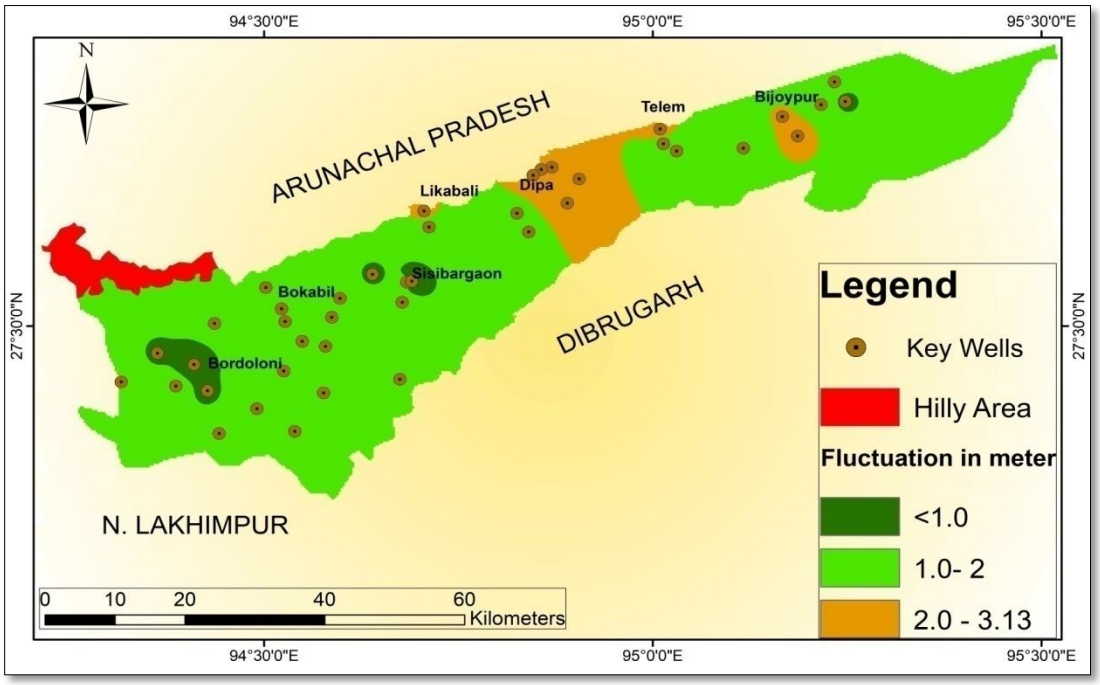


Fig. 3.6: Water Level Fluctuation map of the study area

Ground Water Movement

The water table contour has been prepared based on water level of ground water monitoring stations which is shown in Fig.3.7. The ground water flow direction is from north to south. The highest water table is 130m and lowest water table 100 m above the mean sea level. In the pediment zone contours are generally closely spaced indicating recharge area.

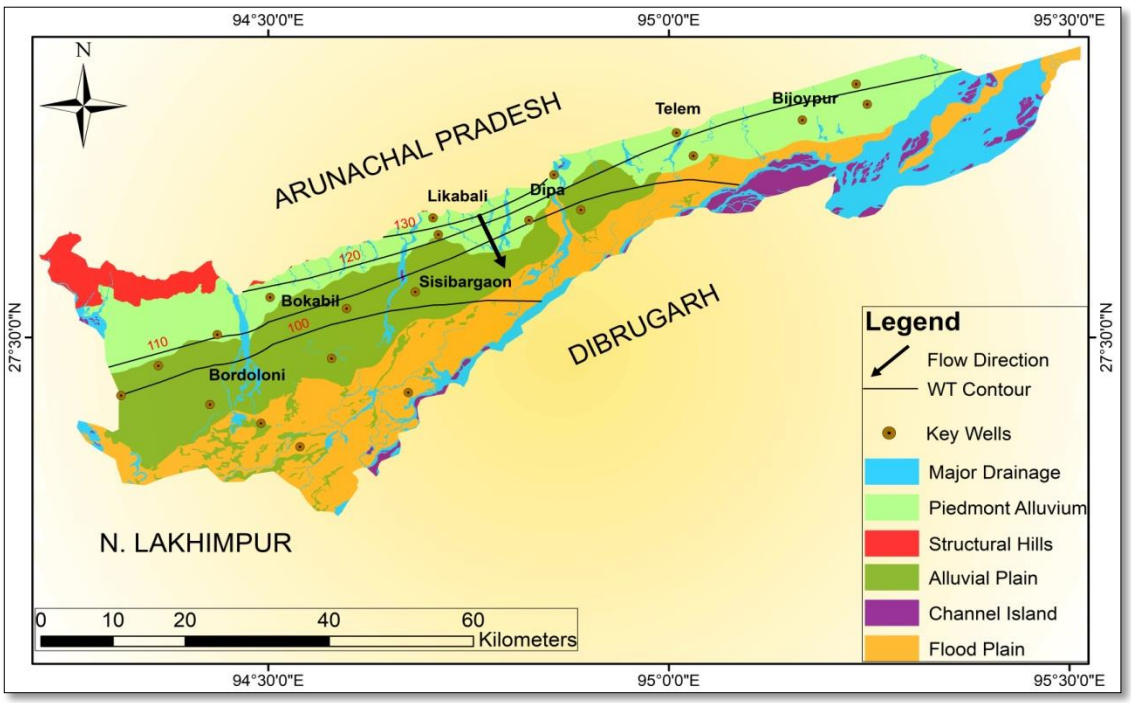


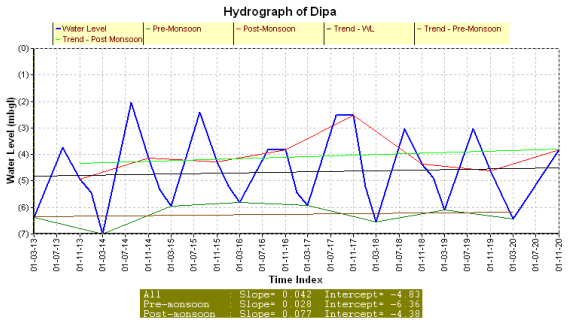
Fig. 3.7: Water table contour of the study area

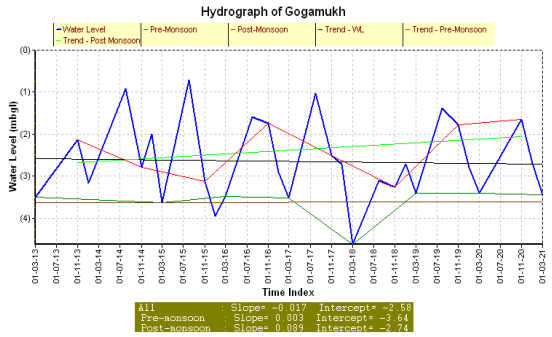
3.3 Water level trend analysis

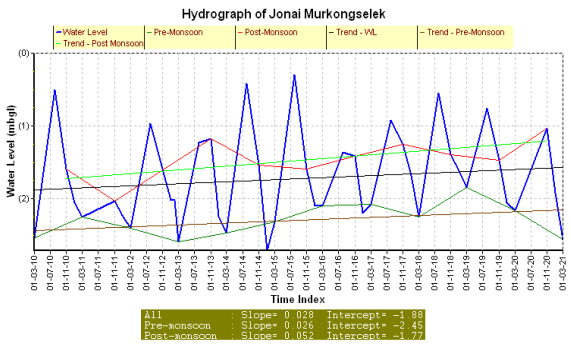
For analysis of long-term behavior of ground water level, data from Ground Water Monitoring Stations (GWMS) are utilized. Historical depth-to-water level data (in mbgl) are plotted as individual hydrographs and are given in Figure 3.8 and Table 3.3 shows the overall trend of water levels in GWMS wells of Dhemaji district, Assam.

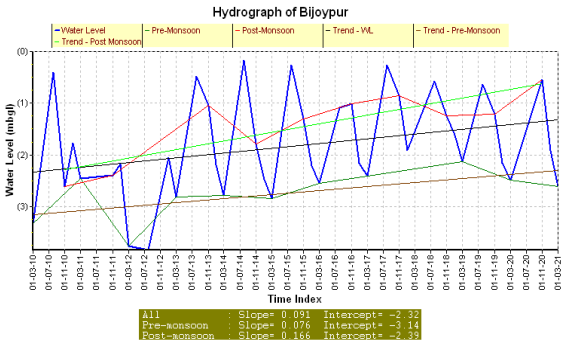
Table 3.3 Trend of Water levels in GWMS Wells

SN	Locality/Name	No. of years	Water Level Trend	
			Post-monsoon	Pre-monsoon
1	Dipa	8	No significant change	
2	Bijoypur	12	Rise	Rise
3	Dhemaji	9	Rise	Rise
4	Bhagban Charali	12	No significant change	
5	Bokabil	9	Rise	Rise
6	Gogamukh	9	Rise	No change
7	Jonai Murkongselek	12	Rise	Rise
8	Telem	12	No significant change	









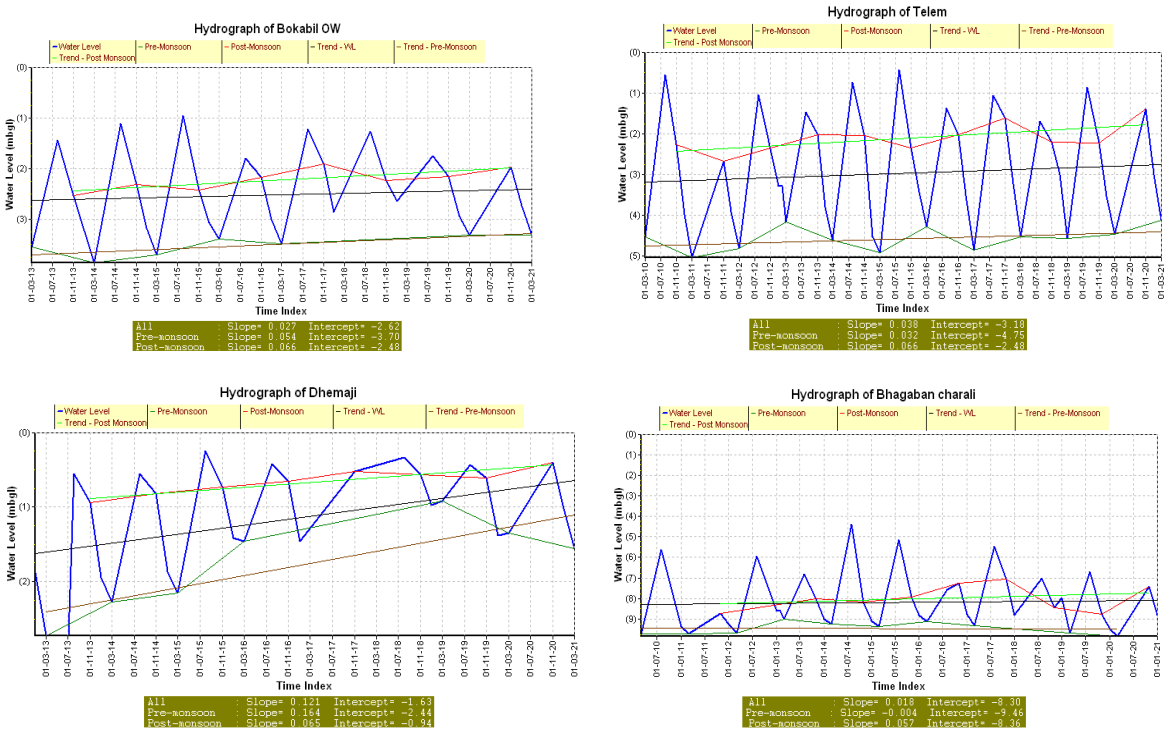


Fig.3.8: Hydrograph of GWMS wells of study area

3. 4 Ground water quality

During AAP 2020-21, 30 nos of Shallow aquifer Groundwater samples were collected from dug well/ hand pump during post monsoon and 35 nos. sample in pre-monsoon for water quality study of Dhemaji district. EC and pH was measured using portable digital meter on site. Chemical analysis of ground water samples are carried out by regional chemical laboratory of Central Ground Water Board, North Eastern Region, Guwahati. In the present study the quality of water with respect to major ion, heavy metals, iron, arsenic and uranium, TDS, TH etc. was estimated and various parameter analyzed to evaluate the suitability of ground water in the study area for human consumption and agriculture practices.

