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

DARRANG DISTRICT, ASSAM

उत्तर पूर्वी क्षेत्र, गुवाहाटी
North Eastern Region, Guwahati

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Central Ground Water Board

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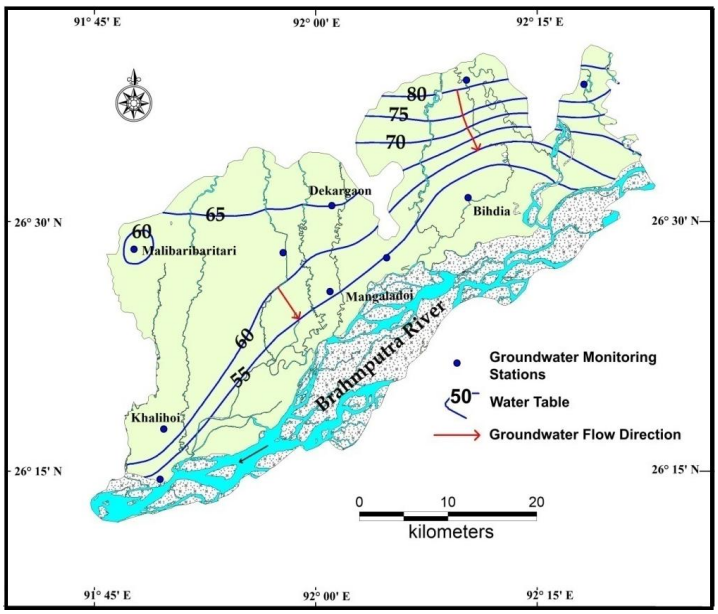
GOVERNMENT OF INDIA

भारतसरकार

AQUIFER MAPPING AND MANAGEMENT PLAN OF DARRANG DISTRICT, ASSAM

ANNUAL ACTION PLAN, 2019-20



NORTH EASTERN REGION

उत्तरपूर्वीक्षेत्र

GUWAHATI

गुवाहाटी

October, 2021

AQUIFER MAPPING REPORT OF DARRANG DISTRICT, ASSAM (AAP 2019-20)

By

R.K.Kalita, Scientist D

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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 contaminated area and prepare a groundwater management plan.

1.2 Scope of the study

The part of the Darrang district has vast groundwater and surface water resources. However, the agro based economy of the area has no irrigation facility. Moreover, the groundwater of the area is contaminated with iron and arsenic which possesses serious health hazard to the general public. Proper hydrogeologic 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 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 (MapInfo-11.0 using Projection category longitude/latitude (WGS 84). 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: It is a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. On the basis of integration of data generated from various studies of hydrogeology and geophysics, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared to delineate the lateral and vertical disposition of aquifers and their characterization on 1: 50,000 scale.

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 under Survey of India Toposheet No. 78N/14 (part), 78N/15, 83B/2 (part), 83B/3(part), B/5 (part), 83 B/6 (part) bounded by 26.1858 and 26.6432 northern latitude and 91.7480 and 92.4263 east longitude

Administrative set up of the study area:

The district has only one sub divisions viz. Mangaldoi and six revenue circles and seven civil blocks. Total population of the district is 928500 souls (as per 2011 census) with average population density of 586 persons/sq.km. The decadal variation of population for 2001-2011 is 22.19 percent. There are total 17 Mouza, 6 Anchilik Panchayats, 1 Zila Parishad, 1 Municipal Board and 1 Town Committee in the district.

Table 1.1 Administrative Division

No of Civil Subdivision	No of Blocks	No of Revenue Circles	No of Gram Panchayats	No of Villages (Inhabited)	No of Villages (Uninhabited)
1	7	6	75	552	9

Data Source: Statistical Handbook, Assam

Table 1.2 Block Level Geographical Area (in sq.km) and Population Darrang District

Civil Subdivision	Blocks	No of Villages	Area (sq.km)	Population
Mangaldoi Civil Subdivision:	Khoirabari (Part)	7	17.11	8398
	Sipajhar (Part)	180	481.52	221556
	Pachim-Mangaldai (Part)	90	181.81	92472
	Pub-Mangaldai (Part)	75	202.24	176604
	Gerimari Chapori (CT) Kalaigaon (Part)	56	96.01	82606
	Bechimari (Part)	65	161.67	124907
	Dolgaon-Sialmar	79	332.09	177467

#Data source: Census Handbook 2011

Darrang district is connected with the rest of the State by NH 52 and by railways service**.**

Darrang district is basically agrarian, where more than 65 percent of the population is engaged in agriculture and allied activities. Out of the total population, 39.85 percent population is involved in agriculture as a main source of income and livelihood. Around 25 percent of the total population is agricultural labourers. Moreover, males are predominantly involved in agriculture and allied activities with 43.60 percent while women share is 27.97 percent of the total population of district. However, women

are overwhelmingly in manufacturing and production in household, small scale industry, rearing of livestock etc. Like elsewhere, women are also engaged in agricultural labour. Like the trend in the country men predominate the main worker category both in rural and urban, women outweigh men in marginal workers category. The working females in rural Darrang are mostly marginal workers.

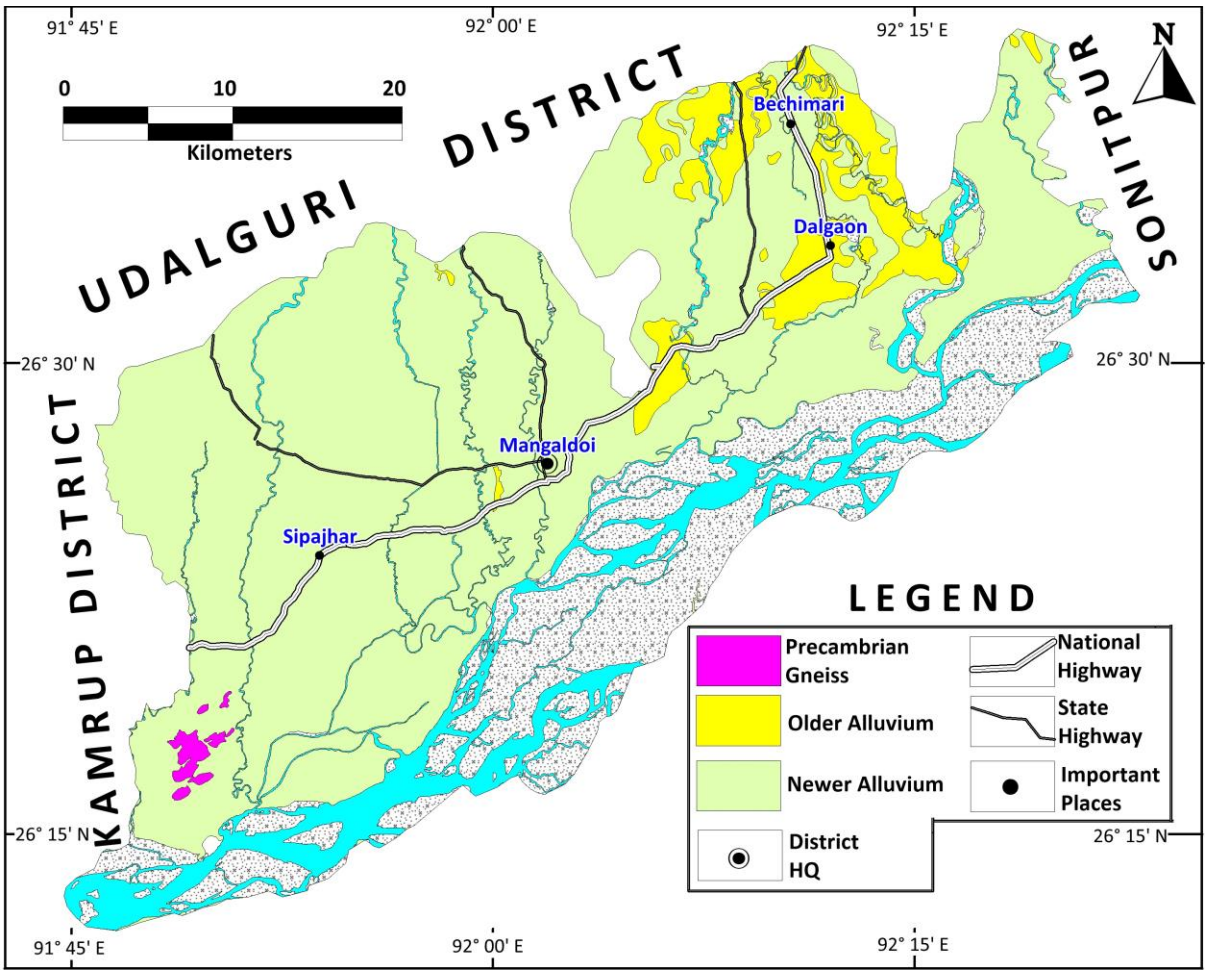


Fig.1.1: Index Map of the study area

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 (MapInfo-11.0 using Projection category longitude/latitude (WGS 84).

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 Darrang district, Assam

SN	Theme	Type	Data available	Data gap	Data generation	Total
1	Borehole Lithology Data		10	9	6	16
2	Geophysical data		Nil	9	Nil	Nil

SN	Theme	Type	Data available	Data gap	Data generation	Total
3	Groundwater level data	Dug well	6	11	26	32
		Piezometer Aquifer-I	2	6	6	8
4	Groundwater quality data	Dugwell-Aquifer-I	6	11	26	32
		Piezometer Aquifer-I	2	6	6	6
5	Specific Yield		Nil	7	Nil	Nil
6	Soil Infiltration Test		Nil	12	7	7

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

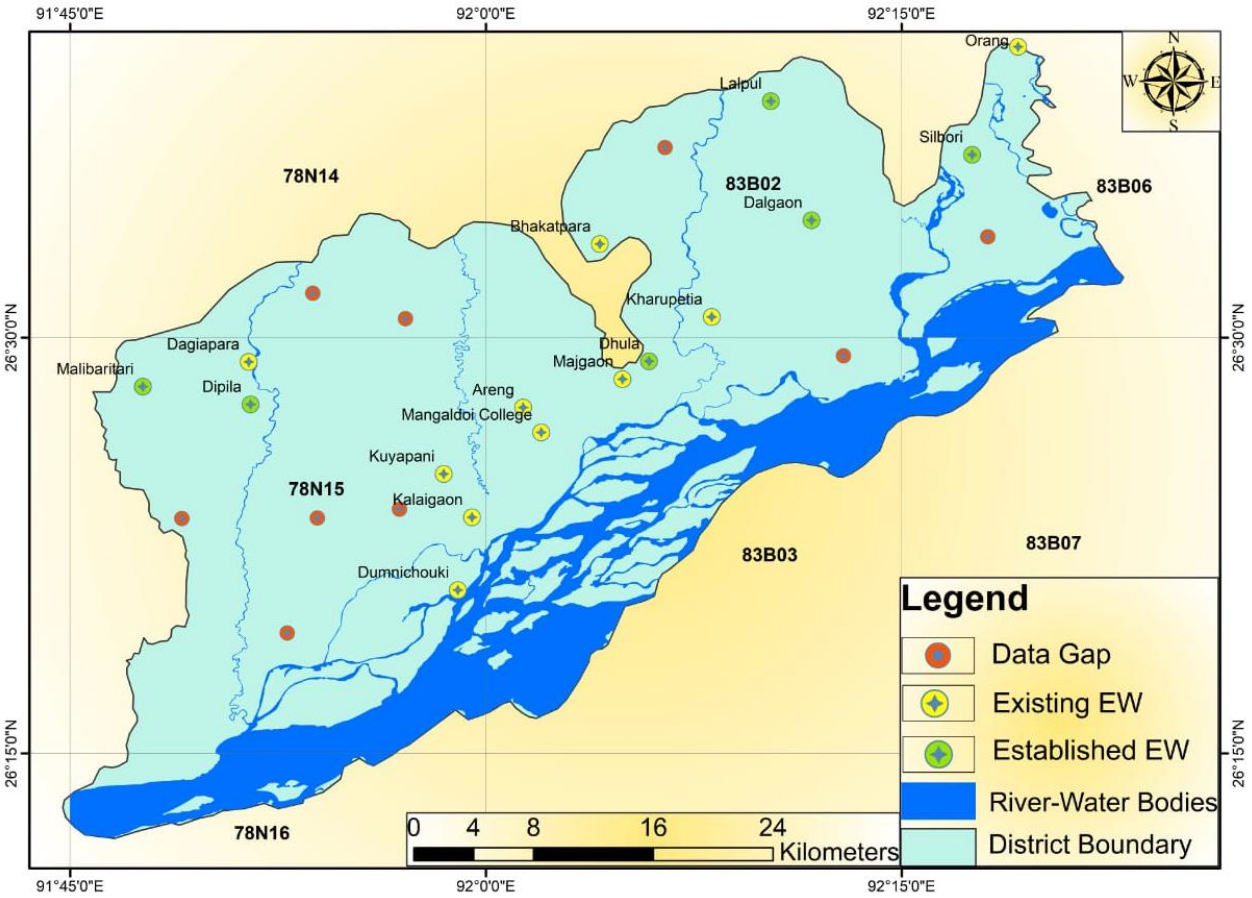


Fig. 1.2: Available data and data generation of exploration in the study area

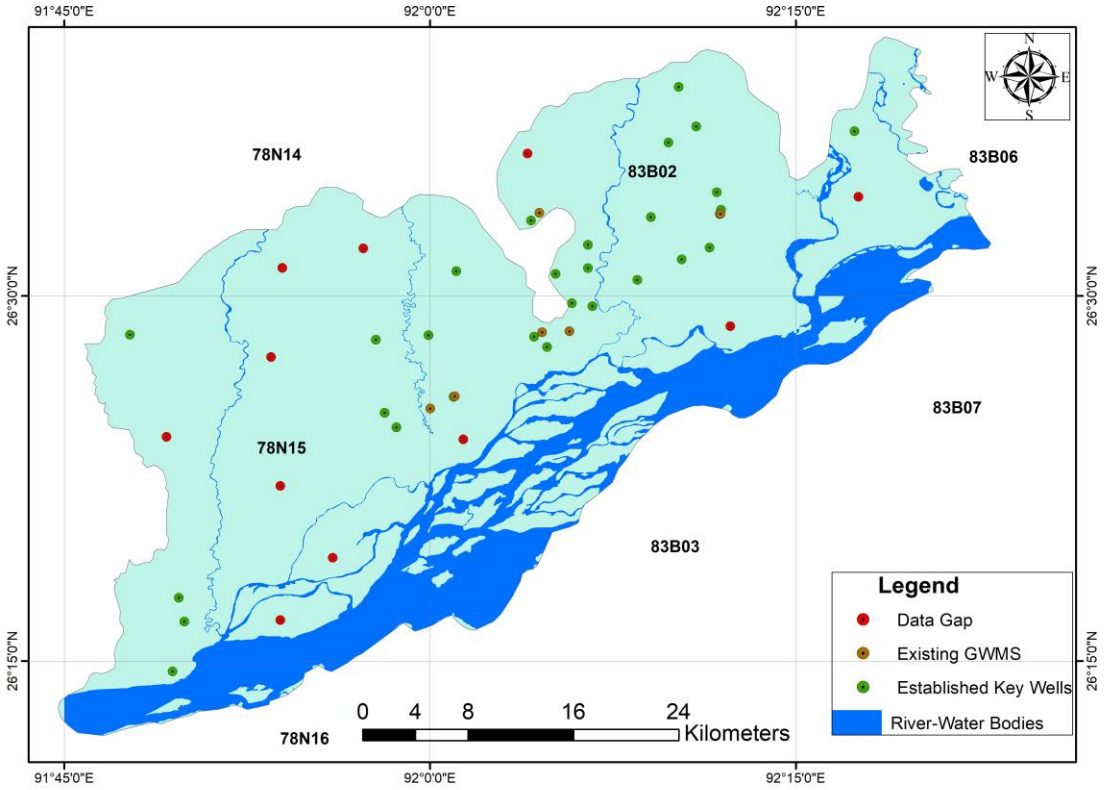


Fig. 1.3: Available data and data generation of ground water level

1.6 Rainfall distribution

The average annual rainfall recorded from 2010 to 2019 in Kopat TE is 1664.84mm. Rainfall during January to April contributes nearly 15.64% to the total rainfall whereas the rainy season which commences from May and continues up to September contributes 80.1%. October to December rainfall makes up the rest. December receives least rainfall and maximum rainfall occurs during June (Table- 1.4)

Table 1.4: Average monthly rainfall distribution of Darrang district, Assam for the period from 2010 to 2019

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2010	0	0.4	132.2	222	328.6	407.6	213.8	171.2	189.4	33.2	4.4	0	1702.8
2011	5.8	7.8	88	99	205.8	375.8	129.8	221.2	112.8	9.2	12.8	0	1268
2012	8.4	5.2	28.8	200.6	123.2	449.6	247.1	178	280.5	53	0	0.5	1574.9
2013	0	9.8	43	96.8	358.2	179.8	292.8	216.6	248.6	103.6	0	0	1549.2
2014	0	20	5.4	48.6	325	447.4	202.6	249.4	293.4	1.5	0	0	1593.3
2015	8.5	6.9	10.8	238.8	395.5	463.5	264.4	457.2	173.7	36	30.6	29.8	2115.7
2016	41	2.3	130.6	251.6	250.2	255	245	169.4	223.4	77.2	0	13.4	1659.1
2017	0	83.8	64.2	156.6	223.3	441	284.3	204.9	230.1	180.8	14	0	1883
2018	0	16	70.6	173	287.7	160.9	193.3	203.8	171.2	6	11	19.7	1313.2
2019	1	45	78.5	203	368.6	399	382.4	170.5	272	69	0.2	0	1989.2

The average monthly rainfall from 2010 to 2019 and also yearly rainfall distribution of Kopati T.E of Darrang district are illustrated in Fig.1.4 and Fig 1.5

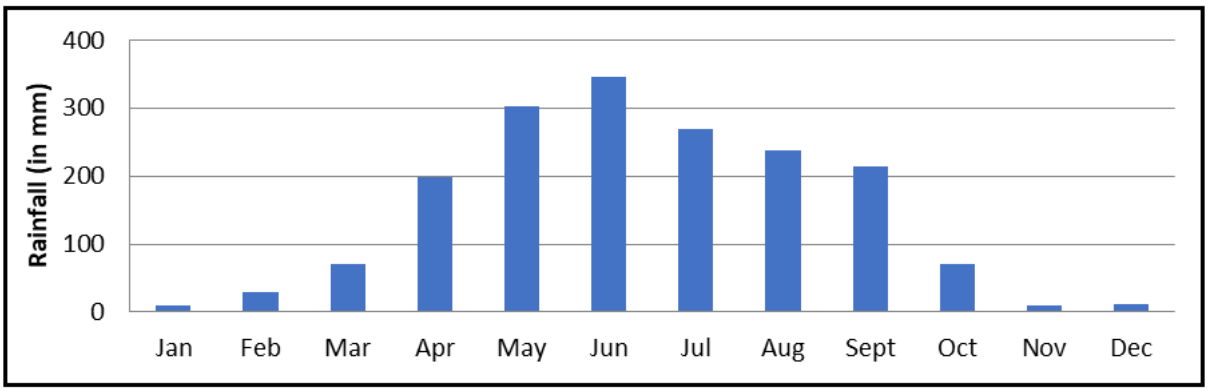


Fig. 1.4 Average monthly rainfall variations of Darrang district

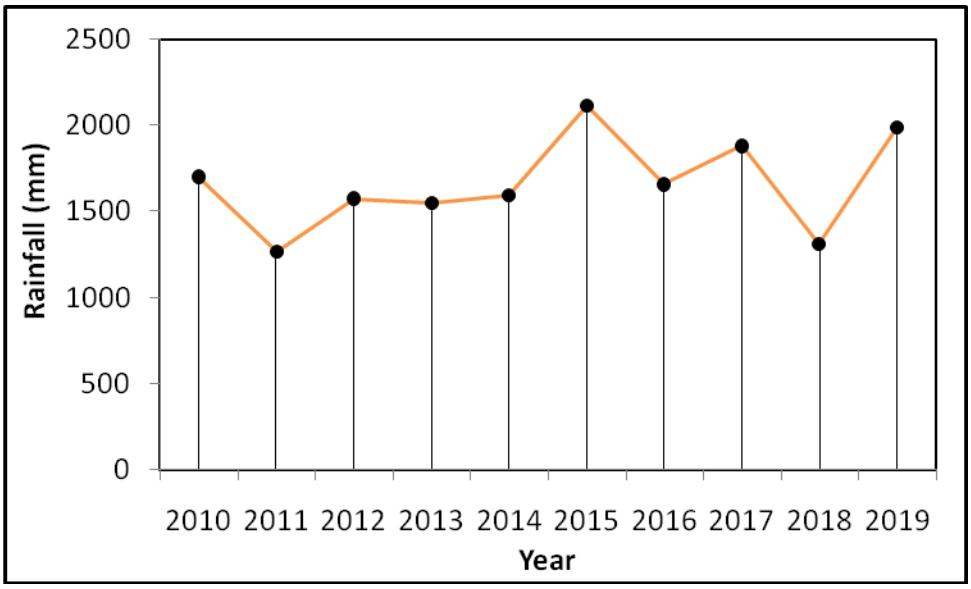


Fig.1.5: Annual variation of rainfall as recorded in Kopati TE rain gauge stations of Darrang district

IMD (Indian Meteorological Department) data of 2019 and normal rainfall are shown in Table 1.5 and graphical illustration is given in Fig. 1.6.

