केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

Dakshin Dinajpur District
WEST BENGAL

पूर्वी क्षेत्र, कोलकाता

Eastern Region, Kolkata

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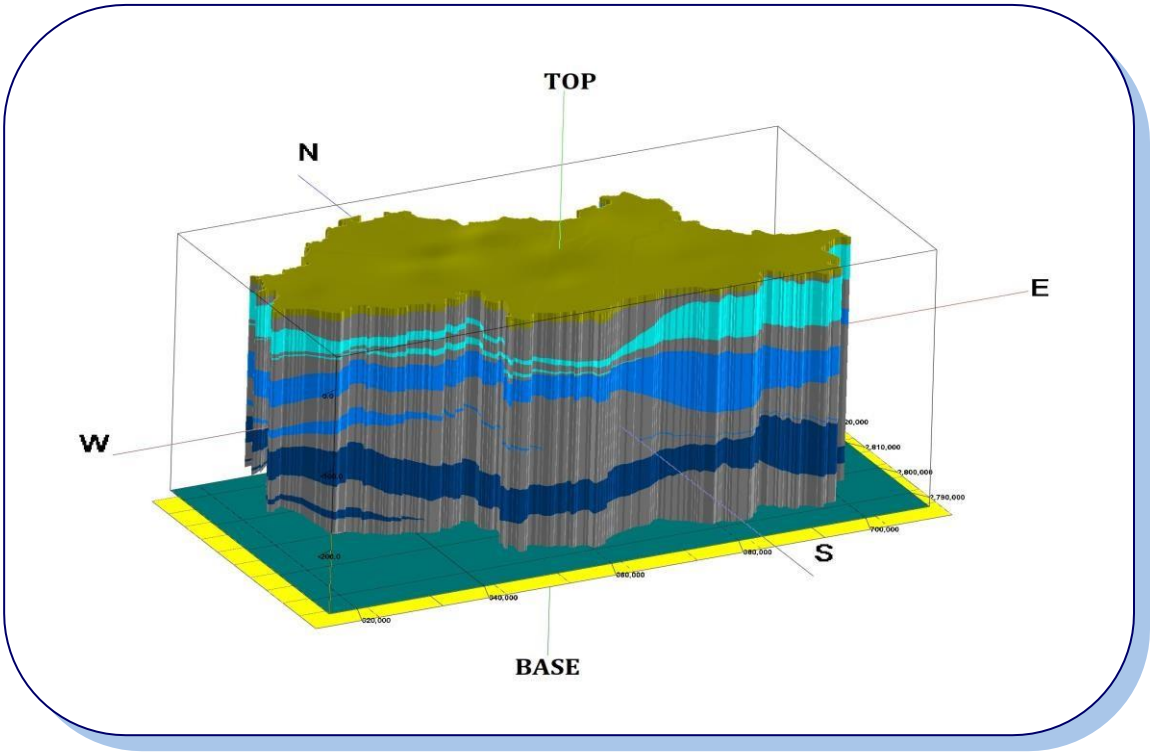
Report
On

NATIONAL AQUIFER MAPPING & MANAGEMENT PLAN

in

Dakshin Dinajpur District, West Bengal



Central Ground Water Board

Eastern Region, Kolkata

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FOREWORD

To understand the nature and occurrences of groundwater, Aquifer geometry, dispositions & characteristics and management of groundwater resource, National Aquifer Mapping & Management Programme (NAQUIM) has been taken up by CGWB under XIIth Plan. During the Annual Action Plan 2019-2020, Aquifer Mapping studies & Management plan was taken up in Dakshin Dinajpur district.

The study under the aegis of NAQUIM includes four major components namely; Data gap analysis, Data generation, Data collection & compilation and preparation of Aquifer maps and Aquifer Management Plan.

This report is presented in three parts, where Part-I embodies general report for the study area, Part-II include Block Management Plans and Part-III comprises Data Gap Analysis done for the district. Relevant data in respect of the said subjects have been collected from different departments and their publications, viz. Public Health Engineering Dept., State Water Investigation Dept., Agri.-Irrigation Dept., Bureau of Economics & Statistics, Land & Land Reforms Dept., Data of Indian Meteorological Dept., National Bureau of Soil Survey & Land Use Planning, etc. of Govt. of India have also been used. Hydro-geological data is sourced from the scientific studies of CGWB pertaining to groundwater explorations, hydrogeological surveys, chemical analysis and outsourcing explorations being taken up for data generation.

Compilation of this report, evaluation of data and preparation of relevant maps, 2D cross-sections & 3D models of aquifers and their reproduction in the form of present report is outcome of the efforts given by Miss Monisha Baruah, Scientist-B and Miss Zumchilo T Ezung, Scientist-B under the supervision of Mrs Sandhya Yadav, Scientist-D (OIC/NAQUIM). The section pertaining to Hydrochemistry has been prepared by Shri Atalanta Narayan Chowdhury, Assistant Chemist and his effort is thankfully acknowledged.

Effective method of dissemination of the existing technical information to different user agencies is an important aspect of NAQUIM which plays a very vital role in the safe and optimal development of groundwater resources in our country. In this regard, Central Ground Water Board has taken up a great initiative in incorporating NAQUIM project since 2012 to fulfill this directive. It is much anticipated that, this report will become an important tool not only for various user agencies, Engineers, Scientists, Administrators, Planners and others involved in groundwater planning, development and management but also to the common people to make them aware of local groundwater issues and its sustainable management.

(Dr. S.K. Samanta)
Regional Director, CGWB, ER, Kolkata

EXECUTIVE SUMMARY

The study area comprises of 8 blocks of Dakshin Dinajpur districts in West Bengal. The total geographical area encompassed under the project is 2219 sq. km. The mapable area for the same is about 2189 sq. km. It is bounded by the north latitudes 26˚35'15" and 25˚10'55" & east longitudes of 89˚00'30" & 87˚48'37" in Survey of India toposheet no.s 78C/7, 78C/8, 78C/11, 78C/12, 78C/15, 78C/16, 78D/1, 78D/5.The district with its headquarters at Balurghat can be divided into two sub-divisions namely Balurghat Sadar and Buniadpur sub-division. The district has two municipal towns at Balurghat and Gangarampur. The total population of the study area is 1676276 as per 2011 Census with rural population accounting for almost 86% and the rest 14% as urban population.

The district is basically an alluvial tract characterized by flat to gently sloping terrains towards the south east following the trends of the rivers and having rolling topography. The ground elevation varies from 22 - 42 meters amsl. The district has two distinct geomorphic units namely the Barind tract and the flat alluvial plains. Common soil types over the area are sandy loam, loamy soil, silty loam, clayey and red soils. The prominent rivers of the district are Atrai, Punarbhaba, Tangon and Brahmani. The district has humid tropical climate like other places of the North Indian plains, which is marked by hot and oppressive summer (38^0 - 40^0C), short and fairly cold winter and a protracted monsoon. The normal rainfall of the district is 1800 mm. About 90% of rainfall occurs during monsoon and the rest 10% occurs during non-monsoon.

Important crops grown in the district are paddy (*Aus, Aman* and *Boro*), potato, wheat, jute, sugarcane, mustard, musur, etc. The district has got vast irrigation potential, which is yet to be fully utilized. The crops grown are mainly rain-fed. The kharif, rabi and boro paddy and vegetables are grown mostly by ground water through DTW and STW. There are a total of 10756 tanks, 246 RLI, 612 DTW and 3558 STW as sources for irrigation in the district.There is no large scale industries as such except for some small scale industries like food products, wood, silk & synthetic fibre textiles, printing, publishing and allied industries, non-metallic mineral products etc.

DakshinDinajpur district forms a part of the Garo-Rajmahal gap filled up with older and younger alluvium which is the result of shallow subsidence and concomitant deposition in fore-deep area of the Himalayas during the Pleistocene and Recent periods. This Garo-Rajmahal gap has to a greater extent contributed in the continuous sedimentation from Mesozoic to Recent in the Bengal basin. The Bengal basin is primarily a large alluvial basin with Quaternary sediments deposited by the Ganga and Brahmaputra river system. This district is a part of the Barind tract, the largest Pleistocene Era physiographic unit in Bengal basin. The Bengal basin is marked by a sequence of major tectonic faulting at greater depths and is covered with huge alluvial layer. However, secondary en-echelon faults have developed at the surface which has affected the Barind as well.

In the present study area, CGWB, ER has not conducted any surface geophysical survey. However, a total of 23 resistivity logging by UPTRON logger was carried out in exploratory boreholes upto a depth of 300 meters.

There is one Principal aquifer system in the study area i.e, Alluvium. . There are two major aquifer systems; The Older Alluvium comprising the Barind tract and the Younger/Recent Alluvium which covers the remaining part of the district. In these

alluviums, ground water occurs under confined to semi confined condition below a blanket of clay beds except in the eastern part of Balurghat, Hilli and northern part of Kumarganj where ground water occur at shallow depths under water table conditions.The aquifers in the study area can be broadly categorized as *Shallow aquifers (Aquifer-I) and Deeper aquifers (Aquifer-II & III).* The shallow aquifers generally occur under water table and semi-confined conditions and are essentially restricted to a depth of 10-15 mbgl.The cumulative thickness varies from 18-30m. The discharge from the aquifers range from 25-35 m^3/hr. Transmissivity value range from 37.91–133.32 m^2/day. The deeper aquifers occur under semi-confined to confined condition within a depth of 50 – 300 mbgl. The average cumulative thickness of granular zones for the deeper aquifers varies from 30 to 48 m. Discharge ranges from 75 - 200 m^3/hr for a drawdown of 7.5 to 15.2 m. Transmissivity value range from 37–2000 m^2/day and Storativity vale from $1.35x10^{-3}$to $7.23x10^{-4}$. The depth to water level range for Aquifer-I varies from 2.81-18.14 m and Aquifer-II range varies from 4.10-20.93m during the pre-monsoons. The post-monsoon variation for Aquifer-I is from 1-4.59 m and 2.15-7.40 m for Aquifer-II respectively.

As per the computation, the net ground water availability for recharge for Dakshin Dinajpur district is estimated at 150689.14 Ham, while the total extraction for all uses is estimated at 80049.2 Ham. The total in-storage for the district is 794944.66 MCM. The stage of ground water development in the district stands at 53.12%, deemed as 'Safe'.

Five blocks of the district namely Kusmundi, Kumarganj, Harirampur, Bansihari and Tapan are Fluoride affected. Balurghat is declared as arsenic affected. Iron concentration beyond the permissible limit is found in many samples collected from the study area.The unscientific management of water in agricultural fields along with excess water during monsoon season leads to water logging in these areas.

At present all the 8 blocks in the district are under 'Safe' category and there is large scope for ground water development in agricultural, domestic and industrial sectors through different structures considering optimum command area of the abstraction structures. However, effective water management technique is proposed for planning and management of resources in the district. Care should be taken for drinking water supply from tube well in Fluoride infested area. In the block affected by Arsenic contamination, arsenic filtering plant should be installed and the wells constructed should have proper cement sealing. The depth of the tubewells may be restricted down to the depth of 250 mbgl in Barind tract areas. Conservation through rain water harvesting structures is suggested for all the blocks in view of better ground water sustainability in the study area. Recharge structures like Percolation tank, REET with RS and Injection Wells have been proposed in the recharge priority areas.

CONTRIBUTORS

Data Acquisition	:	Monisha Baruah (Scientist-B)
		Zumchilo T Ezung (Scientist-B)
Data Processing	:	Monisha Baruah (Scientist-B)
		Zumchilo T Ezung (Scientist-B)
Data Compilation & Editing	:	Monisha Baruah (Scientist-B)
		Zumchilo T Ezung (Scientist-B)
Data Interpretation	:	Monisha Baruah (Scientist-B)
		Zumchilo T Ezung (Scientist-B)
GIS & Thematic Map Preparation	:	Monisha Baruah (Scientist-B)
		Zumchilo T Ezung (Scientist-B)
		Mahashweta Mukherjee (YP)
		Rajyashree Nandi(YP)
Chemical Analysis & Interpretation	:	Atalanta Narayan Chowdhury (Asst. Chemist)
Report Compilation	:	Monisha Baruah (Scientist-B)
		Zumchilo T Ezung (Scientist-B)
Technical Guidance	:	Sandhya Yadav (Scientist-E)
Overall Supervision	:	S. K. Samanta, Regional Director

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PART – I

AQUIFER MAPPING & MANAGEMENT PLAN OF DAKSHIN DINAJPUR DISTRICT

CHAPTER-1

INTRODUCTION

Groundwater is one of the prime sources of fresh water contributing significantly for the survival of mankind. However, overexploitation, surface runoff and subsurface groundwater discharge have depleted the fresh groundwater availability considerably. Assessing the groundwater potential zone is extremely important for the protection of water quantity & quality, and the management of groundwater system. In this context, the National Aquifer Mapping& Management Programme (NAQUIM) has been taken up by CGWB under XIIthPlan. As per the annual action plan, groundwater management studies in 8 blocks of Dakshin Dinajpur have been taken up by CGWB, ER, Kolkata. In this report the salient features of aquifer geometry, characteristics; ground water occurrences, availability, resource vis-a-vis quality, development & management, scope of ground water etc. of the 8 blocks have been covered.

1.1 OBJECTIVE

The broad objective of the study is to establish the geometry of the underlying aquifer systems in horizontal and vertical domain, its resource potential in respect of quality & quantity, aquifer characterization, scope for development potential and prepare aquifer-wise management plans.

1.2 SCOPE OF STUDY

The scope of the present study is broadly within the framework of National Aquifer Mapping & Management Programme (NAQUIM) implemented by CGWB. There are four major components of this activity viz.: (i) Data gap analysis (ii) Data generation (iii) data collection / compilation and (iv) Preparation of aquifer maps and management plan to achieve the primary objective. Data compilation included collection, and wherever required procurement, of all maps from concerned agencies, such as the Survey of India, Geological Survey of India of the Union Govt. and offices of the Govt. of West Bengal (W.B.), computerization and analyses of all acquired data, and preparation of data bases of different themes. Identification of Data Gap included ascertaining requirement for further data generation in respect of hydro-geological, geophysical, chemical, hydrological, hydro-meteorological studies, etc. Relevant data in respect of the said subjects have been collected from different authorities, viz. Public Health Engineering Dept., State Water Investigation Dept., Agri.-Irrigation Dept., Bureau of economics & Statistics, Land & Land Reforms Dept., Data of Indian Meteorological Dept., National Bureau of Soil Survey & Land Use Planning, etc. of Govt. of India have also been used. The existing data of hydro-geological data including those of exploratory wells, piezometers, slim holes, etc. by erstwhile E.T.O., CGWB as well as chemical quality data including trace elements in ground water, either by in-situ or out-sourcing, lying in the Central Ground Water Board, Eastern Region have been thoroughly studied. Besides, data have been generated by hydro-geological surveys and collection of water samples, followed by their laboratory analyses for all major parameters including arsenic. Additional data pertaining to sub-surface lithology and aquifer parameters were obtained through in-situ drilling of exploratory wells, pumping tests, etc.

1.3 APPROACH & METHODOLOGY

An approach and methodology adopted to achieve the major objective have been shown below step-wise.

I. Compilation of existing data
II. Identification of data gaps
III. Data generation based on data gaps
IV. Preparation of thematic maps on GIS platform
V. Preparation of 2D/3D aquifer disposition maps
VI. Compilation of Block-wise Aquifer Maps and Management Plan

1.4 LOCATION, EXTENT AND THE ACCESSIBILITY

The study area comprises 8 blocks of Dakshin Dinajpur districts in West Bengal. The present study area covers a total of 2162 sq. km. geographical area. It is bounded by the north latitudes 26˚35'15" and 25˚10'55" &east longitudes of 89˚00'30" & 87˚48'37" in Survey of India Toposheet no.s 78C/7, 78C/8, 78C/11, 78C/12, 78C/15, 78C/16, 78D/1, 78D/5.

The district is flanked by the international border with Bangladesh on the Eastern, Northern and part of Southern boundary and is bounded by Uttar Dinajpur district in the West and Malda district in south. The district headquarters is at Balurghat and is connected with state capital Kolkata, by railways (Eastern Railways and North-Frontier Railways) and road (NH-34, NH-31) networks. The district is also connected to Bihar and Assam via Dalkhola through National Highway-31. Apart from this, state highways, other narrow metaled roads connect all the other important towns in this district and the all weather roads connect almost all the villages.

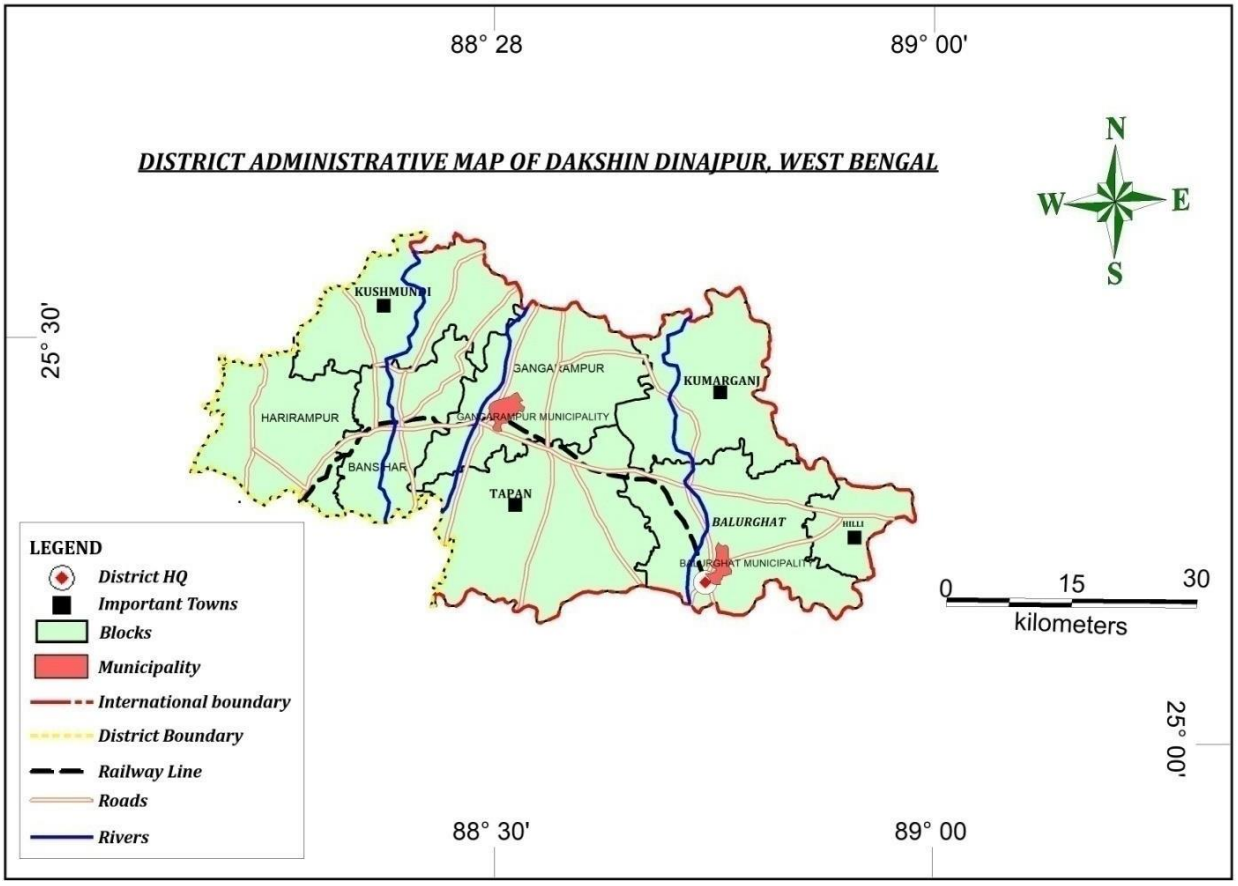

Figure-1.1: Administrative map for Dakshin Dinajpur district of West Bengal.

1.5 ADMINISTRATIVE DIVISION AND POPULATION:

The district with its headquarters at Balurghat can be divided into two sub-divisions namely Balurghat Sadar and Gangarampur at Buniadpur. Each sub-division has been divided into blocks as Balurghat Sadar with 4 blocks(Kumarganj, Tapan, Balurghat & Hilli) and Buniadpur sub division with 4 blocks (Gangarampur, Harirampur, Banshihari, Kusmandi). The district has two municipal towns at Balurghat and Gangarampur. The administrative detail of the district is presented in **Table 1.1(a)** and **Table 1.1(b).**

Table-1.1(a): Major administrative division for Dakshin Dinajpur district.

DISTRICTS	SUBDIVISION	BLOCK
Dakshin Dinajpur	Gangarampur	Kusmandi
		Bansihari
		Harirampur
		Gangarampur
	Balurghat	Kumarganj
		Tapan
		Balurghat
		Hilli

The study area covers a total of 8 panchayat samity, 65 gram panchayat, 1002 gram sansad, 1638 mouzas, 1582 inhibited village, 396406 house-holds, 2 municipalities, 43 wards and 5 census towns.

Table 1.1(b): Details of Panchayat, Mouzas, Inhabitated villages, Households, Municipality and Census Towns for Dakshin Dinajpur district.

Block	Panchayat			Mouzas	Inhabited Villages	House-holds	Town		
	Samity	Gram	Gram Sansad				Municipality		Census Town
							No.	Ward	
Kushmandi	1	8	133	231	228	45135	-	-	-
Banshihari	1	5	97	161	160	32707	-	-	-
Harirampur	1	6	98	155	144	31441	-	-	1
Gangarampur (Municipality)	-	-	-	-	-	12589	1	18	-
Gangarampur	1	11	161	203	198	54319	-	-	1
Kumarganj	1	8	118	218	208	41290	-	-	-
Tapan	1	11	166	279	271	59443	-	-	-
Balurghat (Municipality)	-	-	-	-	-	37507	1	25	-
Balurghat	1	11	174	309	294	61479	-	-	3
Hili	1	5	55	82	79	20496	-	-	-
Total	**8**	**65**	**1002**	**1638**	**1582**	**396406**	**2**	**43**	**5**

(Source- District Statistical Handbook,2014)

Distribution of population of the study area is presented in **Table-1.2**.

Table-1.2: Distribution of population in administrative units of the study area.

Block	Rural Population			Urban Population			Total Population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Kushmandi	100317	98435	198752	-	-	-	100317	98435	198752
Banshihari	72161	69125	141286	-	-	-	72161	69125	141286
Harirampur	66489	65343	131832	2569	2452	5021	69058	67795	136853
Gangarampur(M)	-	-	-	29095	27122	56217	29095	27122	56217
Gangarampur	119358	111254	230612	3583	3433	7016	122941	114687	237628
Kumarganj	87098	82004	169102	-	-	-	87098	82004	169102
Tapan	128500	122004	250504	-	-	-	128500	122004	250504
Balurghat(M)	-	-	-	75794	75622	151416	75794	75622	151416
Balurghat	120867	113272	234139	8387	8238	16625	129254	121510	250764
Hilli	42981	40773	83754	-	-	-	42981	40773	83754
District Total	**737771**	**702210**	**1439981**	**11942**	**11686**	**23629**	**85719**	**81907**	**167627**

(Source- District Statistical Handbook,2014)

Table-1.3: Geographical area and Mappable area for Dakshin Dinajpur district of West Bengal.

District	Block_Name	Geographical Area	Mappable Area
Dakshin Dinajpur	Balurghat	363.39	363
	Bansihari	196.69	203
	Gangarampur	327.15	312
	Harirampur	215.02	235
	Hilli	87.85	87.85
	Kumarganj	279.25	288
	Kushmandi	310.58	283
	Tapan	439.08	414
TOTAL AREA		2219	2185.85

1.6 LAND-USE, CROPPING PATTERN AND IRRIGATION

Land-use:

Dakshin Dinajpur district is basically agrarian district of the state of West Bengal. Land use pattern of urban and rural areas mainly depends on Socio-economic and Socio-cultural factors. The change in land use pattern can be explained as follows:

- The rapid growth of population demands for rapid increase in agricultural productions by bringing more and more areas under cultivation. In this regard, cropping pattern also plays a significant role as *Boro* paddy cultivation is gaining importance day by day, which also brings more areas under *Boro* cultivation.
- Urbanization of the area (urban population being 9.0 % in 2001 census, of total population of the district) changes the land use pattern regularly and more areas are being brought under urban activities and settlement.
- The other important change is in the form of conversion of low-lying water logged areas into cultivable land.