Table 3.4 Minimum and maximum of hydrochemical parameters of groundwater

Parameter	Unit	Post Monsoon			Pre Monsoon		
		No of Samples	Min	Max	No of Samples	Min	Max
pH	No unit	30	6.152	7.520	35	7.22	8.80
Ec	µs/cm	30	90.93	552.4	35	100.9	365
TDS	mg/l	30	47.09	291.4	35	49.92	188.6
Turbidity	No unit	30	BDL	0.5	35	BDL	0.5
Sodium	mg/l	30	4.49	38.13	35	2.58	60.91
Potasium	mg/l	30	1.32	22.76	35	2.24	28.82
Calcium	mg/l	30	6	48.04	35	8.01	36.03
Magnesium	mg/l	30	4.84	53.39	35	2.42	31.55
Chloride	mg/l	30	7.09	42.54	35	10.64	46.09
Bicarbonate	mg/l	30	30.52	372.4	35	30.52	299.14
Sulphate	mg/l	30	3.66	77.68	35	3.58	84.88
Flouride	mg/l	30	0.03	0.71	35	0.32	1.50
Nitrat	mg/l	30	BDL	7.41	35	0.18	9.14

Iron	mg/l	30	0.454	17.884	35	0.28	56.88
Arsenic	µgl	30	BDL	49.7250	35	-	-
Uranium	µgl	30	BDL	1.3565	35	-	-
TA	mg/l	30	30.52	372.4	35	30.52	268.61
TH	mg/l	30	40	280	35	30	175
Na%	%	30	7.57	59.74	35	9.14	60.81
SAR	No unit	30	0.155	2.012	35	0.196	1.95
RSC	meq/l	30	-0.194	1.21	35	-0.896	1.005
PI	%	30	49.52	112.65	35	51.02	107.93
KR	No unit	30	0.0573	0.883	35	0.076	1.45
MH	%	30	19.94	78.56	35	33.29	86.66
PS	mg/l	30	0.247	1.873	35	0.337	1.795

3.4.1 Drinking Water Quality

Post monsoon groundwater analysis data has been analyzed and were compared with the Bureau of Indian Slandered for drinking water quality (BIS-2012)/WHO to evaluate the suitability of groundwater in the study area for human consumption shown in table 3.5

pH of study area varies from 6.15 to 7.52 shows 90% samples under acceptable limits and 10% sample exceeding the acceptable limit. Total dissolve solid (TDS) ranges from 47.09 to 291.4 with average 146.83 mg/l in study area and shows 100% samples are under acceptable limit for drinking and domestic purpose. Total Hardness (TH) in groundwater ranges from 40 to 280 mg/l, shows 86.67% samples are under acceptable limit and 100% samples under permissible limits. Most of samples come under soft to moderately hard category.

All other parameters as shown in table 3.5 are within acceptable or permissible limit for drinking and domestic consumption except iron and arsenic. 56.67% groundwater samples have iron concentration above the acceptable limits, and 20 % arsenic sample also having concentration above the permissible limit.

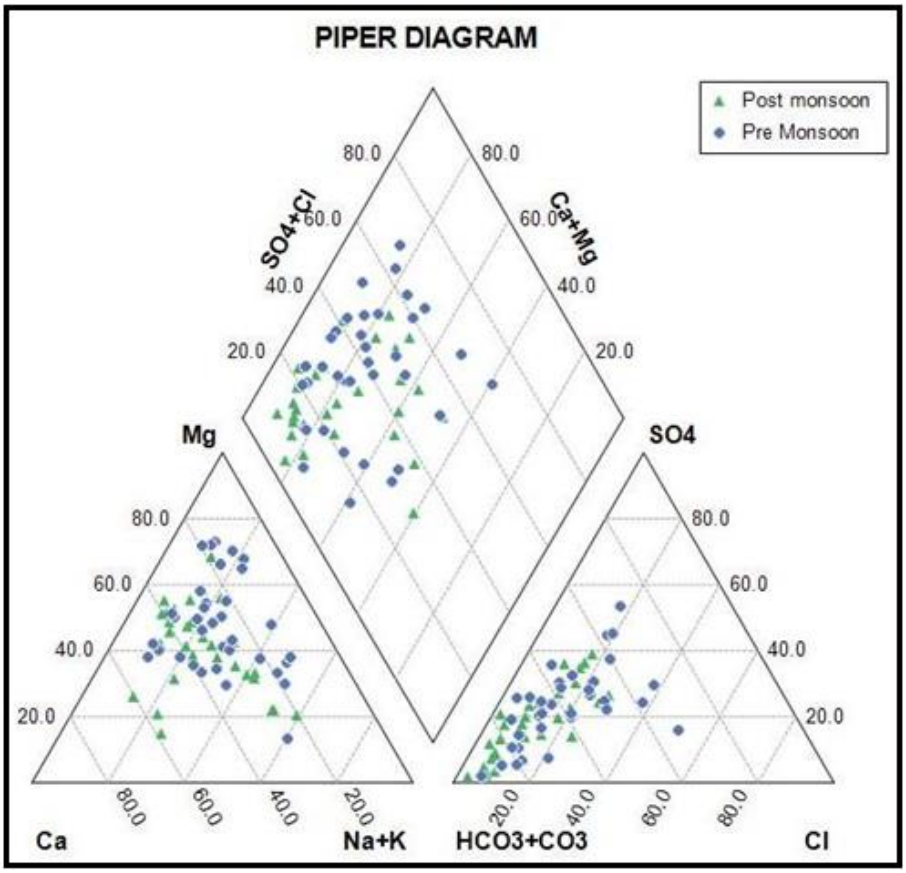


Fig 3.9: Major Hydrochemical facies of Groundwater

Hydrochemical analysis data is plotted in Piper diagram (fig 3.9). Post Monsoon: in the present study majority of plotted samples (76.67%) are concentrated in Magnesium Bicarbonate field. 13.33% of the samples are in Ca-Mg-Cl field. Rest of them fall in Ca-Na-HCO_3 and Na-Cl field. Pre Monsoon: 68.5 % sample in Magnesium Bicarbonate field, 22.8 % sample of Ca-Mg-Cl type and rest fall in other field.

Table 3.5 Suitability of groundwater for drinking purposes of study area.

Parameter	Unit	Acceptable Limit BIS (2012)/WHO	% of sample under acceptable limits	% of sample exceeding acceptable limits
pH	No unit	6.5- 8.5	90	10
TH (as COCO3)	mg/l	200	86.67	13.33
TDS	mg/l	500	100	0
Turbidity	NTU	1	100	0
Total Alkalinity	mg/l	200	80	20
Potassium	mg/l	12	90	10
Calcium	mg/l	75	100	0
Magnesium	mg/l	30	86.67	13.33
Chloride	mg/l	250	100	0
Sulphate	mg/l	200	100	0
Fluoride	mg/l	1	100	0
Nitrate	mg/l	45	100	0
Iron	mg/l	1.0	43.33	56.67
Arsenic	µgl	10	80	20
Uranium	µgl	30	100	0

Distribution of Iron and Arsenic in groundwater: 56.57 % of post monsoon water sample showing iron concentration above the permissible limits throughout the district, lowest value 0.454 mg/l observed in Bemgenagarh and highest 17.884 mg/l in Jamuguri. 6 nos (20%) of water sample also found arsenic concentration above the permissible limit, highest value 49.725 microgram/liter found in 2 no Joyrampur Bihari gaon Bordoloni block (Details in Annexure-I).

In previous study Dr. I. Roy, Sc-B from CGWB, NER, Guwahati carried out a special study on occurrence of arsenic in Dhemaji district, Assam during AAP 2006-07, collected and analyzed 94 nos. of water samples in pre and post monsoon from shallow and deep aquifer and found 45.7% sample during pre-monsoon and 53.9% sample during post monsoon has arsenic concentration above the permissible limit (Fig.3.10 to 3.13). Arsenic contamination most severe in Dhemaji, Bordoloni blocks, significant high value also present in Sisibargaon and Muchkhowa Block. In case of iron concentration the most serve cases exist in Dhemaji and Bordooni block and all other blocks also affected. (Details in Annexure-II).

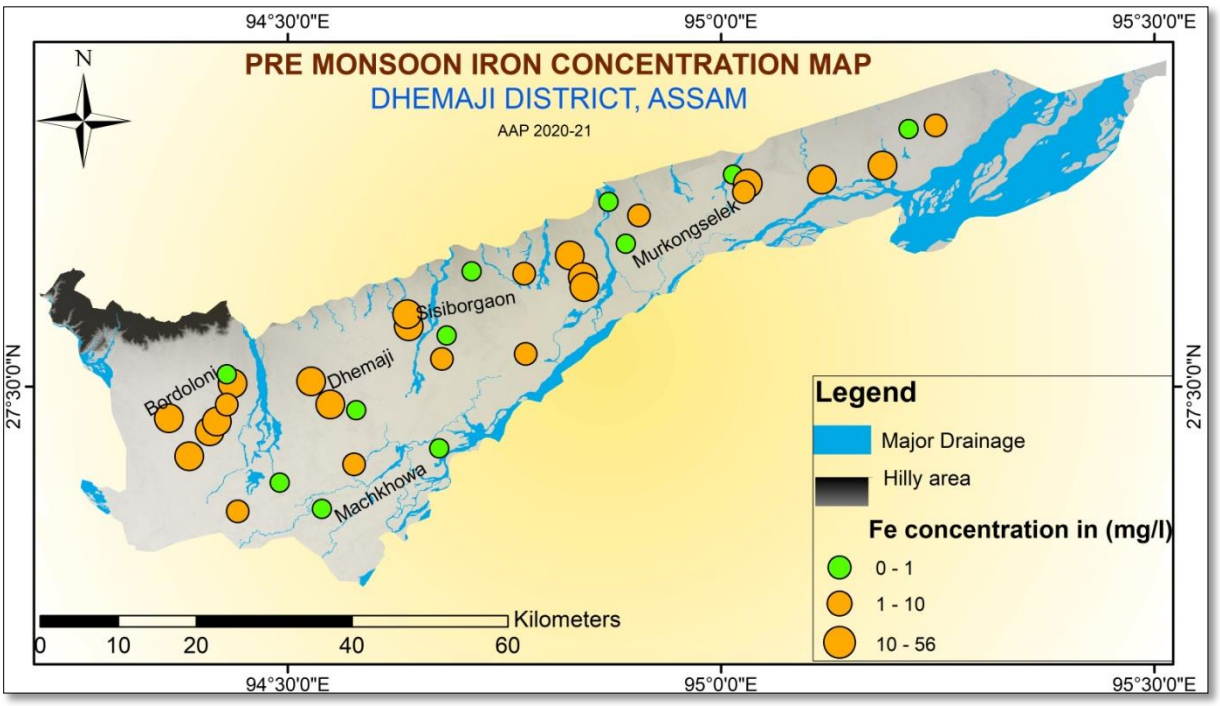


Fig: 3.10: Pre monsoon Iron Concentration map of Dhemaji District (CGWB Data 2006-07)