Table 1.5: IMD rainfall data of 2019 and normal rainfall, Darrang District, Assam

Month	Actual RF (%)	Normal RF (%)	Deficit RF (%)
Jan	3	17.2	-83
Feb	7	26.7	-74
Mar	60.7	63.5	-4
Apr	216.6	186.9	16
May	253.5	300.9	-16
Jun	63.6	418.7	-85
Jul	75.3	335.5	-78
Aug	65.2	271.7	-76
Sep	164.8	231.2	-29
Oct	74.5	110.3	-32
Nov	0	18.5	-100
Dec	0	10.2	-100
Total	**984.2**	**1991.3**	**49**

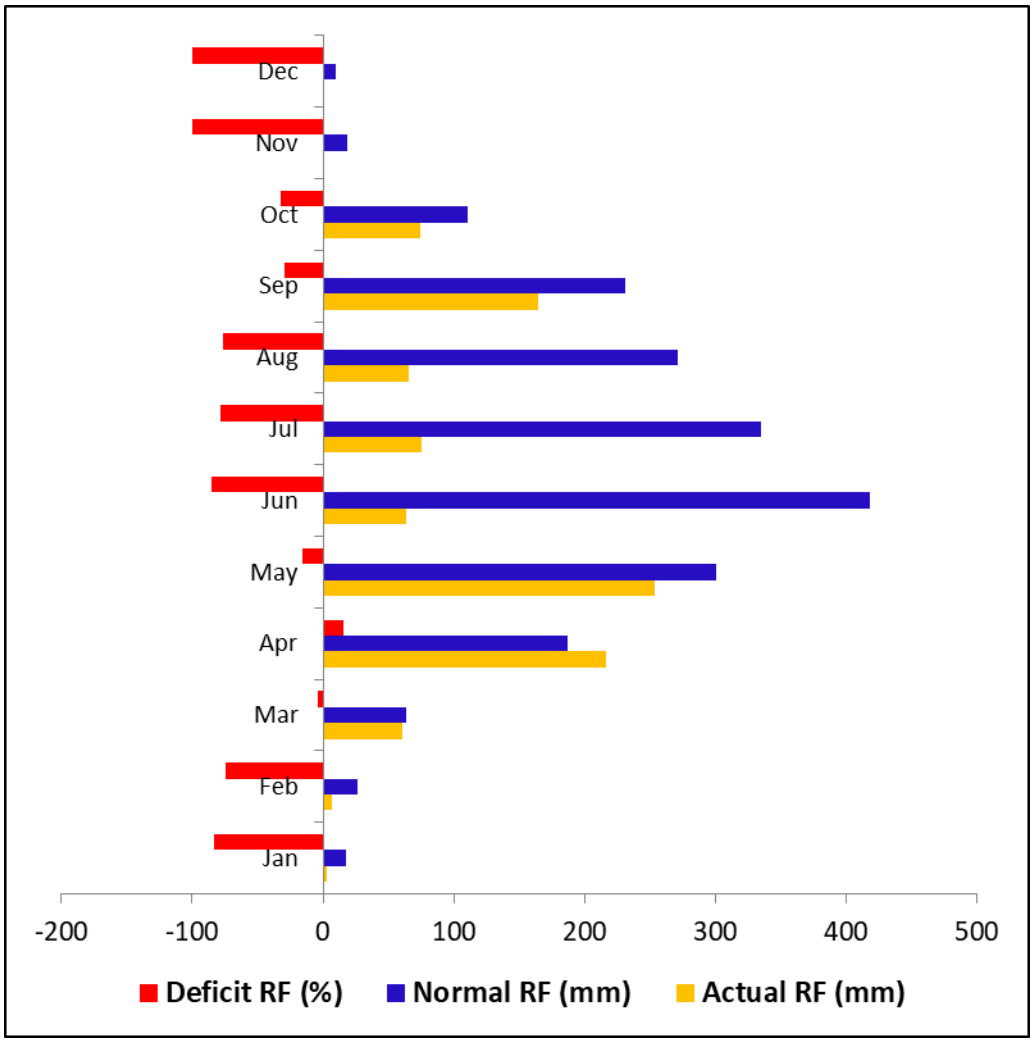


Fig. 1.6: Actual rainfall deviation from normal rainfall, Darrang District, Assam

It is observed from IMD rainfall data that during 2019, there is huge deficit of rainfall almost in all the season in Darrang district.

1.7 Temperature

The temperature in the region begins to increase from the end of February and reaches the highest point during June and July. January is the coldest month of the year. The air is highly humid throughout the year and winds are light in the district. The average weekly minimum and maximum temperature in the summer is 28°C and 38°C respectively. However, the mean temperature in the summer is 33°C. Further, there is a significant decrease in the minimum temperature during the rainy season with 20°C and maximum temperature in this season remains 38°C. The average weekly temperature in the winter's ranges from slightly cold with 15°C to moderate temperature of 25°C.However, the mean weekly temperature in the winter season is 20°C.

1.8 Physiographic set up

Physiographically, Darrang district is a part of the Brahmaputra river valley. Almost the entire district is plain area with slope between 0 to 10%. Archean inselbergs are found in the south western corner of the district with slope ranging from 20 to 60%. The maximum elevation of the inselberg is 100 metre above mean sea level (Fig.1.7).

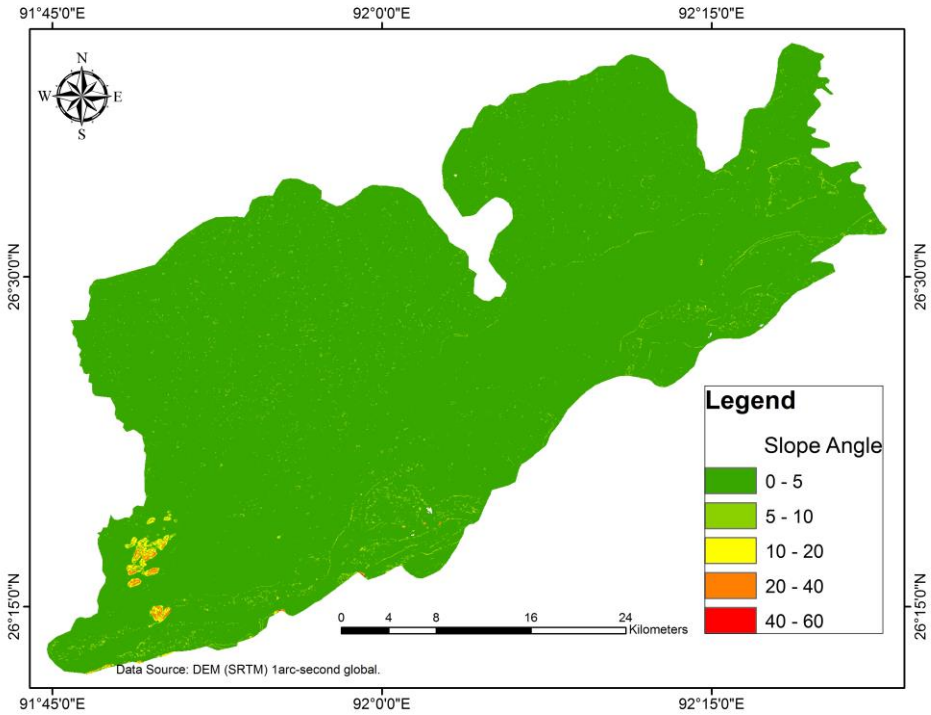


Fig.1.7: Slope map of the study area based on 90m resolution srtm data

1.9 Drainage and Morphometric Features

In the north bank the Brahmaputra River has several tributary systems. The main tributaries of Brahmaputra are Dariya or Kalapani Nadi, Nanai, Kulsi, Bhola, Bega, Daiphong, Mora Dhansiri, Dhansiri, Barnadi, Saktola, Noa, Tangani Jhora etc.

All these tributaries have southerly direction of flow from foothills of Himalaya. The drainage network of the area shows sub parallel pattern.

The rivers and streams show high meandering nature with sudden change of course and represent unstable condition which results in inundation of large areas. Because of heavy soil erosion and subsequent deposition, silting problem is more prominent day by day.

1.10 Geology

The Darrang district is underlain by Quaternary sediments of enormous thickness deposited over Archaean basement. Quaternary sediments composed of fine to coarse sand, silt, grey clay with occasional gravel.

In the south western part of the district about an area of 5 sq km is occupied by inseberg of granites and gneiss.

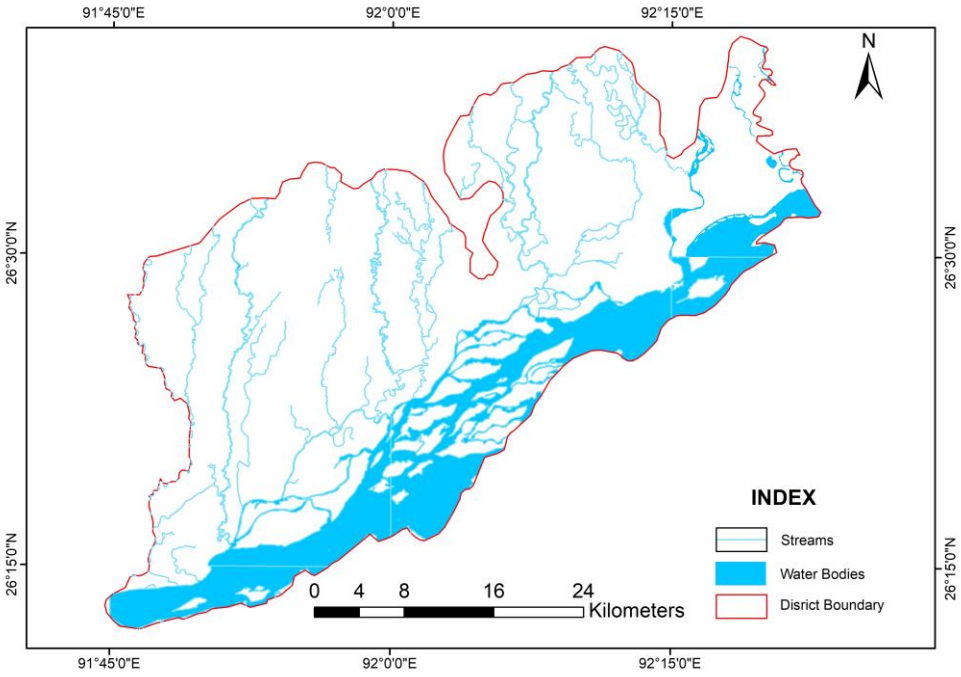


Fig. 1.8: Drainage Map of Darrang District, Assam

1.11Geomorphology

Geomorphologically the area can be classified mainly into three divisions: flood plain, younger alluvial plain and inselberg.

The flood plain areas are restricted to flood plain of river Brahmaputra and its tributaries consisting of unconsolidated material like gravel, sand, silt and clay. Due to seasonal floods the different depositional environment like paleo channel, natural levees, back swamps wetlands and channel bars are common features of flood plain area. These areas are good for ground water development in shallow depth.

The major part of the district is occupied by younger alluvial plain. The elevation of the younger alluvial plain is slightly higher than the flood plain areas, consisting of gravel, sand, silt and clay.

Inselberg occupies a very small part in the extreme south western corner of the district. It consists of granite and granite gneisses in the form of small isolated hills and suitable for ground water development through dug wells in the weathered zones. (Fig. 1.9).

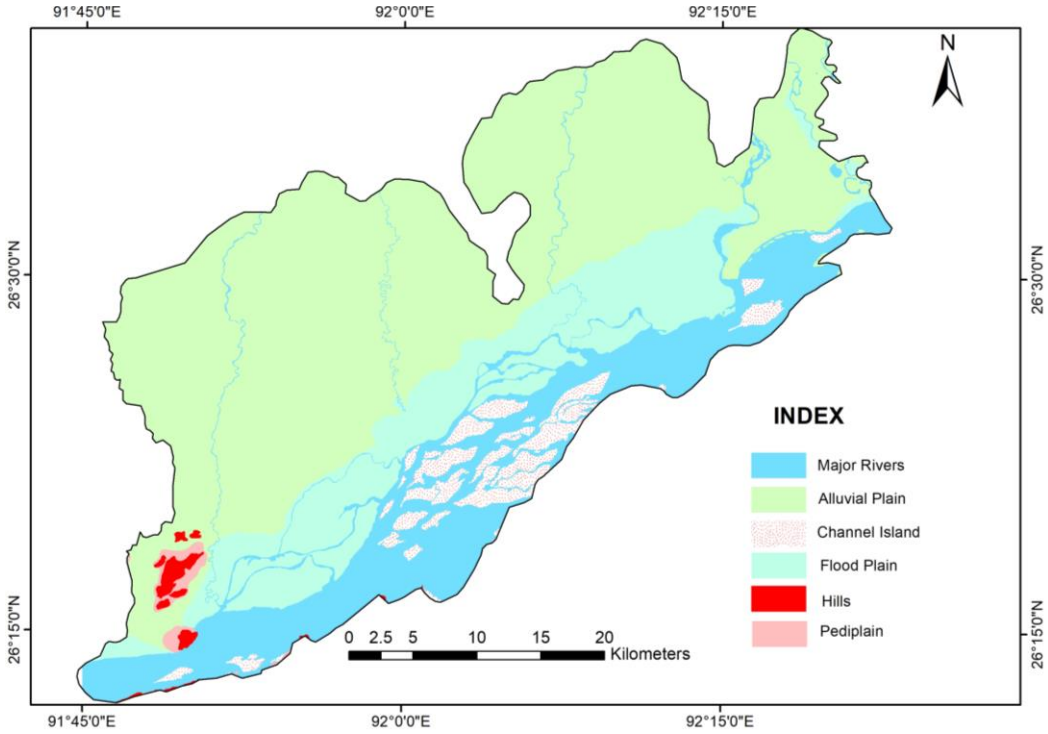


Fig. 1.9: Geomorphological Map of Darrang District, Assam

1.12 Land use Pattern

The net sown area of the district is 73,619 ha which accounts for 46.44 percent of the geographical area of the district & the land utilization pattern in the district

The gross cropped area of the district is 141062 ha with cropping intensity of 191.61% percent. Out of the total cropped area 141062 ha and that 47.8 percent are used in more than once. In same part of the district especially in Dalgaon –Sialmari and Bechimari block are used their land in four times at the same time Sipajhar and Paschim Mangaldai the farmers are sowing only Sali paddy.

Table 1.6 Land Use Pattern in Darrang District

Total Geographical Area (Ha)	Area under Agriculture (Ha)									under Forest (Ha)	Cultivable Waste Land (Ha)	Area under Other Uses (Ha)
	Cultivable Area	Net cropped area	Mono crop area	Double crop area	Triple crop area	Gross crop area	Cropping Intensity (%)	Chronically drought prone area	Chronically flood prone area			
158500	81626	**73619**	28659	24644	20316	141062	191.61	3000	13200	10541	3879	97319

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

1.13 Soil

The soil of the district is sandy to sandy loam in texture and acidic in reaction and is characterized by medium to high organic carbon, low to medium phosphorus and potash content. The texture of the soil ranges from sandy loam to silty loam in nature. The soil is suitable for cultivation of rice crops.

Table 1.7 Soil Profile of the district

Soil Type		Land Slope			
Major Soil Classes	Area (ha)	0-3% (ha)	3-8% (ha)	8-25% (ha)	>25% (ha)
Sandy Loam	67,500	67,500	-	-	-
Clay Loam	49,900	35261.25	14638.75	-	-
Silty Clay Loam	22,500	-	22,500	-	-

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

Alluvial plain soil is light grey to dark grey of recent age occurring along the major river valleys. Older alluvial soils are light grey to dark grey in color. It is unaltered alluvium representing a broad spectrum of sand, silt and humus rich bog clay depending on landform component. Alluvial soil, are alluvial plain soils, developed along vast places of Brahmaputra basin. These are yellow to yellowish grey in color and are unaltered alluvium representing sand, silt and humus rich bog clay depending on land form component. Soil pH is generally feebly alkaline excepting bogsoils. Tarai soil, soil group representing Bhabar and Tarai fall in this sub-division. These are brownish grey soil and are mainly constituted of sand with very little clay. These soil groups are generally slightly alkaline to acidic. The soil of this district is very fertile for cultivation.

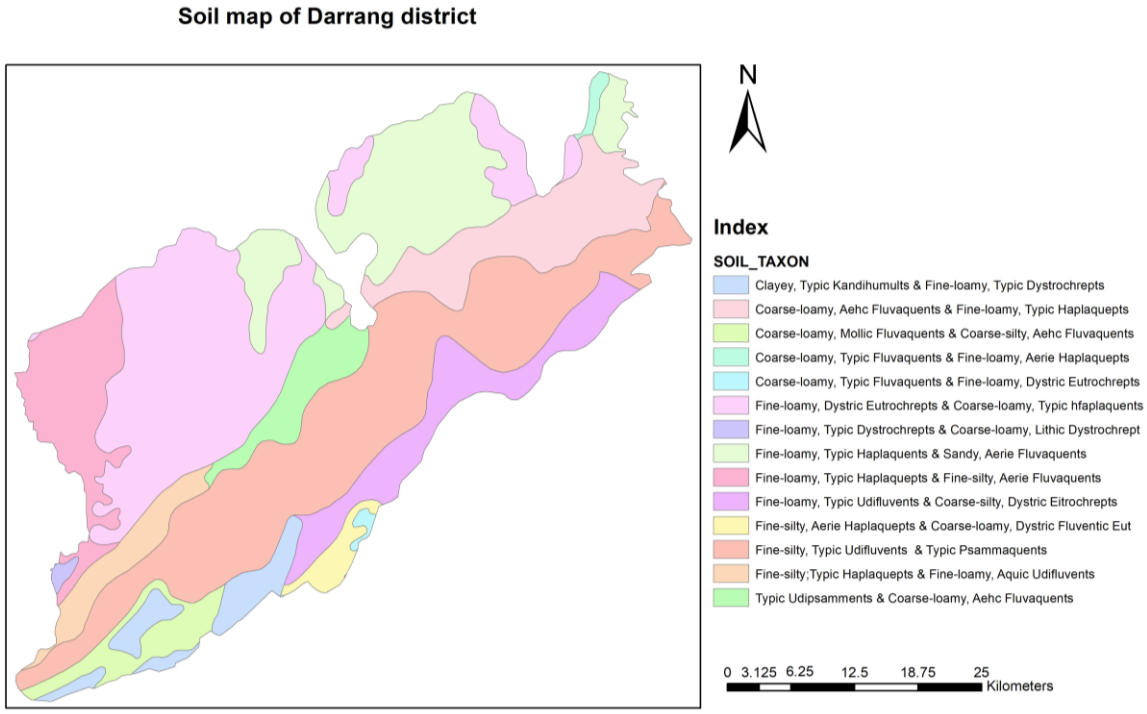


Fig. 1.10: Soil Map of Darrang District, Assam

1.14 Hydrology and surface water

Surface water bodies are mainly observed in the flood plain area where south and south western flowing rivers loses its gradient. Waterlogged and marshy lands are observed.

The area covered by the surface water bodies are shown in the following Table 1.8

Table: 1.8 Water bodies in Darrang District

Sl no	Water bodies	Area in ha
1	Ponds and tanks	2978.2
2	Paddy cum fisheries	160
3	Derelict water bodies	802.45
4	Beel fisheries	942.2
5	River fisheries	6040
6	Eco hatchery	20
7	Magur hatchery	5
8	Others	1
Total		**10,949**

Source: District Animal Husbandry & Veterinary Department, Darrang

1.15 Agriculture

Agriculture in Darrang is characterized by small holdings operated by family labour, both men & women. Average land holding size in Darrang is 0.95 ha. However, small & marginal farmers & Landless, who make up 89 % of land holders, have an average farm size of 0.57 ha.

The net sown area of the district is 73,619 ha which accounts for 46.25 percent of the geographical area of the district & the land utilization pattern in the district

Paddy is the principal crop grown in the district and *autumn paddy*, *winter paddy* and *summer paddy* are the three main types of paddy grown in the district. Winter paddy is the most important crop in the district occupying 70.6 % followed by summer paddy 25.4% and autumn paddy 4% of the total annual paddy area. In the district summer rice cultivation has received more attention to avoid flood and other natural calamities to make the district self-sufficient in rice production. The total area under paddy cultivation during the year 2014-15 was 68385 ha and total production was 137877.1 MT. Almost 52% of the Gross cropped area is under paddy cultivation.

Next to paddy, wheat, rapeseed, mustard, sugarcane and vegetables are the main agricultural produce. Among cash crops Jute accounted for 3.2 % and sugarcane 0.38 % of the total cropped area (source: www.aau.ac.in).

In Darrang, 50% of the cultivated land is irrigated. The cereals crops are cultivated in 10539 hectare in Kharif while 3880 hectare of cereals is cultivated under irrigated land during Rabi. In summer a total of 8924 hectare area is cultivated with all the area under irrigated category.

The gross and net irrigated areas in the district have been 32765 hectares and 21843 hectares respectively. While, the total rainfed area is 10922 hectares. Due to

abundant rainfall, the major portion of agriculture in the district is dependent on rain fed conditions while only less area is cultivated under irrigated conditions.

Table 1.9: Irrigation Based Classification

Irrigated (Area in Ha)		Rainfed(Area in ha)	
Gross Irrigated Area	Net Irrigated Area	Partially Irrigated/Protective Irrigation	Un- Irrigated or Totally Rainfed
32765	21843	NA	10922

Source: District Agriculture Officer, Darrang

Table 1.10 Shares of Surface and ground water irrigation

	MCM per Ha	Kharif	Rabi	Summer	Total
S.No.	Sources				
1	Surface Irrigation				
(i)	Canal(Major & Medium Irrigation)	Nil	Nil	Nil	Nil
(ii)	Minor Irrigation tanks	Nil	Nil	Nil	Nil
(iii)	Lift Irrigation/Diversion	1810	968	-	2778
(iv)	Various Water Bodies including Rain Water Harvesting	-	-	-	-
(v)	Treated Effluent Received from STP	-	-	-	-
(vi)	Untreated Effluent	-	-	-	-
(vii)	Perennial sources of water	-	-	-	-
2	Ground Water				
(i)	Open Well	-	-	-	-
(ii)	Deep Tube Well	1830	880	-	2710
(iii)	Medium Tube Well	-	-	-	-
(iv)	Shallow Tube Wells	30	20	-	50

Source: District Irrigation Department, Darrang

CHAPTER 2.0

2.0 Data Collection and Generation

2.1 Data collection

Data collection includes collection of rainfall data from state government, litholog collection from state groundwater departments, compilation of CGWB's earlier survey data, exploration and geophysical data. Population data is collected from Census of India website. Agriculture data are taken from District Irrigation Plan, 2016-2020, Darrang, Assam prepared by NABARD.

CGWB had constructed 10 exploratory wells in this area earlier. Public Health Engineering Department and Directorate of Geology and Mining, Govt. of Assam had constructed number of tube wells in the area and the department provided lithology and chemical analysis data. However, all the wells are not incorporated in the present study due to lack of coordinate data. Details of the wells are given in Table 2.4.

Rainfall data was collected from Kopati Tea Garden, Kopati, Darrang district, Assam

2.2 Data Generation

2.2.1 Hydrogeological data

The entire study area is covered by regular monitoring of existing 7 GWMS and another 27 key wells have been established. All these wells are under monitoring after establishment (Table 2.1).