The details of the land-use are presented in **Table-1.4** below:

Table-1.4: Block-wise details of Land-use pattern (in hectares) for Dakshin Dinajpur district of West Bengal.

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Barren and Un-culturable land	Land under misc tree crops	Culturable wastes	Fallow land Other than current fallow	Current fallow	Net area sown
Kushmandi	31058	234	2547	-	48	33	20	6	31058
Banshihari	19669	7	3056	-	27	19	16	0	16544
Harirampur	21502	-	2808	-	42	-	-	9	18643
Gangarampur	32715	6	5010	10	24	10	-	2	27653
Kumarganj	27925	22	601 5	8	70	24	22	5	21759
Tapan	43908	369	5568	-	65	11	-	12	37883
Balurghat	36347	294	5319	-	45	29	6	-	30654
Hili	8785	-	1799	-	109	26	17	16	6818

(*Source- Directorate of Agriculture, Government of West Bengal)*

Cropping pattern:

The Principal crops of the district are paddy (*Aus, Aman* and *Boro*), potato, wheat, various pulses etc. as food grains; mustard and other oil seeds; jute and sugarcane as miscellaneous crops and other *Rabi* crops. Among the food grains paddy is the principal crop and among paddy, *Boro*and *Aman* are the main paddy crops in this district. The jute cultivation ranks next to paddy in the area. Apart from paddy, potato is also an important crop in this area. Among cash crops, mango ranks as principal fruit grown in the area.

Geomorphological conditions play an important role on land use and cropping pattern for an area. Accordingly in Dakshin Dinajpur district also, the agriculture is confined to 'Tal' or swampy area, 'Diara' or flood plain area and the low-lying water logged area in 'Barind' tract. Swampy or 'Tal' area is mainly used for Jute and Paddy cultivation and its southern part is used for '*Rabi*' crops, where as '*Boro*' paddy (high yielding summer paddy) is produced in low-lying area of 'Barind' tract. In the 'Diara' or flood plain area, which is highly fertile, paddy is the main agricultural produce though sugarcane, oil seeds, barley etc. are also grown. The junction of 'Diara' and 'Tal' area is extensively used for cultivation of different crops and mango production is also high in this transition area.

Out of the three varieties of paddies, *Aman* (autumn paddy) is grown over a larger area of the district. The productivity is far away from the state average particularly in case of *Aush* paddy, potato, and barley but the same in case of other crops is more or less at par with the state average or even more in few cases like sugarcane, wheat and *Aman* paddy.

The details of the crops grown, the production and yield are presented in tabular form in table 1.6 below.

Table-1.5: Type of Crops cultivated in Dakshin Dinajpur District of West Bengal.

Name of Block	Aus			Aman			Boro			Wheat			Jute		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.*	Yield**
Kushmandi	117	0.218	1860	42367	129.177	3049	2725	8.630	3167	2412	7.502	3110	4793	68.732	14.34
Banshihari	149	0.277	1860	43350	117.344	2707	1321	4.207	3185	958	3.416	3566	1189	17.371	14.61
Harirampur	-	-	-	1221	3.082	2524	3059	9.485	3101	4291	14.112	3289	800	9.856	12.32
Gangarampur	2	0.004	1899	23945	62.971	2630	4448	14.458	3250	1097	2.874	2619	2289	36.120	15.78
Kumarganj	447	0.818	1830	1741	4.178	2400	1794	5.579	3110	807	2.053	2544	3305	49.773	15.06
Tapan	176	0.329	1870	42978	121.683	2831	2443	9.416	3854	542	1.450	2676	1110	17.560	15.82
Balurghat	-	-	-	1213	2.944	2427	4459	13.900	3117	1824	5.616	3079	5004	83.817	16.75
Hili	-	-	-	656	1.526	2327	1311	4.482	3418	398	1.263	3172	1189	16.729	14.07

Name of Block	Maskalai			Khesari			Mustard			Potato			Musur		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Kushmandi	62	0.040	638	-	-	-	1206	0.965	801	1118	31.194	27902	92	0.080	867
Banshihari	121	0.112	923	10	0.006	615	6798	7.409	1090	1193	34.054	28545	62	0.048	768
Harirampur	-	-	-	-	-	-	617	0.273	443	110	2.561	23279	20	0.014	704
Gangarampur	209	0.182	871	8	0.005	589	9898	13.264	1340	965	24.217	25095	5	0.003	578
Kumarganj	120	0.124	1032	10	0.005	549	857	0.280	327	275	6.035	21947	3	0.002	620
Tapan	-	-	-	-	-	-	1249	1.048	839	198	4.378	22111	2	0.001	709
Balurghat	162	0.136	837	-	-	-	2798	2.524	902	905	23.330	25779	9	0.005	511
Hili	9	0.006	635	70	0.044	629	842	0.702	834	192	4.196	21853	10	0.007	738

(Source- District Statistical Handbook, 2014)

***Area** = hectare, * **Production** = thousand million tones, ****Yield**= Kg/hecares.*

Irrigation:

The district has got vast irrigation potential, which is yet to be fully utilized. It is a rice growing district. The crops grown are mainly rain-fed. The kharif, rabi and boro paddy and vegetables are grown mostly by ground water through DTW and STW. In summer, due to high temperature most of the tanks become dry and fails to provide irrigation for summer crop. Table 1.6 explains the irrigation potential created by different structures in the study area**. Table 1.7** explains the total culturable command area created so far by groundwater and surface water irrigation schemes.

Table-1.6: Area irrigated by different sources in the study area.

Name of Block	Canal Area	Tank		RLI		DTW		STW		Total	
		No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
Kushmandi	-	1200	1278	24	1633	116	859	742	2968	2082	6738
Banshihari	-	467	882	34	1158	148	721	381	1524	1030	4285
Harirampur	-	1032	1343	2	18	67	459	402	1608	1503	3428
Gangarampur	-	1488	957	60	5084	101	504	524	2096	2173	8641
Kumarganj	-	1307	841	49	6440	38	603	434	1736	1828	9620
Tapan	-	2679	3791	33	5027	22	84	83	332	2817	9234
Balurghat	-	1087	922	42	3367	95	1224	701	2669	1925	8182
Hili	-	1496	341	2	19	25	351	291	1016	1814	1727
Total	**-**	**10756**	**10355**	**246**	**22746**	**612**	**4806**	**3558**	**13949**	**15172**	**51856**

RLI*= River Lift Irrigation,* ***DTW****= Deep Tube-well,* ***STW****= Shallow Tube-well,* ***ODW****= Open Dug well.*

1.7 URBAN AREA, INDUSTRIES & MINING ACTIVITIES:

It is already mentioned that out of total area of 2162 sq.km, there are two municipalities namely Gangarampur & Balurghat covering an area of 10.29 & 10.46 sq. km respectively. The rapid urbanization brings more and more areas under residential and industrial sector. The main industries present in the area are food products, wood, silk & synthetic fibre textiles, printing, publishing and allied industries, non-metallic mineral products etc. mining activity is absent in the area.

Table-1.7: Culturable command area created by surface water and ground water.

Block Name	Dugwell		Shallow Tubewell		Medium Tubewell		Deep Tubewell		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
BALURGHAT	2	6.8	4636	12013.77	13	79.16	98	3601.7	1	2	59	3633.46	15701.43	3635.46	19336.89
BANSIHARI	0	0	1565	4232	0	0	3	120	2	40	36	726	4352	766	5118
GANGARAMPUR	0	0	5076	11189.13	1	40	16	262	0	0	78	1853	11491.13	1853	13344.13
HARIRAMPUR	0	0	1894	4766.33	4	120	4	160	0	0	46	546.6	5046.33	546.6	5592.93
HILI	0	0	1687	3658	1	40	19	760	0	0	3	240	4458	240	4698
KUMARGANJ	0	0	4155	8594.42	3	60	22	792	1	42	102	4782.96	9446.42	4824.96	14271.38
KUSHMANDI	0	0	3610	8475.59	5	81.6	22	880	0	0	38	660.69	9437.19	660.69	10097.88
TAPAN	16	66.8	1967	6540.49	52	454.8	39	207.1	5	252	145	2038.21	7269.19	2290.21	9559.4
TOTAL	**18**	**73.6**	**24590**	**59469.73**	**79**	**875.56**	**223**	**6782.8**	**9**	**336**	**507**	**14480.92**	**67201.69**	**14816.92**	**82018.61**

CHAPTER-2

CLIMATE

The district is characterized by humid tropical climate like any other places of the North Indian plains, which is marked by hot and oppressive summer (38^0 - 40^0C), short and fairly cold winter and a protracted monsoon. Winter sets in the end of November and continues till early part of March. December and January are the coldest months with the temperature hovering around 7-11^0C.

2.1 RAINFALL

The normal rainfall of the district is 1800 mm. It is observed that average 64% to 68% of annual rainfall is received during monsoon period (June to September) and 22% to 26 % of annual rainfall is received during pre-monsoon period (March to May). Thus 90% of the annual rainfall is received during the month of April to September. The post-monsoon period (October-November) and winter (December-February) season receives 6% and 4% of annual rainfall respectively. Regular monitoring of rainfall is done from eight rain gauge stations distributed over the district. Most of them are placed within the agricultural block seed farms and mainly monitored by the State Government. IMD rainfall station is located at Balurghat town.

Table-2.1: Annual rainfall for Dakshin Dinajpur District from 2014 to 2018.

District	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Dakshin Dinajpur	2014	0	25.8	0.1	15.9	127.2	325.8	245.9	243.4	275.8	28.5	0	0
	2015	9.3	13.9	16	62.2	80	111.1	194	247.3	165.2	24.7	17.3	0
	2016	0	0	5.2	12.3	50.1	86.8	310.1	62.8	244.6	78.9	0	0
	2017	1.6	0	40.9	91.5	68.5	150.3	161.2	522	133.4	75.7	0	0
	2018	0	8	9.4	30.9	138.8	131	230.8	108.3	103.2	17.7	0	7.8

2.2 TEMPERATURE

The mean annual temperature of the district is 25^0C. Late December and early part of January are marked as the coolest period in the district with minimum temperature during winter hovering around 7^0-11^0C. Sometimes the minimum temperature goes down to 4˚C. The winter season is the most pleasant period in the year. Day temperature during this period is from 25^0C - 27^0C. May is the hottest month with temperature sometimes soaring as high as 43^0C. Generally the temperature rises from the beginning of March and the day temperature goes up to 40˚C in the months of April and May.

2.3 HUMIDITY

Humidity is generally lying in the ranges of 71.5% to 88.5% during the non-monsoon period. During the monsoon period humidity increases and is generally above 95%.

Humidity varies in day times. Humidity during morning hours is high while it is marginally low during evening.

2.4 WIND

Wind is generally low and is mostly from north or east. The average wind velocity is 25-35 km/hr. The highest wind velocity is experienced during May to July in the ranges of 46-65 Km/hr respectively.

CHAPTER-3

GEOMORPHOLOGY

3.1 INTRODUCTION

The district is characterized by flat to gently sloping towards south east following the trends of the rivers and having rolling topography with an elevation varying from 22 to 42 meters above mean sea level. Based on the geomorphological characters the district can be divided into two distinct geomorphic units namely (a) ***Barind*** (b) ***Flat Alluvial Plain.***

a) ***Barind:*** The Pleistocene barind area is one of the largest of the units that comprise the Bengal Basin. It differs lithologically mainly from the surrounding Recent Flood Plains and has been Mapped as four district bodies separated by long, narrow, Recent alluvial river valleys. The Barind has essentially a flat or slightly domed surface. South of the Barind is the Recent flood plain with a southerly slope. The Barind tract covering Bansihari, Gangarampur, Tapan blocks are marked by undulating country dissected ravines. Small elevation occurs in this tract where height does not exceed 30 meters.

b) ***Flat Alluvial Plain****:* The flat and fertile land covers in most parts of the district comprises of younger and older alluvial plains locally known as *Diara*. This unit is the result of accretion of flood plain deposits. Soil composition is predominated by loam followed by sandy loam. There are some low-lying area sloping down towards south and is vulnerable to inundation during monsoon period. The soil is of clayey loam type. *Bils* in the form of depressed swampy lands are frequently noticed in the district. *Bils* are also found in the flood plains in an isolated manner. The geomorphological map of the study area is shown in **Figure-3.1.**

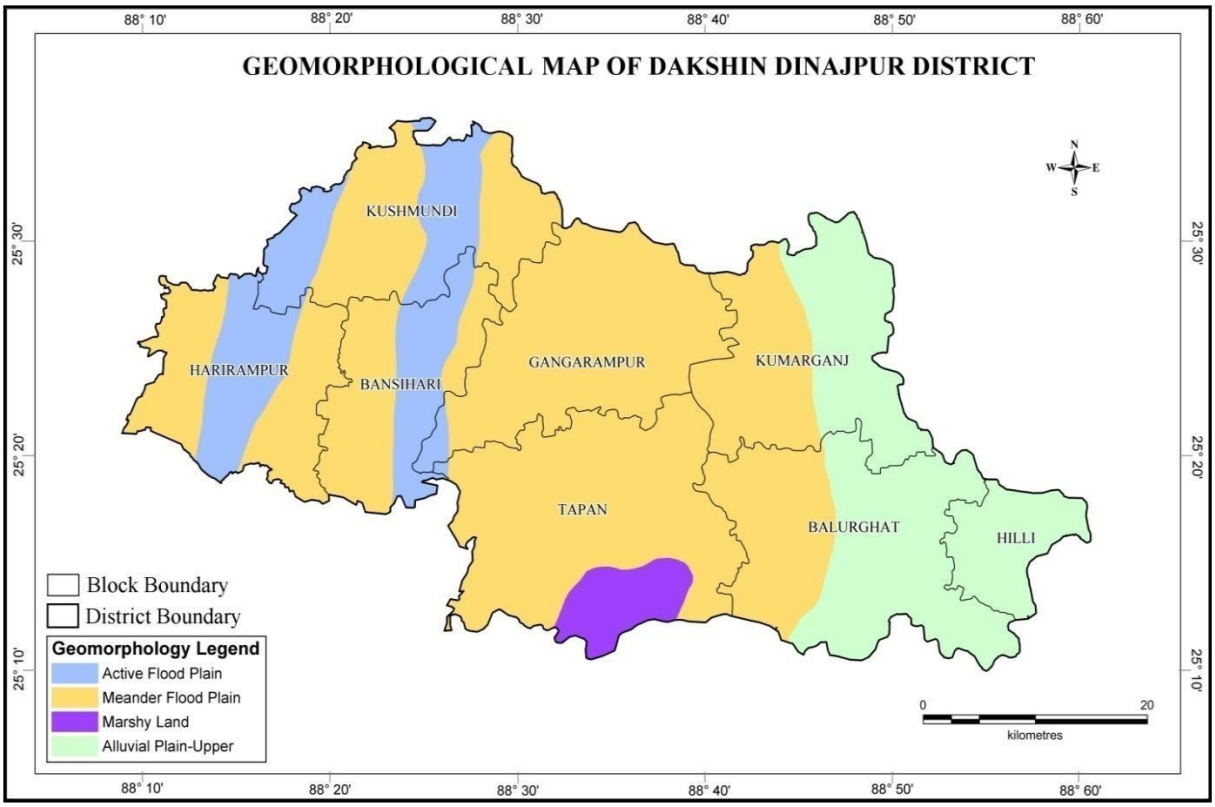

Figure- 3.1: Geomorphological map for Dakshin Dinajpur district of West Bengal.

3.2 DRAINAGE:

The prominent rivers of the district are Atrai, Punarbhaba, Tangon and Brahmani and these rivers forms the main drainage system in the study area. These rivers are flowing from north to south. The Punarbhaba leaves Bangladesh to enter the district across the northern boundary of Gangarampur block. The Tangon and Atrai also enter the district from Bangladesh in Kusmandi and Kumarganj blocks respectively.TheTangon enters Malda district after having a short course in Kusmundi and Bansihari blocks and Atrai re-enters Bangladesh from Balurghat block. All the rivers have full flow during the monsoon only. During the greater part of the year, their flow is sustained by base flow along their channels. The rivers flowing in the district show the meandering nature and have left typical ox-bow lakes along their abandoned channel courses. These rivers played a major role in the overall geomorphological set-up of the district. The drainage map of the study area is shown in **Figure-3.2.**

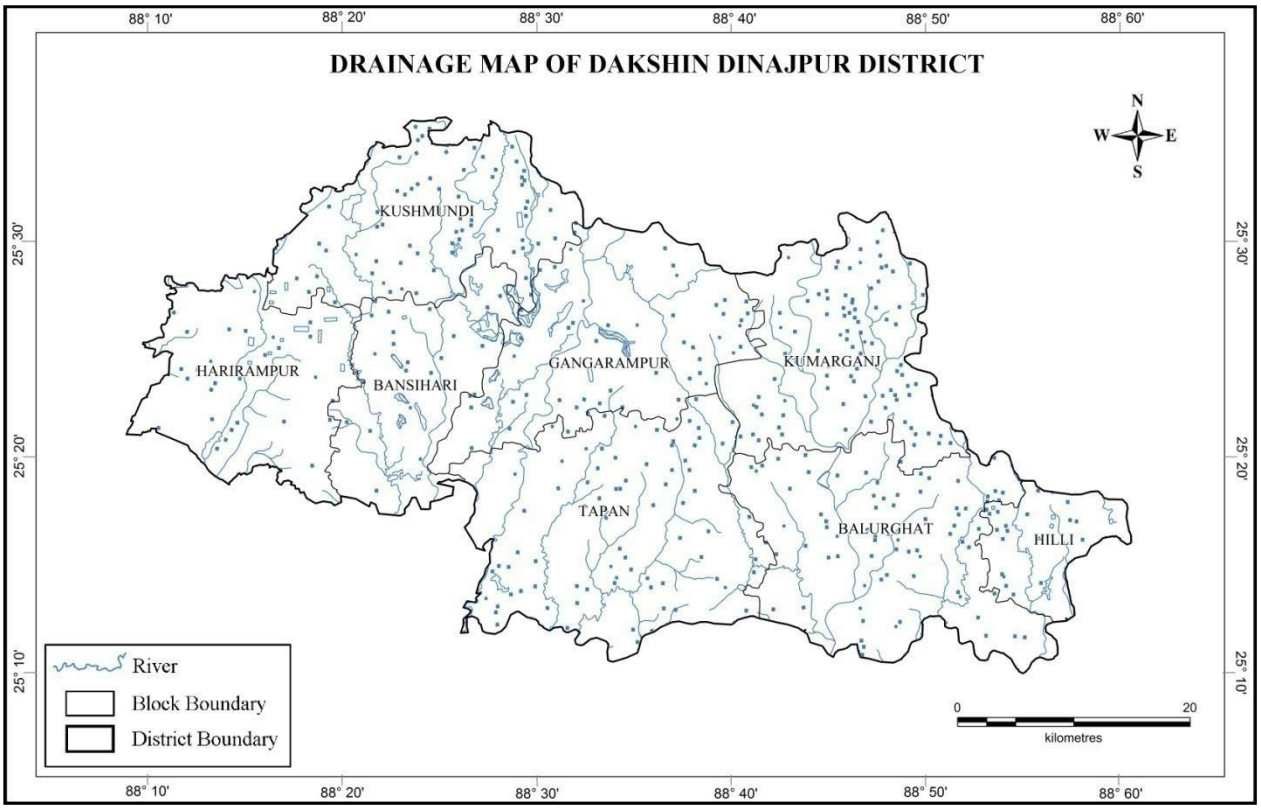

Figure- 3.2: Drainage map for Dakshin Dinajpur district of West Bengal.

3.3 SOIL CHARCTERISTICS

The soil of Dakshin Dinajpur district can broadly be divided into two groups namely Gangetic alluvial soil and red soil. Gangetic alluvial soils in general have one or two sandy layers that are made of fine to very fine sand of grey and greyish white colour. The soils are rich in Calcium and are almost neutral in reaction. Clay content in it is fairly high and the content of organic matter, potash and phosphorous is medium to low. This type of soil is favourable for sericulture and drainage is poor though it supports horticulture to a great extent. Sandy part constitutes 7-9%. Sandy loam constitutes 15-16%, loam constitutes 45-47% clay loam constitutes 13-15%, silt loam 11-12%, clay 5-6%. This soil is very fertile and used for extensive cultivation especially for paddy, jute, pulses, oil seeds etc.

The red soil occurs in the eastern parts of the district covering the 'Barind' tract and is reddish to reddish brown in color. Sandy loam constitutes 0.5%, loam constitutes 10-12%, clay loam constitutes 32-35% and clay 55-57%. The pH of this soil varies from 5.4 to 6.6 indicating mildly acidic in nature. Organic matter as well as phosphate content in the soil is low and it reacts favorably to the application of fertilizers, especially the organic manures. This soil is also fertile and suitable for high yielding paddy (*Aman* and *Boro*), jute, *Rabi* crops etc.

CHAPTER- 4

GEOLOGY

4.1 General Geology

Dakshin Dinajpur district forms a part of the Garo-Rajmahal gap filled up with older and younger alluvium which is the result of shallow subsidence and concomitant deposition in fore-deep area of the Himalayas during the Pleistocene and Recent periods. This Garo-Rajmahal gap has to a greater extend contributed in the continuous sedimentation from Mesozoic to Recent in the Bengal basin. The Bengal basin is primarily a large alluvial basin with Quaternary sediments deposited by the Ganga and Brahmaputra river system. This basin constitutes the largest fluvio-deltaic to shallow marine sedimentary basin comprising of riverine channel, floodplain and delta plain environments (Alam et al., 2003; Roy and Chatterjee, 2015; Goodbred, 2003). The Bengal basin is marked by a sequence of major tectonic faulting at greater depths and is covered with huge alluvial layer. However, secondary en-echelon faults have developed at the surface which has affected the Barind as well. Change in river courses and simultaneous subsidence of the sedimentary deposits in the basin are direct evidences of happening tectonics that still influences its geology and geomorphology.

This district is a part of the Barind tract, the largest Pleistocene Era physiographic unit in Bengal basin. The Barind tract is mainly an alluvial terrace, which abruptly merged into Recent floodplain. These sediments are deposited by the Ganga-Brahmaputra river systems. This barind tract takes the form of a dome. The western part of the Barind tract is higher towards the centre and slopes both to the north and the south. The eastern part is lower with a uniform surface tilted towards south west. The Pleistocene Barind tract overlies the Recent floodplains which probably indicates a differential movement between the Plesitocene and Recent. A generalized stratigraphic succession of the area (after GSI & ONGC) is given below.

Quaternary	Recent	Alluvium
	Pleistocene	Older Alluvium
----------Unconformity----------		
Tertiary	Siwaliks	Sandstones
Archaeans	Basement	Hornblende Gneiss

4.2 Sub-surface Geology

Deep exploratory drillings were conducted in the Barind tract area in 1959 under the Indo-US agreement. Subsequent installation of the production wells was done by the Government of West Bengal for agricultural use as well as for public water supply. The drilling records have provided an insight into the sub-surface geology of the area.

The bedrock configurations show that the bedrock gradually slopes towards the east, north and south. Exploratory drilling at Buniadpur and Patiram has encountered bedrock granite-gneisses at a depth of 304.9 mbgl and grey sandstone at 303.6 mbgl respectively. These bedrocks are overlain by huge thickness of Pleistocene and Recent alluviums deposited by rivers and streams or as flood plain deposits. By stratigraphic rule, Tertiary sediments, whether fluviatile or marine should be overlying the bed rocks but no Tertiary sediments have been encountered in any of the wells drilled. Possibility could be there that Tertiary sediments were earlier deposited but later eroded away before deposition of the Pleistocene sedimentation began.