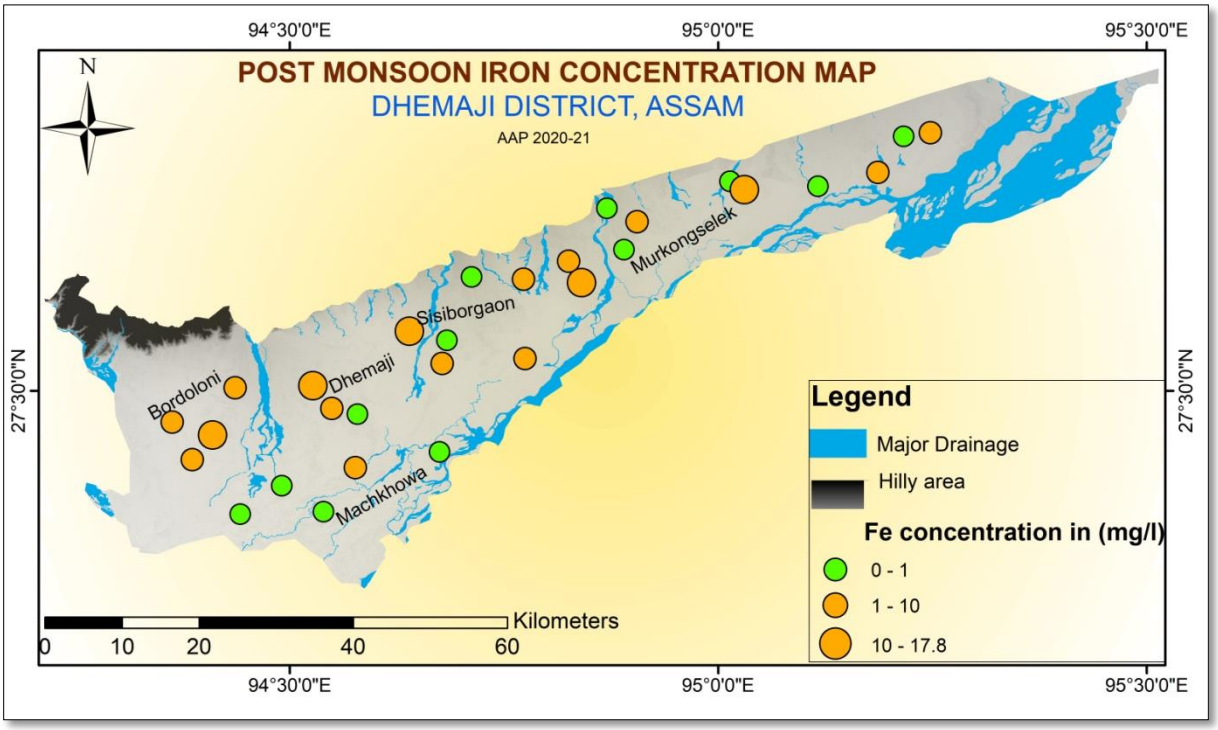


Fig: 3.11: Post monsoon Iron Concentration map of Dhemaji District (CGWB Data 2006-07)

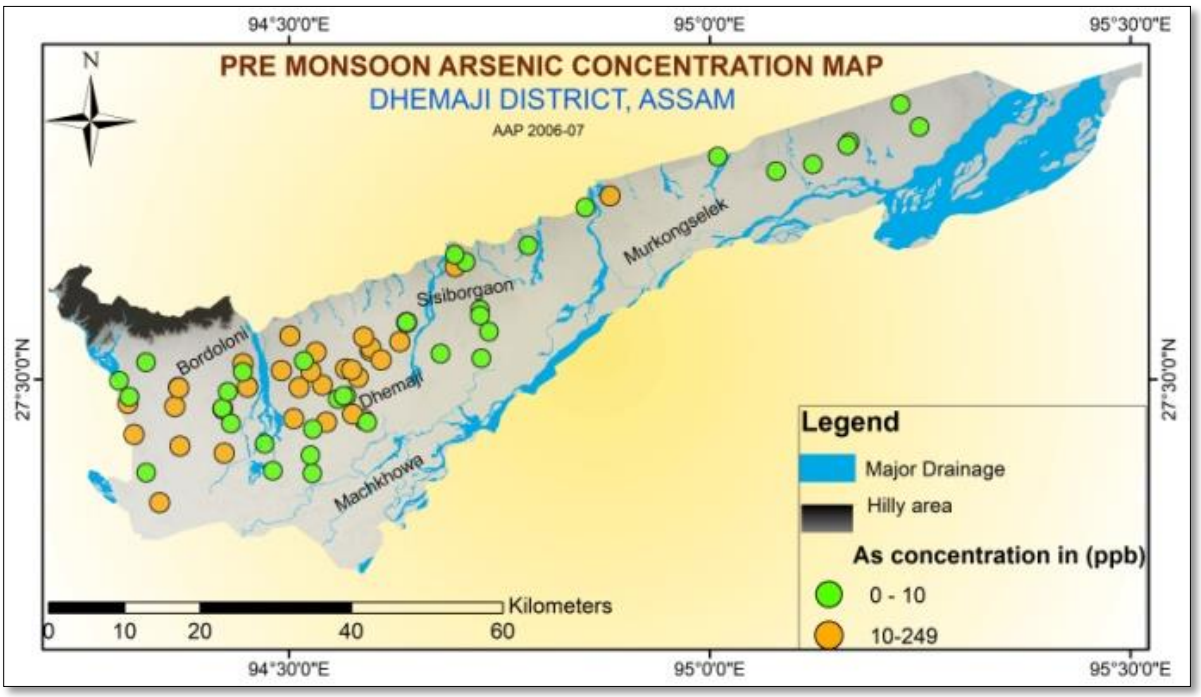


Fig: 3.12: Pre monsoon Arsenic Concentration map of Dhemaji District (CGWB Data 2006-07)

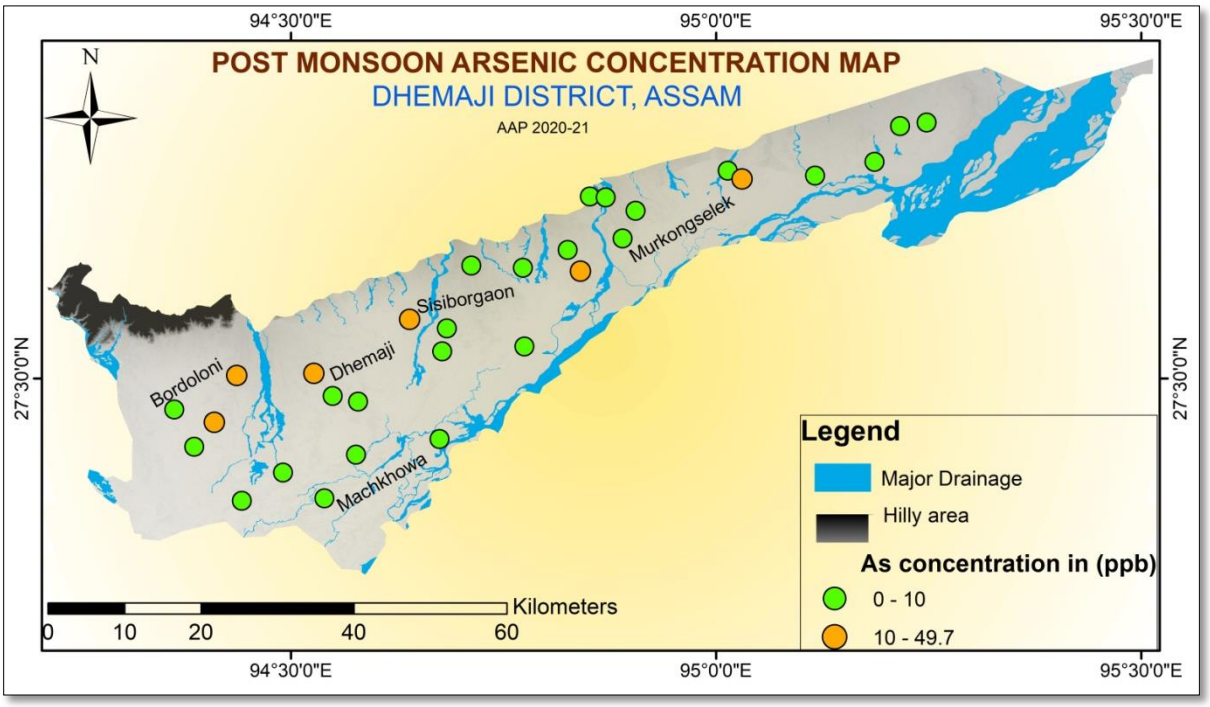


Fig: 3.13: Post monsoon Arsenic Concentration map of Dhemaji District (CGWB Data 2006-07)

3.4.2 Irrigation Water Quality

Sodium hazards (Na%), Kelly's Index (KI) , Permeability Index (PI), Magnesium Hazards (MAR), Residual Sodium Carbonate (RSC), Sodium Adsorption Ratio (SAR), Potential Salinity (PS) etc parameters has been analyzed to evaluate the suitability of ground water in the study area for irrigation. all parameters deciphered the quality of groundwater of study area are Excellent to Good for irrigation purpose and same are summarized in table 3.6 and 3.7.

Table: 3.6 Suitability of groundwater for irrigation.

Based on Electrical Conductivity (Ec)				**Based on Na%**			
EC (µs/cm)	**Water Class**	**Post Monsoon**	**Pre Monsoon**	**Na%**	**Water Class**	**Post Monsoon**	**Pre Monsoon**
		% of samples				**% of samples**	
<250	Excellent	46.66	48.57	**<20**	Excellent	43.33	34.28
250-750	Good	53.34	51.43	**20-40**	Good	36.67	54.29
750-2000	Permissible	0	0	**40-60**	Permissible	20	11.43
2000-3000	Doubtful	0	0	**60-80**	Doubtful	0	0
>3000	Unsuitable	0	0	**>80**	Unsuitable	0	0
Based on Residual Sodium Carbonate				**Based on Permeability Index (PI)**			
<1.25	Good	100	97.15	**>75**	Class-I, Suitable	40	28.57
1.25-2.5	Doubtful	0	2.85	**25-75**	Class-II, Good	60	71.43
>2.5	Unsuitable	0	0	**<25**	Class-III, unsuitable	0	0

Sodium Adsorption Ratio (SAR)				**Kelly Index**			
<10	Excellent	100	100	**<1**	Recommended	100	94.29
10.0 - 18.0	Good	0	0	**>1**	Not recommended	0	5.71
18.0 – 26	Doubtful	0	0				
> 26	Unsuitable	0	0				
Magnesium Hazards (MAR)				**Potential Salinity (PS)**			
<50 %	Recommended	30	17.14	**<3.0**	Suitable	100	100
>50 %	Not recommended	70	82.86	**>3.0**	Unsuitable	0	0

SAR vs EC on the US salinity diagram is shown in fig 3.13, most of groundwater sample fall in C1S1 and C2S1 indicating low sodium content and low to medium salinity nature of groundwater is good for irrigation purpose.