2.2.2 Soil Infiltration studies: Infiltration test

Seven soil infiltration tests were conducted during the field season in the study area. The salient features of the test sites 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 admixtures. The infiltration test was conducted for 80 to 210 mins.

2.2.3 Water Quality

During Pre monsoon period 22 nos and post monsoon period 32 water samples were collected from dug wells and hand pumps of the study area for analysis of detail, iron, heavy metals and arsenic.

2.2.4 Geophysical survey

As per record no geophysical survey was carried out in the district and due lack of geophysicist in the Region geophysical survey was not included in the study.

2.2.5 Exploratory Drilling

During AAP 2019-20, five outsourcing exploratory drilling and one in house exploratory drilling was done in the area by CGWB. A list of wells constructed in the area are prepared incorporating location, well designs, etc (Table 2.3).

Table 2.1: GWMS and Key wells details

Sl No	Village	Lat	Long	Well Type	MP	RL	Depth	Aquifer group	Depth to water in m bgl				
									Apr/May,19	Aug,19	Nov,19	Jan,20	March, 20
1	Upper Kuruwa	26.243	91.824	DUG	0.73	49	8.5	Alluvium	6.57		2.15	2.59	2.71
2	Suwalkuchia Chuba	26.277	91.832	DUG	0.97	46	9.97	Alluvium	2.51		0.11	1.71	2.84
3	Khalihoi	26.29328	91.82831	Dug	0.34	43	5.88	Alluvium			2.66	3.7	4.03
4	Jaljali Gariapara	26.47	91.963	DUG	1.16	57	5.19	Alluvium	1.7		1.5	2.57	2.64
5	Dekargaon	26.517	92.018	DUG	0.72	63	6.85	Alluvium	1.66	2.33	2.73	3.66	3.2
6	Bezpara	26.473	91.999	DUG	0.75	49	2.55	Alluvium	0.14				
7	Dalgaon-PWSS	26.559	92.199	TUB	0.33	65	66	Alluvium	9		8.52	9.24	
8	Khataniapara	26.472	92.071	DUG	1.02	52	8.08	Alluvium	0.43	1.82	0.92		3.21
9	Tangni (Thekerabari)	26.495	92.097	DUG	0.98	56	8.37	Alluvium	5.5	2.12	3.03	5.64	
10	Bihdia	26.525	92.172	DUG	0.28	61	10.02	Alluvium	8.97	3.28	8.25	9.52	9.15
11	Konakat	26.533	92.191	DUG	0.85	59	12.16	Alluvium	10.53	2.55	9.2	10.02	10.14
12	Sialmani	26.571	92.196	DUG	0.81	63	7.48	Alluvium	5	1.99	4.66	5.09	5.22
13	Madhupur	26.643	92.17	DUG	0.96	77	5.67	Alluvium	1.62	2.44	3.17	3.45	3.45
14	5 NO. Baruajhar	26.616	92.182	DUG	1.06	75	5.49	Alluvium	2.81	1.49			
15	4 NO. Baruajhar	26.605	92.163	DUG	0.71	68	4.75	Alluvium	1.62	1.71	1.65	2.46	2.97
16	Pub Kamarpara	26.554	92.151	DUG	0.88	66	7.45	Alluvium	4.76	1.62	3.3	4.45	4.91
17	Fakirpara	26.519	92.108	DUG	1.16	56	5.37	Alluvium	1.91		3.1	3.41	3.29
18	Ghinamari	26.535	92.108	DUG	1	60	6.09	Alluvium	2.27		3.25	3.52	3.6
19	Botabari	26.515	92.079	DUG	1	57	7.49	Alluvium	0.6	2.4	1.63	4.41	4.51
20	Bhakatpara	26.543	92.074	DUG	1.04	62	6.4	Alluvium	3.72	2.11	2.35	3.39	3.6
21	Panighat	26.493	92.111	DUG	0.71	53	6.25	Alluvium	3.5	2.11			
22	Ondulajhar	26.465	92.08	DUG	0.54	65	20	Alluvium	1.58		3.01	5.45	5.78
23	Aulachauka	26.41	91.977	DUG	1.12	51	4.35	Alluvium	2.22	1.39	3.24	3.43	
24	Nandapara	26.42	91.969	DUG	0.57	61	4.83	Alluvium	1.73	2.05	1.81	3.53	
25	Malibaribaritari	26.4735	91.79478	DUG	0.65	53	6.53	Alluvium			2.95		3.8
26	Kharupetia (Thakurpatti)	26.51103	92.14164	DUG	0.88	54	8.77	Alluvium			2.26	2.95	3.07
27	Silbori	26.61272	92.29011	DUG	0.63	68	4.46	Alluvium			2.43	3.57	4.02
28	Dalgaon	26.556	92.198	DUG	0.79	65	6.18	Alluvium	4.26	1.91	2.58	3.95	4.07
29	Gelabil Thelamara	26.69742	92.29086	DUG	0.90	51.00	5.00	Alluvium	2.81	1.60	2.51	2.58	
30	Majagaon OW	26.47511	92.07658	OW	0.55	48.00	146	Alluvium		3.00			
31	Majgaon Part2	26.47511	92.07647	DUG	0.94	45.00	9.00	Alluvium		4.66	4.10	5.44	
32	Mangaldoi	26.43144	92.017	DUG	0.65	53.00	7.80	Alluvium	2.76	4.25	4.38	4.57	5.12
33	MangaldoiII	26.42292	92.00033	DUG	1.00	4.70	6.90	Alluvium		2.01	3.85		
34	Thekerabari.1	26.65958	91.90653	DUG	0.80	53.00	6.80	Alluvium					

Table 2.2: Summary of Infiltration Test Results of Darrang district, Assam

Sl No	District	Site	Latitude	Longitude	RL (m)	Land use	Soil type	Infiltration rate (mm/hr)	Duration of test (min)	Total Quantum of water added in mm	Total quantum of water recharged in m	Infiltration Factor
1	Darrang	Dumnichowki	91.81925	26.34858	51	Barren Land	Silty Clay	9	210	200	0.00505	4.04
2		Dalgaon	92.195472	26.57072	61	Barren Land	Clay	36	80	190	0.00896	4.71
3		Silbori	92.292389	26.61006	53	Barren Land	Clay	12	100	200	0.00496	2.48
4		Malibaritari	91.793833	26.47061	35	Barren Land	Sandy Clay	9	100	200	0.00336	1.68
5		Dipila	91.858556	26.46003	40	Barren Land	Sandy Clay	18	90	200	0.00944	4.72
6		Kuruwa	91.812069	26.24191		Barren Land	Clay	2	165	190	0.00144	0.75
7		Mahaliapara	91.88835	26.51479		Barren Land	Sandy Clay	6	100	200	0.00368	1.84

Table 2.3: Details of exploratory wells in Darrang District, Assam

Sl No	Location	Block	Toposheet No	Long	Lat	Type of Well (DW/ BW/ TW)	Depth	Depth of construction (m)	Source
1	Dumnichouki-EW	Sipajhar (Part)	78N/15	91.8545	26.3486	TW	219.24	168.00	CGWB
2	Kharupetia-EW	Pub-Mangaldai (Part)	83B/3	92.1097	26.411	TW	300.20	167.00	CGWB
3	Kuyapani-EW	Pachim-Mangaldai (Part)	78N/15	91.9747	26.418	TW	300.20	134.00	CGWB
4	Kalaigaon-EW	Kalaigaon	83B/2	91.9768	26.5492	TW	300.20	148.00	CGWB
5	Mangaldoi College-EW	Pachim-Mangaldai (Part)	83B/3	92.0333	26.443	TW	202.00	129.00	CGWB
6	Areng-EW&OW	Pachim-Mangaldai (Part)	83B/3	92.0225	26.458	TW	191.00	108.00	CGWB
7	Dagiapara-EW	Sipajhar (Part)	78N/15	91.8236	26.583	TW	202.00	135.00	CGWB
8	Bhakatpara-EW	Kalaigaon	83B/2	92.0778	26.539	TW	195.60	144.00	CGWB
9	Majgaon-EW	Pub-Mangaldai (Part)	83B/3	92.0822	26.475	TW	176.90	172.00	CGWB
10	Silbori EW	Dolgaon-Sialmari	83B/6	92.2924	26.6099	TW	106.8		CGWB
11	Malibaritari	Sipajhar (Part)	78N/15	91.7938	26.4705	TW	305.5	286	CGWB
12	Dipila	Sipajhar (Part)	78N/15	91.8586	26.4598	TW	305.5	275	CGWB
13	Dhula	Pub-Mangaldai (Part)	83B/3	92.0981	26.486	TW	305.5	276	CGWB
14	Dalgaon	Dolgaon-Sialmari	83B/2	92.1959	26.5706	TW	305.5	286	CGWB
15	Lalpul	Bechimari (Part)	83B/2	92.1713	26.6422	TW	305.5	239	CGWB

CHAPTER 3.0

Data Interpretation, Integration and Aquifer Mapping

3.1 Data Interpretation

Central Ground Water Board, North Eastern Region, Guwahati has drilled 16 exploratory wells in the district. Public Health Engineering Department has also drilled number of wells in the area. During aquifer mapping, the district is explored down to the depth of 305m through outsourcing. The litholog of all the exploratory wells are used to identify the major aquifer in the district. The lithologs of all the exploratory wells are dominated by grey colour sand and discontinuous grey colour clay bands with gravel which indicate deposition in riverin environment. The major aquifer of the district is younger alluvium.

3.1.1 Aquifer Diposition

To understand the disposition of aquifer, 2D sections and 3D panel diagrams are constructed using the lithologs of the exploratory wells.

2D disposition: Three sections are constructed to visualize the aquifer disposition

(a) a north east - south west section from Dumnichouki to Dalgaon in the alluvial formation parallel to the River Brahmaputra (Fig. 3.1)

(b) a north east - south west section from Malibaritari to Lalpul in the alluvial formation parallel to north of the Dumnichouki to Dalgaon section(Fig. 3.2)

(c) a north west to south east section from Malibaritari to Kuyapani, i.e., Perpendicular to flood plain (Fig. 3.3).

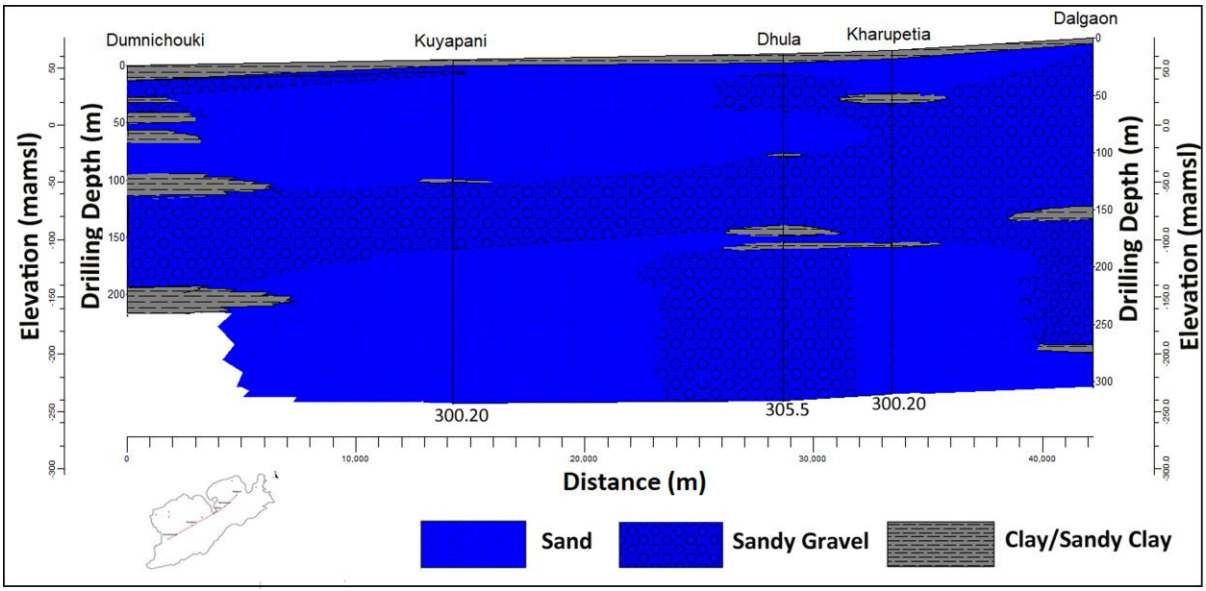


Fig.3.1: **North east - south west** Section showing aquifer disposition along central part

(a) Presence of a thick gravelly layer is conspicuous in the northeast-southwest section along the Brahmaputra River. Thickness of gravelly layer is more towards the northeastern part where it attains a thickness of nearly 250m. Clay occurs as lenses

The clay lense at 110m is 11m thick and another clay lense is found at 250m depth in Dalgaon EW. The gravelly layer above 110m clay layer continues throughout the section with increasing thickness towards northeastern part. The gravelly layers deposited below 110m clay layer occur intermittently in the section up to Dhula EW and it ceases to continue towards southwest. Numbers of clay layers are observed in the southwest part of the section. Except the top clay layer, neither of the clay layers is found to continue towards the northeastern part.

(b) Another northeast-southwest section along the northern border of the district is constructed which is parallel to the Dumnichouki to Dalgaon section. Gravel is more in the northeast and is found below the top clay layer. The gravel found in the top in the northeast is observed throughout the section but its thickness decreases from nearly 55m in the northeast to nearly 10m in the southwest. There are numbers of clay layers are observed within the gravelly layer in the northeast. Barring the top, third and ninth clay layers others are pinched out. Moreover, except the top clay layer the other clay layers thickness reduces towards the southwest.

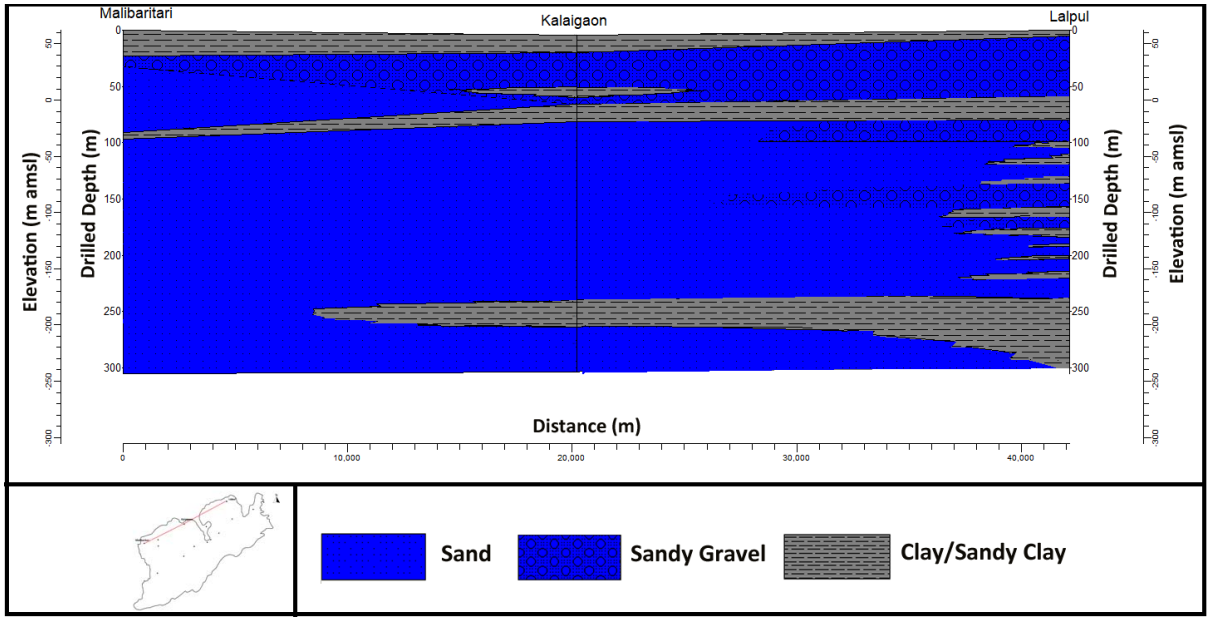


Fig.3.2: Section showing aquifer disposition along northern part

© A north west – south east section constructed almost across the other two sections shows the presence of thick gravelly layer below 100m at Dipila EW and it thins out toward the Brahmaputra plain (Fig. 3.3). This nearly 200m thick gravel layer is absent in the Malitaribari EW. Presence of three clay layers is observed in the section and all the clay layers are pinched out toward the southeast, i.e., towards the Brahmaputra plain.

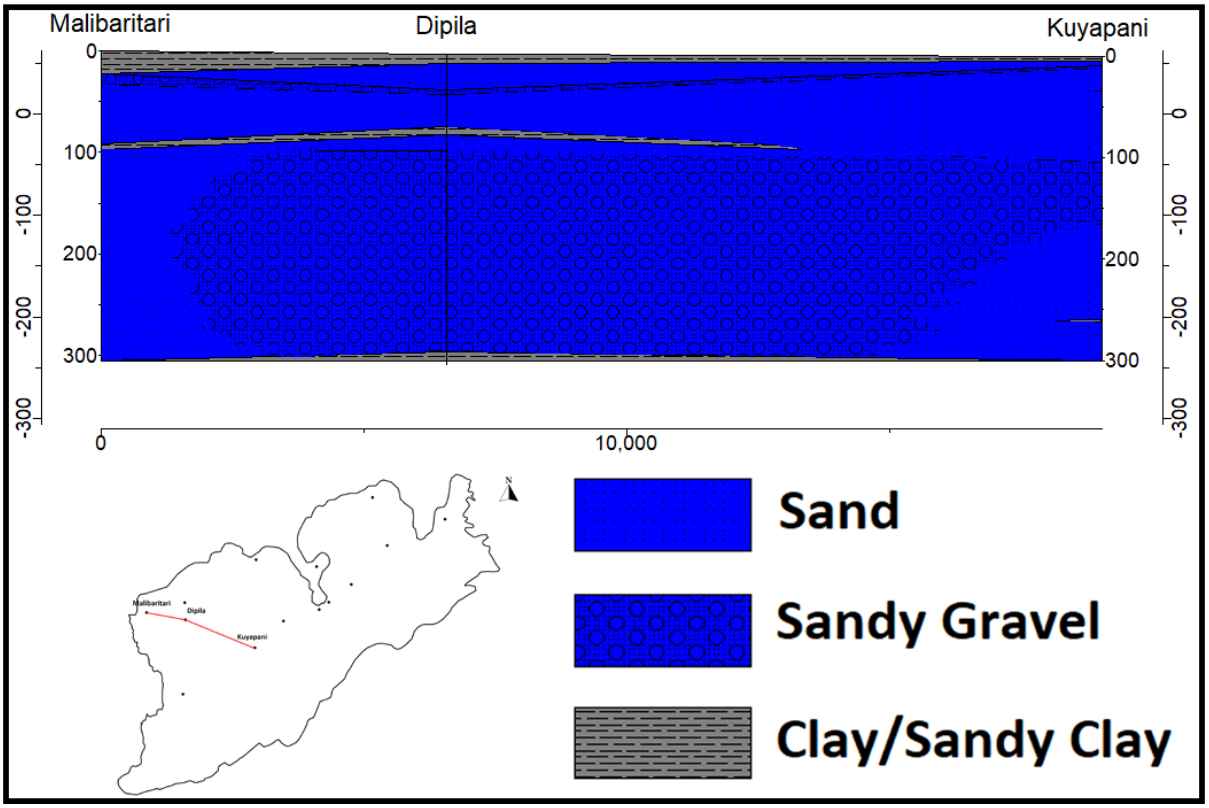


Fig. 3.3: Section showing aquifer disposition normal to flood plain, i.e., towards Brahmaputra river

3D dispostion of aquifer: The alluvial aquifer is sand and gravel dominated is evident from the 3D fence diagram.

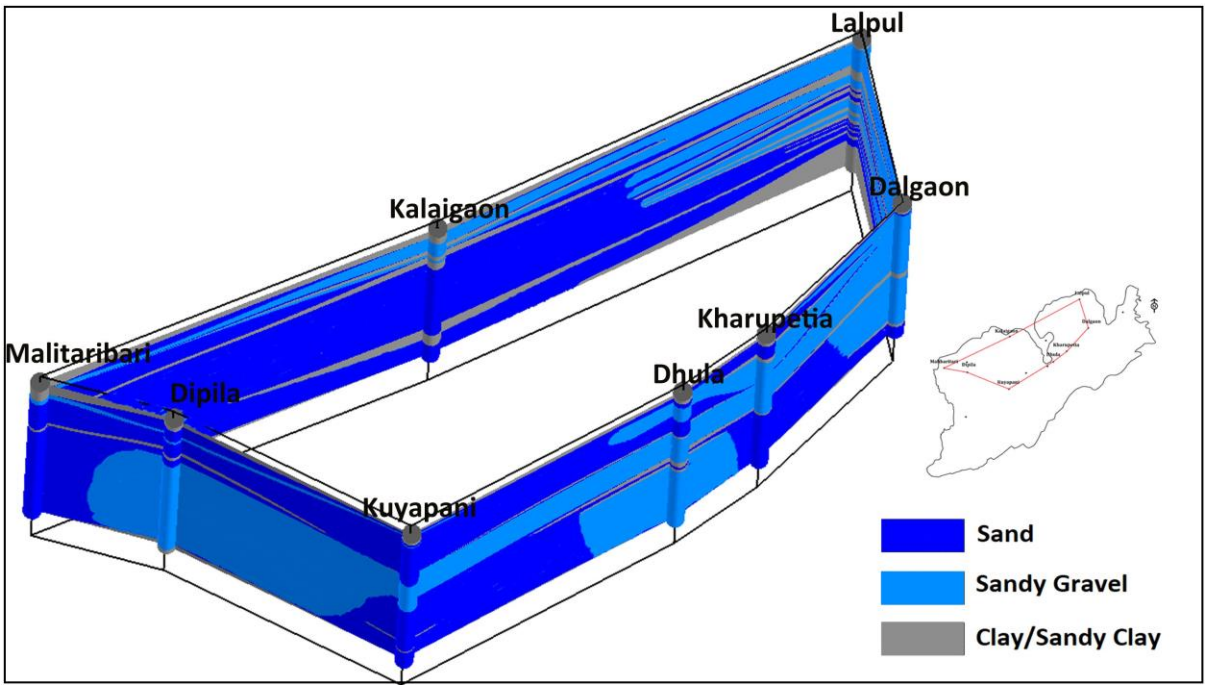


Fig. 3.4: 3D disposition of aquifer in the study area

However, gravelly layer is pinches out towards the north-western part of the district. Numbers of clay layers are observed. Their lateral continuity is limited. The top clay layer is generally observed in all the exploratory wells in the district. Presence of clay layers, their extent and their thickness in the central part of the district close to river Brahmaputra is less compared to the distal part of the district. Thus the disposition of aquifer materials gives rise to a mono-aquifer system with local exception.