The general sub-surface lithology constitute of alternating sand, silt, clay and gravels. The granular zones are predominant within the depth from 30 to 150 mbgl.

The Barind tract is composed of well oxidized, massive and reddish argillaceous formation (Older Alluvium). They are also found associated with kankar and ferruginous concretions at the top weathered portions. This Barind tract which topographically lies above the Recent flood plains covers a major part of the district.

The Flood plain is characterized by Recent alluvial deposits and deposits of river borne silt, sand and clay in the low lying areas. These younger alluvium deposits occur along the course of the Tangon&Purnabhaba River.

According to Wadia and Auden (1959), Siwaliks maybe underlying the alluviums which are overlying the basement gneiss. Their buried contact is considered to be an overlap. However, there is this possibility of occurrence of a number of faults below the alluviums. Presence of a North-South fault has been indicated by the geophysical survey conducted by ONGC in 1961. Morgan & McIntyre (1959) recorded that eastern margin of high lands of Barind are marked by en-echelon faults.

The sediments in the southern part of the district in Hilli, Balurghat, Tapan, Kumarganj, Gangarampur & Banshihari blocks is predominantly argillaceous. The top clay bed is lenticular. It pinches out northwest of Harirampur and southeast of Balurghat. This is clearly evident as in; there is a continuous clay horizon of about 10m to 20 m from Bunaidpur to Patiram at the top zone but at Gadaipur and Hilli block, the top layer is composed of continuous 40m granular zone. Coarse sand occurs at shallow depth near Fulbari. Very often the sediments in the area are intermixed. The deposition of fine sand, silts, sandy clay, lenticular sand and gravels throughout the stratigraphic column in the district gives a fine indication that there must have been an irregular change in the river courses over the area with time. This may give the explanation to the type of irregular sedimentation throughout its depositional history in this area.

At Buniadpur area, six lenticular sand beds of about 60 m cumulative thickness occurs within the depth span of 300 m. At Patiram, Balurghat block, sandstones has been encountered at 303 mbgl.

The geology map of the study area is given below in **Figure- 4.1.**

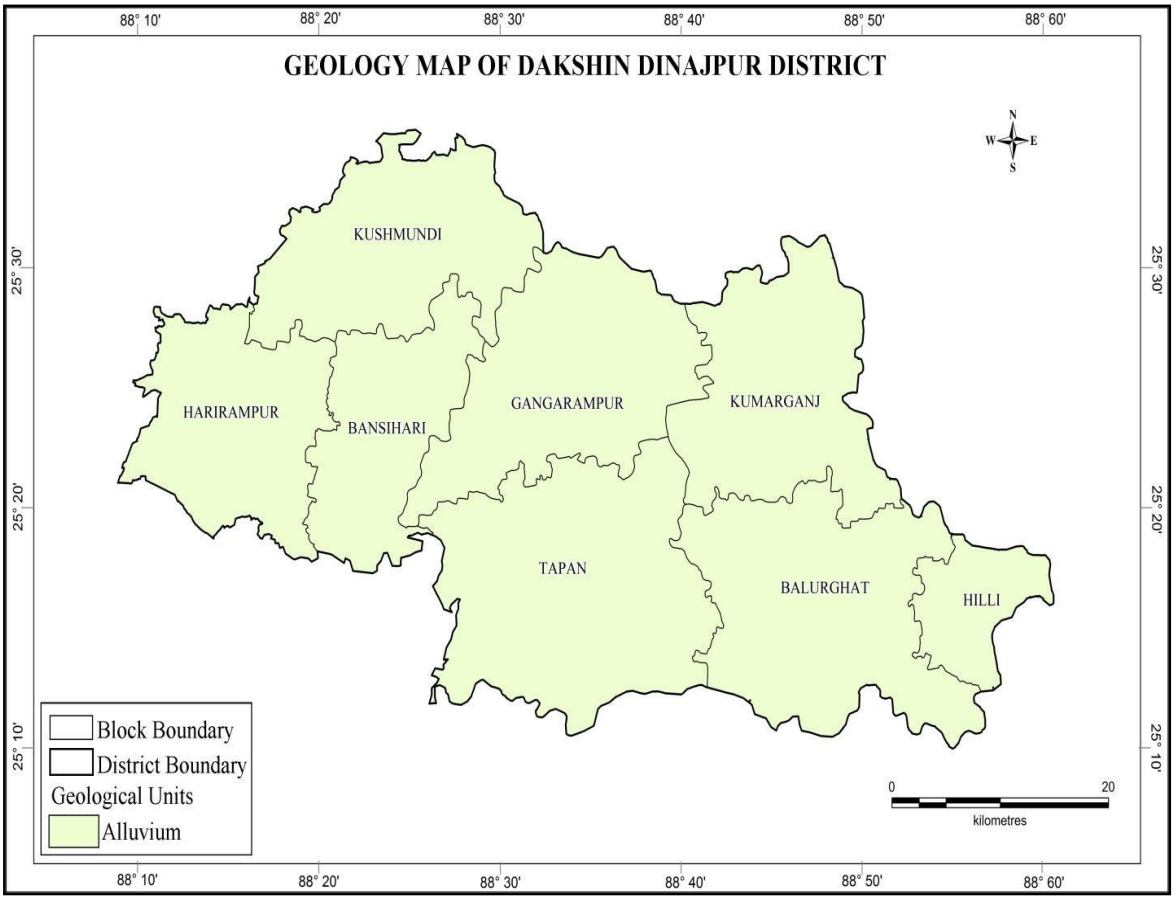

Figure- 4.1: Geological map for Dakshin Dinajpur district of West Bengal.

CHAPTER-5

GEOPHYSICAL STUDIES

Geophysical study in field can be broadly divided into two categories, namely surface geophysical investigation or resistivity survey (VES and profiling) and electrical borehole logging.
Surface geophysical investigation is the pre-drilling approach and in ground water exploration it has many fold objectives that depends on formation characteristics likely unconsolidated, semi-consolidated and consolidated formations.

In alluvial areas identification of granular and non-granular formations, thickness of the individual layers and their resistivity values, identification of saline/fresh water interface etc. are required to be done. Lithology, resistivity, formation factor, formation resistivity, porosity, permeability, specific yield of water bearing formations, chemical and physical characteristics of water of a particular formation of interest can also be calculated.

Electrical resistivity investigation is also adopted in exploratory drilling program to locate a tube/bore-well site due to its wide simplicity in field proceedings and low cost of operation. It also helps for mapping potential aquifers in buried stream channels and also demarcating the areas suitable for artificial recharge and prone to water logging.

Electrical well logging measures the physical properties of surrounding rocks with a sensor located in a borehole. It is performed by lowering a 'logging tool' - or a string of one or more instruments on the end of a wireline into a borehole and recording the physical properties using a variety of sensors. Several types of logging methods are available. However the most commonly used is the electrical resistivity method. This method works by characterizing the rock or sediment in a borehole by measuring its electrical resistivity which is the ability to impede the flow of electric current. Resistivity is expressed in ohm meter (Ω-m), and is frequently charted on a logarithm scale versus depth because of the large range of resistivity. The natural resistivities of soft rocks are mentioned in table 5.1

Table-5.1: Range of resistivity in soft rocks.

Lithology	Range of resistivity (Ohm-m)
Clay/ clayey sand with saline water	3-6
Clay with sand lens	10-15
Clay	15-25
Mixed (sand +clay)	15 -25
Fine Sand	25-35
Medium sand	30-60
Sand with fresh water	20-80
Coarse sand	60-100
Sand coarse to medium	40-50
Gravel	70-100
Gravel with sand	60-70
Pebble	100-150
Boulder	150-200
Sand Stone	300-1000
Dry Sand	>1000

Lithology	Range of resistivity (Ohm-m)
Sand/Sandstone saturated with fresh water	30-150
Sand saturated with saline water	<3

In the present study area, CGWB, ER has not conducted any surface geophysical survey. However, a total of 23 resistivity logging by UPTRON logger was carried out in exploratory boreholes upto a depth of 300 metres. The Formations, findings and recommendations from the study conducted are explained through the following tables for each block.

1) Borehole Logging 01:

Location: Amuliya::**Block**: Kumarganj::**Co-ordinates**: 25° 28' 53"N, 88° 42' 50"E

Table-5.2: Borehole logging details from Amulia, kumarganj block of Dakshin Dinajpur district.

Sl. No.	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones Tapped (m)
	From	To						
1	30	42.5	12.5	56-142	60-90	80-130	Sand Medium to Fine grained	128-140, 147-153, 174-183
2	78	95	17	62-76	52-80	90-130	Sand Fine grained	
3	125	140	15	68	56	85-130	Sand Fine grained	
4	146	153	7	88	115	70-110	Sand Medium to Fine grained	
5	173	183	10	65	70	113-140	Sand Fine grained	

2) Borehole Logging 02:

Location: Dangapara::**Block**: Harirampur::**Co-ordinates**: 25° 24' 17"N, 88° 15' 52"E

Table-5.3: Borehole logging details from Dangapara, Harirampur block of Dakshin Dinajpur district.

Sl. No.	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones tapped (m)
	From	To						
1	16	32	16	24-54	35-66	75-165	Sand Medium to Fine grained	210-216, 234-240, 244-250, 278-290
2	65	94	29	26-49	31-61	66-144	Sand Medium to Fine grained	
3	115	123	8	34-39	42-54	94-156	Sand Medium to Fine grained	
4	133	143	10	25-44	34-56	83-158	Sand Medium to Fine grained	
5	146	152	6	30-36	33-48	75-141	Sand Medium to Fine grained	
6	171	177	6	29-37	30-57	41-107	Sand Medium to Coarse grained	
7	184	198	14	20-40	29-51	22-219	Sand Medium to Fine grained	
8	198	232	34	25-33	27-44	68-137	Sand Medium to Fine grained	
9	232	240	8	26-48	29-62	62-196	Sand Medium grained	
10	244	249	5	30-46	32-63	101-207	Sand Medium to Fine grained	
11	254	272	18	31-41	36-50	73-158	Sand Medium to Fine grained	
12	272	288	16	40-52	49-69	61-146	Sand Medium to coarse grained	

3) Borehole Logging 03:

Location: Domutha BOP::**Block**: Gangarampur::**Co-ordinates**: 25° 28' 42'' N, 88° 39' 09'' E

Table-5.4: Borehole logging details from Domutha BOP, Gangarampur block of Dakshin Dinajpur district.

Sl. No.	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones tapped (m)
	From	To						
1	20	24	4	33-37	63-75	85-118	Medium to Fine grain Sand	132-138, 156-168, 172- 181, 187-190
2	75	84	9	34-52	48-65	87-150	Medium to Fine grain Sand	
3	132	141	9	56	80	52-105	Coarse to Medium grain Sand	
4	141	168	27	33-44	38-60	77-130	Medium to Fine grain Sand	
5	172	181	9	29-34	37-50	70-110	Medium to Fine grain Sand	
6	187	190	3	26-32	50-75	58-110	Coarse to Medium grain Sand	

4. Borehole Logging 04:

Location: Ganglar BOP::**Block**: Kusmandi:: **Co-ordinates**: 25° 31' 07'' N, 88° 32'07'' E

Table-5.5: Borehole logging details from Ganglar BOP, Kusmandi block of Dakshin Dinajpur district.

Sl. No.	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones tapped (m)
	From	To						
1	45	49	4	91	70	90-150	Fine to Medium grain Sand	84-90, 103-106, 184-193
2	53	58	5	92	66	88-160	Fine to Medium grain Sand	
3	66	73	7	80	55	80-150	Medium to Fine grain Sand	
4	83	91	8	80	60	70-120	Medium to Fine grain Sand	
5	102	106	4	52	36	75-125	Medium to Fine grain Sand	
6	183	195	12	37-66	40-50	90-140	Medium to Fine grain Sand	

4) Borehole Logging 05:

Location: Khadimpur ::**Block**: Balurghat ::**Co-ordinates**: 25°12' 57'' N, 88°46' 31'' E

Table-5.6: Borehole logging details from Khadimpur, Balurghat block of Dakshin Dinajpur district.

Sl. No.	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones tapped (m)
	From	To						
1	8	34	26	63-120	58-89	61-101	Medium to Coarse grain Sand	122-128, 138-141, 144-147
2	39	54	15	57-130	44-84	62-105	Medium to Coarse grain Sand	
3	86	89	3	34-48	30-46	64-102	Medium to Coarse grain Sand	

5) Borehole Logging 06:

Location: Babupara :: **Block**: Hilli :: **Co-ordinates**: 25°17' 2'' N, 89° 0'10'' E

Table-5.7: Borehole logging details from Babupara, Hilli block of Dakshin Dinajpur district.

Sl.No	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones tapped (m)
	From	To						
1	30	33	3	30-43	40-57	69-93	Sand fine to medium grained	267-283
2	35	52	17	50-69	53-64	65-119	Sand medium grained	
3	93	98	5	40-52	49-63	48-81	Sand Coarse to medium grained	
4	100	107	7	41-58	47-67	46-87	Sand Coarse to medium grained	
5	266	284	18	40-77	50-84	28-63	Sand Coarse to medium grained	

6) Borehole Logging 07:

Location: Chakramai::**Block**: Bansihari:: **Co-ordinates**: 25° 26' 6'' N, 88° 27' 59'' E

Table-5.8: Borehole logging details from Chakramai, Bansihari block of Dakshin Dinajpur district.

Sl.No	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones tapped (m)
	From	To						
1	56	68	12	75	90	62	Medium to very Coarse Sand	139-142, 156-168, 200-206, 216-222, 231-234
2	72	77	5	50	80	68	Medium to very Coarse Sand	
3	117	128	11	60	50	95	Coarse to Medium Sand	
4	142	148	6	40	50	90	Medium Sand	
5	163	182	19	50	70	68	Coarse to Medium Sand	
6	231	261	30	40	60	60	Coarse to Medium Sand	

7) Borehole Logging 08:

Location: Sebashram::**Block**: Tapan::**Co-ordinates**: $25^0 18' 35"$N, $88^0 34' 2"$E

Table-5.9: Borehole logging details from Sebashram, Tapan block of Dakshin Dinajpur district.

Sl.No	Depth Range (m)		Thickness (m)	LN-64" N Resistivity (ohm.m)	SN-16" N Resistivity (ohm.m)	NGAM-Natural Gamma (cps)	Inferred Lithology	Zones tapped (m)
	From	To						
1	42	49	7	22-42	25-66	72-138	Sand fine to medium grained	217-229, 249-261, 288-294
2	136	155	19	30-38	41-63	55-118	Sand medium to fine grained	
3	155	170	15	29-36	36-58	80-133	Sand fine to medium grained	
4	170	176	6	32-40	35-65	69-108	Sand medium to fine grained	
5	180	185	5	27-41	32-68	69-117	Sand medium to fine grained	
6	215	240	25	40-83	48-127	42-116	Sand medium grained	
7	240	261	21	41-55	53-89	32-84	Sand Coarse to medium grained	
8	261	276	15	34-40	44-85	51-106	Sand medium grained	
9	286	299	13	31-58	36-93	27-66	Sand Coarse to medium grained	

Conclusions

The predominant lithology encountered is coarse, medium and fine sand. The most promising water bearing zones are located between the depths of 84-290 mbgl.

CHAPTER-6

HYDROGEOLOGY

6.1 Occurrence, movement, yield and Aquifer properties:

Dakshin Dinajpur is basically an alluvial terrain which constitutes its principal aquifer system. There are two major aquifers in the area. They are the Older Alluvium comprising the Barind tract and the Younger/Recent Alluvium which covers the remaining part of the district.

In the Older alluvium Barind tract, ground water occurs under confined to semi confined condition below a blanket of 15-20 m clay bed in Bansihari-Gangarampur-Tapan area. In the Recent alluvial areas, ground water occurs under semi-confined to confined condition under a clay blanket. However, in the eastern part of Balurghat, Hilli and northern part of Kumarganj, ground water at shallow depths occur under water table conditions.

Recent Alluvium comprising of Coarse to fine sand and gravel deposits constitutes the main repository of ground water in the area. These deposits are capable of transmitting ground water at large and are replenished easily by downward percolation of rain water during monsoons.

The aquifers in the study area can be broadly categorized into two;

a). ***Shallow aquifers*****:** These aquifers generally occurs under water table and semi-confined conditions. They are essentially restricted to a depth of 10-15 mbgl. However, in some parts of Tapan, Bansihari and Gangarampur blocks, the water table can even reach down to a depth of 20 mbgl. The cumulative thickness of the aquifers down to a depth of 80 mbgl varies from 18-30m. Shallow tube wells tapping an average thickness of 18 m granular zones gives a discharge of 25-35 m^3/hr. Sub-surface geology suggests that below the top 21-30 metres thick clay layers, the water table aquifers are found as packets or lenses of sand or clayey sand within the clap cappings.

b). ***Deeper aquifers*****:** Ground water in deeper aquifers occurs under semi-confined to confined condition. Exploration up to 300 mbgl has been achieved at Buniadpur in Bansihari block, Laskarhat in Tapan block and Patiram in Balurghat block. The average cumulative thickness of granular zones for the deeper aquifers varies from 30 to 48 m. Deep tube wells constructed down to a depth of 150-250 mbgl tapping these granular zones are found to give a yield of 75 to 200 m^3/hr for a drawdown of 7.5 to 15.2 m. The sand and clay layers are highly intercalated. The older Barind sediments can be identified from the Younger/Recent sediments as in; the Barind sediments are oxidized and yellowish brown in colour. Whereas, the Recent sediments are rather less compact, light grey in colour with very high water bearing capacity.

Change in the sedimentary facies over time has contributed immensely in variation of the yield potentiality of the existing aquifers. The discharge of aquifers in both the Older

and Younger alluviums ranges from 50-150 m^3/hr. In parts of Balurghat, Hilli and Northern part of Kumarganj, the yield from high duty tube wells renders discharge which sometimes exceeds 150 m^3/hr. The depth range, yield potentials, zones tapped and thickness of aquifers in the study area are given in **Table-6.1 & 6.2**.

The general direction of ground water flow in near surface aquifer is from higher elevation in the north towards the plain area in south. A distinct ground water mound is observed near Buniadpur in Bansihari block, where the piezometric level lies at 32.6 m above the mean sea level. This might be probably due to topographic relief rather than a large ground water withdrawal. The ground water flow in the area as a whole is found to be controlled both by local and regional topography. All the rivers and streams in the district are effluent in nature. Ground water flow is towards south and south-east. The slope of the water table varies from 0.32 m/km in north to 3.60 m/km in the central part.

The hydrogeological map of DakshinDinajpur is given in the following page.

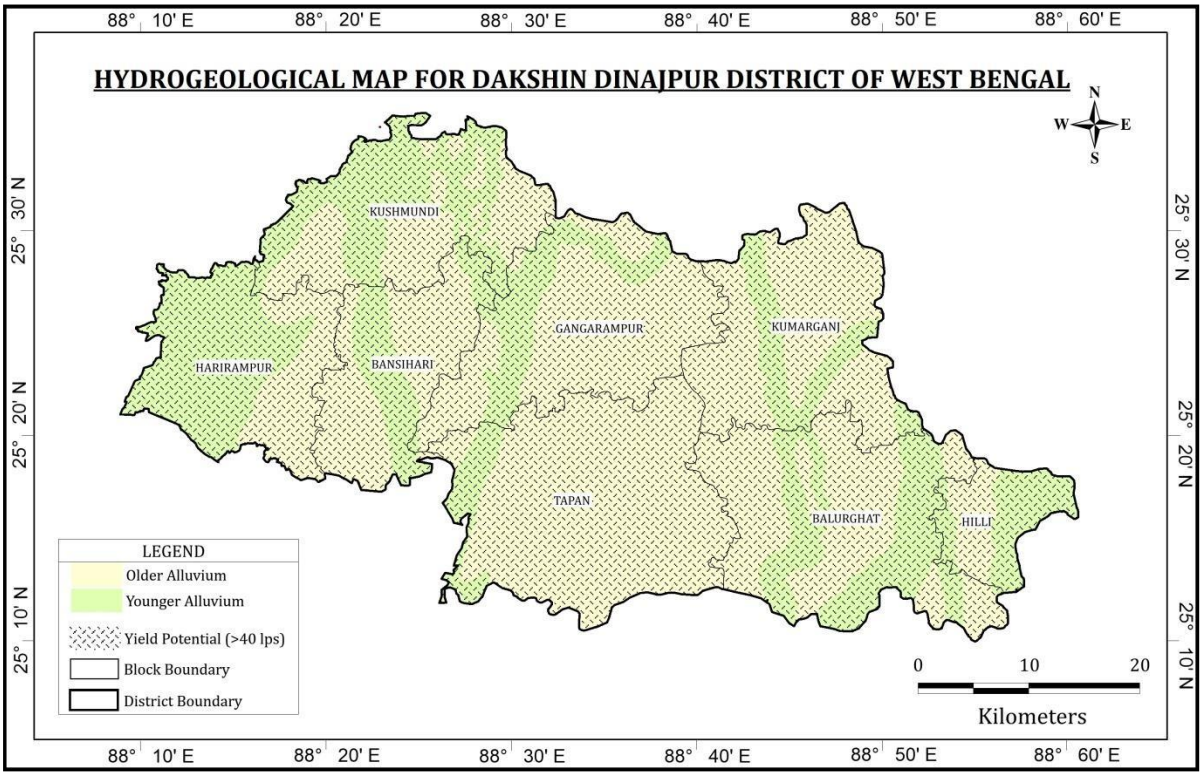

Figure-6.1: Hydrogeological Map for Dakshin Dinajpur District of West Bengal.

Table-6.1: Aquifer parameters in Dakshin Dinajpur district of West Bengal.

Block	Aquifer I					Aquifer II					Aquifer III				
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Draw down	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown
Balurghat	6.1-73.11	222.73	133.32	-	2-6.63	54-159	32.94	1330.1	$2.183 * 10^{-4}$	2.01-25.65	151-286	63.78-111.06	96.79	-	6.03-26.39
Bansihari	9.14-53.47	-	-	-	--	51.81-149.34	5.4-115.81	75.65	-	--	152-283.44	5.4-115.81	75.65	-	--
Gangarampur	13.04-54.70	-	37.91	-	6-8	53-130.61	74.63	37.91	-	6-8	155-203	14.04-38.16	33.6	-	3.15-20
Harirampur	3.50-39.62	-	-	-	--	51.70-146.30	>40	37-2000	-	--	155.32 - 277.37	>40	37-2000	-	--
Hilli	6.09-76.2	-	-	-	--	51.82-76.2	>40	37-2000	-	--	152.4-243.84	>40	37-2000	-	--
Kumarganj	7-58.44	-	-	-	--	52.53-150.88	>40	37-2000	-	--	150.88 -202.3	>40	37-2000	-	--
Kushmundi	6.09-57.91	-	-	-	--	60.95-124.96	1.8	37-2000	-	--	152.39 -308	>40	37-2000		--
Tapan	42.64-54.82	-	-	-	--	52-153	7.74-33.01	70.68-77.97	$1.35x10^{-3}$to $7.23x10^{-4}$	4.66-14.86	152.25 - 301.47	5.4-36	99.3-192.66	-	4-17.21

Table-6.2: Water bearing zone/zones tapped for the Aquifers in Dakshin Dinajpur District of West Bengal.