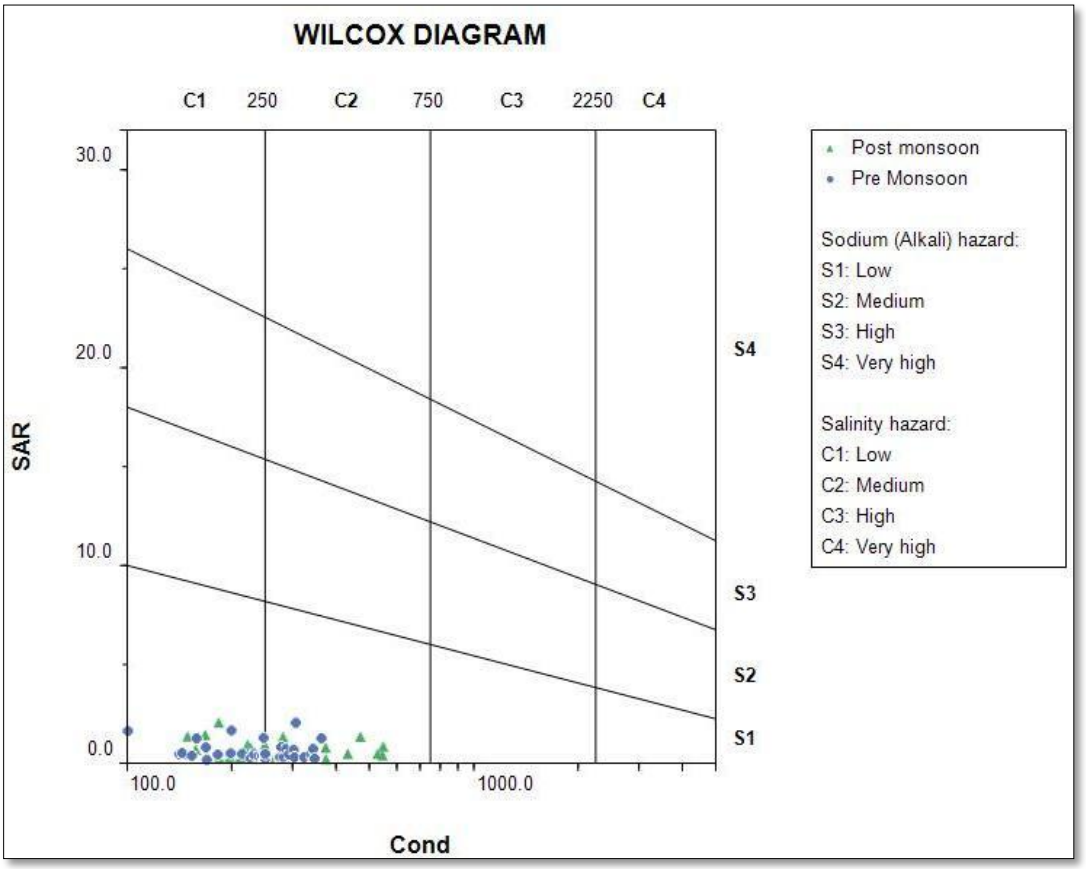


Fig 3.14: Wilcox diagram showing suitability of groundwater for irrigation based on sodium and salinity hazard.

CHAPTER 4.0

Ground water Resources

4.1 INTRODUCTION

The computation of ground water resources available in the district has been done using GEC 2015 methodology. The dynamic resource estimation is done district wise due to paucity of block-wise data. In the present report the same calculation is used and the resource is proportionately divided among blocks based on their geographical areas.

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. In RIF method, rainfall infiltration factor has been taken as 0.22 for major aquifer like valley fill. In WLF method, specific yield has been taken as 0.12.

2) Last ten years rainfall data is considered for groundwater resource calculation.

3) 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 since deepest water levels are recorded during the month of March.

The average pre- and post-monsoon water level of Dhemaji district is 3.26 mbgl and 1.76 mbgl.

4) The population figures were collected from Census, 2011and projected to 2020. The per capita domestic requirement for the rural population has been considered as 60 lpcd and for urban population, it is 135 lpcd.

5) The dependency on ground water resource for domestic and industrial water supply in rural areas is considered as 91% and for urban areas, the dependency is 79%.

6) In order to calculate the canal seepage, the data on length of the drainage channels are taken from the Irrigation Department, Govt. of Assam. The factor for return flow from surface water irrigation has been taken as 0.50 (paddy) and 0.30 (non-paddy) and for Ground water irrigation it has been taken as 0.45 (paddy) and 0.25 (non-paddy). Recharge from tanks and ponds are calculated based on the norms suggested in GEC'2015.

7) Recharge from water conservation structure has been taken as nil.

The total replenishable ground water resources available in the study area have been computed using the average water level fluctuations in observation wells and specific yield of aquifers. These have been normalised using normal rainfall data to eliminate variations in recharge due to excess or deficit rainfall. The monsoon recharge arrived at is then compared with the recharge computed using rainfall infiltration method. In cases where the difference between the two is more than 20 percent, the recharge is computed using ad hoc method.

4.1 Recharge

Total area of assessment unit 323700 Ha, out of which 315156 Ha considered for recharge worthy area. The aquifers of the study area are recharged through a) infiltration of

rainfall b) seepage from the tanks and ponds c) subsurface inflow across the up dip margin. The area experiences south-east monsoon. Monsoon rainfall contributes approximately 81 percent of total rainfall (May, June, July, August, and September). 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.

The monsoon recharge of recharge worthy area from rainfall is 96472.88 ham while non-monsoon recharge is 38006.99 ham. Recharge from other sources during monsoon is 717.31 ham and during non-monsoon is 325.31 ham. Total ground water recharge is 135522.49 ham (Table 4.1).

4.2 Ground Water Extraction

The ground water extraction of unconsolidated aquifer is created by natural discharge like seepages and draft created by human interference, viz., (a) withdrawals for irrigation and industry and (b) public-supply wells. In the district total natural discharge is 13552.25 ham of the total groundwater recharge. Total irrigation extraction created is 1631.28 ham, for industry 4.08 ham and extraction for domestic uses is 1411.58 ham. Total groundwater extraction for all uses is only 3046.94 ham (Table 4.1).

The water trend analysis shows that there is no significant change in the water level for both post-monsoon periods.

Stage of Ground Water Extraction: The area has very little irrigation facilities. Similarly industrial development in the area is practically less. Groundwater is mainly utilized for domestic purposes. The stage of groundwater extraction in the district is 2.94%.

4.3 Allocation of resources up to 2025

The net ground water resource is allocated for domestic uses are 1596.65 ham while 100538.98 ham resource is available for future use.

Table 4.1: Groundwater Resources Estimation

Components of Dynamic Resources			Values (Ham)
Ground Water Recharge	Monsoon	Rainfall	96472.88
		Other sources	717.31
	Non- Monsoon	Rainfall	38006.99
		Other sources	325.31
	Total ground water recharge		**135522.49**
Natural discharge			13552.25
Annual extractable ground water resource			**103770.98**
Current Annual ground water extraction	irrigation		1631.28
	Industries		4.08
	Domestic		1411.58
	Total		3046.94
Annual GW allocation for domestic use as on 2025			1596.65
Net ground water availability for future use			100538.98
Stage of ground water Extraction in %			**2.94**

CHAPTER 5.0

GROUNDWATER RELATED ISSUES

The main groundwater issue in this area is vulnerable to water logging and ground water pollution.

5.1 Water logged areas

Water logged areas are observed in the southwestern and eastern part of the study area shown in figure 5.1 a) and 5.2. In the water logged areas, post monsoon depth-to-water level varies from -0.05 to 1.96 mbgl and during pre-monsoon season the depth-to-water level varies from 0.85 to 1.8 mbgl. Water logged areas are found in the alluvial plain and flood plain. In the water logged areas high iron concentration is also observed.

Fig 5.1 a):Water logged area near Luhitpuria b): Interaction with villagers during field study.

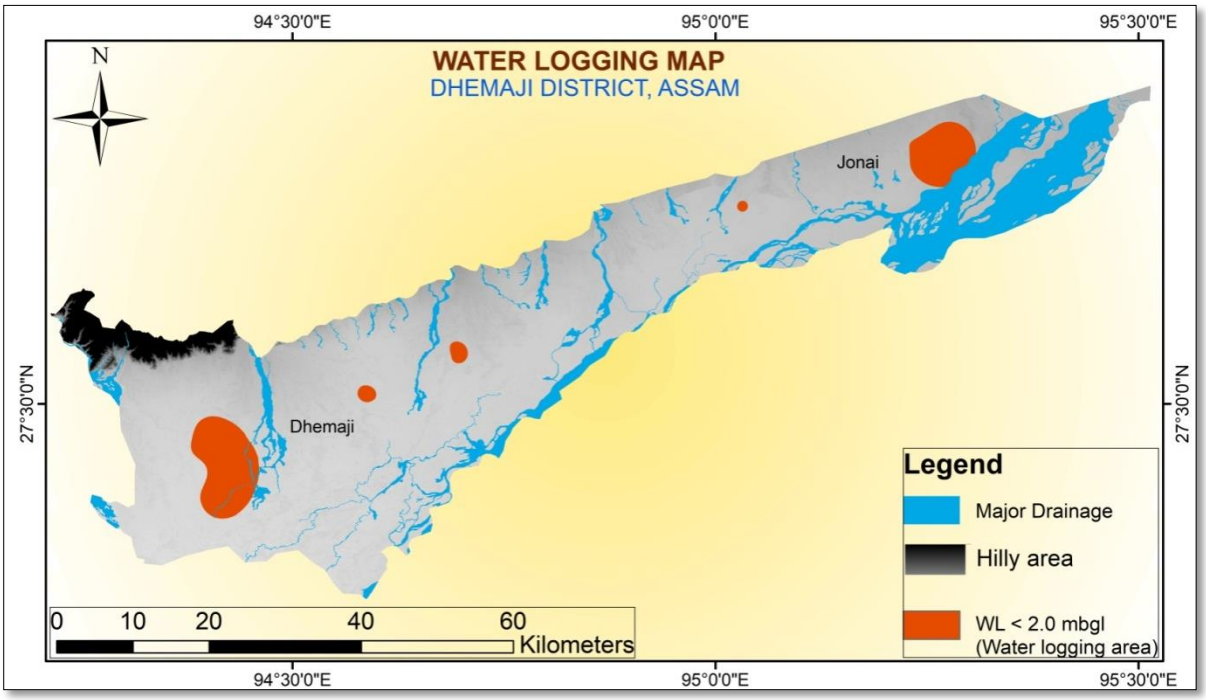


Fig: 5.2 Map showing area vulnerable to water logging.

5.2 Flood prone area

All the development blocks of the district are prone to flood. The district can be divided into three physiographic divisions. 1. Pedimont plain, 2. Active flood plain, Alluvial Plain and channel bar island. About 1174.17 Sq Km of area is vulnerable to flooding in monsoon time.

5.3 Iron and Arsenic in groundwater

56.57 % of post monsoon water sample showing iron concentration above the permissible limits throughout the district, lowest value 0.454 mg/l observed in Bemgenagarh and highest 17.884 mg/l in Jamuguri. 6 nos (20%) of water sample also found arsenic concentration above the permissible limit, highest value 49.725 microgram/liter found in 2 no Joyrampur Bihari gaon Bordoloni block (Details in Annexure-I).