3.1.6 Aquifer Characteristics

The alluvial aquifer of Darrang district can be divided into two, viz, shallow and deeper, based on the subsurface geology deciphered from drilling and prevailing ground water conditions.

Shallow aquifers: The water bearing horizons occur within 30-50mbgl is considered to constitute shallow aquifer system. Ground water in this aquifer occurs under unconfined to semi-confined conditions. The aquifer materials comprise sands of different grades with varying proportions of gravels. The upper surface of the shallow aquifer is bounded by a confining layer and its thickness is varying from nearly 3m (Areng) to 22.75.m (Malibaritari). The thickness of this confining layer is more towards the northern part of the district. Barring the pervasive top clay layer, generally there is no clay layer within 50m. Dominance of gravel is more towards the Brahmaputra plain. State Government has constructed number of shallow tube wells and discharge of the shallow tube wells ranges from 12 to 45m^3/hr

Deeper Aquifers: In the deeper aquifers, ground water occurs under semi-confined to confined conditions. The upper confining layer is generally 3 to nearly 50m thick and is not regionally extensive. The aquifer materials are composed of sands and gravels of different size grade. In this district, CGWB, NER had explored the subsurface down to the depth of 305m in Malibaritari, Dipila, Dhula, Dalgaon, Lalpul, Kuyapani, Kharupetia and Kalaigaon areas. The cumulative thickness of the granular zones in the deeper aquifer varies from 111 to 286.2m. Discharge of exploratory wells tapping 15 to 70m of granular zones (below 100m) generally ranges from 10 to 270 m3/hr .

Table 3.1: Aquifer parameters

S N	Location	Depth (m)	Zones tapped up to 50	Zones tapped up to 100 m	Zones tapped up to 200 m	Zones tapped up to 300 m	SWL (mbgl)	Discharge (m^3/hr)	Draw Down (m)	T (m2/ day	Storativity	Permeability (m/day)
1	Dumnichouki	219.24	30.5-35.58	51-53.07, 57-66, 85-91,	98-110, 125-143, 150-153, 159-165		20.6	45.9	0.30	1720		64.8
2	Kharupetia	300.20		56-68, 83-91, 76.90-110.96	115.54-128, 140-146.21, 158-14.26		7.64	270.24	5.63	1189.4		70.0
3	Kuyapani	300.20	36.84-43, 46-52.17,	64-82.56, 93.86-101	101-109, 115-122		1.10	251.74	3.724	7902.9		111.76
4	Kalaigaon	300.20	38-44,	55-60.9, 78.14-84,	106-5-130, 139-145		0.98	188.04	5.23	3447.3		
5	Mangaldoi College	202.00		65-77, 83-86, 90-95,	104-110, 117-126		1.61	47.7	0.66	2891		
6	Areng	191.00		45.95-71.73, 76.01-98.44,	99.47-108.97, 112-09-118.32, 138.85-145		3.44	43.63	0.79	383		
7	Dugiapara	202.00	40-52,	57-79,	93-105		2.05	48.6	3.13	191	$2.45x10^{-5}$	
8	Bhakatpara	195.60		78-96,	120-132							
9	Majgaon	176.90	42-48	72-78, 84-90,	120-132, 136-142		4.58	44.73	4.62			
10	Malibaritari	305.5		88-91	108-111, 117-120, 148-151, 177-180,	233-236, 243-246, 259-262, 272-275, 279-282	0.81	138.08	5	13059.9	$4.2x10^{-3}$	725.55
11	Dipila	305.5			171-177, 196-202,	212-218, 230-236, 265-271	2.12	15.73	39.04	90	$7.2x10^{-5}$	2.97
12	Dhula	305.5				206-212, 218-224, 230-236, 248-254, 266-272	4.78	46.83	29.1	6364.32	$5.5x10^{-2}$	212.14
13	Dalgaon	305.5			181-187	226-232, 244-250, 258-264, 276-282	9.47	11.12	27.14	58.45	$1.47x10^{-5}$	1.94
14	Lalpul	305.5			168-174, 183-189, 194-197,	207-213, 224-230	8.83	7.38	-	-	-	-

3.1.2 Ground water level

To study ground water regime, depth to water level from 34 monitoring stations (GWMS 7, Key well 27) are measured seasonally. Block wise variation of water level can be discussed as below.

Pre-monsoon depth-to-water level of the key wells in Bechimari (Part) Block is 2.97 to 3.45 mbgl, Dalgaon-Sialmari Block 3.29 to 10.14 mbgl, Kalaigaon (Part) 2.64 to 3.60m bgl, Pachim-Mangaldai block is 3.20 to 5.12 mbgl , Pub-Mangaldai Block 3.21 to 5.78 mbgl, Sipajhar block depth-to-water level varies from 2.71 to 4.03mbgl. (Fig. 3.5)

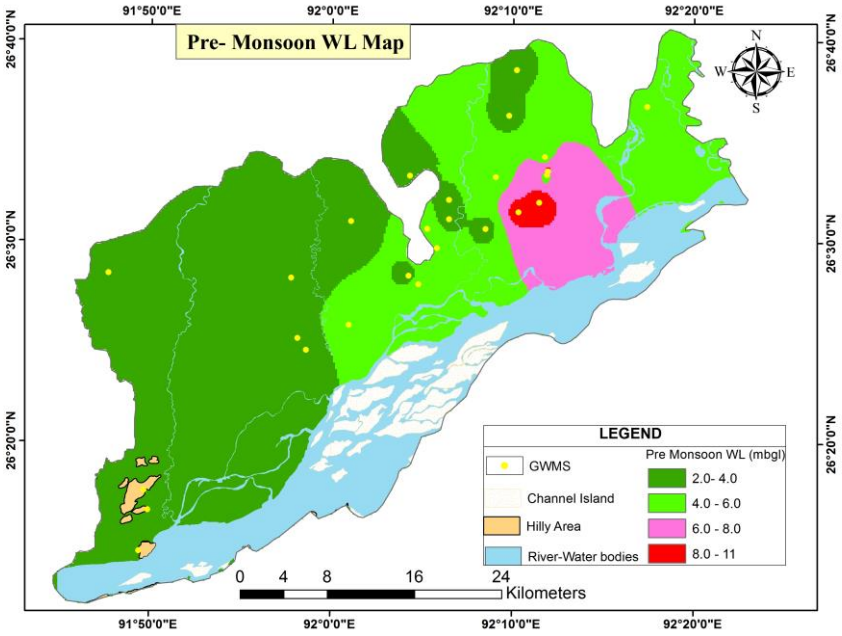


Fig. 3.5: Pre-monsoon DTW level contour of Darrang district, Assam

Post-monsoon water level data of Bechimari (Part) Block is 1.65 to 3.17 mbgl, Dalgaon-Sialmari Block 2.43 to 9.2 mbgl, Kalaigaon (Part) 1.50 to 2.35m bgl, Pachim-Mangaldai block is 2.73 to 4.38 mbgl , Pub-Mangaldai Block 0.92 to 3.30 mbgl, Sipajhar block depth-to-water level varies from 0.11 to 2.95mbgl (Fig. 3.6).

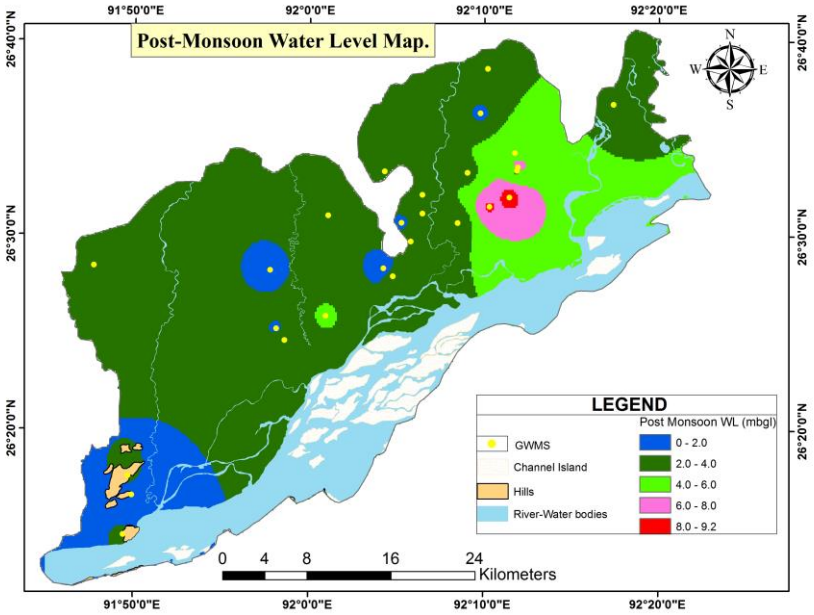


Fig. 3.6: Post-monsoon DTW contour of the study area

Block wise Fluctuation of water level pre- and post monsoon water level difference ranges from in Bechimari (Part) Block is 0.28 to 1.32 mbgl, Dalgaon-Sialmari Block 0.86 to 0.94 mbgl, Kalaigaon (Part) block is 1.14 to 1.25 mbgl , Pachim-Mangaldai Block 0.47 to 0.74 mbgl, Pub-Mangaldai block 2.29 to 2.48mbgl, Sipajhar Block 1.08 to 2.60 mbgl. (Fig. 3.7)

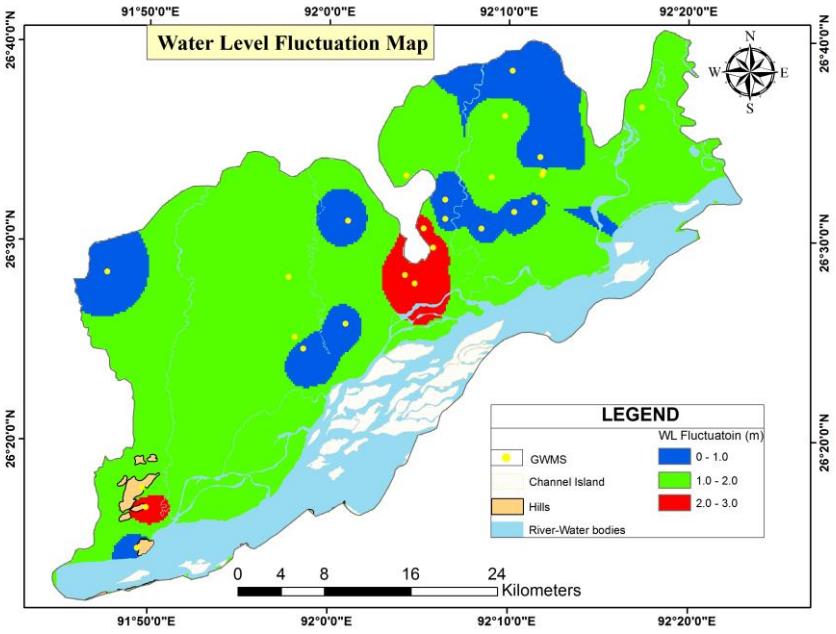


Fig. 3.7: Water Level Fluctuation map of the study area

3.1.3 Ground Water Movement

The water table contour has been prepared based on water level of ground water monitoring stations (Fig.3.8). The ground water flow direction is from the higher

elevation in northwestern side to towards the Brahmaputra river in the south eastern side. The highest water table is 80 m above mean sea level.

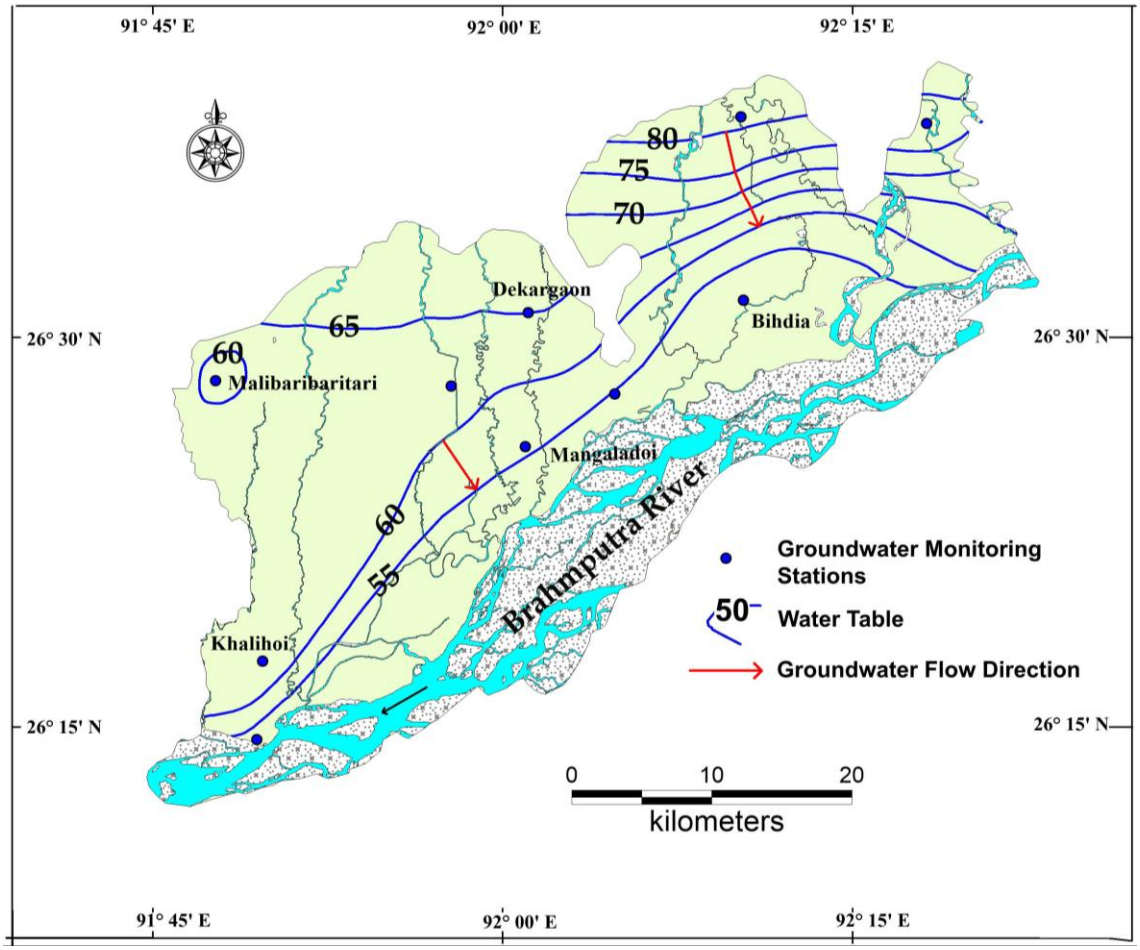


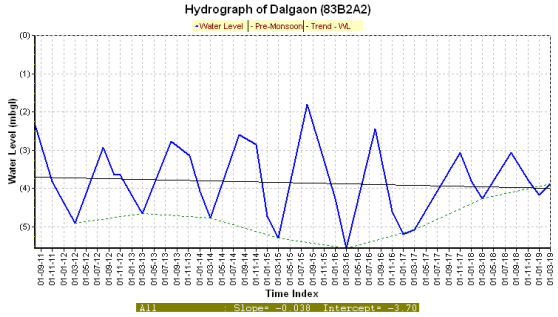
Fig. 3.8: Water table contour of the study area

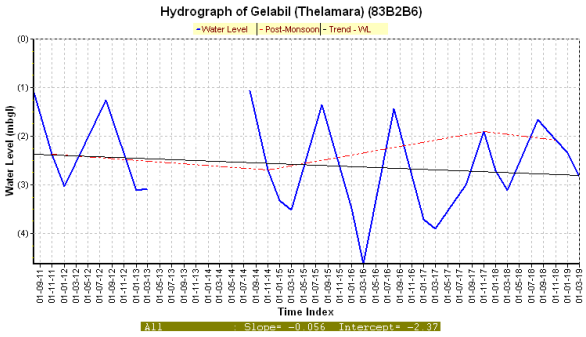
3.1.4 Water level trend analysis

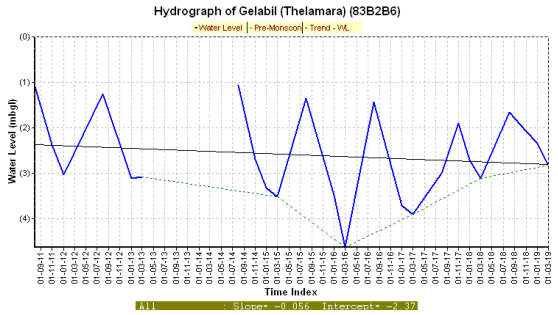
For analysis of long-term behavior of ground water level, data from Ground Water Monitoring Stations (GWMS) are utilized. Historical depth-to-water level data (in m bgl) are plotted as individual hydrographs and are given in Figure 3.9 and Table 3.2 shows the overall trend of water levels in GWMS wells.

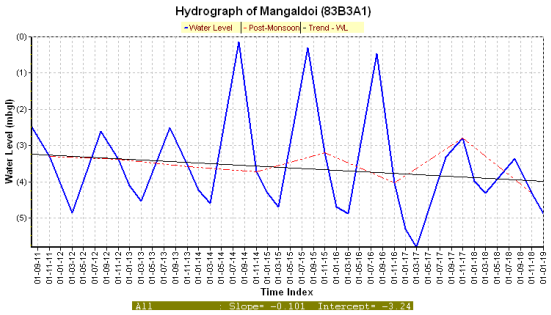
Table 3.2 Trend of Water levels in GWMS Wells

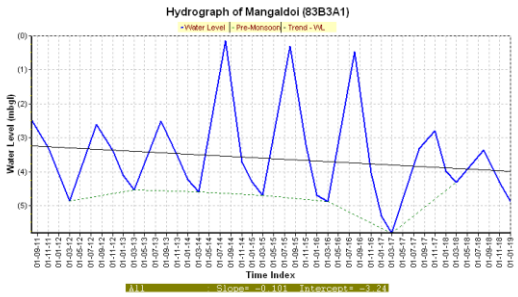
SN	Locality/Name	No. of years	Water Level Trend	
			Post-monsoon	Pre-monsoon
1	Dalgaon	9	Rise	Fall
2	Gelabil (Thelamara)	9	Rise	Fall
3	Mangaldoi	9	Rise	Fall
4	Chamuapara	7	Rise	Fall
5	Mangaldoi II	9	Rise	Fall
6	Majgaon II	7	Rise	Fall
7	Bhakatpara ow	7	Rise	Fall
8	Majgaon ow	7	Rise	Fall
9	Thekerabari I	9	Rise	Fall

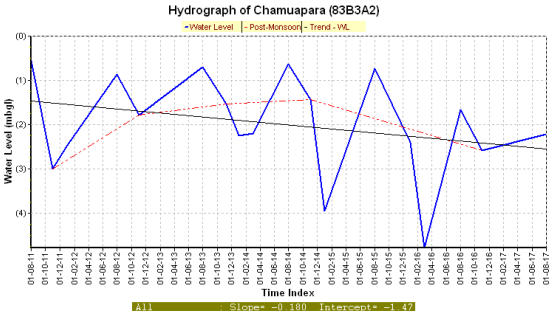

Hydrograph of Dalgaon (83B2A2)
Water Level | - Pre-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.038 Intercept= -3.70

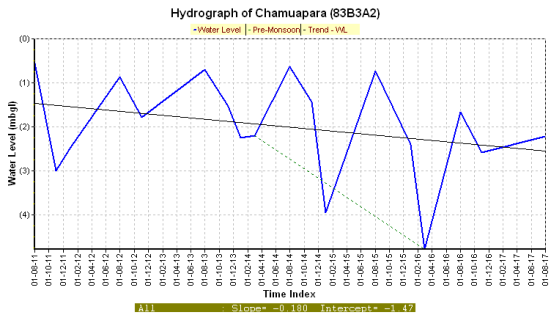

Hydrograph of Gelabil (Thelamara) (83B2B6)
Water Level | - Post-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.056 Intercept= -2.37

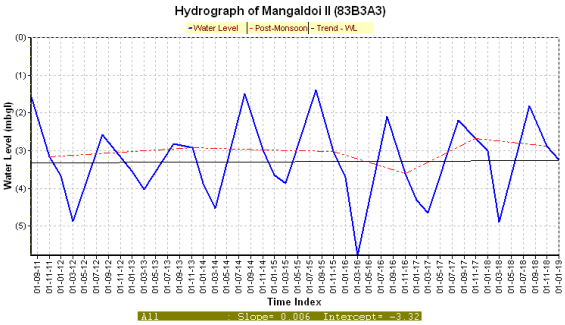

Hydrograph of Gelabil (Thelamara) (83B2B6)
Water Level | - Pre-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.056 Intercept= -2.37

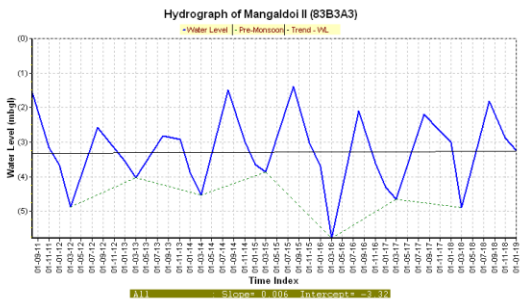

Hydrograph of Mangaldoi (83B3A1)
Water Level | - Post-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.101 Intercept= -3.24

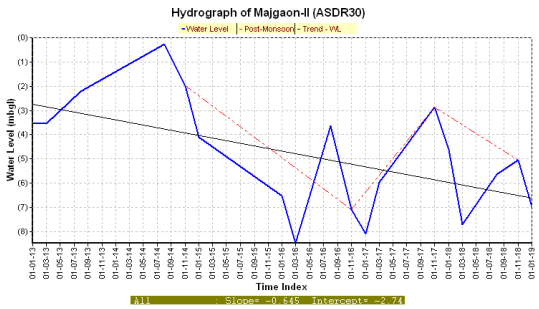

Hydrograph of Mangaldoi (83B3A1)
Water Level | - Pre-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.101 Intercept= -3.24