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (0-50 mbgl)	Aquifer-II (50 -150mbgl)	Aquifer-III (150 -300mbgl)
Balurghat	Alluvium	26.57-33.13,37.23-52.82, 54-66, 87-96, 115-127,139-142, 147-159, 156-168, 172-182 ,200-209, 215-221, 229-235, 240-252, 258-265, 272-275, 280-286	6-15	3-12	3-12
Bansihari	Alluvium	5-15, 20.5-42.5, 20.72-27.73, 56-89, 67-88, 69.8-109.73, 108-136.6, 117-148, 163-196, 231.16-243.84, 217-258, 266.1-273.1	7-12	21-39.93	7-40.5
Gangarampur	Alluvium	26.87-30.02,53-65, 72.31-78.80,83.69-86.94,96.65-104.72,106.56-109.51,117.62-130.61, 155-164, 173-194, 168.00 – 180.00,183.00 – 195.00, 176-188,191-203	4	3-12	9-21
Harirampur	Alluvium	9-30, 16.53-54.7, 52-8, 63.53-93.22, 110-143, 112-145, 116.67-152.29, 170-186, 170.13-210, 156-210, 255-275.	9.8-38.17	6.33-33	16-30.87
Hilli	Alluvium	35-50 (within 86 mbgl)	3-40	3-12	6-60
Kumarganj	Alluvium	7-30, 18.6-48, 24.38-51.82, 75.48-93.22, 79.45-115.69, 119.57-161.22, 124.34-153.88, 161.54-193, 167.13-191.08, 171.96-229.91	13.82-29.4	17.74-41.65	23.95-57.95
Kushmundi	Alluvium	98-104,110-116	3-30	3-24	3-60
Tapan	Alluvium	62-128, 88-102, 150-178, 175-186, 175-205, 195-240.	--	14-66	11-45

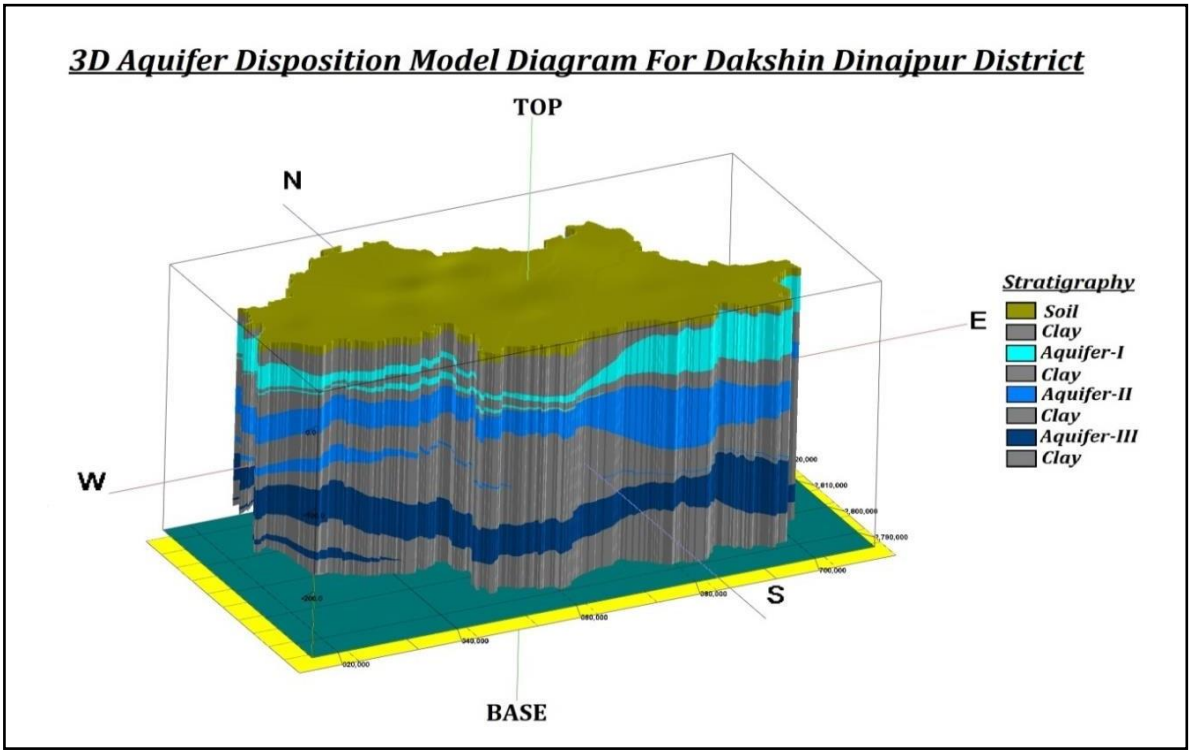

Figure-6.2: 3D Model diagram for the disposition of Aquifers in Dakshin Dinajpur District of West Bengal.

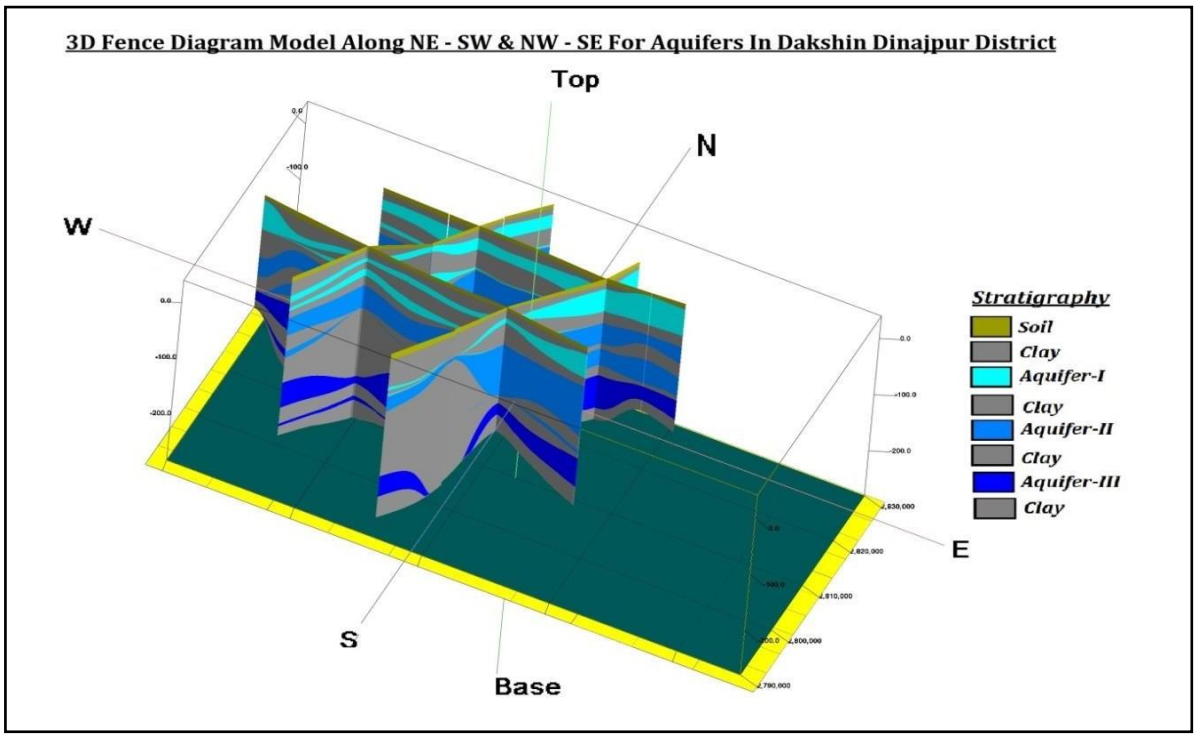

Figure-6.3: Fence model diagram for the disposition of Aquifers in Dakshin Dinajpur District of West Bengal.

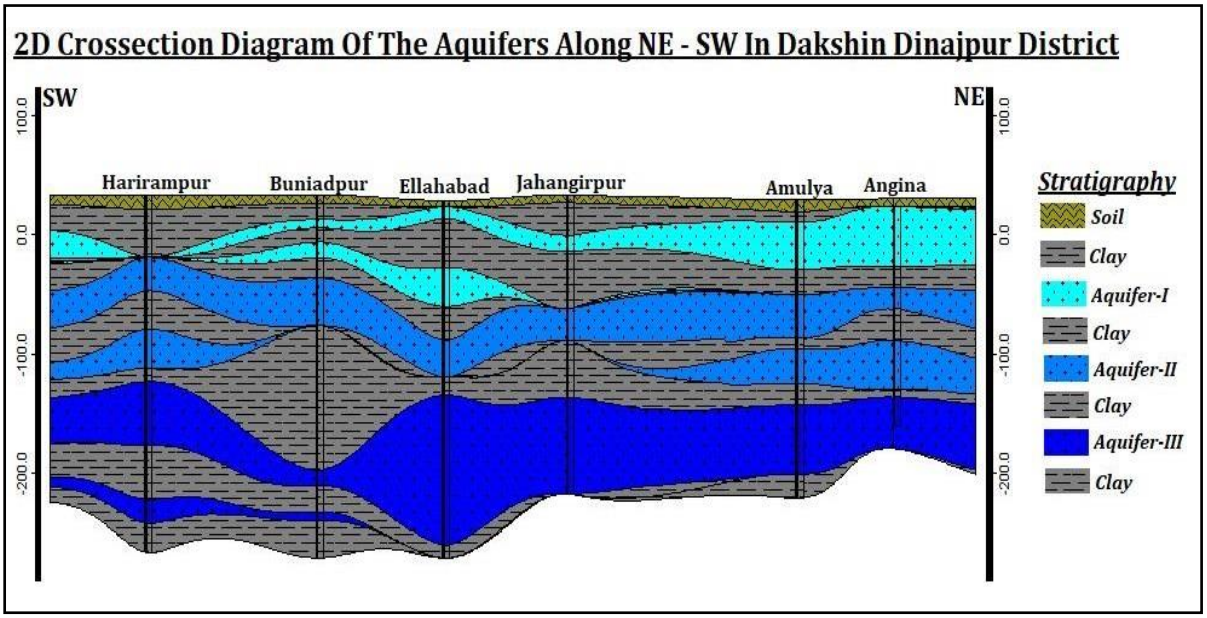

Figure-6.4: 2DCross-section diagram for the disposition of Aquifers along SW – NE in Dakshin Dinajpur district of West Bengal.

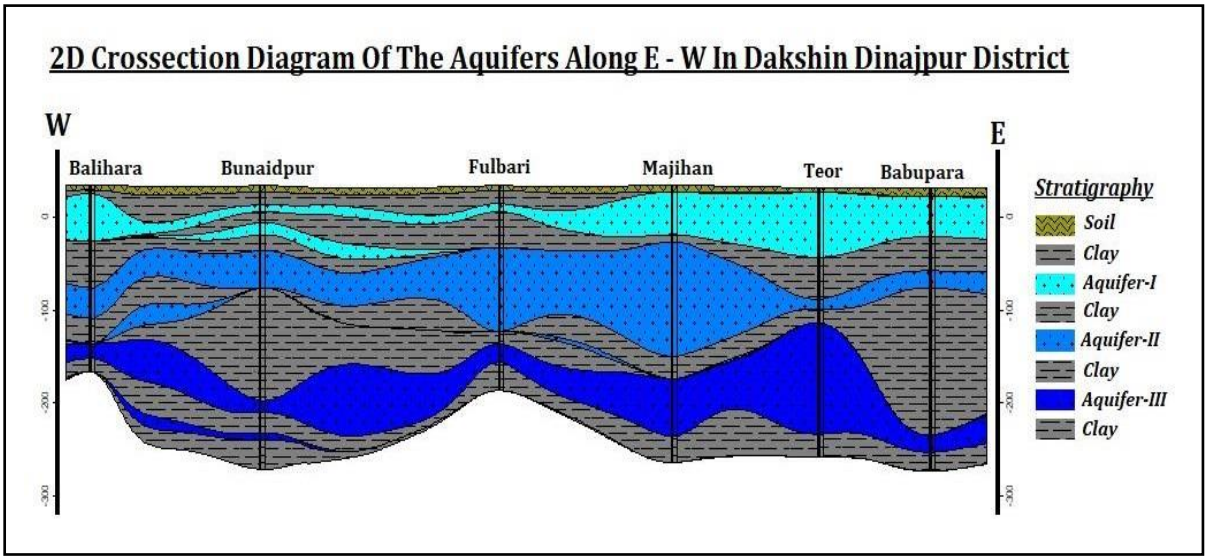

Figure-6.5: 2D Cross-section diagram for the disposition of Aquifers along W – E in Dakshin Dinajpur district of West Bengal.

6.2 Ground water Regime, Depth to water level, Wells and Fluctuations

Groundwater at shallow depths in the flood plain areas occur under phreatic conditions while, at greater depths they occur under semi-confined to confined conditions.

For the year 2019-2020, 52 monitoring wells of CGWB and SWID have been considered for study. The depth to water level range for Aquifer-I varies from 2.81-18.14 m and Aquifer-II range varies from 4.10-20.93m during the pre-monsoons. The post-monsoon variation for Aquifer-I is from 1-4.59 m and 2.15-7.40 m for Aquifer-II respectively. Deep water level is recorded in Tapan block. A groundwater mound is observed in this block during the pre-monsoon. This is suggested to be a recharge zone for the aquifers in the nearby areas.

Hydrographs of selected network stations in the district has given a conclusion that there is a rising water level trend in Sundarpur, Balurghat and Jittarhut network stations. Falling trend is observed in Buniadpur, Narori, Kushmundi, Gangarampur and Patiram network stations. However, no significant fall in the water level trend has been recorded in the district.

The ground water in the district are abstracted through a system of dug wells, hand pumps, shallow tube wells and deep tube wells. The water from these sources is supplied through pipelines to the population in the area for drinking and domestic purpose. There is a network of piped water supply schemes by PHED. The depth of dug wells varies from 12.5 to 20.0 mbgl. The depth of the medium tube wells and shallow tube wells installed by PHED, ranges from 70 to 140 mbgl and 40 to 80 mbgl respectively. These wells tap aquifers with granular zones thickness of 6-9 metres. The depth of the exploratory wells constructed by Central Ground Water Board varies from 69.6 mbgl at Hussainpur, Balurghat block to 244.06 mbgl at Laskarhat in Tapan block; tap 12-48 m of granular zones.

The results of ground water exploration and subsequent development of aquifers by the State Government department through construction of production tube wells have established that aquifers of considerable thickness occur within shallow depth from ground level throughout the district except in some few patches in the Barind tracts and these aquifers have large yield prospects (40-130 m^3/hr) for economic drawdown.

The district of DakshinDinajpur has well defined seasonal rainfall and the water table rise and fall in annual cycle. The rise corresponds to the rainfall period and the fall stage corresponds to the dry/lean period. The monitoring/network stations over the district reveals that the deepest water level occur during the month of April/May and most shallow during the month of October/November. Fluctuation for the given study area is considered by taking April month as the Pre-monsoon and November month as the Post-monsoon. The magnitude of fluctuation of water level in a particular area is influenced by its climate, drainage, topography, relief and the existing hydrogeological conditions. The fluctuation tends to diminish from a higher to lower altitude corresponding to areas of recharge and discharge.

The water level range, fluctuation and trends for the blocks in the study area are given in the table below.

Table-6.3: Long term trends for Aquifer-I & II during Pre-monsoon and post-monsoon season in the last 10 years (2009-2018)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Balurghat	I	-	-	-	-	-	-
	II& III	6.16-10.01	-	0.540	2.88-5.89	-	0.339
Bansihari	I	-	-	0.159		-	0.036
	II& III	6.36-13.58	0.258	-	4.23-7.40	-	0.279
Gangarampur	I	3.52-8.68	-	5.230	1.82-3.74	-	0.115
	II& III	7-10.9	-	0.49	3.82-5.15	-	0.517
Harirampur	I	3.55	-	-	1.54	-	0.111
	II	10.44-11.42	-	-	3.14-7.20	-	-
Hilli	I	9.24	-	0.43	1.66-4.36	-	0.016
	II& III	7.6-7.40	-	0.018	2.15-2.65	-	0.174
Kumarganj	I	5.08-12.80	0.229	-	1.25-2.19	0.106	-
	II& III	9.37-13.11	5.090	-	2.50-2.71	0.198	-
Kushmundi	II& III	-	-	0.070	-	-	-
	II	4.10-9.63	0.389	-	2.95-4.02	-	0.053
Tapan	I	2.81-18.14	-	1.003	1-4.59	-	0.330
	II& III	17.14-20.93	-	0.283	1.77-6.54	-	0.356

The water level contour maps, water table contour maps and fluctuation maps for both shallow and deeper aquifers are shown in the following pages.

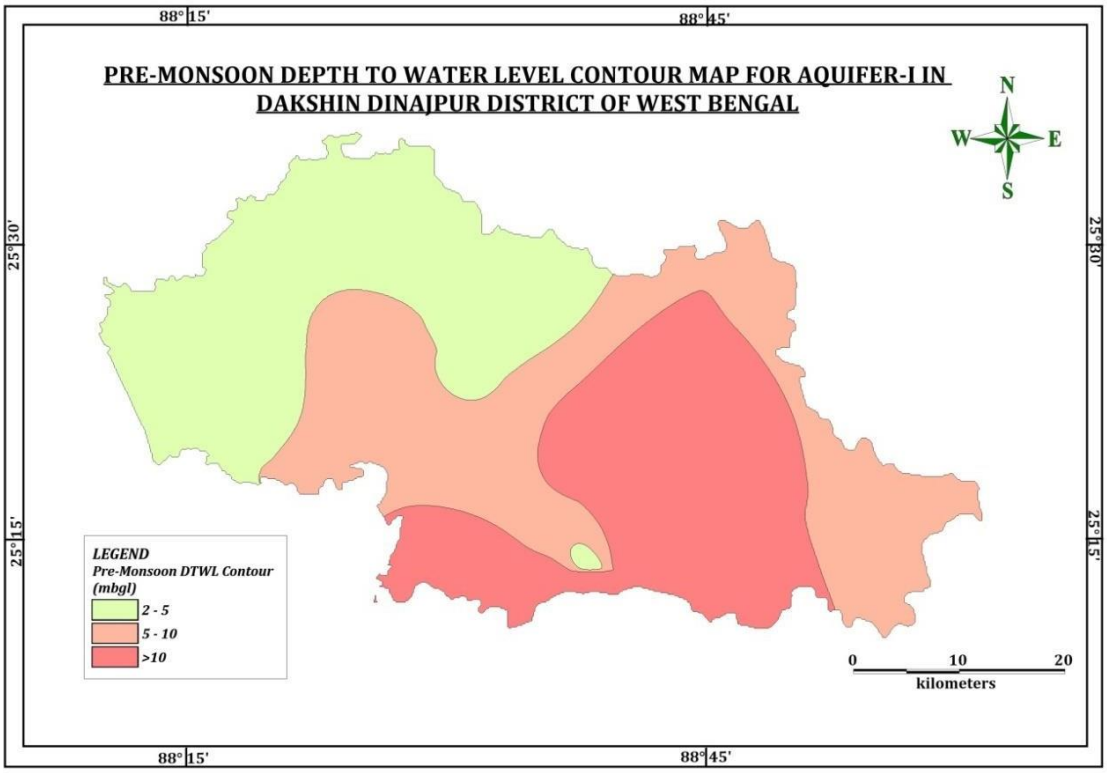

Figure-6.6: Pre-Monsoon DTWL Contour map for Aquifer-I in Dakshin Dinajpur district of West Bengal.

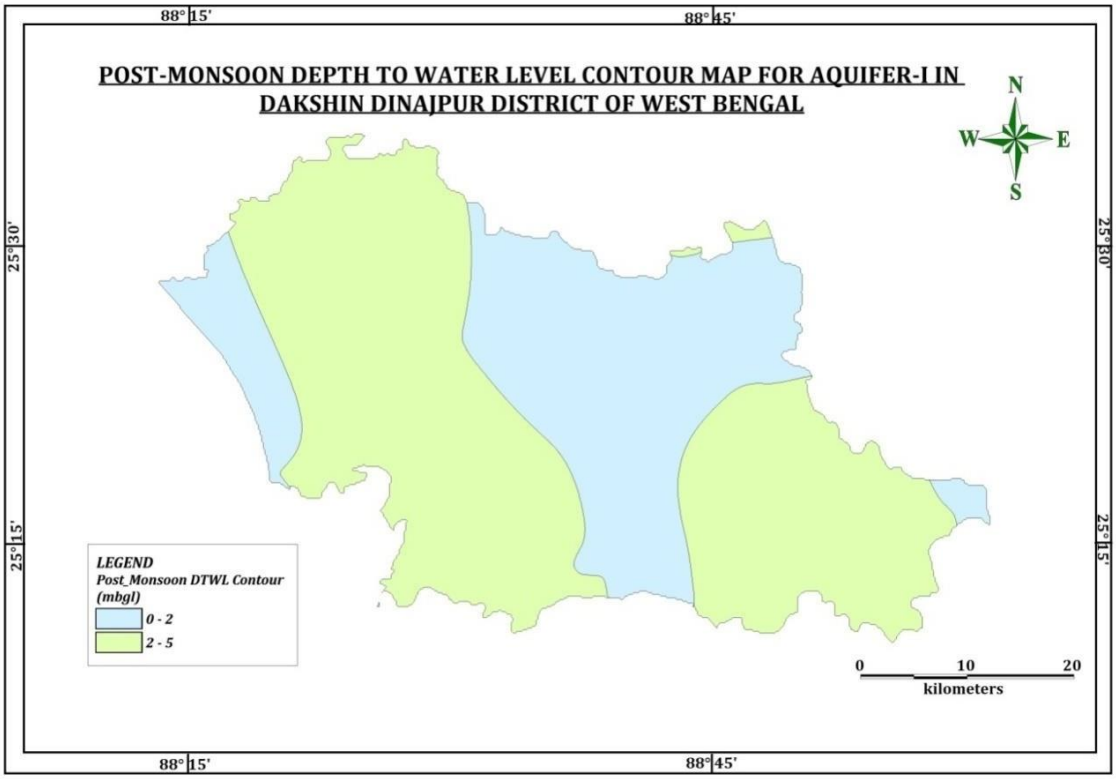

Figure-6.7: Post-Monsoon DTWL Contour map for Aquifer-I in Dakshin Dinajpur district of West Bengal

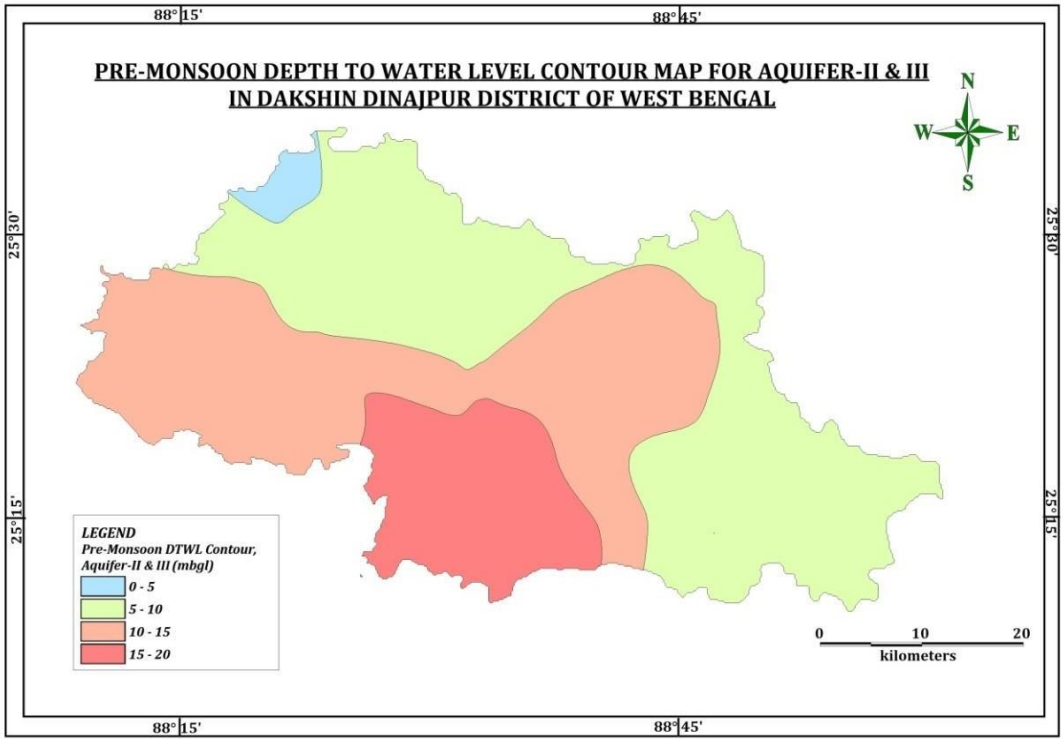

Figure-6.8: Pre-Monsoon DTWL Contour map for Aquifer-II & III in Dakshin Dinajpur district of West Bengal.