In previous study Dr. I. Roy carried out a special study on occurrence of arsenic in Dhemaji district, Assam during AAP 2006-0 7, collected and analyzed 94 nos. of water samples in pre and post monsoon from shallow and deep aquifer and found 45.7% sample during pre-monsoon and 53.9% sample during post monsoon has arsenic concentration above the permissible limit. Arsenic contamination most severe in Dhemaji, Bordoloni blocks, significant high value also present in Sisibargaon and Muchkhowa Block. In case of iron concentration the most serve cases exist in Dhemaji and Bordooni block and all other blocks also affected. (Details in Annexure-II)

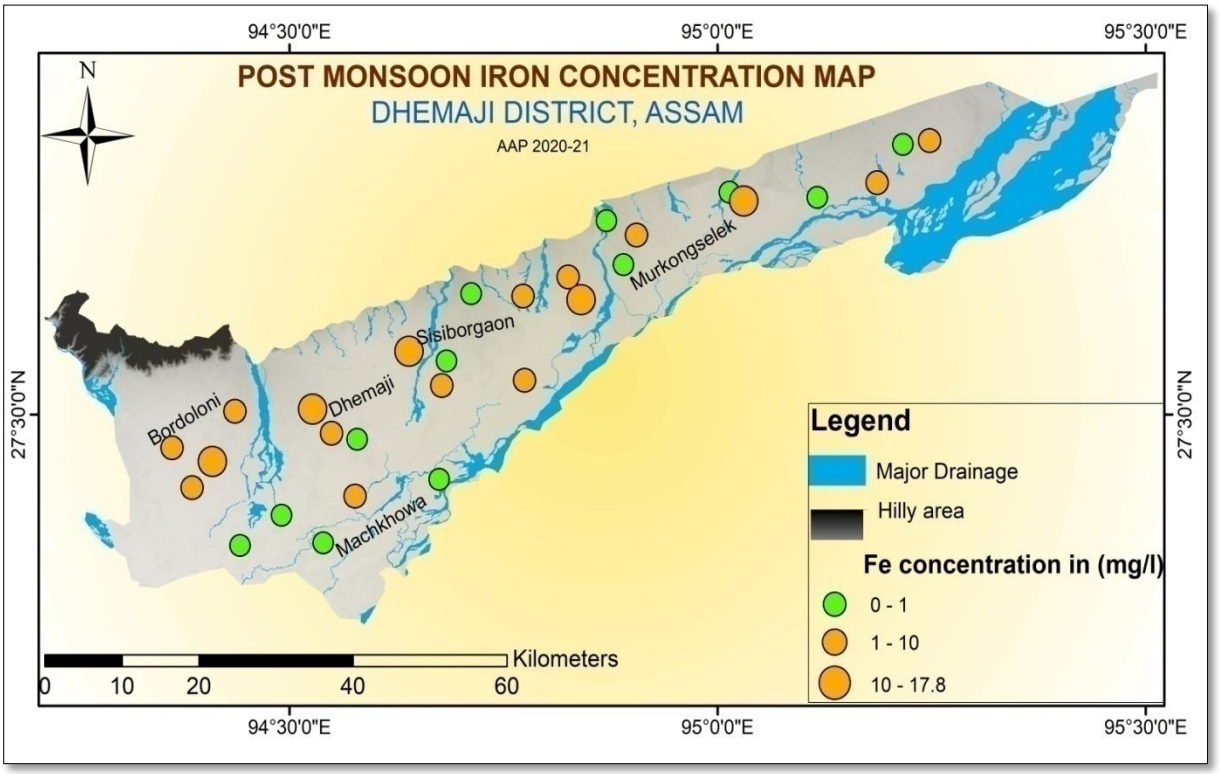


Fig. 5.2 : Post monsoon Iron concentration map of Dhemaji District

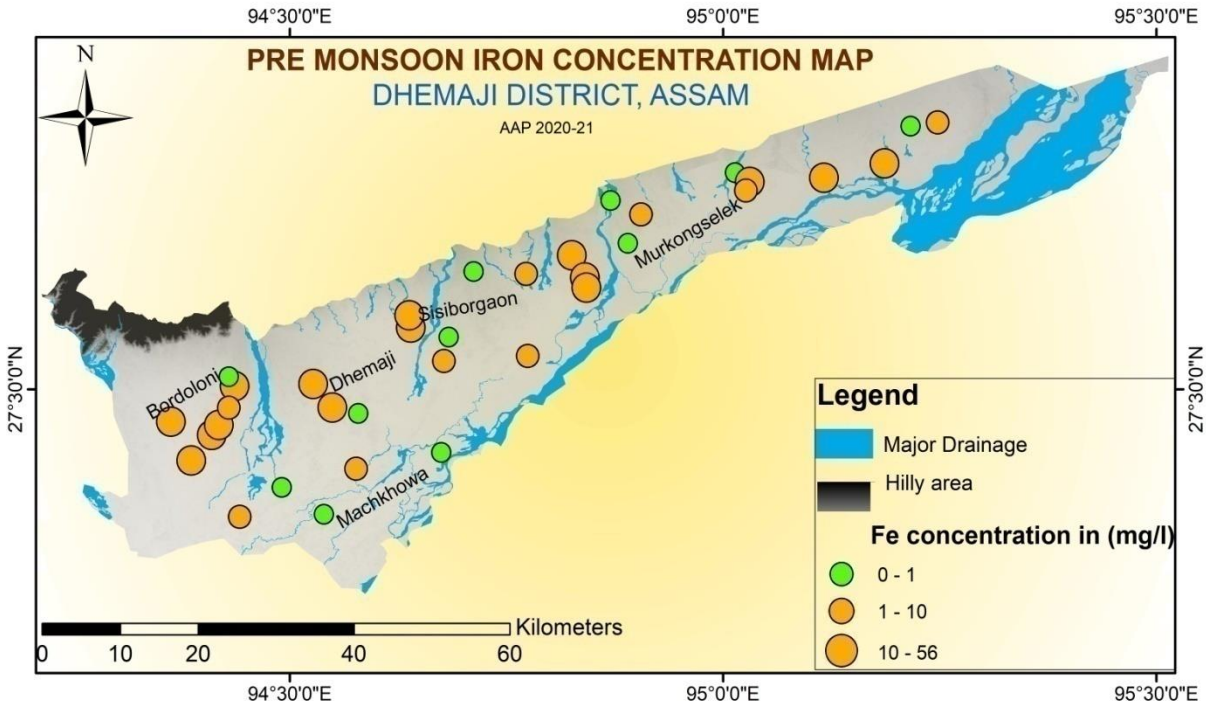


Fig. 5.3 : Pre monsoon Iron concentration map of Dhemaji district.

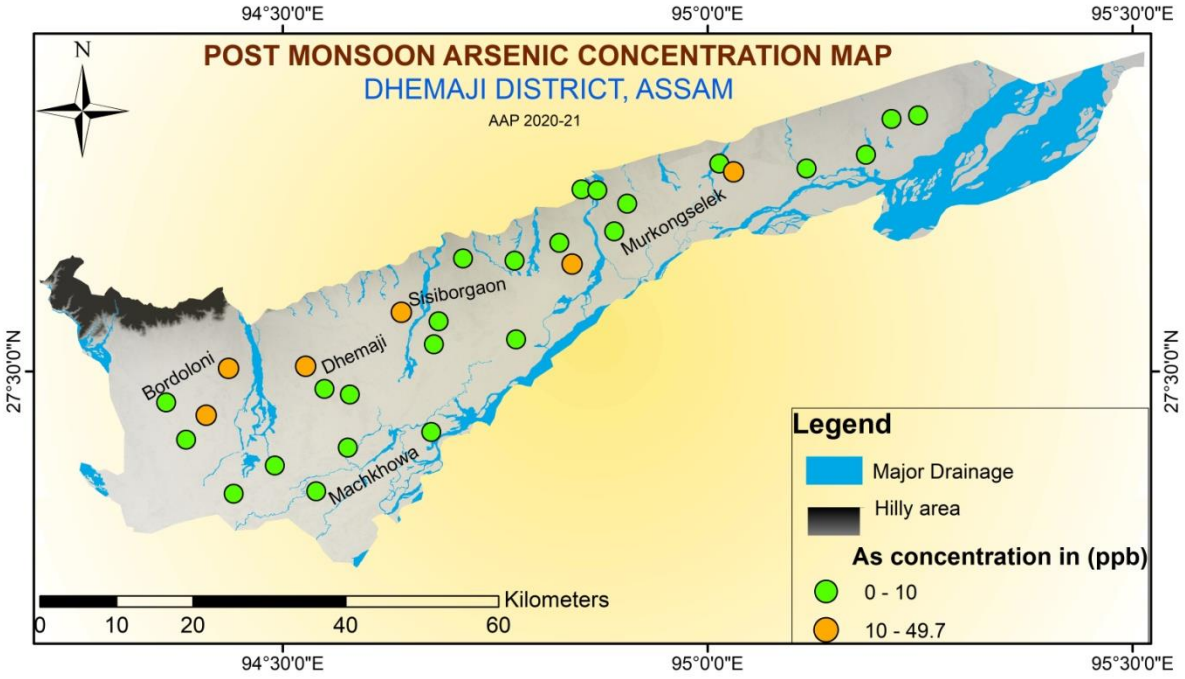


Fig. 5.4 : Post monsoon Arsenic concentration map of Dhemaji district.

CHAPTER 6

MANAGEMENT STRATEGIES

The aquifer system in the study area is a mono or single aquifer type. From the panel diagram it is clear that bouldery or gravelly bed is present all along the foothills from south west to north east direction of the study area while the aquifer material become finer towards the flood plain. The variations of lithology and geomorphic set up of the district have significant influence on the ground water regime. In the piedmont slope pre-monsoon water level is deeper and difference of pre and post monsoon water level is high. In the piedmont zone water level fluctuation is less compared to piedmont slope while flood plain area is characterized by water logged condition.

The objective of management is to utilize the available ground water resources to fulfill human needs and also to boost economy of an area without hampering the interest of future generation. That objective can be achieved by finding out demand of various sectors and adjusting the demand with available resource.

6.1 Sustainable Management of GW resources for Irrigation

As per dynamic ground water resource estimation of Dhemaji District for 2020, annual extractable ground water is 103770.98 ham and stage of ground water extraction is only 2.94 %. The district is having balance net ground water availability for future development in the tune of 100538.98 ham. If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available, then 60323 ham of groundwater resources is available in the district for the future irrigation uses. There is ample scope for ground water development in Dhemaji district for irrigation purpose which will help the district in achieving self-reliance on food grain. In Dhemaji District, net sown area is 87151 ha, Gross Cropped area 95915 ha and cropping intensity is about 110%. The net sown area included field crops as well as horticulture and plantation. Cropping intensity is calculated generally from field crops, which are of short duration whereas horticulture (like citrus, banana etc) and plantation crops like spices are long duration crops. Therefore, there is enough scope for future development of ground water in the study area to bring more area under irrigation practice. Cropping pattern data has been taken from agriculture census 2015-16 (https://agcensus.dacnet.nic.in/TL/tktabledisplay6b.aspx).

To use the groundwater for irrigation purpose a cropping plan has been designed for the district by using CROPWAT model developed by FAO. Climate/ ETo data for the district is presented in table 6.1, and cropping pattern data in table 6.2.

During kharif season, paddy (winter) is cultivated in 75599 in which 75585 ha is unirrigated, and during summer season paddy is cultivated in 3758 ha only. The total area which remains fallow during rabi season is about 75585 ha. The intention of this plan is to bring this fallow land under assured irrigation during Rabi season which will help to increase gross cropped area to 171500 ha and thereby increase cropping intensity up to 200% from 110%. In rice fallow, with the support of irrigation potato, summer rice, pulses, winter vegetables, rabi vegetables and cotton can be grown. Present cropping pattern, proposed cropping pattern, intended increase in cropping intensity were shown in table 6.3 and 6.4.