Hydrograph of Chamuapara (83B3A2)
Water Level | - Post-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.180 Intercept= -1.47


Hydrograph of Chamuapara (83B3A2)
Water Level | - Pre-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.180 Intercept= -1.47


Hydrograph of Mangaldoi II (83B3A3)
Water Level | - Post-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= 0.006 Intercept= -3.32


Hydrograph of Mangaldoi II (83B3A3)
Water Level | - Pre-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= 0.006 Intercept= -3.32


Hydrograph of Majgaon-II (ASDR30)
Water Level | - Post-Monsoon | - Trend - WL
Water Level (mbgl)
Time Index
All : Slope= -0.648 Intercept= -2.74

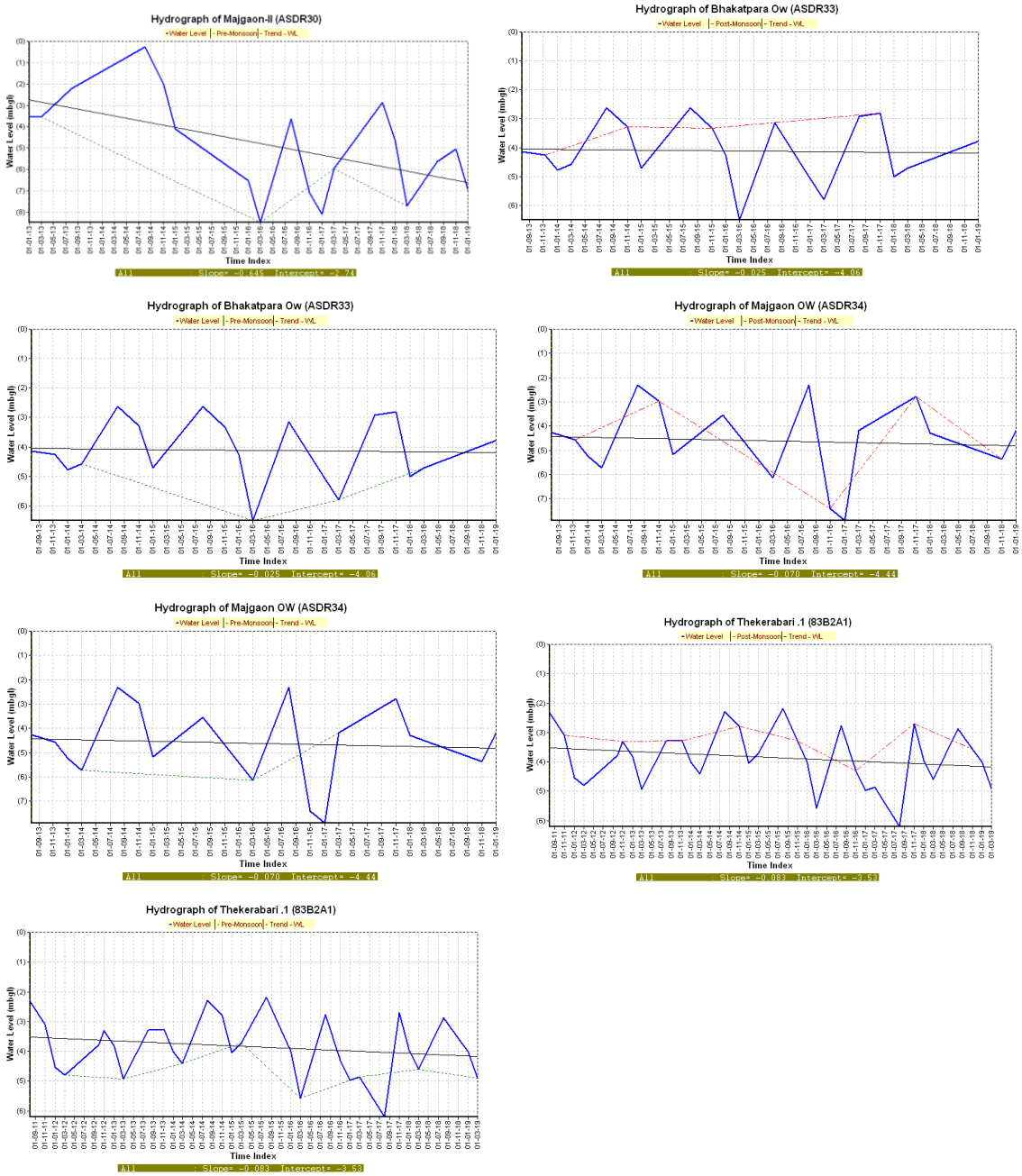


Fig.3.9: Hydrograph of GWMS wells

3.1.5 Ground water quality

Chemical analysis of ground water samples are carried out by regional chemical laboratory of Central Ground Water Board, North Eastern Region, Guwahati. Water quality data is also collected from Public Health Engineering Department, Division office, Mangaldoi.

Groundwater quality of shallow aquifer for domestic purpose:

Pre-monsoon pH value ranges from 7.78 to 8.51 and in the post-monsoon pH value ranges from 6.38 to 8.34 indicating wide variation in pH. Pre-monsoon iron concentration ranges from 0.17 to 3.27mg/l. In post monsoon water samples iron

concentration is ranges from 0.14 to 13.1mg/l. In general most of the samples Iron concentration is more than permissible limit. In pre monsoon sample 22% of dug wells are within permissible limit, 32% dug wells are more than permissible limit and 46% of Hand pump sample Iron concentration is Iron concentration is more than permissible limit. In post monsoon Iron concentration is more than permissible limit in 12.5% of dug well and 50% in Hand pump sample whereas 34% dug wells and 3% Hand pump sample Iron concentration is within limit. Hand pump and Tara pump samples of Sonapur, Dipila Balipara, Malibaritari, Deo Mornoi, Jonaram Chowka, Chopai, Mahaliapara, Kharupetia etc shows iron concentration is more than permissible limit. 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. So ground water of Darrang district is potable for other constituent except iron in some pockets **Annexure-1**(Table 1d) and shown in the Fig 3.10a and 3.10b.

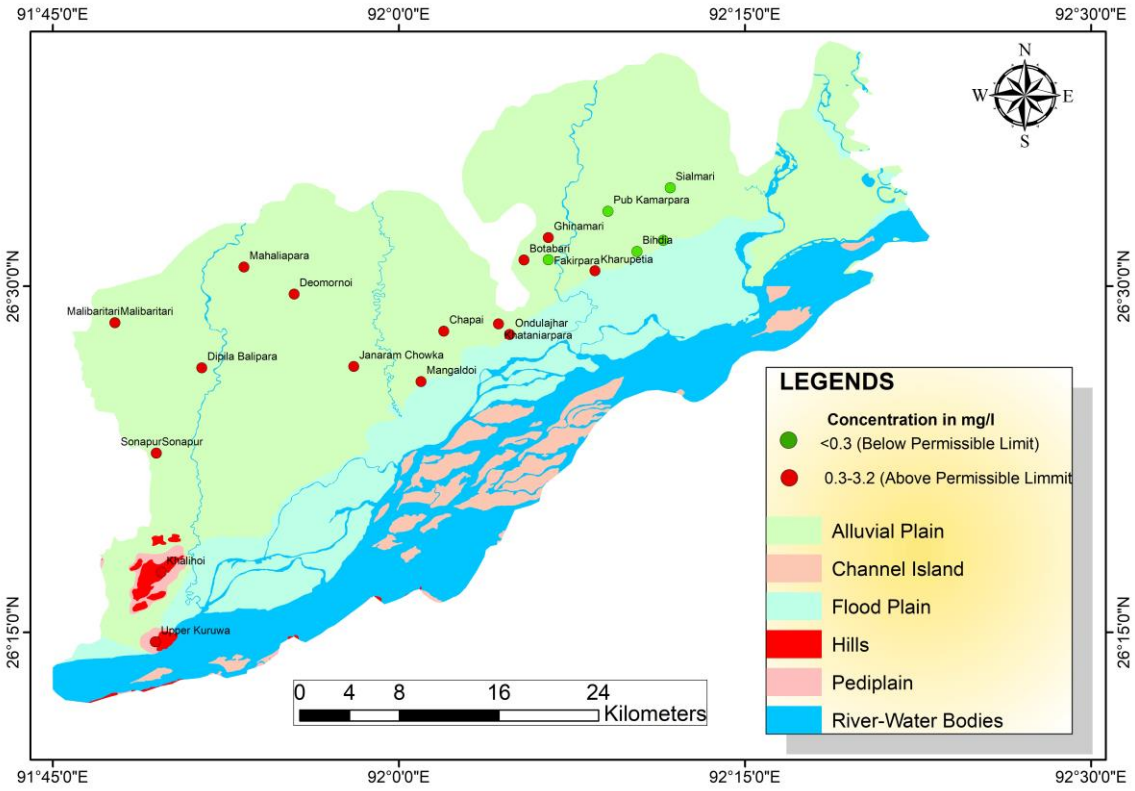


Fig. 3.10 a : Pre monsoon Iron Concentration map of Darrang District

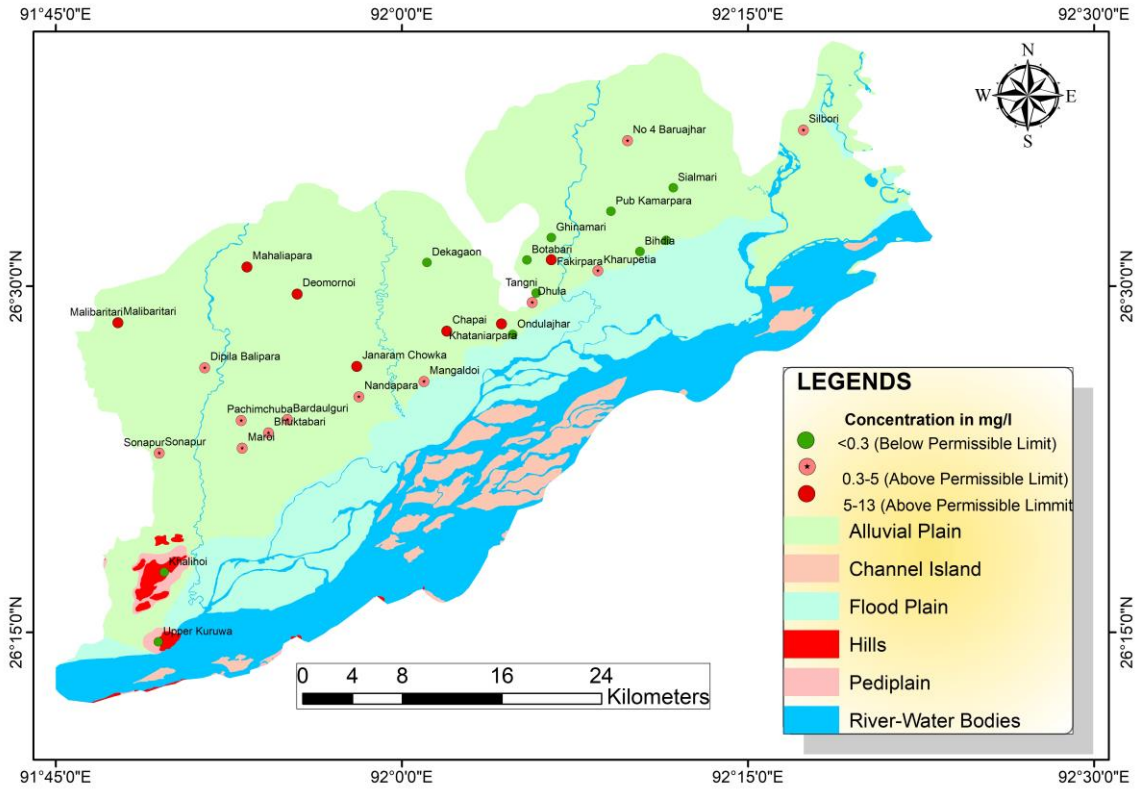


Fig. 3.10 b : Post monsoon Iron Concentration map of Darrang District

Concentration range of different chemical elements in ground water during pre- and post monsoon in the study area is given in **Annexure-1**(Table 1 a, b)

Arsenic in shallow aquifer: During aquifer mapping pre and post monsoon ground water samples were collected from dug well, hand pump and tara pumps .and submitted in NABL accredited Regional Chemical Laboratory of Central Ground water Board, Guwahati for arsenic analysis.

As> 10 ppb were found in NW part of the district in younger alluvial plain. GW samples collected from Hand and Tara pump at Mahaliapara and Malitaribari village have arsenic above permissible limit (Table 3.3).

Table 3.3: Arsenic concentration above permissible limit

Longitude	Latitude	**Location**	Type of sample (TW or DW)	**Depth (m)**	**Arsenic concentration (ppb)**	
					Pre-monsoon	**Post-monsoon**
91.79478	26.4735	Malibaritari	HP	40	10.296	13.313
91.88814	26.51381	Mahaliapara	TP	60	30.4	27.78

PHED, Darrang Division carried out water testing in its laboratory. 238 ground water samples collected from Tara pump, shallow hand pump, hand tube well were analyised and results shows that arsenic concentration ranges from 20 to 50ppb.

Annexure Table: 1C. List of Arsenic affected villages (0.01ppm & above), Darrang district, Assam (PHED) Mangaldoi, PHED, August, 2016.

Chemical quality of shallow aquifer for irrigation purpose: The chemical data of shallow aquifer is plotted in Wilcox diagram to test its suitability for irrigation purpose (Fig. 3.11)

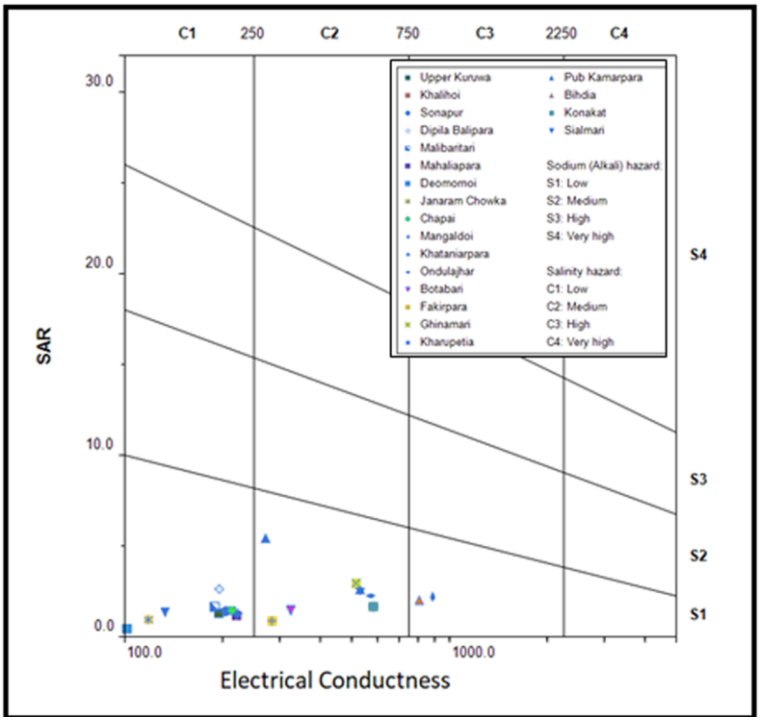


Fig.3.11: Na-and salinity hazard zonation of GW samples from shallow aquifer

Table 3.4: Na-and salinity hazard zonation of GW samples from shallow aquifer

Quadrant	% sample	Na-Hazard	Salinity Hazard
C3-S1	9.0	Low	High
C2-S1	32.0	Low	Medium
C1-S1	59.0	Low	Low

Fig. 3.11 and Table: 3.4, clearly indicates that most of the samples clustered in C1-S1 and C2-S1 zones of Wilcox diagram which signifies that groundwater from shallow aquifer is by and large suitable for irrigation purpose.

Groundwater quality of deeper aquifer for domestic purpose:

CGWB had constructed five exploratory wells during AAP 2019-20 through outsourcing. Groundwater samples were collected during pumping tests and tested. The chemical analysis data is for groundwater samples collected from a depth range of 88 to 282m depth. Summarised chemical tests analysis data for basic elements are provided in Table 3.5.

Table 3.5: Chemical analysis data of GW samples from deeper aquifer

Parameter	**Concentration**
pH	6.3 to 7.8
EC (mS/cm)	62 to 197
TDS(mg/l)	37.2 to 118.2
TH(mg/l)	30 to 125
Fe (mg/l)	0.08 to 13.1
F(mg/l)	0.2 to 1.1
As (ppb)	1 to 9

Groundwater from deeper aquifer is slightly acidic to slightly basic and the EC within permissible limits. Iron and fluoride contents of deeper aquifer zones are within the permissible limit. From Table 3.5, it is clearly observed that the groundwater from deeper aquifer zones is suitable for domestic purposes.

Arsenic in groundwater from deeper aquifer is also within permissible limit (Table: 3.5).

Chemical quality of deeper aquifer zones for irrigation purpose: The chemical data of deeper aquifer zones is plotted in Wilcox diagram to test its suitability for irrigation purpose (Fig. 3.12)

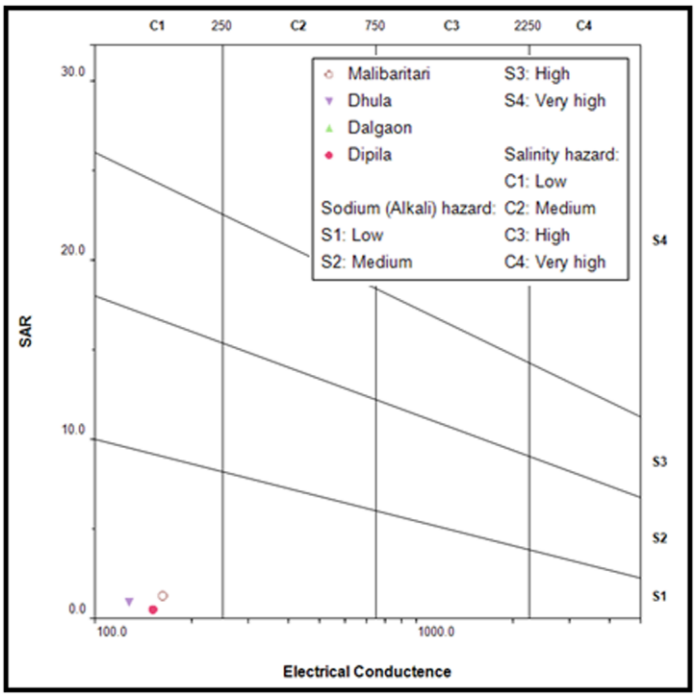


Fig.3.12: Na-and salinity hazard zonation of GW samples from shallow aquifer

Table 3.4: Na-and salinity hazard zonation of GW samples from shallow aquifer

Quadrant	% sample	Na-Hazard	Salinity Hazard
C1-S1	100	Low	Low

Fig. 3.12 and Table: 3.5, clearly indicates that the samples clustered in C1-S1 zone of Wilcox diagram which signifies that groundwater from deeper aquifer zones is suitable for irrigation purpose.

CHAPTER 4.0

Ground water Resources

The computation of ground water resources available in the district has been carried out using GEC 2015 methodology. The assessment unit in the present assessment is district due to paucity of block-wise data. The summarised result is presented in Table 4.1.

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 Darrang district is 4.54mbgl and 3.26mbgl.

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. 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

The aquifers of the study area are recharged through a) infiltration of rainfall on the outcrop 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, September) while share of post and pre monsoon rainfall are approximately 13 and 6 percent each.

The monsoon recharge of the 158500 hectre of recharge worthy area from rainfall is 44493.56 ham while non-monsoon recharge is 17536.82ham. Recharge from other sources during monsoon is 2048.29 ham and during non-monsoon is 5974.18 ham. Total ground water recharge is 47429.02 ham.

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 natural discharge is 4742.90 of the total groundwater recharge, i.e., 47429.02 ham. Total irrigation extraction created is 15469.44ham, for industry 73.725 ham and extraction for domestic uses is 2425.05 ham. Total groundwater extraction for all uses is only 17969.22 ham.

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

4.3 Allocation of resources up to 2025

The net ground water resource is allocated for domestic and industrial and irrigation sector. 2700.50ham of resource is allocated for domestic while 24442.45ham resource is available for future use.

4.4 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. However, Public Health Engineering & Water Supply Department has supplied water mainly through surface water sources. The stage of groundwater extraction in the district is 42.10%.

Table 4.1: Dynamic GW resources of Darrang District, Assam

Annual GW Recharge (Ham)	Natural Discharge (Ham)	Annual Extractable GW Resource (Ham)	Total Extraction (Ham)	Annual GW allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of GW Extraction (%)	Categorization
47429.02	4742.90	42686.12	17969.22	2700.50	24442.45	42.10	Safe

CHAPTER 5.0

Groundwater Related Issues

Identification of issues: The main groundwater issue in this area is vulnerability issue. The vulnerable areas generally include areas vulnerable to water logging and polluted areas.

5.1 Area vulnerable to water logging

Water logged areas are found both during pre- and post-monsoon seasons. During pre-monsoon season depth-to-water in some villages of Bechimaari, Dalgaon, Pachim and Pub-Mangaldoi blocks are recorded within 0.14 to 1.91mbgl. During post-monsoon season also depth-to-water level varies from 0.11 to 1.81mbgl.