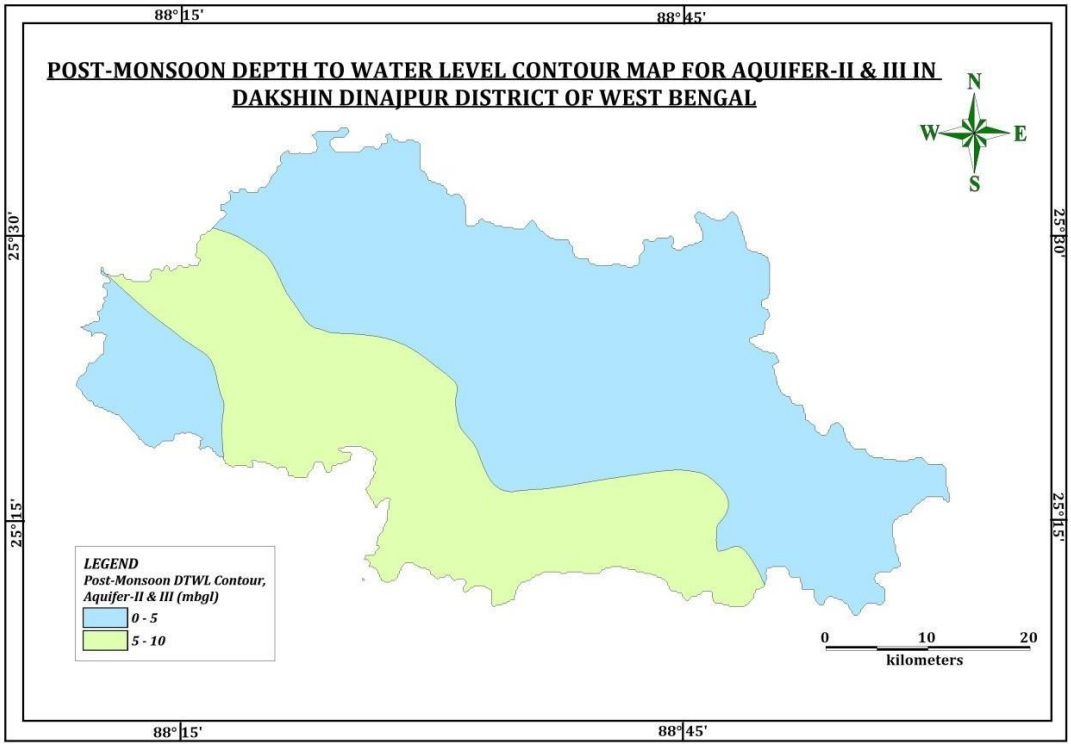

Figure-6.9: Post-Monsoon DTWL Contour map for Aquifer-II & III in Dakshin Dinajpur district of West Bengal.

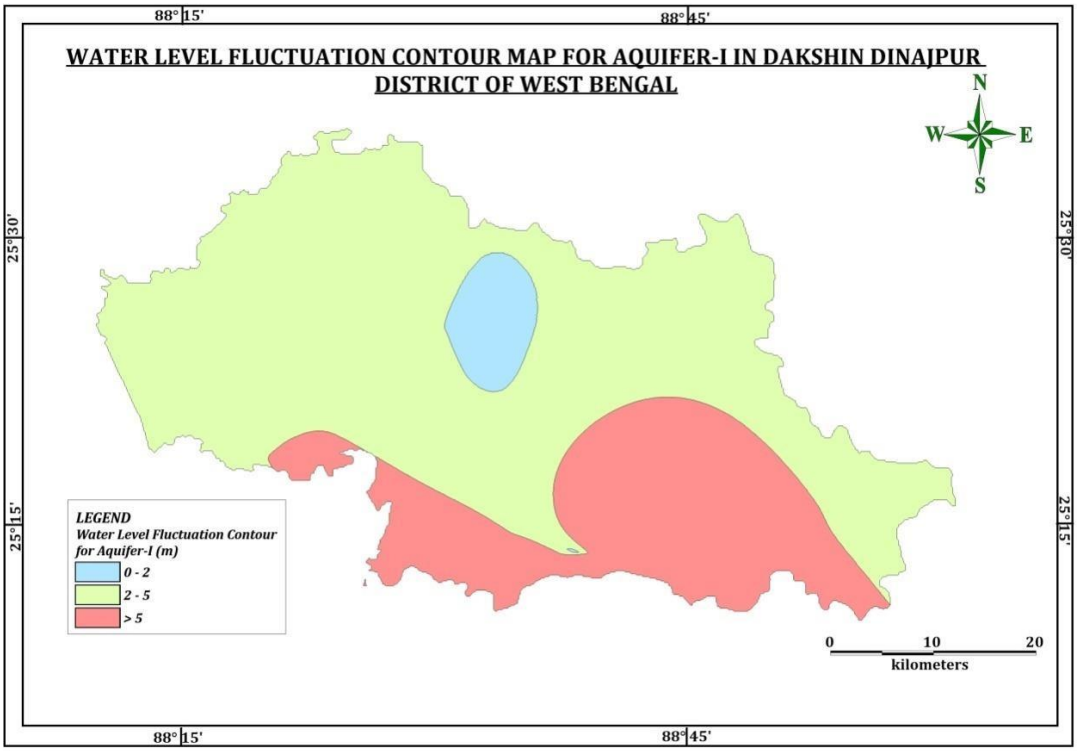

Figure-6.10: Water Level Fluctuation Contour map for Aquifer-I in Dakshin Dinajpur district of West Bengal.

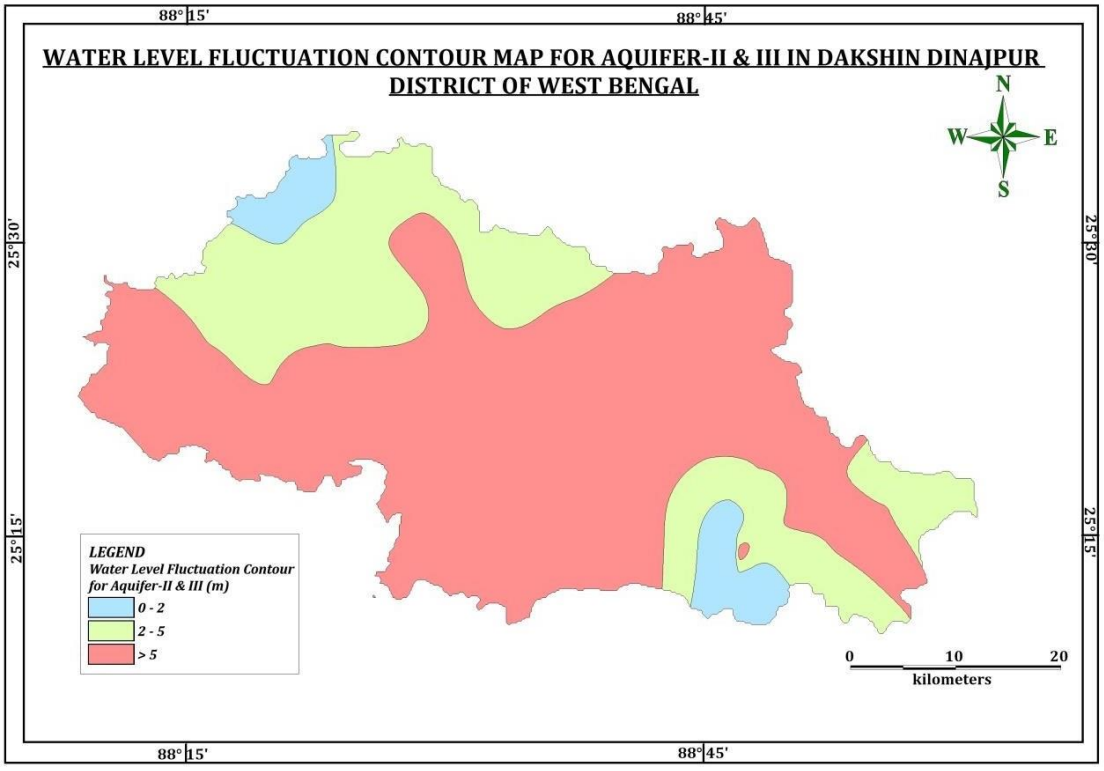

Figure-6.11: Water Level Fluctuation Contour map for Aquifer-II & III in Dakshin Dinajpur district of West Bengal.

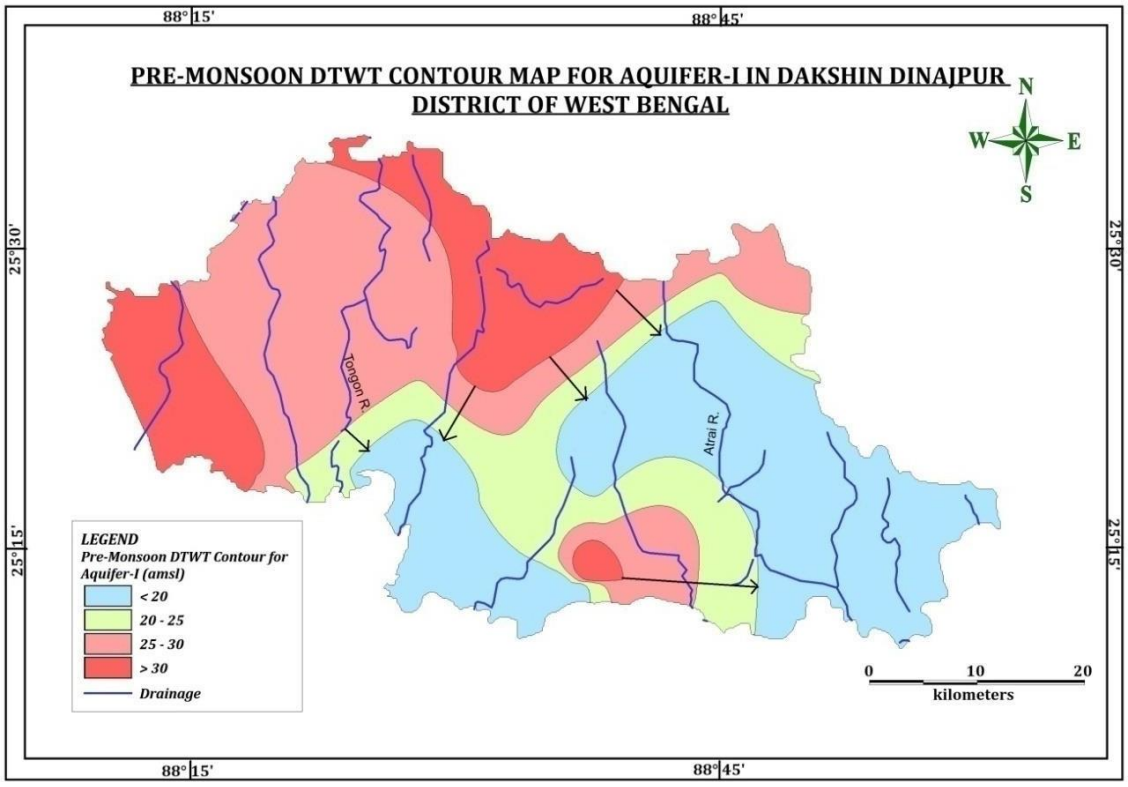

Figure-6.12: Pre-Monsoon DTWT Contour map for Aquifer-I in Dakshin Dinajpur district of West Bengal.

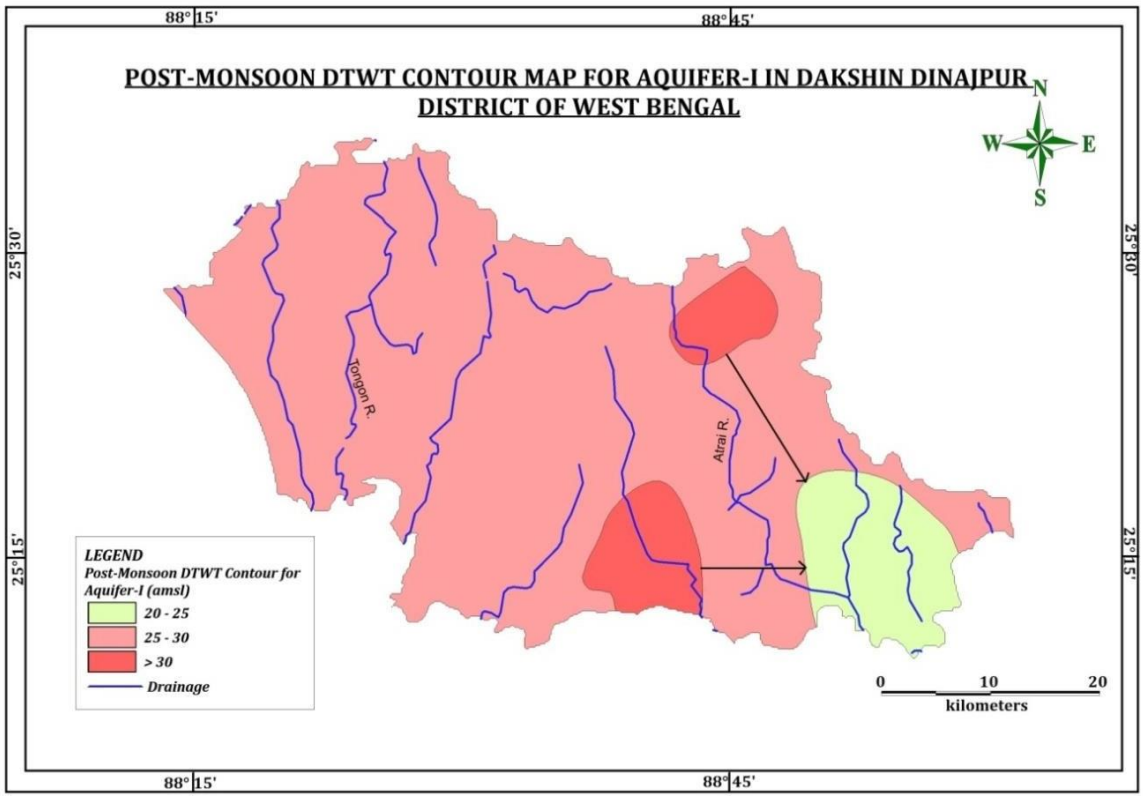

Figure-6.13: Post-Monsoon DTWT Contour map for Aquifer-I in Dakshin Dinajpur district of West Bengal.

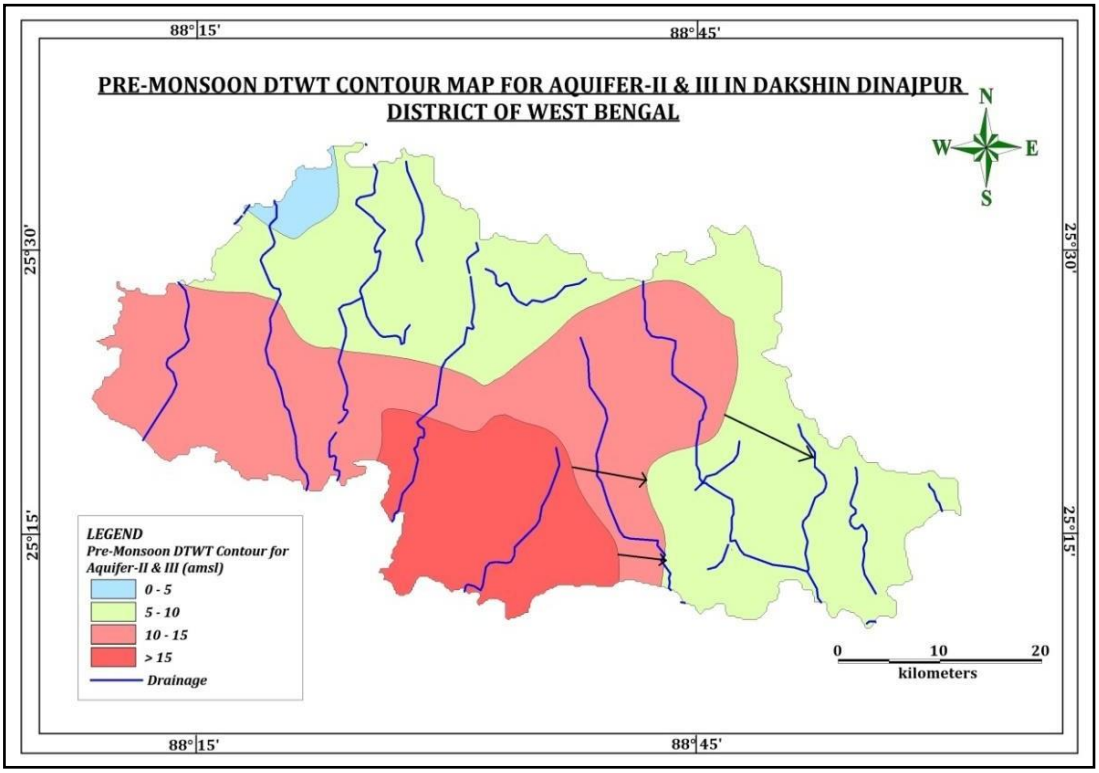

Figure-6.14: Pre-Monsoon DTWT Contour map for Aquifer-II & III in Dakshin Dinajpur district of West Bengal.

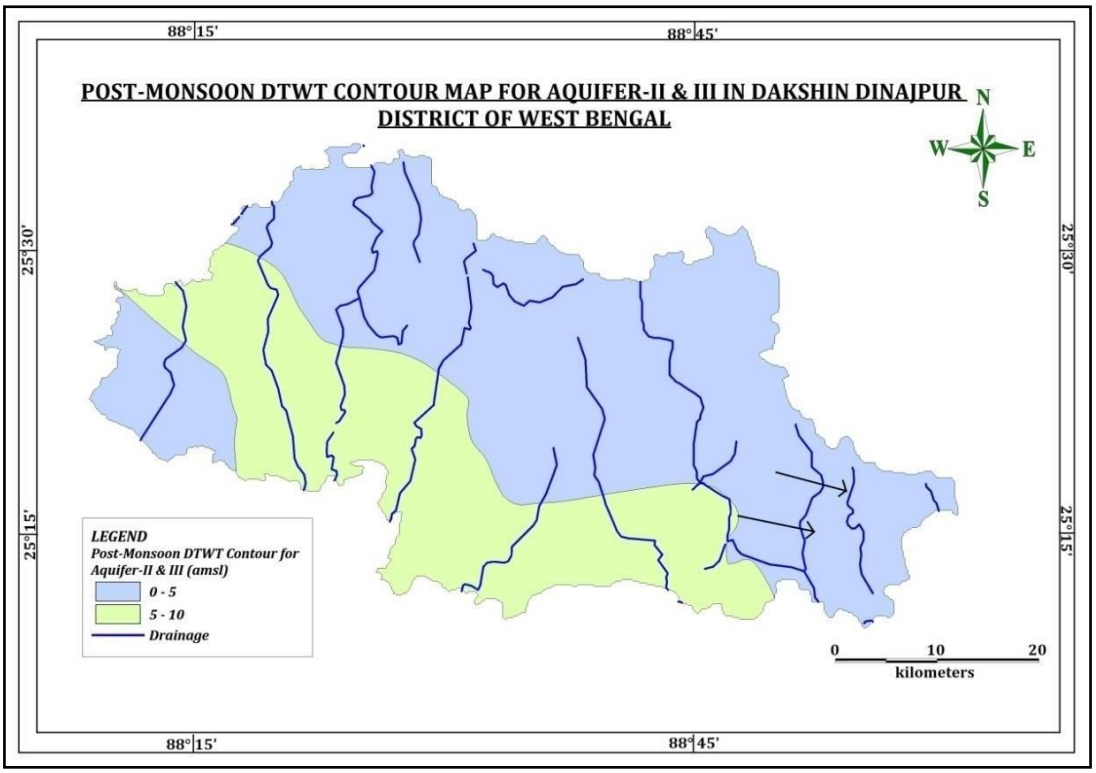

Figure-6.15: Post-Monsoon DTWT Contour map for Aquifer-II & III in Dakshin Dinajpur district of West Bengal.

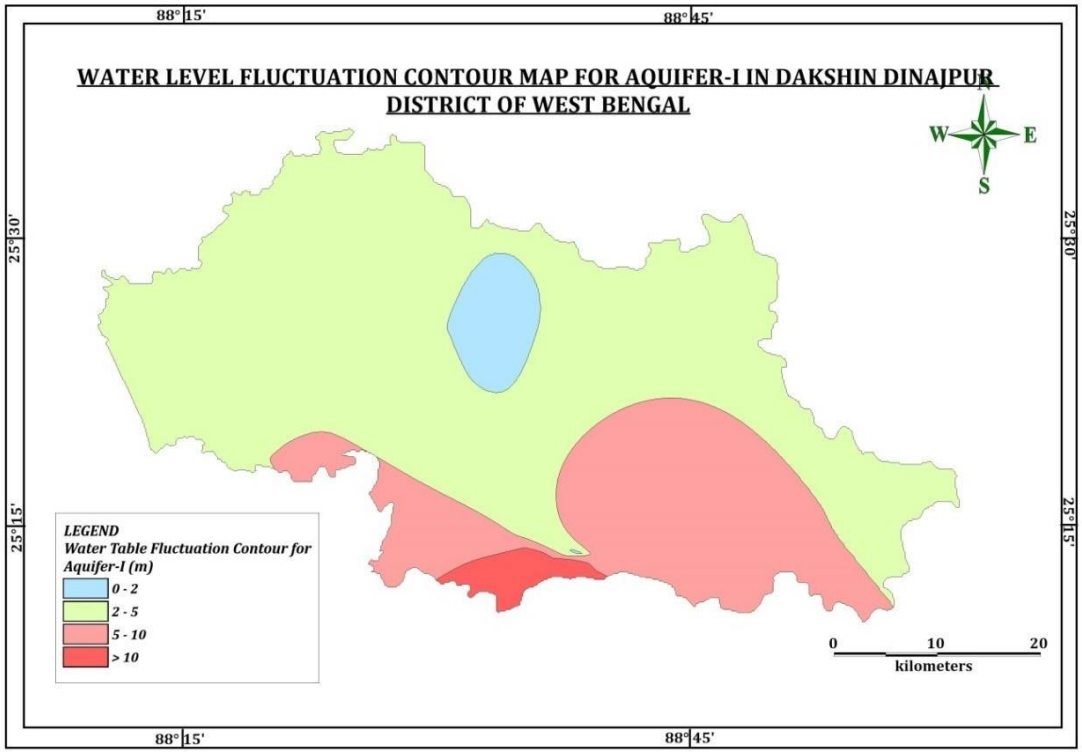

Figure-7.16: Water Table Fluctuation Contour map for Aquifer-I in Dakshin Dinajpur district of West Bengal.