Crop-wise and month-wise irrigation water requirement (Precipitation deficit) has been taken from CROPWAT after giving necessary meteorological, soil, crop plan inputs and the same has been shown in table 6.5. Crop-wise and month-wise Irrigation water requirement in ham has been further calculated in table 6.6.

Table 6.1. Climatic/ ETo data from CROPWAT 8.0 of Dhemaji District.

Country: Location 208 Station: Dhemaji

Altitude: 106 m. Latitude: 27.43 °N Longitude: 94.90 °E

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	10.2	22.5	100	41	5.5	11.7	1.57
February	12.9	23.6	89	53	4.1	11.8	1.86
March	15.8	26.7	90	69	3.6	13.1	2.36
April	19.2	28.2	86	81	2.9	13.6	2.77
May	21.7	29.2	94	67	2.7	14.0	2.86
June	23.7	30.2	99	64	2.7	14.2	2.96
July	24.5	30.7	94	64	3.4	15.0	3.24
August	24.7	30.9	94	57	3.9	15.2	3.28
September	23.9	30.2	100	53	4.9	15.3	3.16
October	21.0	29.5	98	43	5.1	13.6	2.69
November	15.6	27.1	100	35	6.2	12.8	2.19
December	11.1	24.0	100	38	5.9	11.5	1.66
Average	18.7	27.7	95	55	4.2	13.5	2.55

Table 6.2. Cropping Pattern data from CROPWAT 8.0 of Dhemaji District.

No.	Crop file		Crop name	Planting date	Harvest date	Area %
1.	...Data\CROPWAT\data\crops\FAO\RICE.CRO	...	Rice	15/12	13/04	30
2.	...a\CROPWAT\data\crops\FAO\PULSES.CRO	...	Pulses	20/12	08/04	20
3.	...CROPWAT\data\crops\FAO\VEGETABL.CRO	...	Small Vegetables	10/11	12/02	10
4.	...\CROPWAT\data\crops\FAO\POTATO.CRO	...	Potato	15/12	23/04	20
5.	...CROPWAT\data\crops\FAO\VEGETABL.CRO	...	Small Vegetables	20/02	25/05	10
6.	...\CROPWAT\data\crops\FAO\COTTON.CRO	...	COTTON	10/11	23/05	10

Table 6.3. Cropping pattern, proposed cropping pattern, intended cropping intensity Dhemaji District.

Cropping pattern (s)				
Rice based cropping pattern				
1. Rice-Rice 2. Rice-Pulses 3. Rice-Leafy vegetable 4. Rice-Potato 5. Rice-Vegetables 6. Rice –Cotton	Present Cultivated area (**ha**)	Area to be cultivated (**%**)	Area to be cultivated (**ha**)	Irrigation requirement (**ham**)
	1.1	2 (= % of 1)	3	4
Rice (main crop)	75585		75585	
Summer Rice		30	22676	8461
Pulses		20	15117	1017
Leafy Vegetable		10	7559	899
Potato		20	15117	1312
Other Vegetable		10	7558	127
Cotton		10	7558	1031
Net cultivated area				
Gross cultivated area (1+pulses/+Millet/+potato/+mustard/+Veg)			75585	
Total irrigation requirement				12847
Actual water requirement (considering 30% water loss)				**18353**
Cropping intensity	**110% (Present)**		**200% (Intended)**	
Total (Dhemaji District)				

Table 6.4. Proposed cropping pattern with water deficit months and IWR Dhemaji district.

Rice based cropping pattern			
Crop	**Growing period (Months)**	**Periods/months of water deficit**	**Irrigation requirement**
			(ham)
1. Rice	4	4	8461
2. Pulses	4	4	1017
3. Leafy Vegetable	3	3	899
4. Potato	3	3	1312
5. other Vegetables	3	3	127
6. Cotton	6	5	1031

Table 6.5: Crop-wise and month-wise precipitation deficit (IWR) from CROPWAT 8, Dhemaji District.

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit (in mm)												
1. Rice	45.9	23.1	26.1	6.7	0	0	0	0	0	0	61.8	209.5
2. Pulses	21.1	21.0	19.1	0	0	0	0	0	0	0	0	6.1
3. Leafy Vegetable	39.8	10.7	0	0	0	0	0	0	0	0	28.2	40.2
4. Potato	24.5	20.8	24.6	5.2	0	0	0	0	0	0	0	11.7
5. Other Vegetables	0	1.3	4	11.5	0	0	0	0	0	0	0	0
6. Cotton	37.5	24.1	29.1	13.0	0	0	0	0	0	0	12.7	20.1

Table 6.6: Irrigation Water Requirement (in ham), in Dhemaji District.

Crops	Area in ha	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation deficit (ham)														
1. Rice	22676	1041	524	592	152	0	0	0	0	0	0	1401	4751	8461
2. Pulses	15117	319	317	289	0	0	0	0	0	0	0	0	92	1017
3. Leafy Vegetable	7559	301	81	0	0	0	0	0	0	0	0	213	304	899
4. Potato	15117	370	314	372	79	0	0	0	0	0	0	0	177	1312
5. Other Vegetables	7558	0	10	30	87	0	0	0	0	0	0	0	0	127
6. Cotton	7558	283	182	220	98	0	0	0	0	0	0	96	152	1031

For ground water exploration programmed, CGWB has constructed 5 nos Exploratory wells in this area and has established that the aquifer in the district is having discharge ranging from 44.72 m^3/hr to 48.5 m^3/hr. A tube well in the district is expected to yield at least 45 m^3/hr. The ground water potentiality of the area is very good, are feasible for sustainable ground water development. Therefore, those areas can be brought under irrigation by developing ground water through bore wells. A tube well in the area is expected to yield 45m^3/hr. If such a bore well runs for 8 hrs/day for 120 days, then it will create a draft of 4.32 ham.

In considered net sown area of 75585 ha, 12847 ham water requirements is calculated for rabi cropping by using cropwat 8.0 model, if we consider 30% water loss during irrigation, then net amount of water requirement is 18353 ham and for the same total 4248 nos. of shallow tube wells need to be constructed. Considering 200m safe distance between any two shallow tube well, then 18896 nos. of shallow tube wells can be constructed. Thus it is advisable to construct nearly 4250 nos. of shallow tube wells to extract 18353ham groundwater. Implementation of this management plan will increase the stage of ground water extraction from 2.94% to 20.62%.

6.2 Management of groundwater for drinking and domestic uses:

Iron and Arsenic pollution: When managing a precious and scarce resource such as groundwater, it is essential that the resource is not subjected to pollution. The chemical quality of ground water indicates that groundwater in the area have high iron concentration in some wells which are beyond the permissible limit, which warrant proper treatment before use. Removal of the iron is best effected by aeration process followed by sedimentation and filtration. Potassium permanganate or chlorine/chloride may be employed to oxidize the iron, which is then filtered from the waters. The process is applicable very much when bacteria is present in the water. Iron can also be removed by addition of a mixture of sodium carbonate and sodium phosphate to precipitate iron as insoluble, followed by settling and filtration. The pH value is also low in some dug well and hand pump in study area which should be treated with lime before consumption.

Earlier and during study it has been confirmed the occurrence of arsenic in the groundwater. However, it is observed that arsenic is detected in shallow hand pump, dug well or tara pump. Therefore, arsenic detection is restricted most probably to 10-20 m depth. Therefore tube wells can be constructed down to a depth of 100 m tapping lower 20m granular zones. From the 2D and 3D disposition of aquifer diagram it is observed that clay or sandy clay layers are present in many areas. These confining layers can be utilizing to separate the arsenic occurrence zone by adopting proper well construction technique.

Deep tube well in the flood plain and arsenic affected areas may be constructed by proper cement sealing and clay filling as shown in Fig. 6.1

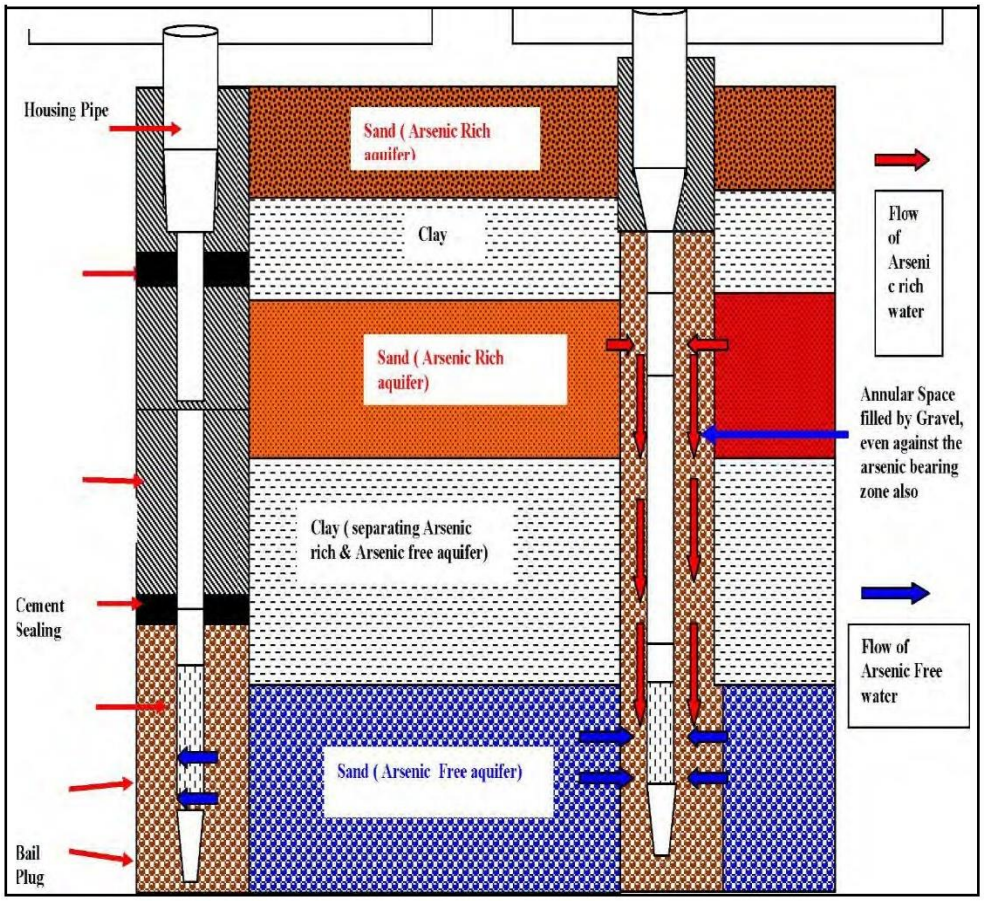


Fig.6.1: Tube-well design of a deep tube well tapping safe deeper aquifer

(Source: Concept note on geo-genic contamination of groundwater in India)