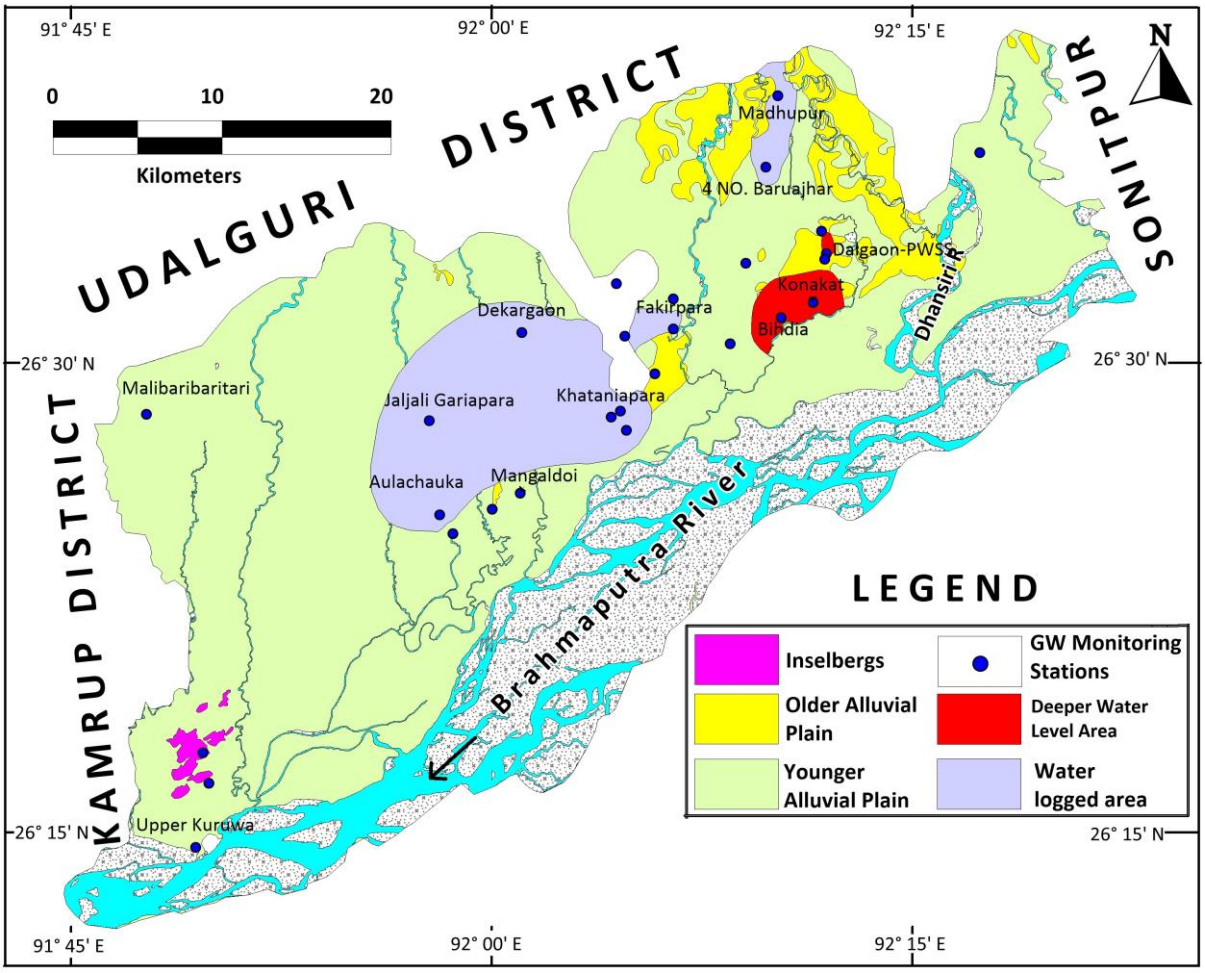


Fig. 5.1 Issues related to water level in Darrang distict

Water logged areas are generally found in the younger alluvial plain area. These areas are mostly found in the interfluve area and near the Brahmaputra River. Presence of near surface clay layer also impedes infiltration of water

Deeper Water Level

In few villages (Konakotapara, Bihdia, etc.) under Dalgaon block, post monsoon DTW (8.0 to 9.0 mbgl) is more than the district average WL (3.3mbgl).

Deeper water level in some villages can be attributed to the increased extraction of groundwater. Micro level study of Konakotapara village indicate stage of groundwater extraction is nearly 75%.

5.2 Water Quality Issue

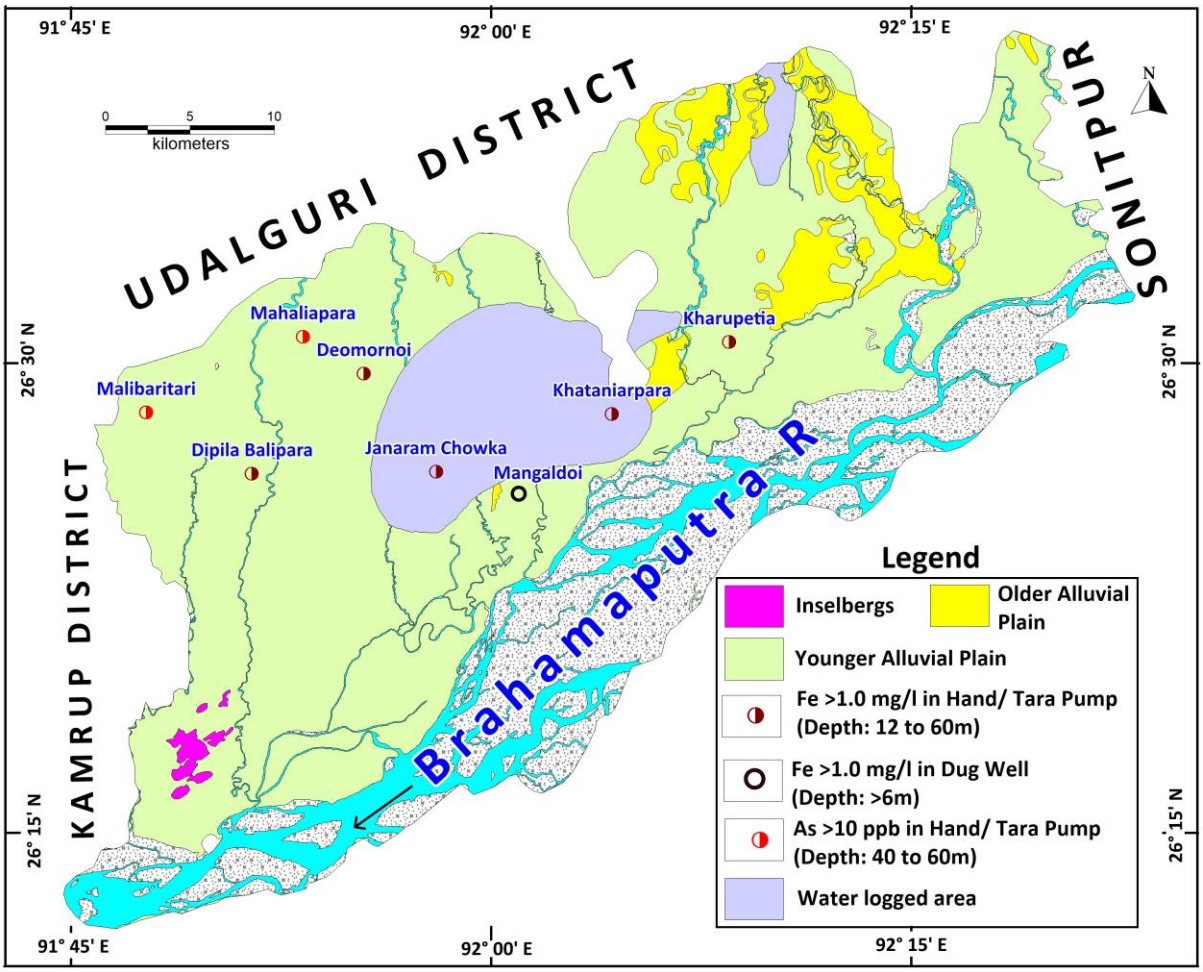


Fig. 5.2 Issues related to water quality in Darrang distict

In general most of the samples of dug wells iron concentration is within limit, but samples from Hand pump and Tara pump shows iron concentration are more than permissible limit. In pre-monsoon GW samples iron above permissible limit is found within 1.71 to 3.27mg/l range while in post-monsoon iron concentration ranges between 1.04 to 6.29 mg/l. High iron concentration is generally observed in the younger alluvial plain and also in water logged area.

Arsenic contamination:

During aquifer mapping pre and post monsoon ground water samples were collected for Arsenic and submitted in NABL accredited Regional Chemical Laboratory of Central Ground water Board, Guwahati.

Arsenic above permissible limit are found in GW samples collected from Hand & Tara pump at Mahaliapara & Malitaribari village. As> 10 ppb were found in NW part of the district in younger alluvial plain (Fig. 5.2).

PHED, Darrang Division carried out water testing in its laboratory. 238 ground water samples collected from Tara pump, shallow hand pump, and hand tube well were analysed and results shows that arsenic concentration ranges from 20 to 50ppb.

Arsenic and iron are geogenic contamination with probable source in younger alluvium which is deposited under reducing environment.

CHAPTER 6.0

Management Strategy

The major aquifer in the district is younger alluvium and the dynamic GW resource of the district is 42686.12ham. Although the stage of groundwater extraction of the district is nearly 42% and nearly 40% of net sown area is under mono-cropped condition, deeper water level condition is noticed in some pockets. The deeper water level condition is mainly attributed by increased groundwater extraction in those areas.

Existing cropping pattern and rainfall of the district: It is observed that more than 60% of net sown area of the district is under multiple cropping system whereas nearly 40% of the net sown area is under mono-cropping system (Fig. 6.1).

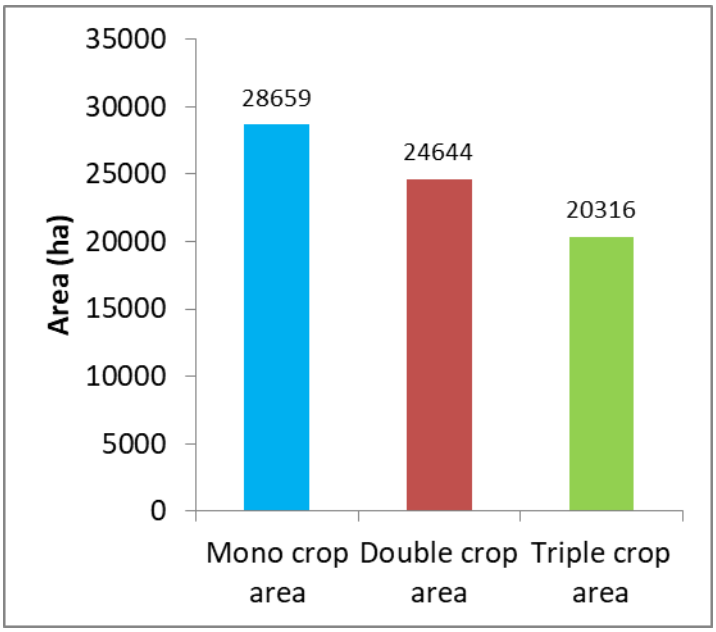


Fig. 6.1: Division of net sown area based on cropping pattern

Table 6.1: Rainfall during different season

Season	Normal RF (mm)	Rainfall 2019 (mm)
Pre-monsoon (Jan-May)	595.2	540.8
Monsoon (June-Sept)	1257.1	368.9
Post-monsoon (Oct-Dec)	139	74.5

In the district winter, autumn and summer rice are cultivated in large scale. Besides rice vegetables, mustard, pulses, etc., are also cultivated in double and triple cropped areas. An attempt is made to determine the precipitation deficit of different crops in FAO's (Food & Agricultural Organisation) CROPWAT software using normal and 2019 rainfall.

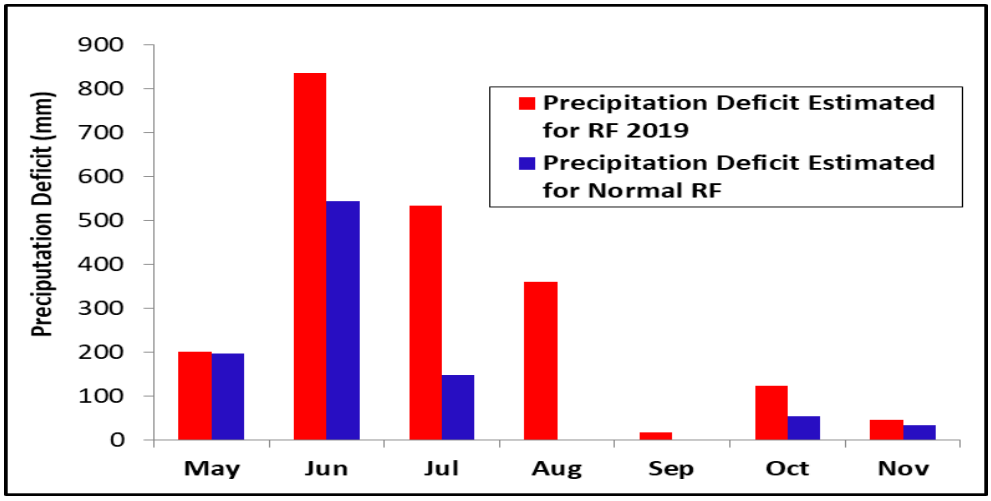


Fig. 6.2a: Comparison of Precipitation Deficit: Winter Paddy

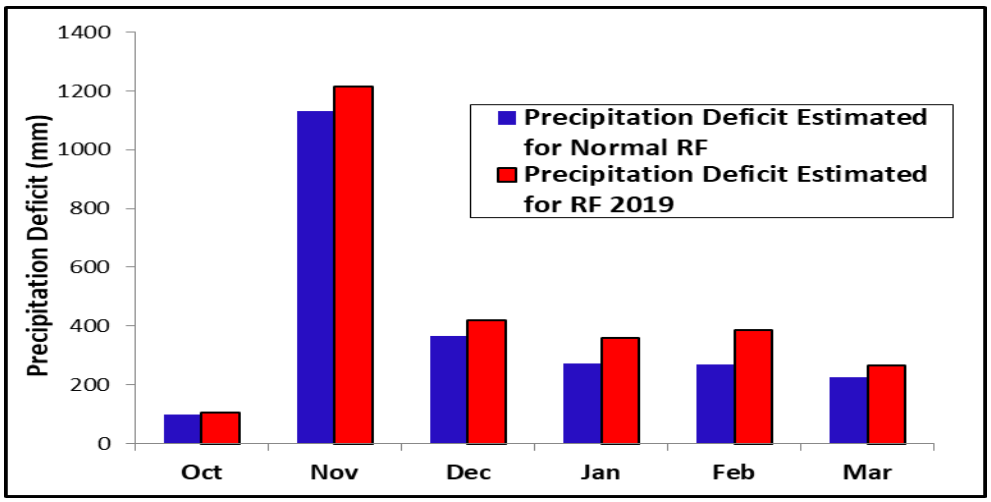


Fig. 6.2b: Comparison of Precipitation Deficit: Summer Paddy

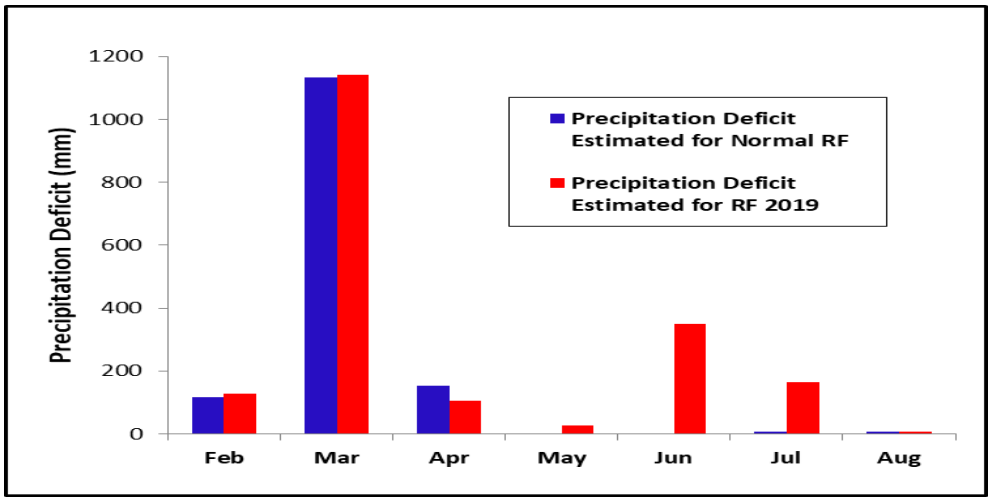


Fig. 6.2c: Comparison of Precipitation Deficit: Autumn Paddy

Table 6.2: Precipitation deficit calculated based on rainfall 2019

Crop	Summer	Kharif	Rabi	Total Precipitation Deficit (mm)
Winter Paddy	200.6	1747.6	170.6	2118.8
Summer Paddy	1011.7	0	1742.1	2753.8
Autumn Paddy	1403.8	520.6		1924.4
Mustard	626.4	3.2	411.8	1041.4
Pulses	0	5.9	411.8	417.7
Kharif Veg	197.9	0	511.9	709.8
Rabi Veg	197.9	0	511.9	709.8

Table 6.3: Precipitation deficit calculated based on normal rainfall

	Precipitation Calculated based on normal rainfall			
Crop	Summer	Kharif	Rabi	Total Precipitation Deficit (mm)
Winter Paddy	196.2	691.6	86	973.8
Summer Paddy	766.1	0	1594.3	2360.4
Autumn Paddy	1404	14.7		1418.7
Mustard	494	3.2	306.7	803.9
Pulses	0	4.6	288.9	293.5
Kharif Veg	3.2	6.8	0	10
Rabi Veg	151.2	0	389.3	540.5

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

1. From Fig. 1.6, it is observed that there is huge deficit of rainfall during monsoon and post-monsoon seasons during 2019. Estimation of precipitation deficit of different crops clearly shows that rainfall during 2019 or even normal rainfall of the district could not sustain existing cropping pattern.
2. **Critical analysis of RF vs. cropping pattern indicates summer paddy cultivation is entirely dependent on irrigation. A bad monsoon season can hamper autumn paddy cultivation also**.

3. However, oilseeds, maize, vegetable cultivation during rabi and summer seasons after harvesting of winter paddy may be a sustainable cropping pattern.
4. A sustainable cropping pattern on one side increase the productivity of land, boost economic condition of farmers and on the other hand optimize the groundwater extraction.
5. The proposed plan intends to bring 28659ha rice fallow land (mono-cropped area) under assured irrigation during Rabi season which will help to increase the cropping intensity of the mono-cropped area as well as district to 200%.

Management of resources for un-irrigated area: The crop water requirement for un-irrigated area of the district is estimated based on soil condition, flooding and geomorphic classification. The cropping pattern proposed in this management plan for rabi season have been selected based on discussion with agriculture department, Darrang District and with other stakeholders**.**

The water demand of agricultural sector to provide assured irrigation potentiality to un-irrigated areas is calculated using Cropwat 8.0 software of FAO (Table 6.3).

Table 6.3: Water requirement for un-irrigated areas of Darrang district, Assam

Pulses-Winter Rice-Potato/Vegetables/Wheat	Present Cultivated area (ha)	Area to be cultivated (%)	Area to be cultivated (ha)	Irrigation requirement (ha m)
Cultivated Area	28659			
	1	2 (= % of 1)	3	4
Rice (main crop)	28659		28659	
Winter Rice (main crop)	28659	50	28659	6274.03
Maize		10	5731.8	300.07
Oilseed		10	5731.8	730.98
Winter vegetables		10	5731.8	625.63
Summer vegetables		10	5731.8	72.54
Potato		10	5731.8	581.52
		50	28659	8584.80
Total		100	57318	
Net cultivated area	28659	57318	28659	
Gross cultivated area (Paddy + Maize +Winter vegetable + Summer vegetable + Mustered + Potato)	28659		57,318	
Total irrigation requirement (70% irrigation efficiency)				12264
Cropping intensity	100		200% (Intended)	

Table 6.4: Crop-wise and month-wise precipitation deficit (IWR) from CROPWAT 8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit (mm)												
1. Rice	0	0	0	0	49.1	148.8	0	0	0	6.4	0	0
2. Rice	0	0	0	0	0.5	146.5	0	0	0	3.9	0	0
3. Rice	0	0	0	0	0	147.1	50.6	0	0	16.2	2.7	0
4. Rice	0	0	0	0	0	49.1	148.6	0	0	20	17.7	0
5. MAIZE	54.4	32.3	0	0	0	0	0	0	0	0	15.3	55.9
6. MAIZE	0	0	0	1.3	0	0	0	2.8	0	0	0	0
7. Mustard	42.3	49.6	48.6	7.9	0	0	0	0	0	0	37.2	50.6
8. Mustard	42.3	49.6	48.6	7.9	0	3.2	0	0	0	0	15.8	44.7
9. Small Vegetables	18.2	0	0	0	0	0	0	0	0	3.8	47	57.3
10. Small Vegetables	48.9	22.9	0	0	0	0	0	0	0	0	29.5	49.3
11. Small Vegetables	0	0	20	2.8	0	6.9	0	0	0	0	0	0
12. Small Vegetables	0	0	10.2	0	0	6.9	0	0	0	0	0	0
13. Potato	54.3	60.7	23.7	0	0	0	0	0	0	0	18.7	40.7
14. Potato	51.5	63.2	38.1	0	0	0	0	0	0	0	9.8	32

Table 6.5: Actual monthly water requirement for different crops in Darrang district, Assam

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Crop wise Total IWR (Ham)
1. Rice	0	0	0	0	422.15	1279.34	0	0	0	55.025	0	0	1756.515
2. Rice	0	0	0	0	4.29	1259.56	0	0	0	33.53	0	0	1297.38
3. Rice	0	0	0	0	0	843.15	435.044	0	0	92.85	23.21	0	1394.254
4. Rice	0	0	0	0	0	281.43	1277.62	0	0	114.63	152.18	0	1825.86
1. MAIZE (Grain)	54.4	32.3	0	0	0	0	0	0	0	0	43.85	160.2	290.75
2. MAIZE (Grain)	0	0	0	1.3	0	0	0	8.02	0	0	0	0	9.32
3. Mustard	42.3	49.6	48.6	7.9	0	0	0	0	0	0	106.61	145.01	400.02
4. Mustard	42.3	49.6	48.6	7.9	0	9.17	0	0	0	0	45.28	128.1	330.95
5. Small Vegetables	18.2	0	0	0	0	0	0	0	0	10.89	134.69	164.21	327.99
6. Small Vegetables	48.9	22.9	0	0	0	0	0	0	0	0	84.54	141.28	297.62
7. Small Vegetables	0	0	20	2.8	0	19.77	0	0	0	0	0	0	42.57
8. Small Vegetables	0	0	10.2	0	0	19.77	0	0	0	0	0	0	29.97
9. Potato	54.3	60.7	23.7	0	0	0	0	0	0	0	53.59	116.64	308.93
10. Potato	51.5	63.2	38.1	0	0	0	0	0	0	0	28.08	91.71	272.59
Month wise crop water requirement	311.9	278.3	189.2	19.9	426.4	3712.2	1712.7	8.02	0	306.93	672.0	947.15	8584.719
Gross irr. Requirement with 70% irr. Efficiency	445.57	397.57	270.29	28.43	609.2	5303.13	2446.66	11.46	0	438.46	960.04	1353.0	12263.88

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 and State Govt. tapping 15 to 35m in shallow alluvial aquifer varies from 12 to 45m^3/hr. It is expected that tube wells of 50m depth tapping 15 m of granular zones of the shallow alluvial aquifer can yield 20 to 40 m^3/hr. If the well is allowed to run 8hrs a day for 120days then a tube well having discharge of 40 m^3/hr will extract 3.84 ham groundwater annually.