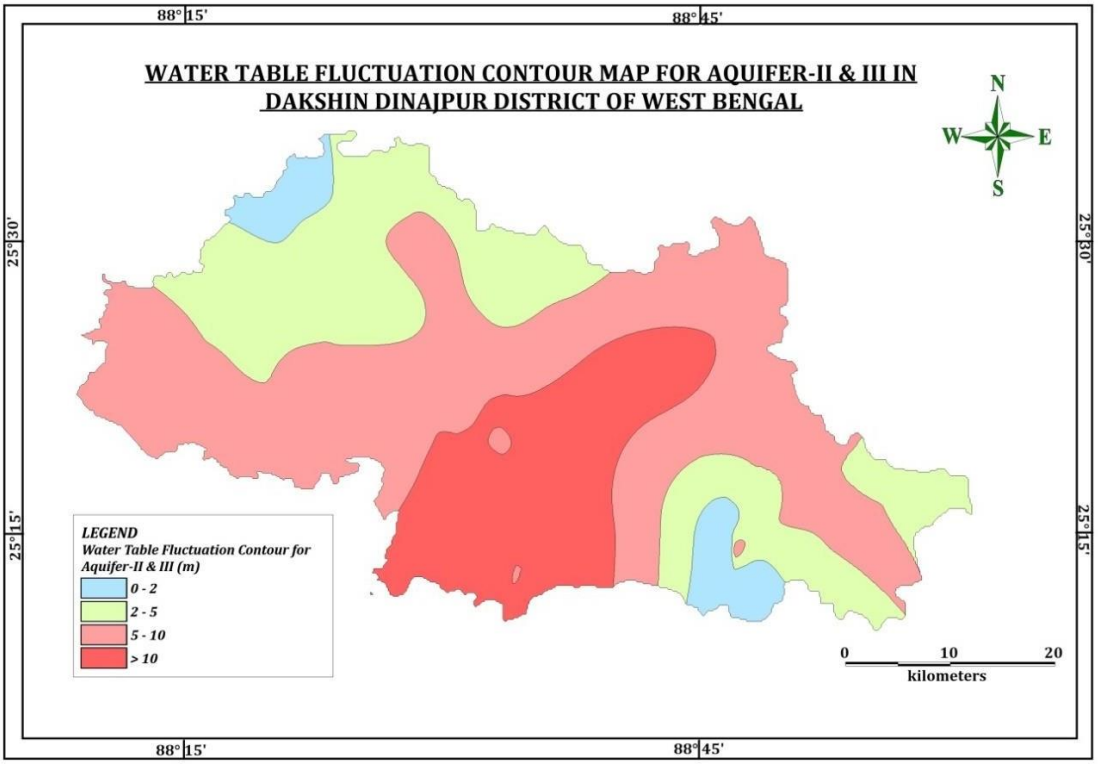

Figure-7.17: Water Table Fluctuation Contour map for Aquifer-II & III in Dakshin Dinajpur district of West Bengal.

CHAPTER- 7

GROUND WATER RESOURCE ESTIMATION

7.1 Dynamic water resource

The present chapter deals with the resources available in the study area. The Dynamic Resource of the area for 2017 has been calculated jointly by CGWB and SWID (State Water Investigation Directorate) using GEC-2015 methodology. The irrigation data available to the 5th Minor Irrigation Census(yet to be published), block wise demographic data of 2011 Census, CGWB water level data, cropping pattern, annual monsoon rainfall and normal rainfall provided the basic input for calculating the resources of the state. Block wise (Groundwater assessment unit) geographical area, area under different hydro-geological sub-provinces (sub-units), area under command and non-command, poor ground water quality area and ground worthy recharge area has also been considered. Gross current draft for all uses, recharge from rainfall, recharge from other sources like tanks, ponds, canal seepages, return flow from ground water and surface irrigation has all been considered. The number of abstraction structures and their unit draft has been taken into account for computation of irrigation draft. The projected population of 2025 (based on census 2011) and per capita consumption (60 lpcd) have been considered for computation and 70 % of the obtained figure is taken as the domestic and industrial draft.

As per the computation, the net ground water availability for recharge forDakshin Dinajpur district is estimated at 150689.14 Ham, while the total extraction for all uses is estimated at 80049.2 Ham. The categorization of the blocks has been done based on their Stage of Development and long term water level trend.

7.1.1 Ground water recharge and resource

Recharge from ground water irrigation through a system of abstraction structures like deep tube wells, shallowtube wells and dug wells, surface water irrigation by surface lift and flow modes and rainfall has been separately calculated for both monsoon and non-monsoon periods. The annual recharge for this district is relatively high and the maximum recharge is from monsoon rainfall. The result of high recharge components in these alluvial dominated areas can also be due to the additional return seepage from irrigation for cultivation of Rabi crops in winter and 'Boro' paddy in summer. The district is very well known for its rice cultivating culture.

7.1.2 Ground water draft

Groundwater draft has been computed on the basis of quantum of water likely to be used for domestic, irrigation and industrial purposes. The estimate is done by projecting the population and the number of ground water abstraction structures. The total extraction for the blocks as a whole is 80049.2 Ham.

7.1.3 Stage of development and category

The unit of assessment is categorized for groundwater development based on two criteria; Stage of ground water development and long term water level trends. The level of ground water development in Dakshin Dinajpur district (53.12%) is a little above the state average of 42%. All the blocks in the district are under 'Safe' category as their stage of groundwater development is < 70% and there is steady water level over the years. The following table gives an account of the groundwater recharge, their draft, and allocation of resource for future use, stage of development and categorization of the blocks in Dakshin Dinajpur district.

Table-7.1: Ground water Recharge, Resource and Stage of Development for Dakshin Dinajpur of West Bengal.

Block Name	Total Annual Ground Water Recharge (Ham)	Total Natural Discharges (Ham)	Annual Extractable Ground Water Recharge (Ham)	Total Extraction	Annual GW Allocation for Domestic and Industrial Use as on 2042	Net Ground Water Availability for future irrigation use	Stage of Ground Water Extraction (%)	Categorization
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Balurghat	26309.72	2630.97	23678.75	16340.43	522.12	7254.75	69.01	Safe
Bansihari	13488.21	1348.82	12139.39	4986.09	194.25	7113.11	41.07	Safe
Gangarampur	25579.73	2557.97	23021.76	16031.63	395.7	6914.85	69.64	Safe
Harirampur	13392.14	1339.21	12052.93	6009.84	193.58	5998.74	49.86	Safe
Hilli	11585.89	1158.59	10427.3	5583.99	112.09	4822.55	53.55	Safe
Kumarganj	23888.19	2388.82	21499.37	13199.59	225.36	8258.81	61.40	Safe
Kushmundi	25921.29	1296.06	24625.23	11613.09	250.89	12977.98	47.16	Safe
Tapan	25827.44	2582.74	23244.7	6284.54	376.04	16857.28	27.04	Safe
	150689.43	15303.18	150689.43	80049.2	2270.03	70198.07	53.12	

7.1.4 Irrigation Potential created and utilized

The net ground water availability for future irrigation use in the district is estimated at 70198.07 Ham. This available balance resource could be utilized efficiently as per feasibility of the area. Presently, irrigation in the district is practiced maximum through shallow tube wells **(Table-1.6)**. Since these blocks falls under 'Safe' category, there is further scope for expansion of ground water irrigation through additional irrigation potential with available resource. The irrigation potential created and the net irrigated area through means of various abstraction structures are given below in **Table -7.2.**

Table-7.2: Irrigation potential created and actual area irrigated with groundwater in Dakshin Dinajpur district of West Bengal.

District	Block	Irrigation Potential Created	Actual/Net Area Irrigated	Achievement (%)
Dakshin Dinajpur	Balurghat	32837.14	10569.44	32
	Bansihari	9740	4137	42
	Gangarampur	23406.53	10468	45
	Harirampur	9346	4990.32	53
	Hilli	9196	3568	39
	Kumarganj	24298.68	8430.56	35
	Kushmundi	18011.26	9162.6	51
	Tapan	13055.76	7738.87	59
Total		139891.37	59064.79	42

(Source: 5thMI census, yet to be published)

Apart from common abstraction structures like dug wells, shallow tube wells and deep tube wells, there are number of surface water bodies in use for irrigation in this district. As per 5th MI Census record, there are a total of 5858 water bodies in the district out of which 5064 are for non-irrigation purpose, 669 water bodies are in use for irrigation and 125 are defunct. Out of 125 defunct water bodies, 50 are found to have the possibility of being revived.

7.2 Static water resource/In-storage

Computation of in-storage is essential not only for estimation of emergency storage available for utilization in case of natural extremities like drought conditions but also for assessment of storage depletion in over-exploited areas for sensitizing stakeholders about the damage done to environment. The in-storage for the blocks under study area is listed in the table below (as of 2009).

Table -7.3: In-storage of groundwater for Dakshin Dinajpur district of West Bengal.

Sl. No.	District	Assessment Unit/ District	Total Fresh In-Storage Ground Water Resources(2009)
1	DakshinDinajpur	Balurghat	244628.5293
2	Dakshin Dinajpur	Bansihari	88110.3432
3	Dakshin Dinajpur	Gangarampur	90750.5765
4	Dakshin Dinajpur	Hilli	33972.9458
5	Dakshin Dinajpur	Kumarganj	124328.115
6	Dakshin Dinajpur	Kushmundi	111006.855
7	Dakshin Dinajpur	Tapan	102147.2914
8	Dakshin Dinajpur	Harirampur	-
	Total		**794944.6562**

CHAPTER-8

HYDROCHEMISTRY

Groundwater samples have been analyzed for Basic Parameters, Iron and other specific constituents collected from study area which consists of 8 (eight) Blocks of DakshinDinajpur District. Findings are as under–

Drinking Water Suitability

pH: pH varies from 7.05 to 8.50 (Madhabpur, Gangarampur Block), with an average of 7.93 ± 0.34. Result indicates groundwater as almost neutral to slightly alkaline in nature. All the samples are found within the permissible limit of 6.5 - 8.5 as per BIS 2012.

EC &TDS: The wide range of Electrical Conductivity (EC) as well as Total Dissolve Solids (TDS) values indicates wide variation in dissolved constituents in groundwater. The minimum conductivity value of 161 µS cm^{-1} (at 25°C) has been observed at Balarampur and TapanBlock whereas, maximum conductivity value of 2243 µS cm^{-1} (at 25°C) has been observed at Madnahar of Gangarampur block. As per the salinity hazard classes noanalyzed sample was found unsuitable (i.e., EC>2250 µS cm^{-1}) for drinking. The median value for the samples is 493 µS cm^{-1}. Six samples from four different blocks *viz.*Bansihari, Gangarampur, Kushmandi and Tapan showed TDS values higher than the Desirable Limit of 500 mg l^{-1}but no sample has TDS value higher than the permissible limit of 2000 mg l^{-1}.

Total Hardness as $CaCO_3$: In general, the quality of groundwater in terms of Total Hardness as $CaCO_3$ has been found in the range 50 – 739 mg l^{-1} (Madnahar of Gangarampur Block). Analyzed samples are found as under.

Table -8.1: Range of Values analyzed for Total Hardness as CaCO3 in Dakshin Dinajpur district of West Bengal.

Water Class	TH as CaCO3 in mg/L	No. of Samples	% of Samples
Soft	<75	01	03
Moderately Hard	75–150	12	34
Hard	150–300	16	46
Very Hard	>300	3	09

Ca & Mg: The maximum concentration of Ca has been found as 246 mg l^{-1} at Madnahar of Gangarampur Block; Mg has been observed at75mg l^{-1}at Shib Bari of Gangarampur Block.

Na & K: The concentration of Na ranges from 5mg l^{-1}at Balapur, Tapan Blockto 241mg l^{-1}atBalapur of Banshihari block with an average of 51 ± 52 mg l^{-1}. K ranged from 0.70mg l^{-1} at Chausa, KushmandiBlockto80mg l^{-1} at Shib Bari of Gangarampur with an average of 09 ± 17 mg l^{-1}.

Carbonate & Bi-Carbonate: Only 4 samples from 3 blocks *viz.* Gangarampur, Kushmandi and TapanBlocks contains carbonate. All the samples are characterized by the presence of Bi-carbonate. The value of Bi-carbonate alkalinity in study area ranged from 31 mg l^{-1} (Balapur, Tapan) to 305 mg l^{-1} (Lalchandpur, Gangarampur) with an average of 154 ± 74 mg l^{-1}.14%. Samples from three of eight studied Blocks showed Total alkalinity as calcium carbonate concentration higher than the acceptable limit of 200 mg l^{-1} with a highest detected concentration of 250mg l^{-1}(Lalchandpur, Gangarampur). All samples lie within the permissible limit of 600 mg l^{-1}.

Chloride, Nitrate& Sulphate: Chloride content of groundwater varies from 7 mg $l^{-1}$to 656mg l^{-1} (Madnahar,Gangarampur)**.** 12%of the analyzed sample from three blocks *viz.*Banshihari, Gangarampur and Tapan show Chloride concentration higher than the acceptable limit of 250 mg l^{-1}but below the permissible limits of 1,000 mg l^{-1} as per BIS (2012). Nitrate concentration of the analyzed samples ranged from traces to 20 mg l^{-1} (Sundarpur, Kumarganj). NO_3 concentration in samples lie within the permissible limit of 45 mg l^{-1} (BIS: 2012).Concentration of sulphate ion ranges from traces to 55 mg l^{-1}(Tapan, Tapan). None of the samples showed sulphate concentration higher than the acceptable limit of 200 mg l^{-1} (BIS: 2012).

Fluoride: Fluoride ion concentration varies from 0.10 mg l^{-1} to 2.90 mg l^{-1}, detected from Nayabazar of Gangarampur block. 23% of the analyzed sample from four Blocks *viz.*Balurghat, Banshihari, Gangarampur and Kushmandi showed Fluoride concentration higher than the permissible limit of 1.5 mg l^{-1} (BIS: 2012).Along with these four blocks, Kumarganj and Tapan are all reported as fluoride affected blocks by Fluoride Task Force, Govt. of West Bengal.

Iron (Fe): As per BIS (2012), the Permissible Limit for Iron in drinking water is 1.0 mg l^{-1}. The Fe content from the samples in the study area range between Traces to 9.4 mg l^{-1}. The maximum Concentration was observed from Samjia of Kumarganj Blocks. Only 32% of the analyzed samples have Fe concentration more than permissible limit and the samples are from five blocks *viz.* Gangarampur, Hilli, Kumarganj, Kushmandi and Tapan. It has been observed from ANOVA analysis that no statistically significant difference of mean of Iron has been observed from the two sample sources *i.e.* Dug well and Tube well but it has been recorded that samples from the tube well possessed comparatively higher level of contaminants than the samples from the dug wells.

Arsenic (As): Arsenic from the samples has values below the permissible limit of 0.01 mg l^{-1}. Though no block of Dakshin Dinajpur has been found Arsenic affected as per CGWB study but Arsenic Task Force, Govt. of West Bengal has declared Balurghat Block as arsenic affected. The range of Arsenic in the district ranges from Traces to 0.005 mg L^{-1}(Samjia, Kumarganj).

Uranium (U): The range of Uranium varies from traces to 0.007 mg l^{-1}. The highest concentration is observed at Thangapara, Gangarampur Block. All of the analyzed groundwater samples were found safe (U<0.03 mg L^{-1}, WHO provisional guideline) as per observed Uranium concentration.

The EC & TDS Contour map, Fluoride & iron (Fe) spot map are given in the following page.

Table-8.2: Drinking Water Suitability and overview of the Physio-chemical Constituents in Dakshin Dinajpur district of West Bengal.

Constituents		Acceptable Limit	Permissible Limit	Total No. of Sample Analyzed	No. of Samples beyond Acceptable Limit	Samples beyond Acceptable Limit (%)	No. of Samples beyond Permissible Limit	Samples beyond Permissible Limit (%)
pH		6.5-8.5	No Relaxation	35	-	-	-	-
Total Hardness (as $CaCO_3$)	mg/L (ppm)	200	600		408	46.00	22	2.48
Calcium (as Ca)		75	200		54	6.09	1	0.11
Magnesium (as Mg)		30	100		369	41.60	17	1.92
Total alkalinity (as $CaCO_3$)		200	600		325	36.64	4	0.45
Chloride		250	1000		62	6.99	2	0.23
Nitrate		45	No Relaxation		60	6.76	-	-
Sulphate		200	400		4	0.45	0	0.00
Fluoride		1	2		68	7.67	28	3.16
TDS		500	2000		235	26.49	5	0.56
Iron		1	No Relaxation		201	22.66	-	-
Arsenic		0.01	No Relaxation		-	-	-	-
Uranium		0.03	No Relaxation		-	-	-	-

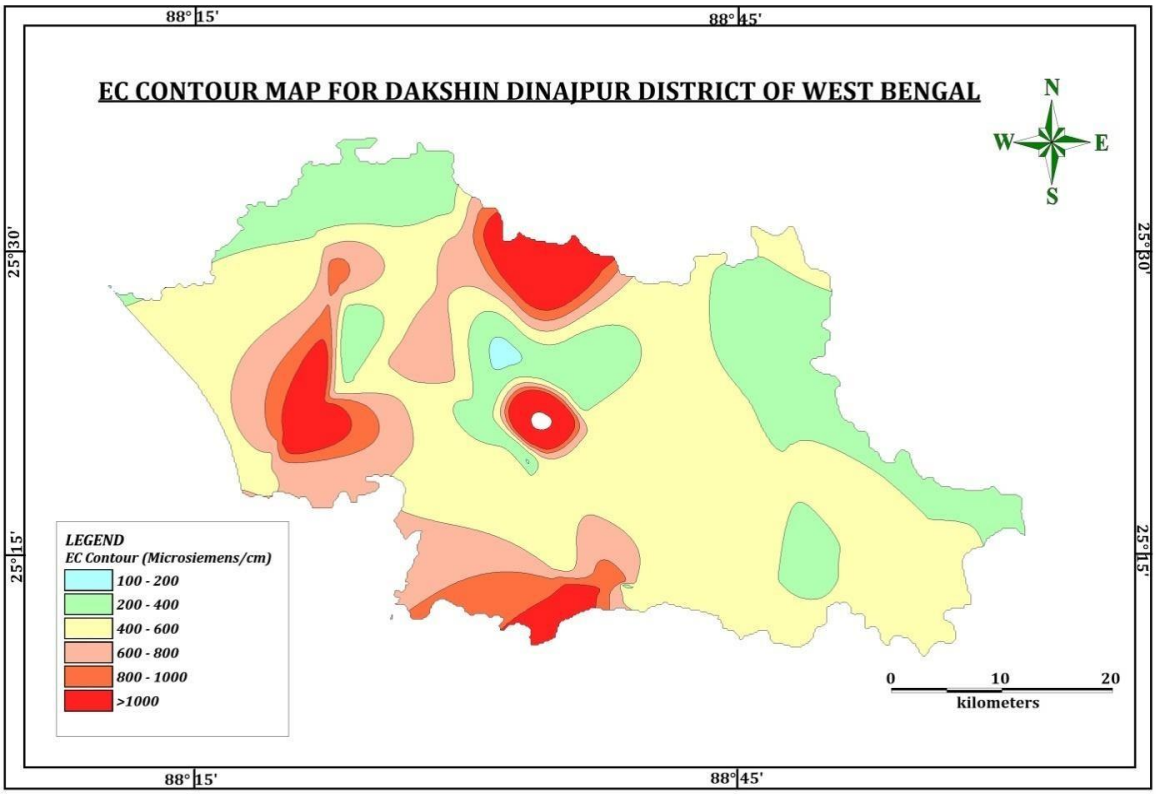

Figure- 8.1: EC Contour Map for Dakshin Dinajpur district of West Bengal.

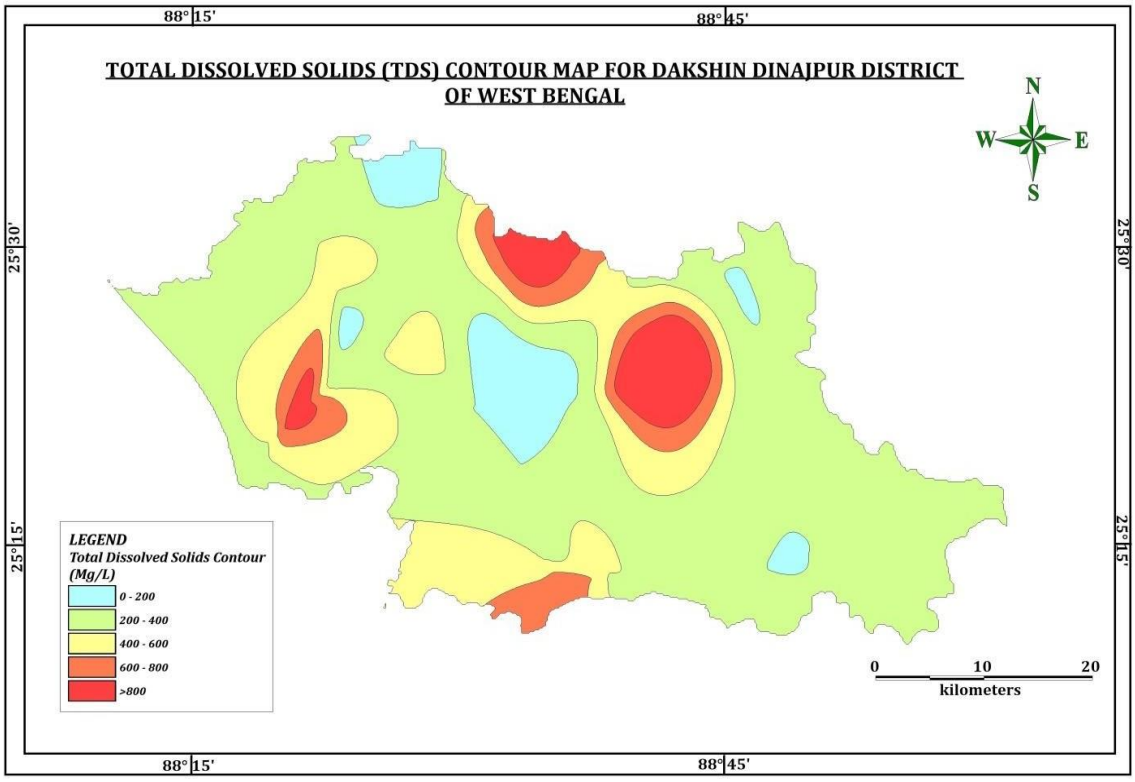

Figure- 8.2: Total Dissolved Solids (TDS) Contour Map for Dakshin Dinajpur district of West Bengal.

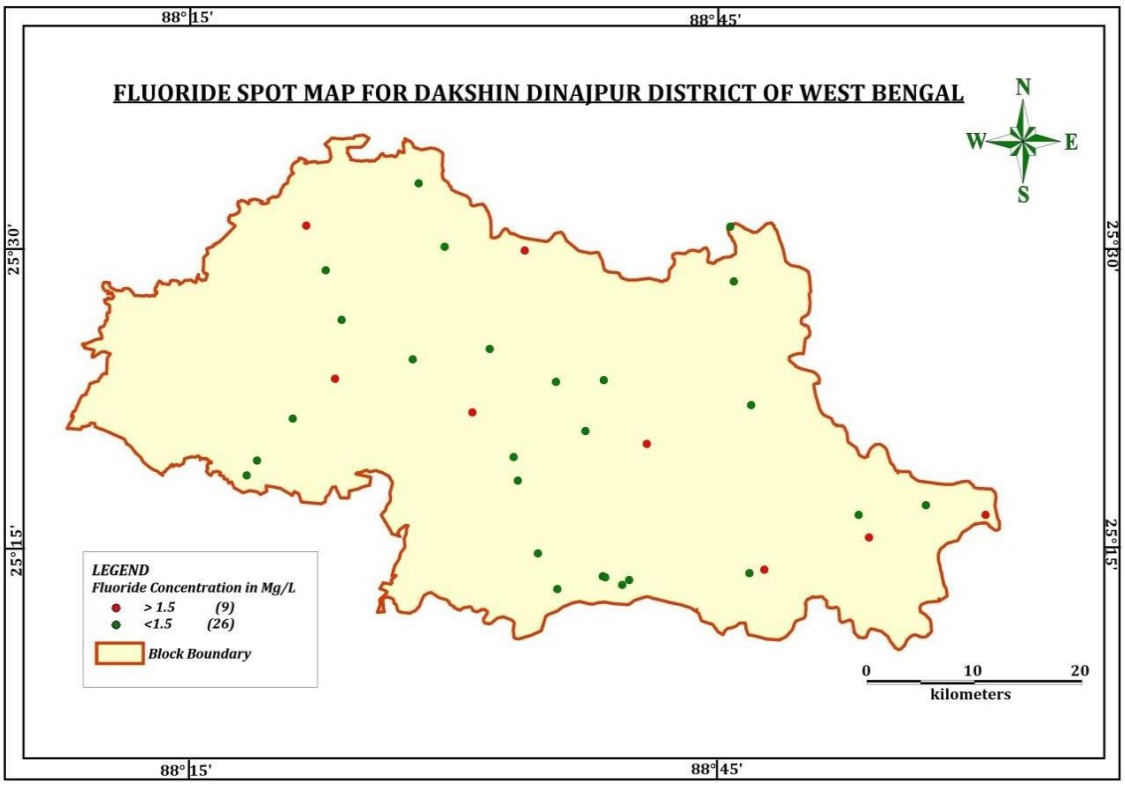

Figure- 8.3: Fluoride Spot Map for Dakshin Dinajpur district of West Bengal.