Annexure-I: Post Monsoon Chemical analysis data of Dhemaji

Village	Lat*	Long	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS	CO_3^{-2}	HCO_3^{-1}	TA (as CaCO3)	Cl-	SO_4^{-2}	NO^3_{-1}	F-	Ca+2	Mg+2	TH	Na	K	Fe	U	As
						mg/L														µg/L	
Naunandi	27.42	94.39	7.00	376.70	0.10	185.5	BDL	189.25	189.25	21.27	12.75	BDL	0.30	48.04	7.26	150.00	20.96	7.55	4.468	1.2482	5.0110
Ghotapathar Bali deori.	27.45	94.41	7.00	254.10	BDL	132.3	BDL	177.04	177.04	7.09	6.61	2.11	0.24	16.01	21.84	130.00	9.73	2.70	14.187	0.2021	17.1500
2 no Joyrampur Bihari gaon	27.5	94.44	7.22	320.50	BDL	165.0	BDL	207.57	207.57	10.64	3.66	1.52	0.71	30.02	23.04	170.00	5.56	3.56	7.0390	0.1806	49.7250
Siker Selok	27.74	95.01	6.86	169.10	BDL	87.75	BDL	85.47	85.47	17.73	51.45	3.15	0.20	14.01	7.27	65.00	25.69	13.36	0.6300	BDL	2.9840
Kamre	27.73	95.03	6.71	219.90	0.20	112.9	BDL	152.62	152.62	7.09	9.78	0.15	0.10	18.01	12.13	95.00	4.76	3.70	16.8980	0.1192	34.4950
Gali Mormi	27.74	95.12	7.00	474.20	BDL	244.4	BDL	213.67	213.67	42.54	64.81	0.35	0.24	30.02	21.83	165.00	38.13	22.76	0.9120	0.2924	2.9840
Namoni Bali Gaon	27.75	95.19	7.31	532.40	BDL	278.5	BDL	341.87	341.87	7.09	4.26	1.13	0.30	36.03	31.54	220.00	14.86	12.49	2.4960	1.1508	6.0180
Jonai Charali	27.8	95.25	7.15	436.40	BDL	229.5	BDL	274.72	274.72	17.73	7.79	0.22	0.18	30.02	32.75	210.00	14.30	3.01	3.2360	0.2969	3.6610
No 2 Rayeng kuli	27.8	95.22	6.36	224.40	BDL	114.3	BDL	79.36	79.36	24.82	30.42	BDL	0.09	12.01	9.70	70.00	17.07	11.11	0.9120	0.1389	2.8140
Likabali	27.63	94.71	7.01	259.60	0.30	135.2	BDL	146.52	146.52	14.18	21.04	BDL	0.21	28.02	15.76	135.00	7.33	3.40	0.4890	0.2621	2.1350
Shilahuti	27.63	94.77	6.86	90.43	BDL	47.09	BDL	30.52	30.52	7.09	21.17	BDL	0.03	6.00	6.07	40.00	7.90	1.32	1.6160	0.1451	1.9640
Phukiya	27.56	94.68	6.42	150.30	0.30	79.39	BDL	91.57	91.57	21.27	16.00	BDL	0.10	12.01	6.06	55.00	22.30	9.60	0.5600	0.0052	1.9640
Siripani	27.57	94.64	6.63	227.40	BDL	118.5	BDL	152.62	152.62	7.09	4.55	BDL	0.24	24.02	9.70	100.00	11.49	2.54	14.433	0.0448	30.482
Sisibargaon	27.53	94.68	6.85	198.90	BDL	103.8	BDL	91.57	91.57	7.09	19.99	4.69	0.14	28.02	7.27	100.00	5.73	2.99	2.2850	0.0715	3.3230
Mersapuri	27.43	94.67	6.95	276.40	BDL	144.8	BDL	189.25	189.25	10.64	12.30	BDL	0.28	24.02	19.41	140.00	7.31	10.80	0.5250	0.2133	2.8140
Arney	27.54	94.77	7.52	549.50	BDL	288.5	BDL	372.40	372.40	10.64	39.49	BDL	0.28	24.02	53.39	280.00	13.57	10.40	3.1650	0.2366	2.8140
Bhagavan Chariali	27.58	27.71	6.15	158.80	0.20	83.25	BDL	54.94	54.94	10.64	30.34	BDL	0.04	12.01	8.49	65.00	11.74	1.95	0.8420	BDL	3.3230
Ranga hari	27.65	94.83	6.90	285.50	BDL	149.6	BDL	122.10	122.10	17.73	44.02	BDL	0.26	26.02	19.40	145.00	7.41	3.04	6.6160	BDL	4.8420
Siemen Alimur	27.63	94.84	6.85	377.10	0.50	196.6	BDL	183.15	183.15	7.09	31.95	7.41	0.50	30.02	26.68	185.00	4.87	3.56	10.313	0.1725	41.143
Siemen Chapari	27.71	94.87	7.37	145.60	BDL	75.34	BDL	91.57	91.57	7.09	17.23	BDL	0.36	22.02	4.84	75.00	8.42	3.17	0.6650	0.0337	3.1530
Jorhatia	27.7	94.91	7.00	238.70	BDL	124.6	BDL	158.73	158.73	7.09	19.92	BDL	0.20	24.02	19.41	140.00	4.75	4.20	3.3420	BDL	3.6610
Somkong	27.66	94.89	6.98	185.10	BDL	96.78	BDL	103.78	103.78	14.18	16.79	BDL	0.41	10.01	6.06	50.00	32.69	2.33	0.7710	BDL	3.4920
Betbari	27.46	94.36	6.67	283.70	BDL	148.6	BDL	146.52	146.52	24.82	35.47	BDL	0.14	18.01	13.34	100.00	29.22	8.99	3.5530	0.3148	4.3370
Jamuguri	27.51	94.53	6.61	213.00	0.40	111.1	BDL	146.52	146.52	7.09	11.94	BDL	0.35	18.01	15.77	110.00	5.40	2.04	17.884	0.1496	21.269
Kalapathar	27.48	94.55	6.95	228.70	BDL	118.7	BDL	146.52	146.52	14.18	41.81	BDL	0.31	20.02	15.77	115.00	17.48	3.04	8.2360	BDL	1.6240
Dhemaji	27.47	94.58	7.36	296.80	BDL	155.2	BDL	189.25	189.25	14.18	50.41	BDL	0.40	32.03	20.62	165.00	14.67	7.55	0.5600	0.2213	1.7940
Bemgenagarh	27.36	94.54	6.566	185.50	0.30	96.38	BDL	54.94	54.94	7.09	29.29	5.01	0.18	12.01	9.70	70.00	4.49	8.97	0.4540	0.0474	0.4280
Parsai kiya Gaon	27.39	94.49	7.194	552.40	BDL	291.4	BDL	372.40	372.40	7.09	77.68	BDL	0.22	32.03	48.53	280.00	30.80	9.38	0.6650	1.3565	BDL
Khikusi	27.36	94.44	6.688	251.30	BDL	131.3	BDL	109.89	109.89	21.27	49.13	BDL	0.26	18.01	13.34	100.00	19.90	10.39	0.5600	0.0854	BDL

Annexure-II : Pre Monsoon Chemical analysis data of Dhemaji

District	Long	Lat*	well type	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS	CO_3^{-2}	HCO_3^{-1}	TA (as CaCO3)	Cl-	SO_4^{-2}	NO_3^{-1}	F-	Ca^{+2}	Mg^{+2}	TH (as CaCO3)	Na	K	Fe
							mg/L													
Naunandi	27.42	94.39	DW	7.99	288.60	BDL	139.40	BDL	158.73	158.73	17.73	10.09	1.07	0.89	14.01	12.13	85.00	14.37	7.00	16.46
Ghotapathar Bali deori.	27.45	94.41	HP	7.92	276.70	BDL	131.90	BDL	152.62	152.62	10.64	6.81	1.20	1.50	10.01	12.13	75.00	5.96	3.51	39.92
2 no Joyrampur Bihari gaon	27.5	94.44	HP	7.92	349.20	0.10	170.80	BDL	177.04	177.04	14.18	26.09	2.22	0.47	14.01	31.55	165.00	5.79	3.12	18.68
Siker Selok	27.74	95.01	DW	7.41	246.30	BDL	122.30	BDL	54.94	54.94	17.73	54.84	7.15	0.90	18.01	10.91	90.00	7.41	19.87	0.71
Kamre	27.73	95.03	HP	7.84	250.80	BDL	123.50	BDL	122.10	122.10	17.73	47.78	2.35	0.67	18.01	14.55	105.00	5.09	3.28	42.49
Gali Mormi	27.74	95.12	DW	7.58	277.80	BDL	138.00	BDL	67.15	67.15	46.09	47.72	1.89	0.88	12.01	15.77	95.00	6.01	3.41	43.72
Namoni Bali Gaon	27.75	95.19	DW	7.95	345.60	BDL	173.80	BDL	244.20	244.20	10.64	3.58	7.81	0.70	18.01	27.90	160.00	19.91	5.25	18.32
Jonai Charali	27.8	95.25	DW	7.92	303.60	BDL	152.70	BDL	170.94	170.94	17.73	8.62	1.81	0.39	20.02	20.62	135.00	17.13	3.42	1.21
No 2 Rayeng kuli	27.8	95.22	DW	8.15	159.30	BDL	79.17	BDL	42.73	42.73	39.00	15.97	0.18	0.66	8.01	8.49	55.00	20.77	4.59	0.71
Likabali	27.63	94.71	DW	7.88	227.80	0.20	114.80	BDL	115.99	115.99	10.64	12.05	0.20	0.32	8.01	23.05	115.00	4.95	3.88	0.37
Shilahuti	27.63	94.77	HP	8.04	100.90	BDL	49.92	BDL	30.52	30.52	10.64	43.61	0.19	0.32	8.01	2.42	30.00	20.00	2.33	1.11
Phukiya	27.56	94.68	DW	7.41	142.00	BDL	71.15	BDL	42.73	42.73	24.82	21.21	1.05	0.35	10.01	12.13	75.00	8.30	5.36	0.33
Siripani	27.57	94.64	HP	7.88	251.50	BDL	127.60	BDL	115.99	115.99	39.00	46.55	2.36	0.69	8.01	20.63	105.00	4.58	2.69	56.88
Sisibargaon	27.53	94.68	DW	7.84	233.30	BDL	117.70	BDL	109.89	109.89	14.18	20.57	1.44	0.64	16.01	18.20	115.00	9.55	4.87	1.21
Mersapuri	27.43	94.67	HP	8.00	340.60	BDL	172.20	BDL	158.73	158.73	17.73	37.07	3.90	0.84	8.01	31.55	150.00	12.04	12.68	0.61
Arney	27.54	94.77	HP	7.81	307.60	0.30	155.30	BDL	268.61	268.61	17.73	80.87	0.52	0.71	18.01	26.69	155.00	56.01	21.49	3.24
Naopara	27.58	94.64	DW	7.88	233.10	0.10	120.10	BDL	122.10	122.10	10.64	60.52	1.76	0.74	18.01	16.98	115.00	11.03	2.24	28.04
Ranga hari	27.65	94.83	HP	7.71	294.10	BDL	151.50	BDL	85.47	85.47	24.82	80.54	0.34	0.78	8.01	27.91	135.00	10.65	4.87	18.20
Siemen Alimur	27.63	94.84	DW	7.94	305.40	BDL	157.00	BDL	140.41	140.41	14.18	41.63	9.14	1.20	28.02	23.04	165.00	7.69	3.63	11.59
Siemen Chapari	27.71	94.87	DW	7.63	183.50	BDL	95.95	BDL	79.36	79.36	10.64	33.05	0.56	0.99	14.01	12.13	85.00	8.42	4.33	0.33
Jorhatia	27.7	94.91	HP	7.79	240.40	BDL	123.60	BDL	103.78	103.78	17.73	50.16	0.27	0.75	10.01	23.05	120.00	8.55	4.32	2.99
Somkong	27.66	94.89	DW	7.46	200.90	BDL	104.60	BDL	79.36	79.36	21.27	39.66	0.60	0.70	10.01	9.70	65.00	29.96	3.58	0.52
Betbari	27.46	94.36	HP	7.67	199.90	BDL	102.70	BDL	85.47	85.47	17.73	23.82	0.73	0.65	18.01	9.70	85.00	9.76	5.50	11.89
Jamuguri	27.51	94.53	HP	7.80	215.60	BDL	110.10	BDL	109.89	109.89	39.00	38.98	1.83	0.94	20.02	10.91	95.00	9.75	2.25	50.47
Kalapathar	27.48	94.55	HP	7.92	283.70	BDL	144.00	BDL	140.41	140.41	24.82	11.10	0.23	0.89	28.02	14.55	130.00	7.49	3.20	16.69
Dhemaji	27.47	94.58	DW	7.86	251.50	BDL	128.50	BDL	122.10	122.10	14.18	30.08	0.18	0.74	8.01	25.48	125.00	11.18	10.21	0.96
Bemgenagarh	27.36	94.54	DW	7.22	154.30	BDL	79.10	BDL	42.73	42.73	14.18	31.21	4.64	0.42	10.01	8.49	60.00	6.01	9.81	0.28
Parsai kiya Gaon	27.39	94.49	HP	7.99	365.40	0.20	188.60	BDL	299.14	299.14	14.18	59.01	0.42	0.70	16.01	35.19	185.00	38.23	28.41	0.76