Total numbers of shallow tube wells require to construct in the district to fulfil the irrigation requirement of **12264** ham, is found to be 3194 nos. On the other hand consideration of safe distance of 200m permits to construct 7165 numbers of shallow tube wells in the un irrigated area of 286.59 sq km area.

Drilling: Direct Rotary Rig is useful for drilling in the alluviual area down to depth of 300 m. a tube well tapping 15 to 30m granular zone can expected to yield 45 to 270m3 /hr. Tube wells can be constructed by using 8" dia. Housing pipe down to 30 m.

Shallow Tube wells can be designed within a depth of 50m. A tube well tapping 12m granular zone can expected to yield 20 to 40m^3 /hr.

Extraction of **12264**ham of groundwater will increase the stage of groundwater extraction to 70.83%. However, the stage of groundwater extraction can be kept below 70%, if the potential resource of the district is utilized for irrigation. Shallow tube wells can be constructed to extract 7066 Ham of potential resource to lower the water level to 5mbgl. Dug well can also be constructed for irrigation purposes.

Aquifer wise availability of unsaturated zone:

To identify areas for artificial recharge, post-monsoon depth-to-water level map has been prepared (Fig. 6.2 & 6.3). For this purpose, depth-to-water level contour maps are prepared based on post-monsoon water level of the key wells of Darrang District, Assam. It is observed that in few villages (Konakotapara, Bihdia, etc.) under Dalgaon block, post monsoon DTW (8.0 to 9.0 mbgl) is more than the district average WL (3.3mbgl) (Fig. 5.1).

The availability of unsaturated zone is worked out as follows:

- Average WL (>5m): 8.66m;
- Area (5m WL contour): 1611ha
- Unsaturated zone thickness (below 5m): 3.66m

Volume of sub-surface storage space available for recharge= Area (5m WL contour) X Specific yield= 3.66m x 1611 x 0.12=707.55ham or 7.08MCM

= (7.08x100)/0.7 m^3 or 10.11MCM (Considering 70% efficiency of recharge structure).

- Presence of top clay layer is evident from aquifer disposition and also number of ponds/tanks in the area indicates the existence of clay layer.

Clay layers impede downward movement of water. Therefore, recharge shafts may be constructed in the village ponds to facilitate recharge to groundwater. Recharge shaft may be lined or unlined. Unlined shaft need to be back filled with permeable materials.

Arsenic pollution: Arsenic above permissible is found in groundwater samples collected from shallow aquifer at Malibaritari and Mahaliapara villages (Table 6.6). However, GW samples collected from CGWB's deep EW at Malibaritari indicate that both As and Fe are within permissible limit. Deep TW can be constructed tapping zones below 100m for domestic use (Table 6.6).

Table 6.6: Comparison of arsenic and iron contamination in shallow and deeper aquifers and arsenic free zones in deeper aquifer in Darrang district, Assam

Location	Source			Zones tapped
	Dug Well	Hand Pump	Deep TW	
Malitaribari	Pre-monsoon Fe: 2.02	Pre-monsoon Fe: 2.47	Fe: 0.8	88-91, 108-111, 117-120, 148-151,177-180,233-236,243-246,259-262, 272-275, 279-282
	Post-monsoon Fe: 0.19	Post-monsoon Fe: 6.04		
		Arsenic (Pre-monsoon) :10.296 ppb	As: 7 ppb	
		Arsenic (Post-monsoon): 13.313 ppb		
Mahaliapara		Pre-monsoon Fe: 2.44		
		Post-monsoon Fe: 5.55		
		Pre-monsoon As: 30.4 ppb		
		Post-monsoon As: 27.78 ppb		

Therefore tube wells can be constructed down to a depth of 50m 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 utilize 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

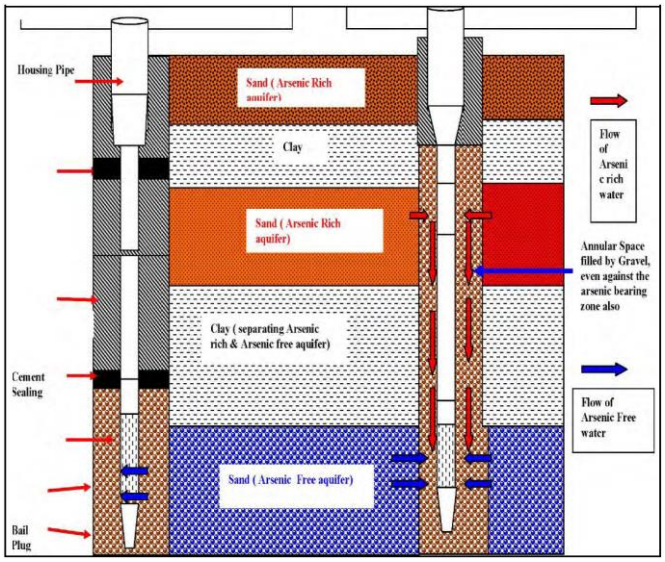


Fig.6.3: Tube-well design of a deep tube well tapping safe deeper aquifer

(Source: Concept note on geogenic contamination of groundwater in India)

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.

The general slope of the area is towards southwest. The slope is greater in alluvium area of north eastern part of the district than in the flood plain. Therefore water logging condition is observed in the flood plain, alluvial plain area. Therefore 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

(i) reducing convenience loss

(ii) improving water application efficiency

Following demand side interventions will increase water use efficiency

1) 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 systems convey water in small quantities through drippers/micro-tubes while sprinklers are pressurized systems where a fountain or spray of water is released by the sprinkler connected by pipes, resulting in foliar irrigation. Drip irrigation can increase crop yield per hectare and also saves water up to 70% than conventional irrigation.

2) Water loss through supply canals can be minimized by proper lining in the canals.

3) 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.

International Rice Research Institute (IRRI) has developed a simple tool to help farmers make decisions on when to irrigate. They found that when field water level recedes to 15 cm below the soil surface, soil water tension in the root zone is always <10 kPa, ensuring good yield. Thus a practical way to implement safe AWD is to monitor the depth of ponded water using a field water tube/ pipe This tube can be made of plastic pipe or bamboo 30 cm long and 15 cm or more in diameter and having perforations on all sides (Fig. 6.2). After transplanting, farmers would keep the field submerged for about 2 weeks to suppress weed growth. The tube is then inserted into the soil by leaving 10 cm above the soil surface. Soil inside the tube is then taken out.

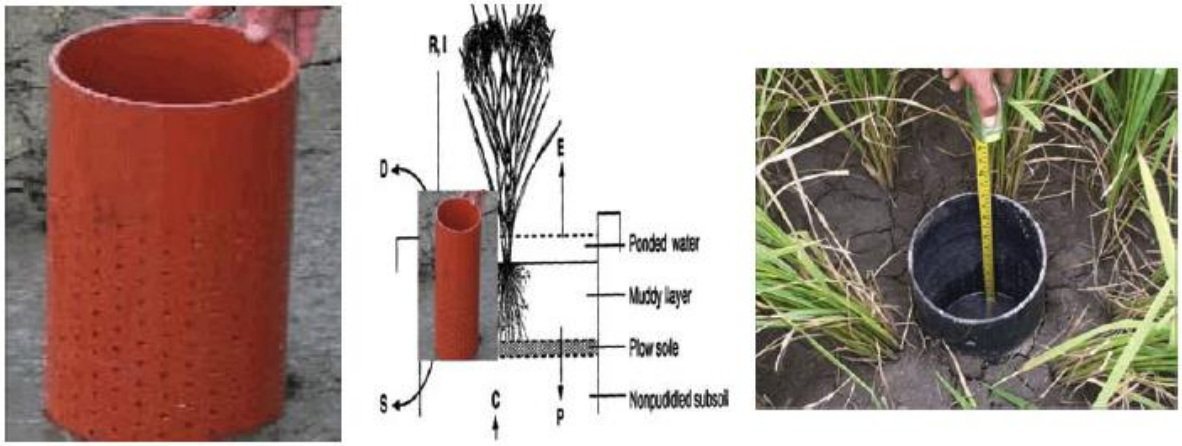


Fig. 6.4: A simple perforated pipe (water tube) installed in the rice field allows farmer to monitor water level beneath the soil surface (Kulkarni, 2011)

4) Reduce losses of water during leveling: As per Food Agriculture Organization, 200mm of water per hectre is required to level the rice field by traditional method. However, use of laser land leveler help in fine leveling of rice field by eliminating unnecessary depression and elevated contour. It saves 40 to 50% water. A uniformly leveled field allows uniform spreading of irrigated water. It is reported that in Punjab 100% use of laser land leveler in the existing cropping pattern (rice-wheat) can prevent 19cm groundwater draft in entire state (Aggarwal, et. al., 2010)

Stress aspect future demand:

Stress on aquifer due to drinking water supply: The population of the study area has been projected based on 2011 census data up to 2025. Based on this projected population drinking water demand of the area is calculated.

There will be surplus of supply in domestic demand considering groundwater 85% dependency on groundwater.

Irrigation:

The additional withdrawal of water may not adversely affect the ground water regime of the area as major portion of the area is under shallow water table condition.

Following recommendations are suggested

1) 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.

2) Rainwater harvesting should be encouraged. During rabi season the conserved water can be drained to paddy field through gravity.

Annexure I

Table: 1 a. Concentration range of chemical constituents in groundwater (Pre Monsoon)

Block wise Pre monsoon Chemical Quality data of Darrang district, Assam																	
Block	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS (mgL^{-1})	CO_3^{-2} (mgL^{-1})	HCO_3^{-} (mgL^{-1})	TA (as $CaCO_3$) (mgL^{-1})	Cl^{-} (mgL^{-1})	SO_4 (mgL^{-1})	NO_3^{-} (mgL^{-1})	F^{-} (mgL^{-1})	Ca^{+2} (mgL^{-1})	Mg^{+2} (mgL^{-1})	TH (as $CaCO_3$) (mgL^{-1})	Na (mgL^{-1})	K (mgL^{-1})	Fe (mgL^{-1})
Dolgaon-Sialmari	7.88 - 8.15	133.3 - 810.5	BDL - 0.1	69.32 - 423.4	BDL	61.04 - 140.41	61.04 - 140.41	24.81 - 170.16	23.37 - 61.09	BDL - 11.87	0.23 - 0.27	10.0 - 16.01	4.84 - 46.1	54.99 - 230	23.06 - 69.45	7.96 - 27.63	0.16 - 0.31
Pachim-Mangaldai (Part)	8.09 - 8.59	118.5 - 888.5	BDL - 0.1	61.27 - 461.3	BDL - 24	91.57 - 463.9	91.57 - 487.97	10.63 - 155.98	22.1 - 5.21	BDL - 0.21	0.34 - 0.5	8.0 - 10.0	8.49 - 71.59	54.99 - 320	15.93 - 89.53	1.92 - 53.62	2.29 - 2.98
Pub-Mangaldai (Part)	7.77 - 8.17	223.9 - 532.5	BDL - 0.4	116.1 - 296.3	BDL - 12	103.78 - 189.25	103.78 - 189.25	35.45 - 131.16	0.33 - 70.10	BDL	0.26 - 42	10.0 - 22.01	4.84 - 33.97	50 - 165	17.8 - 87.82	4.52 - 43.91	0.24 - 3.27
Sipajhar	7.42 - 8.51	76.66-635.4	0 - 0.3	38.39-321.5	BDL-27	48.83 - 409.02	48.83 - 436.02	10.63 - 116.98	2.66 - 59.51	BDL - 2.32	0.17 - 1.1	6.00 - 34.02	3.63 - 65.52	30 - 310	9.1 - 89.07	1.45 - 35.66	0.76 - 2.43

Table: 1 b. Concentration range of chemical constituents in groundwater (Post Monsoon)

Block wise Post monsoon Chemical Quality data of Darrang district, Assam																	
Block	pH	EC (µs/cm) 25C	Turbidity (NTU)	TDS (mgL^{-1})	CO_3^{-2} (mgL^{-1})	HCO_3^{-} (mgL^{-1})	TA (as $CaCO_3$) (mgL^{-1})	Cl^{-} (mgL^{-1})	SO_4^{-2} (mgL^{-1})	NO_3^{-} (mgL^{-1})	F^{-} **(mgL^{-1})**	Ca^{+2} (mgL^{-1})	Mg^{+2} (mgL^{-1})	TH (as $CaCO_3$) (mgL^{-1})	Na (mgL^{-1})	K (mgL^{-1})	Fe (mgL^{-1})
Bechimari (Part)	6.65	277.60	BDL	161.30	BDL	65.05	65.05	42.54	8.08	5.28	1.20	10.01	13.34	80.00	16.11	19.02	1.29
Dolgaon-Sialmari	6.34-8.41	104.6 - 566.7	BDL - 0.4	60.75 - 328.5	BDL - 50.0	45.04 - 145.16	45.04 - 195.16	17.73 - 124.08	7.43 - 36.14	BDL - 6.81	0.07 - 0.94	8.01 - 20.02	7.28 - 30.33	60 - 175	4 - 56.6	2.85 - 41.34	0.01 - 6.29
Pachim-Mangaldai (Part)	7.94 - 8.40	104.7 - 845.2	BDL - 0.1	62.1 - 494.2	BDL - 50.0	70.06 - 170.18	70.06 - 220.18	7.09 - 184.34	2.76 - 11.7	BDL - 7.69	0.34 - 0.57	10.01 - 22.02	7.28 - 47.32	55 - 250	9.2 - 69.72	1.17 - 37.57	0.03 - 5.68
Pub-Mangaldai (Part)	6.41 - 8.33	211 - 617.6	0 - 0.1	123.2 - 362.2	BDL - 40.0	65.05 - 130.14	65.05 - 170.14	31.91 - 152.44	4.67 - 25.41	BDL - 1.79	0.29 - 1.1	10.01 - 18.01	12.13 - 41.25	75 - 215	12.85 - 56.81	2.92 - 28.56	BDL - 13.1
Sipajhar	6.45 - 8.37	97.84 - 675.2	BDL - 0.1	9.4 - 122.9	BDL - 60.0	25.02 - 210.22	25.02 - 270.22	7.09 - 109.9	3.42 - 35.9	BDL - 7.70	0.18 - 1.3	4.0 - 20.02	2.42 - 100	35 - 335	3.31 - 38.98	1.29 - 24.27	0.14 - 6.19

Table: 1 C. List of Arsenic affected villages (0.01ppm & above), Darrang district, Assam (PHED) Mangaldoi, PHED, August, 2016

SNo	District Name	Block Name	Panchayat Name	Village Name	Habitation Name	As (in ppm)
1	Darrang	BECHIMARI (PART)	DALGAON	DALGAON TOWN	DALGAON TOWN	0.02
2	Darrang	BECHIMARI (PART)	CHAKARABASTI KHOIRAKATA	CHIKONMATI BAGICHA	CHIKON MATI BAGICHA	0.02
3	Darrang	DALGAON-SIALMARI (PART)	KALYAN	SIALMARI NEPALI	SIALMARI NEPALI GAON	0.02
4	Darrang	DALGAON-SIALMARI (PART)	KOPATI	KOUPATIGRANT (NO.2 KOUPATIGRANT)	PUB CHUBA	0.02
5	Darrang	DALGAON-SIALMARI (PART)	SHYAMPUR	BILPAR	PACHIM CHUBA	0.06
6	Darrang	PUB MANGALDOI (PART)	BALABARI	NO.2 THEKERABARI	PUB CHUBA	0.02
7	Darrang	PUB MANGALDOI (PART)	BALABARI	JOGIPARA	JUGI PARA	0.04
8	Darrang	PUB MANGALDOI (PART)	BANDIA	BAGHPORI CHAPORI	PUB MUSLIM CHUBA	0.02
9	Darrang	PUB MANGALDOI (PART)	BANDIA	BAGHPORI CHAPORI	BIHARI BASTI	0.02
10	Darrang	PUB MANGALDOI (PART)	BANDIA	BAGHPORI CHAPORI	BAGHPORI MAJOR MUSLIM CHUBA	0.02
11	Darrang	PUB MANGALDOI (PART)	BANDIA	BANDIA GAON	PACHIM SARKAR CHUBA	0.03
12	Darrang	PUB MANGALDOI (PART)	DHULA	PANIAKHAT	PUB CHUBA (PANIA KHAT)	0.02
13	Darrang	PUB MANGALDOI (PART)	DHULA	NO.1 GARAPARI CHAPORI	PUB CHUBA (NC GARAPARI)	0.02
14	Darrang	PUB MANGALDOI (PART)	KHATANIAPARA	KHATANIAPARA	PUB CHUBA	0.02
15	Darrang	PUB MANGALDOI (PART)	KHATANIAPARA	KHATANIAPARA	MAJOR CHUBA (KHATANIAPARA)	0.02
16	Darrang	PUB MANGALDOI (PART)	KHATANIAPARA	NO.2 MAZGAON	NO 2 MAZ GAON	0.02
17	Darrang	PUB MANGALDOI (PART)	KHATANIAPARA	HIRAPARA	MEDHI PARA	0.06
18	Darrang	PUB MANGALDOI (PART)	KHATANIAPARA	HIRAPARA	HIRAPARA CHUBA	0.03
19	Darrang	PUB MANGALDOI (PART)	MOWAMARI	GERIMARI CHAPORI (CT)	NO 2 GERIMARI	0.02
20	Darrang	PUB MANGALDOI (PART)	MOWAMARI	GERIMARI CHAPORI (CT)	NO 1 GERIMARI	0.02
21	Darrang	PUB MANGALDOI (PART)	MOWAMARI	GANDERI MARI	GENDERI MARI	0.02
22	Darrang	PUB MANGALDOI (PART)	OJHAGAON	NIZ KHARUPETIA	DAKHIN CHUBA	0.02
23	Darrang	PUB MANGALDOI (PART)	PUTHIMARI	ALGACHAR N.C.	ALGA CHAR CHUBA	0.02
24	Darrang	KALAIGAON (Pt)	BHURARGARAH	BAGHARBARI	BAGHARBARI	0.02
25	Darrang	KALAIGAON (Pt)	BHURARGARAH	JHAKUAPARA	UTTAR CHUBA	0.03
26	Darrang	KALAIGAON (Pt)	BHURARGARAH	JHAKUAPARA	RAVA CHUBA	0.02
27	Darrang	KALAIGAON (Pt)	BHURARGARAH	JHAKUAPARA	JAKUAPARA	0.02
28	Darrang	KALAIGAON (Pt)	BHURARGARAH	PARIAPARA	PUB PARIAPARA	0.02
29	Darrang	KALAIGAON (Pt)	BHURARGARAH	PARIAPARA	NADIKASH	0.02
30	Darrang	KALAIGAON (Pt)	BORBAGAN	GRANDLAND BAGICHA	PUB CHUBA	0.02
31	Darrang	KALAIGAON (Pt)	BORBAGAN	GRANDLAND BAGICHA	PACHIM CHUBA	0.03
32	Darrang	KALAIGAON (Pt)	BORBAGAN	GRANDLAND BAGICHA	DAKHIN CHUBA	0.02
33	Darrang	KALAIGAON (Pt)	BORBAGAN	KAWADANGA	NORTH KAWADANGA	0.02
34	Darrang	KALAIGAON (Pt)	BORBAGAN	KAWADANGA	EAST KAWADANGA	0.02
35	Darrang	KALAIGAON (Pt)	BORBAGAN	KAWADANGA	BIJOY LAKSHMI CHUBA	0.02
36	Darrang	KALAIGAON (Pt)	BORBAGAN	BARKALA BAGICHA	MAJOR CHUBA	0.02
37	Darrang	KALAIGAON (Pt)	BORBAGAN	BARKALA BAGICHA	HIRAPARA	0.04