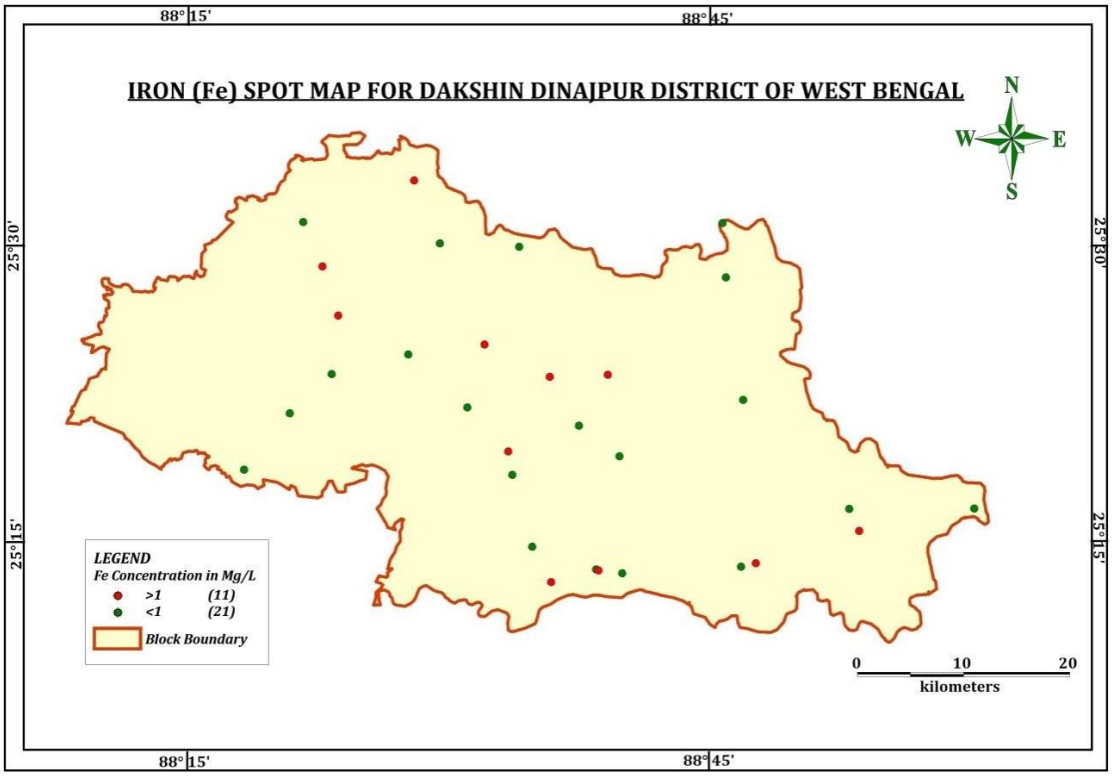

Figure- 8.4: Iron (Fe) Spot Map for Dakshin Dinajpur district of West Bengal.

Irrigation Suitability

Irrigation water quality is generally assessed by some determining factors such as sodium absorption ratio (SAR), soluble sodium percentage (SSP), residual sodium carbonate (RSC), and electrical conductance (EC). Along with the above indicators, some additional indices to categorize the groundwater for irrigation are Magnesium Adsorption Ratio (MAR), Kelly's ratio (KR), Permeability Index (PI), Residual Sodium Bicarbonate (RSBC).

Table-8.3: Summarized table for various indices to assess the suitability of the groundwater for Irrigation in Dakshin Dinajpur district of West Bengal.

SN	Indices	Minimum	Maximum	Average	Standard Deviation
1	Sodium Absorption Ratio (SAR)	0.23	6.44	1.58	1.28
2	Soluble Sodium Percentage (SSP)	6.99	66.57	36.34	11.60
3	Magnesium Adsorption Ratio (MAR)	16.00	81.58	49.39	15.14
4	Kelly's Ratio (KR)	0.07	1.98	0.61	0.47
5	Permeability Index (PI)	35.43	106.86	67.40	18.58
6	Residual Sodium Carbonate (RSC)	-10.77	1.70	-1.29	2.32

Sodium Adsorption Ratio (SAR): The irrigation water quality index of Sodium Adsorption Ratio (SAR) forall the analyzed samples fall under the category of low sodium hazards (in excellent category *i.e.,*<10), which reveals that the groundwater in the district is free from any sodium hazard.

Soluble Sodium Percentage (SSP): SSP<50 indicate good quality of water and higher values (i.e.>50) show that the water is unsafe or irrigation. It has been observed that 77% samples from the district were found safe and rest 33% were found as doubtful or unsuitable.

Magnesium Adsorption Ratio (MAR): Approximately only 50% of total samples has been obtained within the acceptable standard of 50 and rest 50% samples possesses threat of harmful effect related to infiltration problem of soil.

Average Kelly's Ratio (KR): 80% samples have values less than the permissible value of 1.0, showing a good balance of sodium, calcium and magnesium ions.

Permeability Index (PI): Based on the Permeability Index (PI) values, the irrigated water can be classified as Class I (>75 %), Class II (25-75 %) and Class III (<25 %). Nearly 37 % of the samples fall under Class I category and another 49 % of the samples belong to the Class II category, indicating that the water is moderate to good for irrigation purposes. It means, mostly a good tilth condition of the soil with no permeability problem.

Residual Sodium Carbonate (RSC): None of the samples from the district have RSC value >2.5 *i.e.,* all are found safe for irrigation.

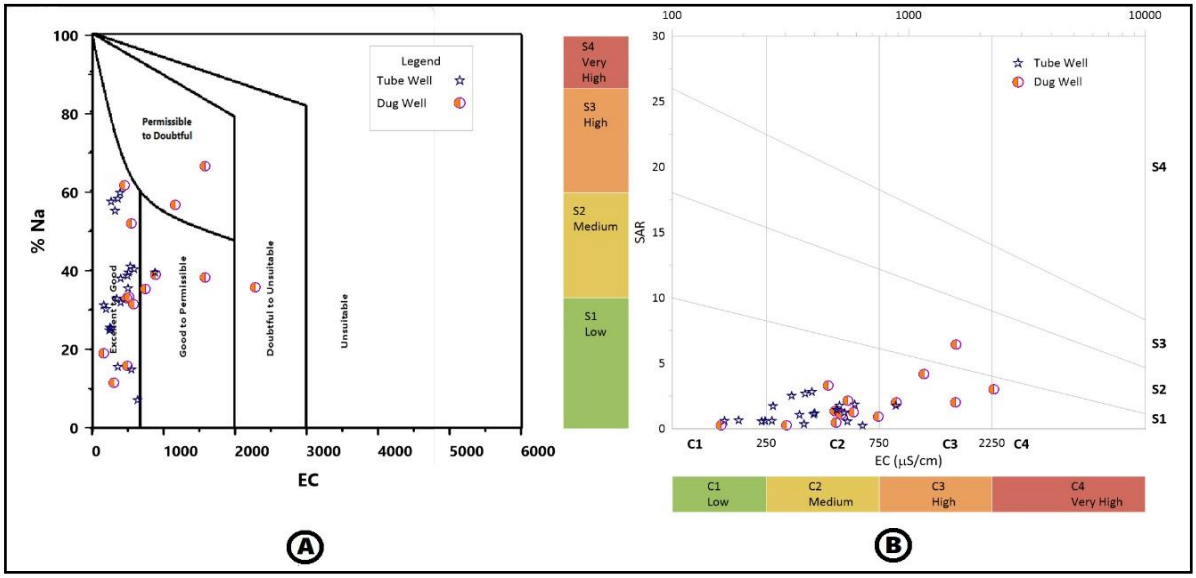

Figure-8.5: Samples of the Study Area of Dakshin Dinajpur plotted in Wilcox Diagram (A) and US Salinity Diagram (B) for Irrigation Suitability.

Wilcox Diagram classification of groundwater for irrigation purposes is based on Percent Sodium and EC. The classification of studied groundwater samples is shown in Figure 8.5(A). The plot reveals that only two samples falls in permissible to doubtful category and one in doubtful to unsuitable category. The rest of the samples are in excellent to permissible category for irrigation purpose.

US Salinity Diagram: According to US salinity diagram {Figure 8.5(B)}, groundwater samples collected from the district fall in S1-C1 (14%), S1-C2 (69%), S1-C3 (11%) category type and hence are found suitable for irrigation.

Considering pH, EC, SAR, RSC and TH the groundwater of the study area is mostly found suitable for irrigation.

Major Ion Chemistry and Hydro-geochemical Facies for Dakshin Dinajpur District.

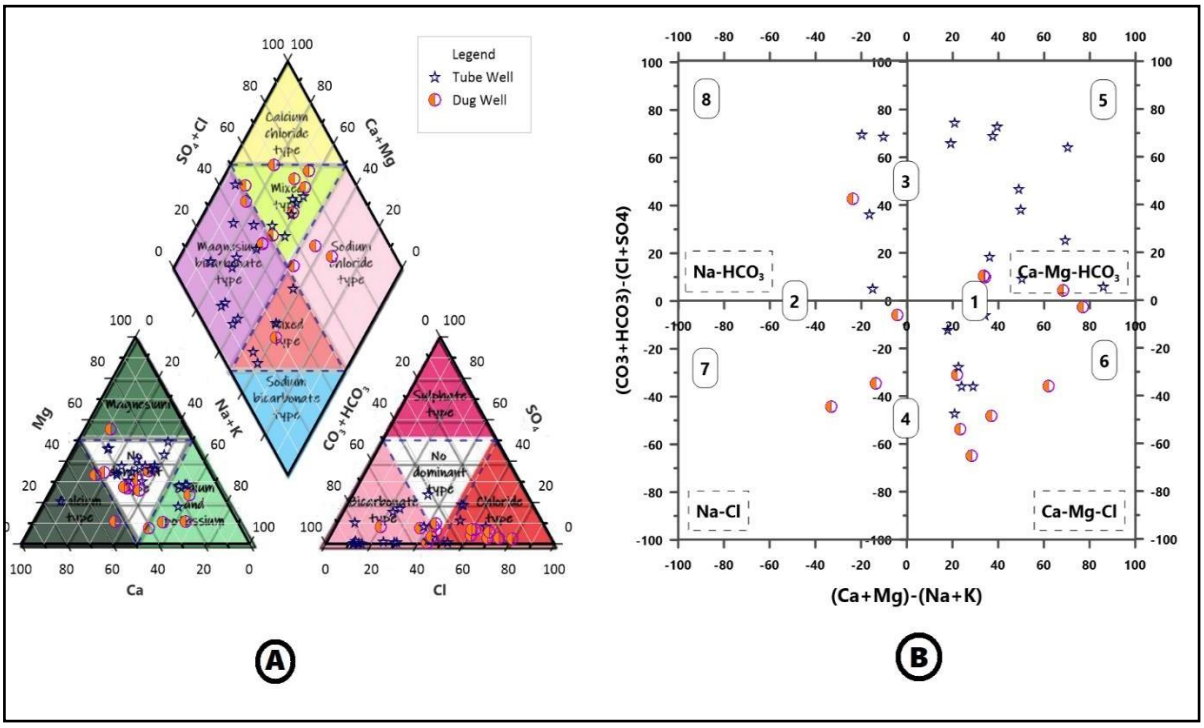

Figure-8.6: Samples of the Study Area of Dakshin Dinajpur Districts plotted in Piper trilinear diagram (A) and modified Piper diagram (Chadha, 1999) (B) for hydro-geochemical facies.

Chemical characteristics of groundwater depend on several factors such as the geology, time of residence of water in the aquifer media, etc. The composition of major ions in groundwater samples of the study area does not vary much. Samples are generally Ca^{2+} and/or Mg^{2+}- rich (69%) with $HCO_3^-$is as dominant type of anion (70%) {Figure 8.6(A)}.

Piper Trilinear diagram: This diagram shows that the as per cationic concentration, groundwater chemistry is mainly characterized by three groups irrespective of the source (Dugwell & Tube well). The first and major group is 'no dominant cation type groundwater' (71%); few samples are of Calcium Type (9%) and some Sodium Potassium Type (20%). As per anionic concentration, 66% samples are HCO_3^- - type.3% of the samples are no dominant anion type and 31% samples Cl^- - type.

Chadhas Diagram {Figure 8.2(B)}: This diagram also supports the presence of Alkaline earths exceeding alkalis and dominance of weak acids exceeding strong acids. From the plot,71% samples have also been classified as Ca^{2+}-Mg^{2+}-HCO_3^-or Ca^{2+}-Mg^{2+}-Cl^-– type with similar ion compositions, which indicates rapid and frequent water-rock exchange and modern recharge in the region. Most of the samples depict origin from shallow groundwater aquifers followed by recharging with fresh water. The major hydrochemical process is weathering-solubilization. Groundwater characterized by low sodium and chloride content signifies absence of any inland salinity hazards throughout the study area.

Durov diagram: The fact that mixed water type prevail in the study area has been supported by data plotted on Durov diagram (Figure 8.3). Based on the classification of Lloyd and Heathcoat (1985), this trend can be attributed to fresh recent recharge water

exhibiting simple dissolution or mixing with no dominant major cation. Addition to this, samples showing major anion type is Bicarbonate.

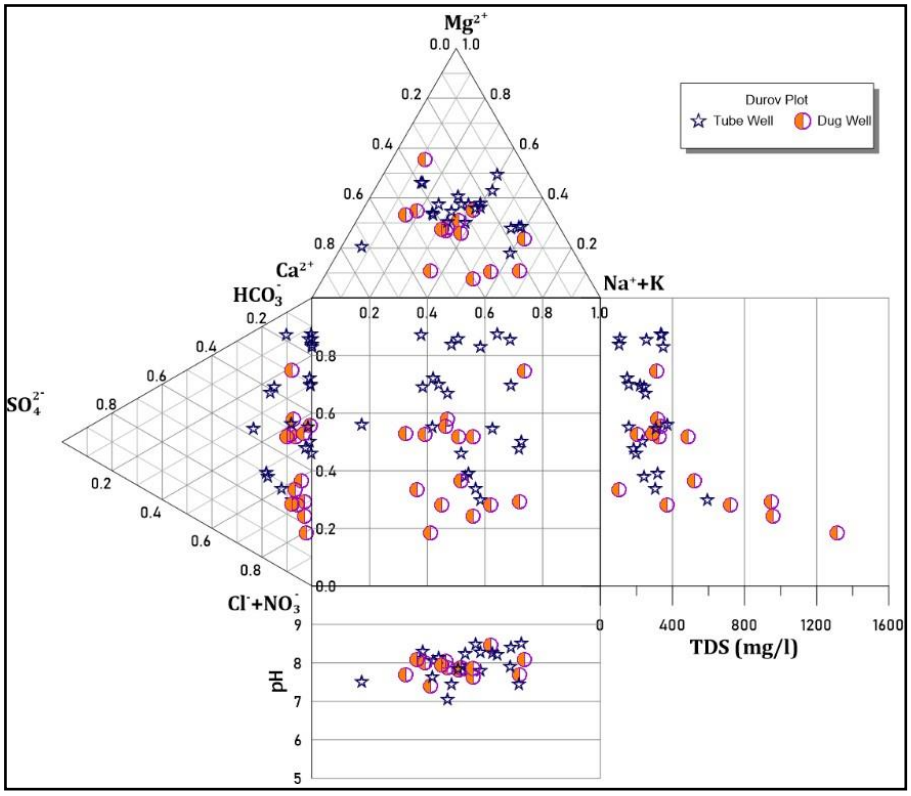

Figure-8.7: Durov Plot for Dakshin Dinajpur district of West Bengal.

Gibbs Plot: Gibbs Plot (Figure 8.8) indicates that the chemical composition of groundwater in study area reflects high rock-water interaction and evaporation sedimentation. Most of the groundwater samples are obtained from areas with ratios of $Na^+/(Na^+ + Ca^{2+})$ or $Cl^-/(Cl^- + HCO_3^-)$ less than 0.5 which signifies the dominance of rock-water interactions and chemical weathering of rock forming minerals. Samples with $Na^+/(Na^+ + Ca^{2+})$ or $Cl^-/(Cl^- + HCO_3^-)$ ratios greater than 0.5 and TDS levels between 105–1317mg l^{-1} shows that the groundwater chemistry has been controlled not only by rock weathering interaction and/or atmospheric precipitation but also by evaporation at places.

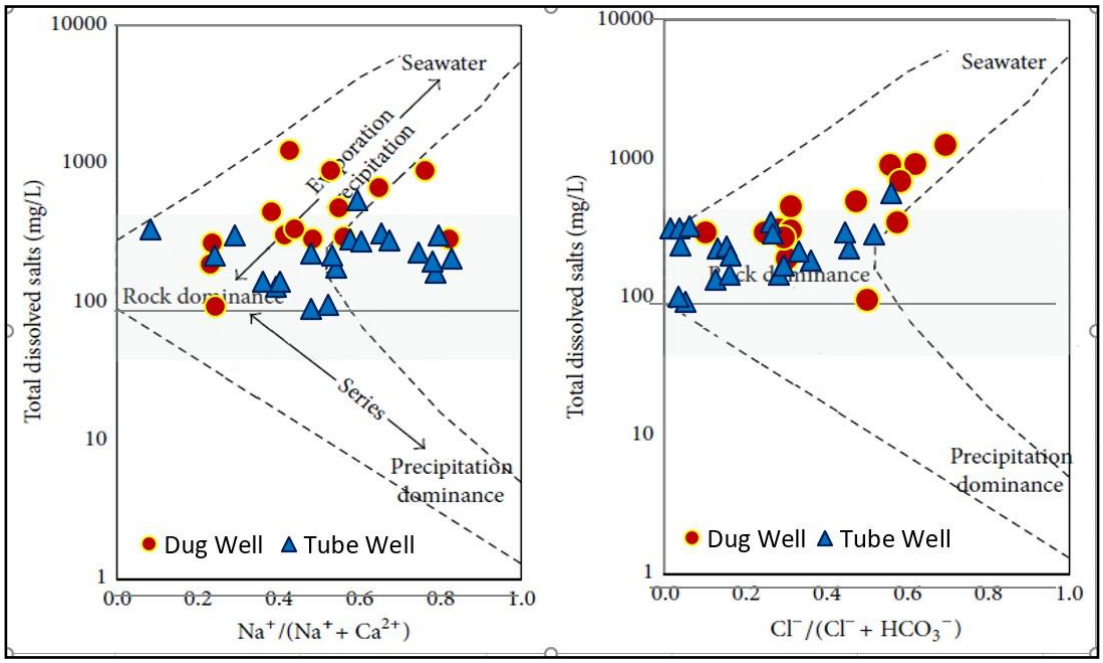

Figure-8.8: Gibbs Diagram of the samples from Study Area of Dakshin Dinajpur district of West Bengal.

CHAPTER 9

GROUNDWATER RELATED ISSUES AND PROBLEMS

The salient groundwater problems in the study area are as follow:

Fluoride contamination: Five blocks of the district namely Kusmundi, Kumarganj, Harirampur, Bansihari and Tapan, fluoride concentration in ground water above permissible limit is reported as a sporadic manner. The maximum concentration of fluoride in ground water has been reported as 2.52 mg/l at Kusmandi block.

Arsenic contamination: Public Health Engineering Directorate, West Bengal has declared that groundwater in Balurghat is arsenic affected.

Iron Contamination: Iron concentration beyond the permissible limit is found in many samples collected from the study area. The value ranges from 0.2 mg/L to as high as 3.196 mg/L. This causes rusting and blockage of screens, pumps and pipes of the tube wells.

Water scarcity in Barind tract area: In the Barind tract area people are facing drinking water scarcity problem particularly in Tapan and Gangarampur blocks. The scarcity occurs during summer months due to declining of water level. The presence of impervious hard clayey soil in the upper surface permits little or no percolation, and large quantity of rain water goes as surface runoff.

Water logging*:* The main crops grown in the study area is paddy which requires a huge amount of water. The unscientific management of water in agricultural fields along with excess water during monsoon season leads to water logging in these areas. Water logging causes land degradation thereby making the land unproductive. Excess water changes the physical, chemical and microbiological properties of water-logged soils.

CHAPTER - 10

GROUNDWATER DEVELOPMENT AND MANAGEMENT

Groundwater development and management involves the planning implementation, and operation necessary to provide safe and reliable ground water. For assessing development potentialities of and aquifer, the following information is required; (i) geometry of the reservoir defining dimensions and boundaries (ii) condition at the boundaries in particular the source of recharge; (iii) lithology and aquifer characteristics; (iv) hydrodynamic condition- whether phreatic, confined or semi-confined; (v) order of magnitude of the reservoirs, (vi) average natural recharge and discharge and (vii) quality of water.

8.1 Urban and rural water supply schemes:

Urban and rural water supply scheme for drinking and domestic purpose is mainly looked after by PHED, local municipality and Gram Panchayat of Dakshin Dinajpur. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area.

8.2 Future Ground Water Development and Management:

A planned ground water management and development is urgently required both for drinking as well as irrigation purposes for development of agricultural based poor socio-economic condition of Dakshin Dinajpur district. At present ground water development is mainly based on shallow tube wells, dug wells and to some extent by bore wells solely for domestic consumption.

In deciding mode of future ground water development in the study area, the following points have been considered.

a. The major part of the area is suitable for heavy duty, medium duty and low duty tube wells.
b. The feasibility of a particular type of ground water structure will depend on local hydrogeological set up and the requirement of water to be used and its quality. Low duty shallow tube wells are mostly suitable for private use because they involve farmers' participation in a co-operative manner and also require less expenditure on maintenance.
c. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.

d. To avoid the mutual interference the spacing between the tube wells should be more than 200 m between two shallow tube wells and more than 1500 m between two deep tube wells. If possible, the farmers can prepare pumping schedule mutually.
e. Water applied for irrigation should not be wasted. For this, an effective water management technique has to be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water in the older alluvial areas of the study area.
f. Care should be taken for Drinking water supply tube well in Fluoride infested area. If fluoride is above the permissible limit, proper care should be taken for fluoride removal equipments before supply for drinking purposes.
g. As all the 8 blocks in the district are categorized as "Safe", large scope for ground water development may be done in agricultural, domestic and industrial field through different structures considering optimum command area of the abstraction structures.
h. It has been observed that the potentiality of the aquifers in Barind tract is low and the drawdown is very high. As a result the scope of ground water development is
i. limited in this area. Dug wells, light duty tube-wells fitted with submersible pump, medium duty tube-wells are feasible for irrigation purposes. But the capacity of the pump needs to be decided in such a way so that drawdown may be minimized. The depth of the tube-wells may be restricted down to the depth of 250 mbgl tapping the aquifers. Heavy duty tube-wells within the depth of 250 mbgl are feasible for irrigation purpose. In Recent alluvium both shallow and deep tube-wells are feasible. There is a good scope for ground water development.
j. Rooftop rain water harvesting and conservation of rainwater by different conservation structures particularly in southern part of the district should be encouraged. Rain water harvesting schemes may be introduced in arsenic infested areas.