Khikusi	27.36	94.44	HP	7.75	279.60	BDL	143.10	BDL	97.68	97.68	24.82	42.55	1.73	0.70	18.01	18.20	120.00	19.58	9.38	1.53
Borbam Dihinji	27.46	94.42	HP	7.65	170.60	BDL	88.17	BDL	79.36	79.36	10.64	23.49	1.28	0.90	16.01	7.27	70.00	2.58	2.90	21.02
Joyrampur	27.51	94.43	HP	7.82	248.70	BDL	128.10	BDL	195.36	195.36	14.18	8.96	0.68	0.92	16.01	16.98	110.00	29.90	9.98	0.28
Baligaon	27.48	94.43	HP	7.56	144.70	BDL	74.35	BDL	67.15	67.15	14.18	17.47	0.18	0.66	14.01	7.27	65.00	8.90	4.76	1.37
Kuligaon	27.61	94.84	HP	7.86	325.50	BDL	167.10	BDL	183.15	183.15	14.18	18.87	0.84	1.20	36.03	19.40	170.00	7.92	3.13	12.19
Ranagoli	27.72	95.03	HP	8.80	308.30	0.30	160.50	21.00	299.14	320.14	10.64	84.88	0.28	0.79	18.01	31.54	175.00	60.91	28.82	3.05

Annexure –III (Chemical analysis data of Dhemaji during AAP 2006-07)

Sam. No.	*Locality*	*Pre- Monsoon*		*Post- Monsoon*		*Pre-Monsoon*			*Post-Monsoon*	
		Field values		*Field values*		*Analyzed by CGWB, Hyderabad*				
		pH	EC	pH	EC	Fe (ppm)	As (ppm)	As (ppb)	Fe (ppm)	As (ppb)
1	Goalchapori	-	309	6.6	321	31.0	0.044	44	31.0	54.3
2	Moridhol	-	378	6.3	512	32.0	0.022	22	47.5	109.6
3	Moridhol Hachwa	-	325	6.5	337	14.0	0.018	18	16.7	17.3
5	Raichapori Lachomgaon	-	376	-	-	65.0	0.029	29	39.3	31.8
6	Jamuguri	-	385	-	-	22.0	0.079	79	17.8	108.5
8	Santipur Konch Gaon	-	239	6.7	-	3.3	0.082	82	6.7	100.1
9	Theckjuri	-	148	-	-	13.0	0.026	26	-	-
10	Jiyadhol Tingharia	-	255	6.4	324	48.0	0.018	18	49.2	15.7
12	Teliajan	-	394	6.6	442	69.0	0.026	26	40.2	52.4
13	Dhemaji	-	305	6.8	379	1.0	0.002	2	0.4	-BDL-
14	Dhemaji I PWSS	-	281	6.5	240	4.7	0.008	8	8.7	-BDL-
15	Matikhola PWSS	-	256	-	-	18.0	0.064	64	-	-
16	Matikhola HP	-	205	6.6	222	1.1	0.001	1	0.4	-BDL-
17	Chengalipathar	-	60	6.2	314	2.8	-BDL-	-BDL-	0.8	-BDL-
18	Samajan	-	603	6.8	525	42.0	0.009	9	46.2	-BDL-
19	Borbila Chutakia	6.3	54	5.8	61	2.3	0.003	3	0.3	-BDL-
20	Majgaon (Lalukjan)	-	216	6.3	172	2.7	0.017	17	2.7	17.2
21	Kamalpur (Lalukijan Dharmapur)	6.3	293	-	-	31.0	0.147	147	-	-
22	Dihingia Barbam	-	202	-	-	21.0	0.006	6	-	-
23	Deuri Barbam	6.9	185	6.4	128	2.5	0.003	3	0.3	5.4
24	Bordoloni	-	345	6.4	347	2.1	0.013	13	7.9	11.4
25	Bhebali	-	340	6.6	178	22.0	0.015	15	14.7	10.0
26	Betbari	7.2	301	6.6	252	24.0	0.023	23	19.5	40.3
27	Bhekali	7.1	131	6.2	180	2.1	0.016	16	4.6	14.7
28	Mohoricamp Tiniali	-	299	6.4	328	15.0	0.02	20	15.7	11.2
29	Dirpai	-	272	6.4	178	30.0	0.002	2	10.0	-BDL-
30	Borolagaon	-	180	6.3	196	17.0	0.009	9	12.7	-BDL-
31	Gogamukh	-	845	6.4	804	36.0	0.059	59	28.8	29.8
32	Bherikichuk	-	185	6.5	128	3.5	0.001	1	2.2	-BDL-
33	Botipur	-	305	6.3	537	0.7	-BDL-	-BDL-	0.5	-BDL-
34	Latakgaon	-	270	6.7	237	1.5	0.0005	0.5	0.6	-BDL-
35	Bordoibum	-	168	6.6	387	6.7	0.102	102	12.3	86.2
36	Sisiborgaon	-	295	6.4	286	36.0	0.001	1	26.4	29.9
37	Kulajan	-	295	6.5	297	0.8	0.002	2	0.8	11.3
38	Akajan	-	166	6.5	374	18.0	-BDL-	-BDL-	16.7	38.9
A39	Silapathar	-	334	6.4	329	38.0	-BDL-	-BDL-	31.0	-BDL-
A40	Madhuripathar	-	449	6.5	406	3.9	-BDL-	-BDL-	0.4	-BDL-
A41	Likhabali MES WSS	-	172	6.3	171	0.3	-BDL-	-BDL-	0.1	29.1
A44	Shripani	7.10	228	6.5	238	29.0	0.02	20	25.5	57.8
47	Bhagaban Chariali	-	111	6.3	128	4.6	0.0008	0.8	0.7	-BDL-
48	Depa	-	48	6.3	48	0.7	-BDL-	-BDL-	0.4	-BDL-
49	Simenchapori	-	187	6.3	155	31.0	0.011	11	13.3	-BDL-
51	Telem (Kaman Selek)	-	101	6.1	71	1.1	-BDL-	-BDL-	0.4	13.4
52	Limekuri	-	79	6.0	49	2.3	-BDL-	-BDL-	0.2	-BDL-
53	Gali	-	231	6.1	221	3.9	-BDL-	-BDL-	0.4	-BDL-
54	Bijoypur	-	89	6.3	67	10.0	-BDL-	-BDL-	4.4	-BDL-
55	Jonai	-	-	6.2	156	32.0	-BDL-	-BDL-	2.3	-BDL-
56	Jonai II PWSS	-	-	6.2	194	18.0	0.007	7	9.5	10.6
57	Bahir Jonai	-	230	6.8	226	0.0	0.002	2	0.6	-BDL-
58	Kachari Baligaon	-	381	5.7	-	39.0	0.108	108	32.1	59.4
59	Naharbari	-	313	5.8	367	26.0	0.016	16	17.6	-BDL-
60	Lachitnagar (Khubulia)	-	233	6.3	233	11.0	0.011	11	5.8	12.1
61	Juktali	-	371	6.4	380	33.0	0.024	24	24.9	28.8
62	Jamuguri (Moridhol)	-	269	6.4	328	23.0	0.022	22	22.7	66.5
63	Bhekeli (II)	7.0	328	6.3	302	37.0	0.249	249	23.6	75.8
64	Lalukijan Dharmapur (II)	6.0	288	-	-	24.0	0.178	178	-	-
65	Lalukijan Majgaon (II)	-	138	6.6	162	5.2	-BDL-	-BDL-	2.3	-BDL-
66	Barbam Garubandha	-	200	6.5	128	20.0	0.02	20	10.6	34.1
67	Dhemaji (II)	-	375	6.8	382	35.0	0.008	8	22.2	36.0
68	Chaporigaon (Goalchapori)	-	240	6.6	238	28.0	0.015	15	17.5	18.8
69	Brishnupur PWSS	-	400	5.8	-	23.0	0.008	8	15.0	16.7
69A	Brishnupur II	-	240	-	-	30.0	0.009	9	-	-
70	Naroathan	-	179	6.7	218	0.0	0.007	7	Tr	-BDL-
73	Moridhol PWSS (II)	-	315	-	-	24.0	0.054	54	-	-
A75	Likhabali II	-	364	6.5	368	13.0	0.054	54	8.6	50.2
81	Mohoricamp CGWB Well	-	371	-	-	22.0	-BDL-	-BDL-	-	-
82	Tarajan	-	308	6.4	328	7.0	-BDL-	-BDL-	3.8	-BDL-
99	Lalunggaon	6.9	801	6.3	753	40.0	0.093	93	33.9	57.8

Sam. No.	*Locality*	*Pre- Monsoon*		*Post- Monsoon*		*Pre-Monsoon*			*Post-Monsoon*	
		Field values		*Field values*		*Analyzed by CGWB, Hyderabad*				
		pH	EC	pH	EC	Fe (ppm)	As (ppm)	As (ppb)	Fe (ppm)	As (ppb)
71	Ghogua	-	-	6.5	128	-	-	-	7.8	-BDL-
72	Barmuthanigaon	-	-	6.6	93	-	-	-	0.9	-BDL-
111	Chengalipathar DTW	-	-	6.1	178	-	-	-	2.3	-BDL-
112	Hatigarh PWSS	-	-	6.6	322	-	-	-	3.3	-BDL-
113	Bherikichuk PWSS (II)	-	-	6.3	316	-	-	-	8.5	19.8
114	Naroathan PWSS (II)	-	-	6.8	125	-	-	-	0.7	-BDL-
115	Maralchuk	-	-	6.5	344	-	-	-	32.2	19.9
116	Dekapam	-	-	6.1	256	-	-	-	0.6	11.0
117	Naharbijuli	-	-	6.3	126	-	-	-	0.8	-BDL-
118	Dali Moromi	-	-	6.5	318	-	-	-	40.0	43.9
119	Barmurai Tiniali	-	-	6.5	328	-	-	-	23.5	35.9
120	Kandulijan	-	-	6.4	381	-	-	-	0.3	-BDL-
121	Pia	-	-	6.5	221	-	-	-	0.2	-BDL-
122	Gelua	-	-	6.4	215	-	-	-	11.1	43.6
123	Gahmara	-	-	6.4	202	-	-	-	9.7	51.6
124	Sisipukia	-	-	6.1	62	-	-	-	0.2	-BDL-
125	Kenduguri	-	-	6.3	162	-	-	-	12.7	24.1
74	Bijoypur	-	-	-	-	0.0	0.000	-	-	-
75	Siripani	-	-	-	-	0.0	0.001	-	-	-
76	Silapathar	-	311	6.8	-	1.2	0.000	-	-	-
131	Misamora	-	-	6.8	-	-	-	-	-	-
132	Chamkang	-	-	6.6	-	-	-	-	-	-