SNo	District Name	Block Name	Panchayat Name	Village Name	Habitation Name	As (in ppm)
37	Darrang	KALAIGAON (Pt)	BORBAGAN	BARKALA BAGICHA	HIRAPARA	0.04
38	Darrang	KALAIGAON (Pt)	LAKHIMPUR	KAWAIMARI	PACHIM KAWAIMARI	0.02
39	Darrang	KALAIGAON (Pt)	LAKHIMPUR	KAWAIMARI	KAWAIMARI	0.02
40	Darrang	KALAIGAON (Pt)	LAKHIMPUR	LAKHIMPUR	LAKHIMPUR (PUB)	0.03
41	Darrang	KALAIGAON (Pt)	LAKHIMPUR	KACHARI PARA	GOSSAI PUKHURI	0.02
42	Darrang	KALAIGAON (Pt)	LAKHIMPUR	KAITH PARA	GOPCHAR CHUBA	0.03
43	Darrang	KALAIGAON (Pt)	LAKHIMPUR	BALIPOTA	BALIPOTA	0.02
44	Darrang	KALAIGAON (Pt)	LAKHIMPUR	BALIPOTA	BALAN CHUBA	0.02
45	Darrang	KALAIGAON (Pt)	NAMKHOLA	BARANGABARI	BHOLKA PARA	0.02
46	Darrang	KALAIGAON (Pt)	OWTALA	KAPILI SATRA	PUB KAPILISATRA	0.02
47	Darrang	KALAIGAON (Pt)	OWTALA	AKALIBARI	METAPARA CHUBA	0.02
48	Darrang	KALAIGAON (Pt)	OWTALA	MATHANGA CHUBURI	MATHANGA CHUBURI	0.02
49	Darrang	KALAIGAON (Pt)	OWTALA	KAMARPARA	KALBARI CHUBA	0.02
50	Darrang	KALAIGAON (Pt)	OWTALA	KAMARPARA	KAKATI CHUBA	0.02
51	Darrang	KALAIGAON (Pt)	OWTALA	KAMARPARA	BARUA PARA	0.02
52	Darrang	KALAIGAON (Pt)	OWTALA	DURGA GAON	KAJOR CHUBA	0.03
53	Darrang	KALAIGAON (Pt)	OWTALA	DURGA GAON	CHAMEHIOPARA	0.02
54	Darrang	KALAIGAON (Pt)	OWTALA	DURGA GAON	BORO CHUBA	0.02
55	Darrang	KALAIGAON (Pt)	OWTALA	BANGABARA CHUBURI	BENGABORA	0.02
56	Darrang	KALAIGAON (Pt)	OWTALA	BECHIMARI	BECHIMARI	0.02
57	Darrang	KALAIGAON (Pt)	OWTALA	BECHIMARI	AROAPARA	0.02
58	Darrang	KALAIGAON (Pt)	OWTALA	AHAKA CHUBURI	AHAKA PUB CHUBA	0.03
59	Darrang	KALAIGAON (Pt)	RAJAPUKHURI	BHER BHERI JHAR	EAST BHERBHERIJHAR	0.02
60	Darrang	KALAIGAON (Pt)	TENGABARI	UDMARI	UTTAR CHUBA	0.02
61	Darrang	KALAIGAON (Pt)	TENGABARI	DAKHIN BOKRAJHAR	PACHIM CHUBA	0.02
62	Darrang	KALAIGAON (Pt)	TENGABARI	BAHJANI	PACHIM BAHJANI	0.02
63	Darrang	KALAIGAON (Pt)	TENGABARI	CHOUDHURI PARA	CHOUDHURI PARA	0.02
64	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	CHENGELIAPARA	PUNIA CHOWK	0.04
65	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	BAINAOJHA PARA	MALO PARA	0.02
66	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	BAINAOJHA PARA	JHAKARA PARA	0.04
67	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	BAINAOJHA PARA	BOINAOJA PARA	0.02
68	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	KUYAPANIPARA	KUYAPANI CHUBA	0.03
69	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	KUYAPANIPARA	KALIA PARA	0.02
70	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	GHATUA PARA	GOSAI CHUBA	0.02
71	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	CHOTO NAGAON	CHOTO NAGAON	0.04
72	Darrang	PACHIM MANGALDOI (PART)	AOULACHOUKA	BARNAGAON	BAR NAGAON CHUBA	0.02
73	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	CHAMUAPARA	SAT GHARIA CHUBA	0.03
74	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	CHAMUAPARA	MUSLIM CHUBA	0.03
75	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	CHAMUAPARA	CHAMUAPARA	0.02
76	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	CHAMUAPARA	BAGA GHARAR CHUBA	0.02
77	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	SALAIPARA	SALOIPARA	0.02
78	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	SALAIPARA	SALOI PARA NO 2	0.02
79	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	SALAIPARA	KULI BASTI	0.02
80	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	SALAIPARA	CHENI BAGISHA	0.02
81	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	ADHIKARI	KAITH PARA	0.02

SNo	District Name	Block Name	Panchayat Name	Village Name	Habitation Name	As (in ppm)
82	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	ADHIKARI	BORIGAON CHUBA	0.03
83	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	ADHIKARI	ADHIKARI	0.02
84	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	ADHAMAPARA	DAKHIN CHUBA	0.02
85	Darrang	PACHIM MANGALDOI (PART)	CHAMUAPARA	BARANGABARI	CHAPARIAL PARA	0.02
86	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	SAIKIAPARA	SAIKIAPARA	0.04
87	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	SAIKIAPARA	KATHPORI CHUBA	0.02
88	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	MEDHIPARA	MEDHIPARA	0.02
89	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	MEDHIPARA	HATI BAKRA	0.02
90	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	MANGALDAI GAON	BEGAR PAR CHUBA	0.03
91	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	MANGALDAI GAON	MANGALDAI GAON	0.03
92	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	GADHIAPARA	GADHIAPARA	0.02
93	Darrang	PACHIM MANGALDOI (PART)	CHAPAI	BEZPARA	BARO CHUBA	0.02
94	Darrang	PACHIM MANGALDOI (PART)	DAHI	BAR - SATRA	MEDHIPARA	0.02
95	Darrang	PACHIM MANGALDOI (PART)	DAHI	NAGAON	DAHI NOWGAON(MEDHI PARA)	0.02
96	Darrang	PACHIM MANGALDOI (PART)	JALJALI	SARENG CHUBURI	SARENG (MAJ GAON)	0.02
97	Darrang	PACHIM MANGALDOI (PART)	JALJALI	JOGIPARA	DALKONA	0.03
98	Darrang	PACHIM MANGALDOI (PART)	JALJALI	JHARGAON	BHEBELAPARA	0.03
99	Darrang	PACHIM MANGALDOI (PART)	JANARAMCHOUKA	KABIKARA (KALIKARA)	SANTI PUR	0.03
100	Darrang	PACHIM MANGALDOI (PART)	JANARAMCHOUKA	KABIKARA (KALIKARA)	SALOIPARA	0.02
101	Darrang	PACHIM MANGALDOI (PART)	JANARAMCHOUKA	PAKABANGIPARA	PAKABANGI PARA	0.03
102	Darrang	PACHIM MANGALDOI (PART)	JANARAMCHOUKA	GAKHIR KHOWA PARA	PAGALA PARA CHUBA	0.03
103	Darrang	PACHIM MANGALDOI (PART)	JANARAMCHOUKA	BARATHIABARI	KAMALA PARA	0.02
104	Darrang	PACHIM MANGALDOI (PART)	JANARAMCHOUKA	KEOT PARA	GANAK PARA	0.02
105	Darrang	PACHIM MANGALDOI (PART)	JANARAMCHOUKA	PATALSINGPARA	DOKAN PARA	0.02
106	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	MOHANPUR	SARU ARENG	0.02
107	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	MOHANPUR	HOWLY MOHANPUR	0.04
108	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	MOHANPUR	BAR ARENG	0.02
109	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	MOLLAPARA	MOLLAPARA	0.04
110	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	HENGERAJHAR	MAUTPARA	0.03
111	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	HENGERAJHAR	HENGRAJHAR RAJA HOWLY	0.03
112	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	KANAI CHUBA (KANIA PARA)	KANAICHUBA	0.02

SNo	District Name	Block Name	Panchayat Name	Village Name	Habitation Name	As (in ppm)
113	Darrang	PACHIM MANGALDOI (PART)	NAGARBAHI	NO.2 BEZPARA	BEZPARA NO 2	0.04
114	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	RAMHARI CHUBA	RAMHARI CHUBA	0.02
115	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	RAMHARI CHUBA	MONGALBECHA	0.02
116	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	DEWANAGAON	PUB DEONAGAON	0.04
117	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BOLOGARATUK	MAROI CHUBA	0.02
118	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BOLOGARATUK	MAJOR CHUBA	0.04
119	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BOLOGARATUK	JHAR PARA	0.04
120	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BOLOGARATUK	BALOPARA TOOK	0.02
121	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	MAZ CHUBURI	MAJA CHUBURI	0.04
122	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	KACHOMARI	KACHOMARI	0.03
123	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	KACHOMARI	GAON BURHA CHUBA	0.04
124	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	DAHA CHUBURI	JOHAIPARA	0.02
125	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	DAHA CHUBURI	HAZARIKA PARA	0.02
126	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	DAHA CHUBURI	DAHA CHUBURI	0.04
127	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	DAHA CHUBURI	BENGALI CHUBA	0.04
128	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	JABERIKUCHI	JABERIKUCHI	0.02
129	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BARAMPUR	CHITKA CHUBA	0.04
130	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BARAMPUR	CHANDOWAL PARA	0.03
131	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BARAMPUR	BASU CHUBA	0.03
132	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BARAMPUR	BARO CHUBA	0.02
133	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BARAMPUR	BARAMPUR	0.04
134	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	BARAMPUR	BAKALI CHUBA	0.02
135	Darrang	PACHIM MANGALDOI (PART)	RAMHARI	DEKARGAON	ALIKASH CHUBA	0.02
136	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	SARUTHEKERABARI	SAIKIAPARA CHUBA	0.02
137	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	SARUTHEKERABARI	MUSLIM CHUBA PACHIM	0.02
138	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	SARUTHEKERABARI	MONOHAR CHUBA	0.02
139	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	NO.1 BANGALPOTA	NO 1 BANGALPOTA	0.03
140	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	NIZ RANGAMARI	NIZ RANGAMATIPARA CHUBA	0.03
141	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	DARIA PARA	MANTAPARA	0.02
142	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	DARIA PARA	DARIA PARA	0.02
143	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	BARTHEKERA BARI	DHAN KHUNDA	0.03

SNo	District Name	Block Name	Panchayat Name	Village Name	Habitation Name	As (in ppm)
144	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	BARTHEKERA BARI	BAR THEKERABARI CHUBA	0.02
145	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	BHOKELIMARA DAL	BHUKELIMARA DAL	0.02
146	Darrang	PACHIM MANGALDOI (PART)	RANGAMATI	BHALUK KHOWA PARA	BHALUKKHOWA PARA	0.02
147	Darrang	PACHIM MANGALDOI (PART)	ROWMARI	NO.1 BOROLEKHAITI	NO 1 BARALAKHAITI	0.03
148	Darrang	PACHIM MANGALDOI (PART)	UPAHUPARA	UPAHUPARA	UPAHUPARA	0.03
149	Darrang	PACHIM MANGALDOI (PART)	UPAHUPARA	KOWAR PARA	KONWAR PARA	0.02
150	Darrang	PACHIM MANGALDOI (PART)	UPAHUPARA	BAMUNPARA	BAMUNPARA	0.02
151	Darrang	SIPAJHAR (PART)	BARAMPUR	SARABARI BARAMPUR	SARABARI BARAMPUR	0.02
152	Darrang	SIPAJHAR (PART)	BARAMPUR	SARABARI BARAMPUR	GHILAKURI	0.03
153	Darrang	SIPAJHAR (PART)	BARAMPUR	GHILAKURI	PUB GHILAKURI	0.04
154	Darrang	SIPAJHAR (PART)	BARAMPUR	GHILAKURI	PACHIM GHILAKURI	0.04
155	Darrang	SIPAJHAR (PART)	BARAMPUR	GHILAKURI	DAKHIN GHILAKURI	0.02
156	Darrang	SIPAJHAR (PART)	BARAMPUR	GHILAKURI	BORA TARI	0.04
157	Darrang	SIPAJHAR (PART)	BARAMPUR	NIZ-BARAMPUR	NIZ BARAMPUR	0.03
158	Darrang	SIPAJHAR (PART)	BARAMPUR	NIZ-BARAMPUR	MAJORTARI	0.03
159	Darrang	SIPAJHAR (PART)	BARAMPUR	ATHKURIA	NATUN TARI	0.03
160	Darrang	SIPAJHAR (PART)	BARAMPUR	ATHKURIA	NANOIKASH	0.04
161	Darrang	SIPAJHAR (PART)	BARAMPUR	ATHKURIA	MAULABI CHUBA	0.03
162	Darrang	SIPAJHAR (PART)	BARAMPUR	ATHKURIA	GHOPELI	0.03
163	Darrang	SIPAJHAR (PART)	BARAMPUR	ATHKURIA	ATHKURIA (BORA TARI)	0.04
164	Darrang	SIPAJHAR (PART)	BARAMPUR	BANEIKUCHI	CHENGMARI CHUBA	0.02
165	Darrang	SIPAJHAR (PART)	BAZNAPATHAR	TEKELIAKUR GRANT	TEKELIAKUR GRANT	0.03
166	Darrang	SIPAJHAR (PART)	BAZNAPATHAR	BAMAN PATHAR	HIRABARI	0.03
167	Darrang	SIPAJHAR (PART)	BAZNAPATHAR	BAJANA PATHAR	BAZNA PATHAR	0.03
168	Darrang	SIPAJHAR (PART)	BAZNAPATHAR	BAMAN PATHAR	BAMAN PATHAR	0.03
169	Darrang	SIPAJHAR (PART)	BAZNAPATHAR	BAMAN PATHAR	ASSAMIA CHUBA	0.03
170	Darrang	SIPAJHAR (PART)	BOONMAJHA	HANGALPARA	NADIRTARI CHUBA	0.02
171	Darrang	SIPAJHAR (PART)	BOONMAJHA	HANGALPARA	HENGALPARA MAIN	0.04
172	Darrang	SIPAJHAR (PART)	BOONMAJHA	BORIGAON	MAZ CHUBA	0.02
173	Darrang	SIPAJHAR (PART)	BOONMAJHA	BORIGAON	BARIGAON BURHA CHUBA	0.02
174	Darrang	SIPAJHAR (PART)	BOONMAJHA	BARBARI	MAZ CHUBA	0.02
175	Darrang	SIPAJHAR (PART)	BOONMAJHA	SALIKAJHAR	ASAN CHUBA	0.02
176	Darrang	SIPAJHAR (PART)	BURHINAGAR	RAMGAON	RAMGAON (BORAKASH)	0.03
177	Darrang	SIPAJHAR (PART)	BURHINAGAR	RAMGAON	MANDALPARA	0.02
178	Darrang	SIPAJHAR (PART)	BURHINAGAR	RAMGAON	LALTUPARA	0.03
179	Darrang	SIPAJHAR (PART)	BURHINAGAR	SANAPATIPARA (SENTIPUKHURI)	PACHIM SENAPATIPARA	0.02
180	Darrang	SIPAJHAR (PART)	BURHINAGAR	MOHALIAPARA	MAHALIAPARA (SIBIPARA)	0.03
181	Darrang	SIPAJHAR (PART)	BURHINAGAR	MOHALIAPARA	DISHPUR	0.03
182	Darrang	SIPAJHAR (PART)	BURHINAGAR	BARERI	GAR GOPA	0.02
183	Darrang	SIPAJHAR (PART)	BURHINAGAR	BARERI	BARERI	0.02
184	Darrang	SIPAJHAR (PART)	BYASPARA	KHATIKUCHI	KEHERA	0.02
185	Darrang	SIPAJHAR (PART)	DEBANANDA	DEBANANDA SATRA	TILA CHUBA	0.03
186	Darrang	SIPAJHAR (PART)	DEBANANDA	DEBANANDA SATRA	KHILA PAM	0.03
187	Darrang	SIPAJHAR (PART)	DEBANANDA	DEBANANDA SATRA	KHAT CHUBA	0.03
188	Darrang	SIPAJHAR (PART)	DEBANANDA	DEBANANDA SATRA	KARHAPARA	0.03
189	Darrang	SIPAJHAR (PART)	DEBANANDA	DEBANANDA SATRA	DHOJA CHUBA	0.03
190	Darrang	SIPAJHAR (PART)	DEBANANDA	DEBANANDA SATRA	DEBANANDA	0.03
191	Darrang	SIPAJHAR (PART)	DEBANANDA	DEBANANDA SATRA	BHELABARI	1.21
192	Darrang	SIPAJHAR (PART)	DEBANANDA	RUPERI KASH	RUPAHI KASH	0.02
193	Darrang	SIPAJHAR (PART)	DEBANANDA	NIZSIPAJHAR	NIZ SIPAJHAR	0.02
194	Darrang	SIPAJHAR (PART)	DEBANANDA	BORA CHUBA	PACHIM CHUBA	0.02
195	Darrang	SIPAJHAR (PART)	DEBANANDA	BORA CHUBA	MATHAURI KASH	0.02
196	Darrang	SIPAJHAR (PART)	DEBANANDA	BORA CHUBA	GAON BURHA CHUBA	0.02
197	Darrang	SIPAJHAR (PART)	DEBANANDA	BORA CHUBA	BORA CHUBA	0.02
198	Darrang	SIPAJHAR (PART)	DEBANANDA	BORA CHUBA	BAR CHALA	0.03
199	Darrang	SIPAJHAR (PART)	DEOMARNOI	LOZORA	UTTAR CHUBA	0.02
200	Darrang	SIPAJHAR (PART)	DEOMARNOI	LOZORA	SAHARIA CHUBA	0.02
201	Darrang	SIPAJHAR (PART)	DEOMARNOI	LOZORA	MUSLIM CHUBA	0.02

SNo	District Name	Block Name	Panchayat Name	Village Name	Habitation Name	As (in ppm)
202	Darrang	SIPAJHAR (PART)	DEOMARNOI	LOZORA	MAJOR CHUBA	0.02
203	Darrang	SIPAJHAR (PART)	DEOMARNOI	LOZORA	LOZORA (BARUA PARA)	0.02
204	Darrang	SIPAJHAR (PART)	DEOMARNOI	LOZORA	JAPMARA BORI	0.02
205	Darrang	SIPAJHAR (PART)	DEOMARNOI	BORIGAON	THATHA PARA	0.02
206	Darrang	SIPAJHAR (PART)	DEOMARNOI	BORIGAON	SAGUN BAHI	0.02
207	Darrang	SIPAJHAR (PART)	DEOMARNOI	BORIGAON	KALITAPARA	0.02
208	Darrang	SIPAJHAR (PART)	DEOMARNOI	KAOIKARAGAON	SENGA CHUBA	0.02
209	Darrang	SIPAJHAR (PART)	DEOMARNOI	KAOIKARAGAON	KAURPARI CHUBA	0.02
210	Darrang	SIPAJHAR (PART)	DEOMARNOI	KAOIKARAGAON	KAIKARA (KAMARPARA)	0.02
211	Darrang	SIPAJHAR (PART)	DEOMARNOI	KUMARPARA	MUSLIM CHUBA	0.02
212	Darrang	SIPAJHAR (PART)	DEOMARNOI	KUMARPARA	MAUTPARA	0.02
213	Darrang	SIPAJHAR (PART)	DUNI	BHERUADOLGAON	UTTAR BHERUA CHUBA	0.02
214	Darrang	SIPAJHAR (PART)	DUNI	BHERUADOLGAON	MAZ CHUBA	0.03
215	Darrang	SIPAJHAR (PART)	DUNI	GHAVARA	DALONG GHAT CHUBA	0.03
216	Darrang	SIPAJHAR (PART)	GANESHKUWARI	KALITAPARA	UTTAR CHUBA	0.03
217	Darrang	SIPAJHAR (PART)	GANESHKUWARI	KALITAPARA	KALITAPARA	0.04
218	Darrang	SIPAJHAR (PART)	GANESHKUWARI	MAJAR CHUBA (MAJAR CHUBA NO.2)	MAJOR CHUBA	0.03
219	Darrang	SIPAJHAR (PART)	GANESHKUWARI	CHAMUAPARA	CHAMUAPARA	0.04
220	Darrang	SIPAJHAR (PART)	GARUKHUTI	SATKHALI	CHOKABARI	0.02
221	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	HAZARIKAPARA	TEZAL CHUBA	0.02
222	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	HAZARIKAPARA	HAZARIKAPARA	0.02
223	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	HAZARIKAPARA	GADALU CHUBA	0.02
224	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	SATMADAR	SWET MODAR	0.02
225	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	PITHAKHOWA	PITHAKHOWA	0.02
226	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	PITHAKHOWA	MAUZADAR CHUBA	0.02
227	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	PITHAKHOWA	BISA SATRA	0.03
228	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	KACHARI PARA	KALITA PARA	0.02
229	Darrang	SIPAJHAR (PART)	HAZARIKAPARA	KACHARI PARA	HALADHIYA PARA	0.02
230	Darrang	SIPAJHAR (PART)	KURUWA	PACHIM KURUAH	PACHIM KURUA	0.03
231	Darrang	SIPAJHAR (PART)	KURUWA	BHATI KURUAH	BHATI KURUA	0.03
232	Darrang	SIPAJHAR (PART)	MAROI	NARIKALI	BAMUN CHUBA	0.02
233	Darrang	SIPAJHAR (PART)	SIPAJHAR	BHUKTABARI	SITALABARI	0.02
234	Darrang	SIPAJHAR (PART)	SIPAJHAR	BHUKTABARI	BHUKTABARI	0.02
235	Darrang	SIPAJHAR (PART)	SIPAJHAR	BHUKTABARI	ALIKASH CHUBA	0.03
236	Darrang	SIPAJHAR (PART)	TORAI	BARKALIAJHAR	LUKUPARA CHUBA	0.02
237	Darrang	SIPAJHAR (PART)	TORAI	GHORASAL	KHALIFA CHUBA	0.02
238	Darrang	SIPAJHAR (PART)	TORAI	GHORASAL	DAKSHIN CHUBA	0.02

Table 1d Results of Iron concentration of Pre-monsoon and post monsoon groundwater samples

Location	Latitude	Longitude	Type of sample (TW or DW)	Post monsoon	Pre Monsoon
Upper Kuruwa	26.243	91.824	Dug well	0.14	0.76
Khalihoi	26.2932778	91.828306	Dug well	0.17	0.93
Sonapur	26.3793611	91.824806	Hand Pump	1.04	1.71
Sonapur	26.3793611	91.824806	Tara Pump	0.83	2.12
Dipila Balipara	26.441	91.857667	Hand Pump	4.39	2.47
Malibaritari	26.4735	91.794778	Dug well	0.19	2.02
Malibaritari	26.4735	91.794778	Hand Pump	6.04	2.43
Maroi	26.3828333	91.884611	Hand Pump	1.11	
Bhuktabari	26.3939167	91.903611	Tara Pump	1.22	
Pachimchuba	26.4028889	91.884	Hand Pump	2.16	
Mahaliapara	26.5138056	91.888139	Tara Pump	5.55	2.44
Deomornoi	26.4942222	91.924333	Hand Pump	6.19	2.35
Janaram Chowka	26.4419444	91.967444	Hand Pump	5.68	2.98
Khataniarpara	26.4726944	92.072028	Hand Pump	13.10	3.27
Tangni	26.495	92.097	Dug well	0.38	
Kharupetia	26.5110278	92.141639	Hand Pump	1.97	2.33
Bihdia	26.525	92.172	Dug well	0.13	0.27
Konakat	26.533	92.191	Dug well	0.01	0.17
Sialmari	26.571	92.196	Dug well	0.12	0.32
No 4 Baruajhar	26.605	92.163	Dug well	1.29	
Pub Kamarpara	26.554	92.151	Dug well	0.23	0.25
Silbori	26.6127222	92.290111	Hand Pump	0.67	
Fakirpara	26.519	92.108	Dug well	6.29	
Ghinamari	26.535	92.108	Dug well	0.14	1.49
Botabari	26.515	92.079	Dug well	BDL	1.261
Ondulajhar	26.465	92.08	Dug well	0.20	2.07
Dhula	26.4881944	92.094139	Hand Pump	0.68	
Chapai	26.4673889	92.0325	Tara Pump	4.21	
Dekagaon	26.5169722	92.018194	Tara Pump	0.03	
Mangaldoi	26.431	92.016	Dug well	1.33	2.30
Nandapara	26.42	91.969	Dug well	0.46	
Bardaulguri	26.4036111	91.917361	Hand Pump	1.05	