8.3 Rainwater Harvesting and Artificial Recharge

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand, the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

No structure has been constructed by CGWB till date. Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. Water level is deeper than 3 mbgl in Tapan and Gangarampur blocks in post monsoon period. As a whole the water level is not alarming condition, except these blocks of the district, where conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting for conservation may be adopted.

Block	Utilizable Surface runoff	Allocation of Utilizable Resource (MCM)			Structures Feasible (No.s)			Cost of structures (in lakhs)			Total cost (in lakhs)
		Percolation tank	REET with RS	Injection Well	Percolation tank	REET with RS	Injection Well	Percolation tank	REET with RS	Injection Well	
Gangarampur	0.040	0.02	0.008	0.012	-	-	-	-	-	-	-
Tapan	31.314	15.657	6.263	9.394	31	63	31	248	252	93	593

Table-10.1: Artificial recharge priority area-structures feasible and their cost of construction for the study area

PART – II

BLOCK MANAGEMENT PLANS FOR DAKSHIN DINAJPUR DISTRICT

1. BALURGHAT

Salient Information:

Block Name : Balurghat

Geographical area (in sq. km): 363.39

Map able area (in sq. km) : 363.39

District : Dakshin Dinajpur

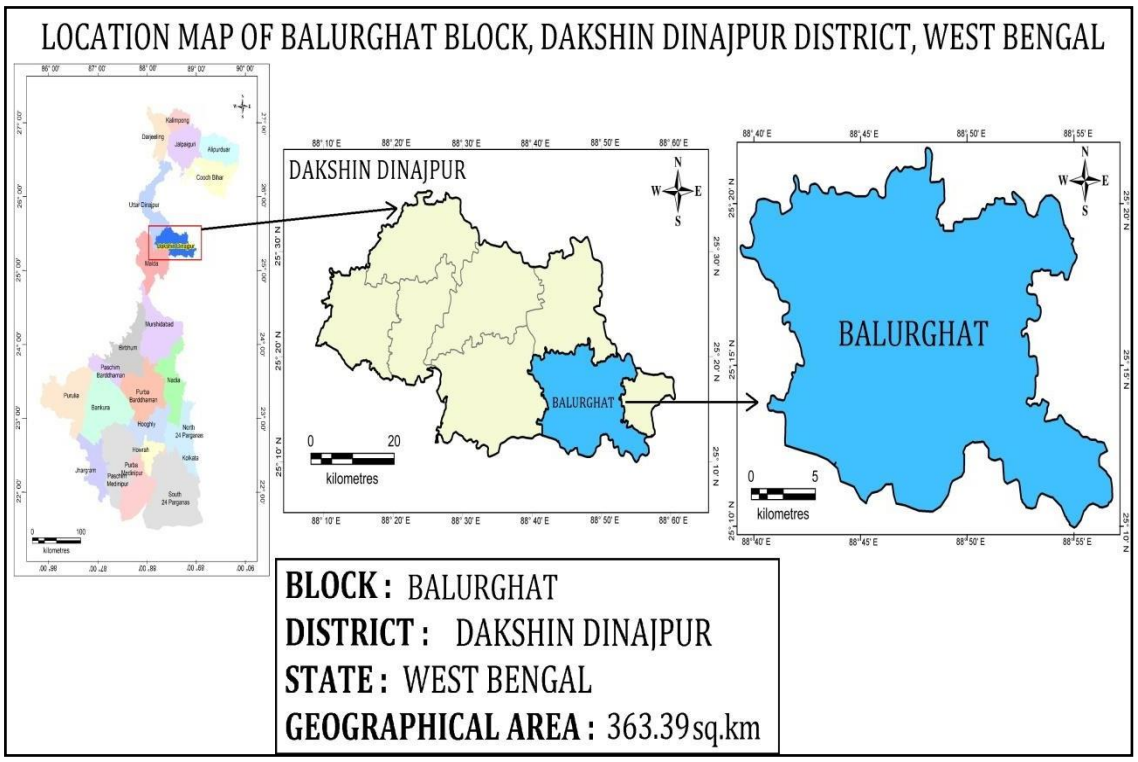

Figure-1.1: Location map for Balurghat block of Dakshin Dinajpur district.

Population (as on 2011):

Table-1.1: Details of Population in Balurghat block of Dakshin Dinajpur district.

Rural	Urban	Total
234139	16625	250764

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (mm)

Table- 1.2: Details of Annual Rainfall for the last five years in Balurghat block of Dakshin Dinajpur district.

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Balurghat	1298.4	1288.4	941	850.8	1245.1	785.9

Agriculture& Irrigation (area in ha):

Table-1.3: Salient Land use features for Balurghat block of Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Balurghat	36339	30734	19336.89	11397.11	294

Aquifer Wise Ground Water Resource Availability & Extraction:

Resource Availability and status of ground water development in Balurghat block	
Total Annual Ground Water Recharge (Ham)	26309.72
Static Resource (MCM)	244628.5293
Annual Extractable Ground Water Recharge (Ham)	23678.75
Total Extraction (Ham)	16340.43
Net Ground Water Availability for future use	7254.75
Stage of development (%)	69.01
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	522.12

Table- 1.4: Details of resource availability and draft (in MCM/Ham) in Balurghat block of Dakshin Dinajpur district.

Disposition of Aquifers:

In Balurghat, there is one principal aquifer system i.e Alluvium and two major aquifer system: Younger Alluvium & Older Alluvium.

The range of Aquifer-I is from 6.1-52.82mbgl. The thickness of individual zone tapped range from 6-15 meters. The zones tapped; 6.1-25, 26.57-33.13, 37.23-52.82(mbgl).

The depth range of Aquifer-II varies from 54-159mbgl. The thickness of individual zone tapped range from 3-12 meters. The zones tapped; 54-66, 87-96, 115-127,139-142, 147-159 (mbgl).

The depth rang of Aquifer-III varies from 151-286mbgl. The thickness of individual zone tapped range from 3-12 meters. The zones tapped; 156-168, 172-182, 200-209, 215-221, 229-235, 240-252, 258-265, 272-275, 280-286 (mbgl).

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50-150mbgl)	Aquifer-III (150 - 300mbgl)
Balurghat	Alluvium	6.1-25, 26.57-33.13,37.23-52.82, 54-66, 87-96, 115-127,139-142, 147-159, 156-168, 172-182 ,200-209, 215-221, 229-235, 240-252, 258-265, 272-275, 280-286	6-15	3-12	3-12

Table- 1.5: Details of Aquifer disposition in Balurghat block of Dakshin Dinajpur district.

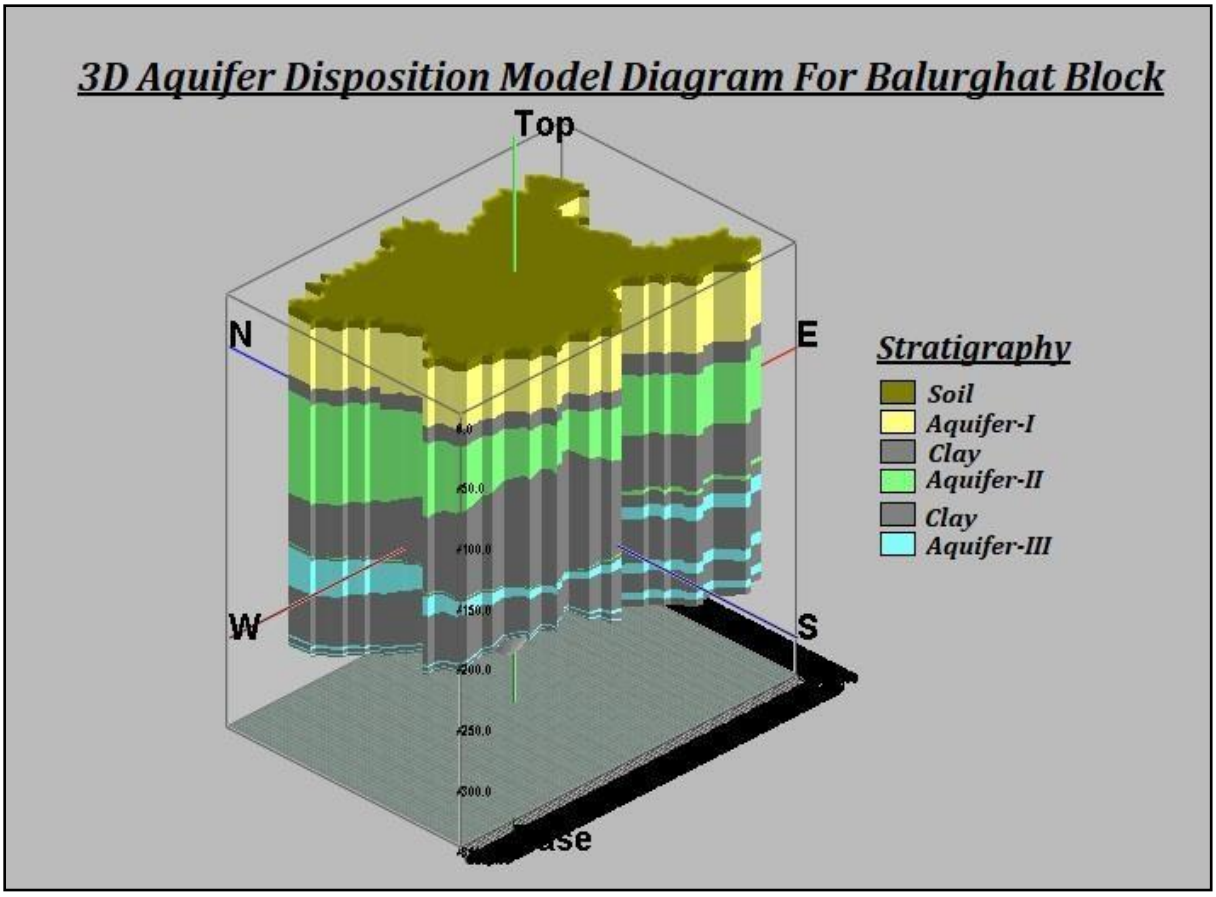

Figure-1.2: 3D aquifer disposition in Balurghat block of Dakshin Dinajpur district.

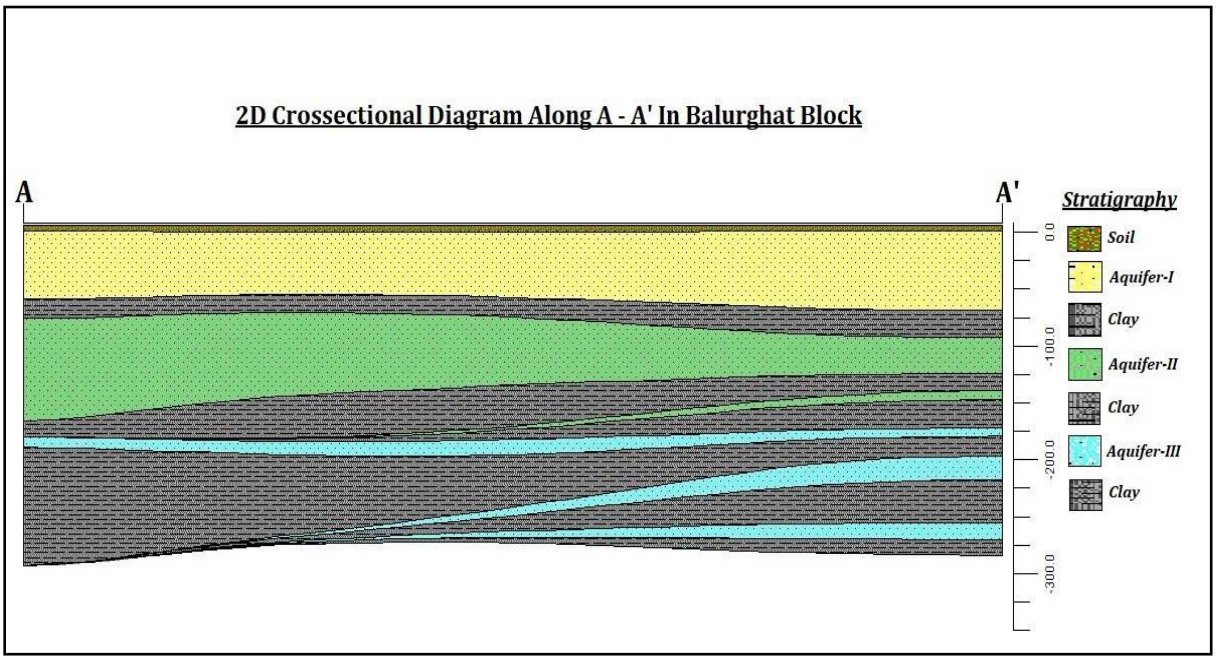

Figure-1.3: 2D Cross- sectional diagram for the aquifers along N-S direction in Balurghat block of Dakshin Dinajpur district.

Table- 1.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Balurghat	I	-	-	-	-	-	-
	II& III	6.16-10.01	-	0.540	2.88-5.89	-	0.339

Table-1.7: Aquifer-wise depth range and parameters in Balurghat block of Dakshin Dinajpur district.

Name of Block	Aquifer I					Aquifer II					Aquifer-III				
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown
Balurghat	6.1-52.82	222.73	133.32	-	2-6.63	54-159	32.94	1330.1	2.183 * 10^{-4}	2.01-25.65	151 - 286	63.78-111.06	96.79	-	6.03-26.39

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table- 1.8: Average concentration of chemical parameter in groundwater for Balurghat block of Dakshin Dinajpur district.

Block	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness(mg/l)
Balurghat	7.96 - 7.92	214 - 319	17.2 - 26.6	7.1 - 60.3	0.8 - 1.9	0.0-4.26	0.4 - 4.3	65 - 125

Fluoride concentration of 1.9 mg/l, which is above permissible limit, is recorded from Balurghat Town. The iron content is also very high in BalurghatTown(4.3 mg/l). More intensive sampling for this block is recommended and appropriate measures be taken to ensure drinking water safety of the public in general.

Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are sixteen (16) commissioned and one (1) ongoing Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. Therefore, rainwater harvesting can also be done as well to supplement sources for drinking purpose.

The conserved rainwater should be utilized for drinking purpose after filtering through Horizontal Roughing Filters.

II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area. The water from the sources however should be filtered through arsenic filtering plants before use.

III. The block is declared arsenic infested block by arsenic Task Force, West Bengal. Therefore, wells in the area should be constructed with proper cement sealing. Arsenic filtering plants should also be installed in the wells.

IV. The block shows a neither rising nor falling trend. However, for monitoring of change in ground water regime in the area, cost of construction of Observation well should be included.

Proposed Design of Arsenic Free Wells by CGWB: A specially designed tube-well using cement sealing technique is suggested to provide arsenic free water in the block. Cement sealing is applied to a suitably thick intervening clay layer separating the arsenic contaminated aquifer from arsenic free aquifer. Cement seal prevents seeping of contaminated water through the annular space which is filled with gravel material.

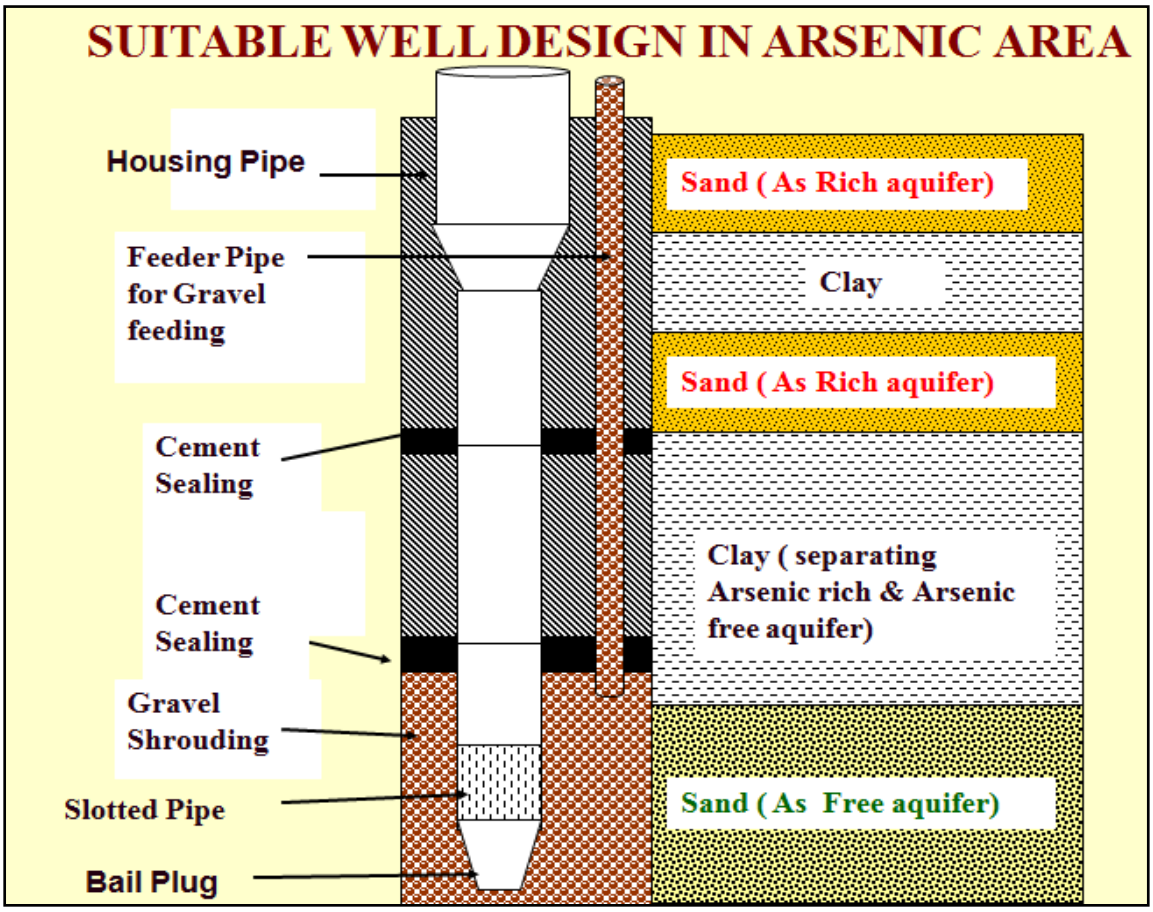

Figure- 1.4: Proposed design of tube well to provide arsenic free groundwater

Management Plan for irrigation:

Table- 1.9: Culturable Command Area created by surface and ground water in Balurghat block of Dakshin Dinajpur district.

Block Name	Dugwell		Shallow Tubewell		Medium Tubewell		Deep Tubewell		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Balurghat	2	6.8	4636	12013.77	13	79.16	98	3601.7	1	2	59	3633.46	15701.43	3635.46	19336.89

(Source: 5th MI Census, yet to be published)

Table- 1.10: Ground Water scenario for irrigation in Balurghat block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Balurghat	36339	30654	8182	22472	69.01	-	-

I. The stage of ground water development in the block is 69.01 %,under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.
II. 22472 hectares more of land can be irrigated.
III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.
IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.
V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.
VI. The block is a part of Barind tract and the potentiality of the aquifers in Barind tract is low and the drawdown is very high. Dug wells, light duty tube wells fitted with submersible pump, medium duty tube wells are feasible for irrigation purposes. But the capacity of the pump should be decided in such a way so that drawdown may be minimized. The depth of the tube-wells may be restricted down to the depth of 250 mbgl tapping the aquifers. Heavy duty tube wells within the depth of 250 mbgl are feasible for irrigation purpose.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-1.11: Area suitable for recharge in Balurghat block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Balurghat	36339	--

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand, the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

No structure has been constructed by CGWB till date. Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. As a whole the water level is not in alarming condition in this block. Water conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting can be considered for the block in future.

This block is not considered under artificial recharge and no Artificial Recharge Structures has thus been proposed at present.

2. KUSHMANDI

Salient Information:

Block Name : Kushmandi

Geographical area (in sq. km):310.58

Map able area (in sq. km) : 310.58

District : Dakshin Dinajpur

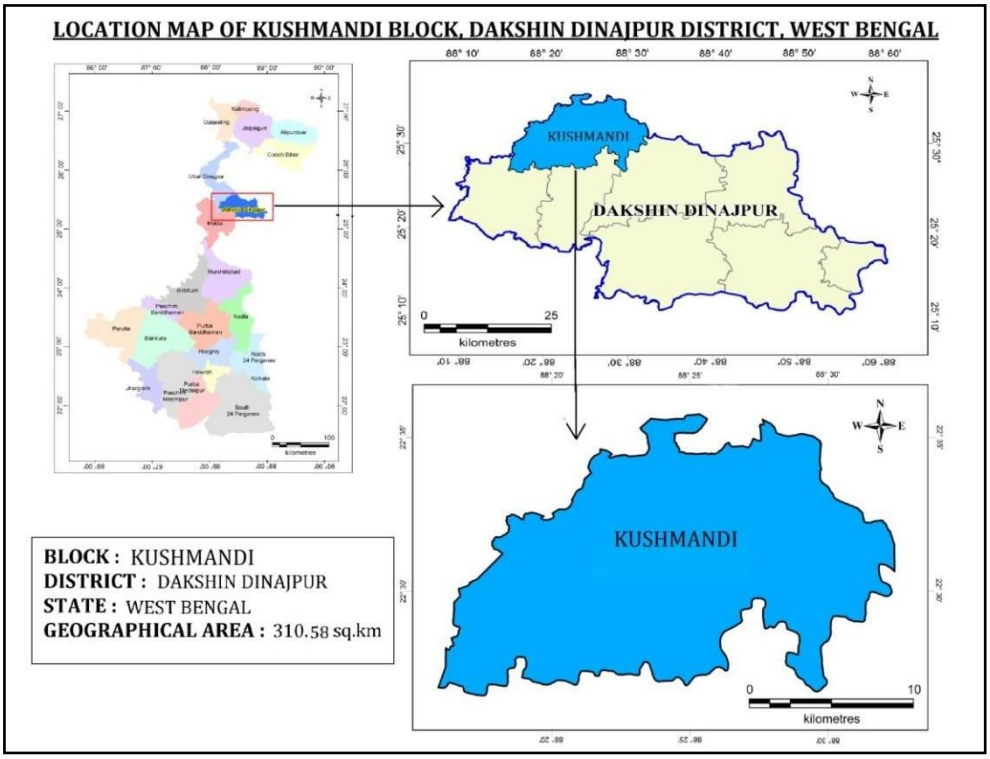

Figure-2.1: Location map for Kushmandi block of Dakshin Dinajpur district.

Population (as on 2011):

Table-2.1: Details of Population in Kushmandi block of Dakshin Dinajpur district.

Rural	Urban	Total
198752	--	198752

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (in mm)

Table- 2.2: Details of Annual Rainfall for the last five years in Kushmandi block of Dakshin Dinajpur district.

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Kushmandi	1298.4	1288.4	941	850.8	1245.1	785.9

Agriculture & Irrigation (area in ha):

Table- 2.3: Salient Land use features of Kushmandi block in Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Kushmandi	31058	31058	10097.88	26960.12	234

Aquifer Wise Ground Water Resource Availability & Extraction:

Table- 2.4: Details of resource availability and draft (in MCM/Ham) in Kushmandi block.

Resource Availability and status of ground water development in Kushmundi block	
Total Annual Ground Water Recharge (Ham)	25921.29
Static Resource (MCM)	111006.855
Annual Extractable Ground Water Recharge (Ham)	24625.23
Total Extraction (Ham)	11613.09
Net Ground Water Availability for future irrigation use	12977.98
Stage of development (%)	47.16
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	250.89

Disposition of Aquifers:

In Kushmandi, there is one principal aquifer system i.e. Alluvium. One major aquifer is present i.e., Younger alluvium.

The range of Aquifer-I is from 6.09-57.91 (mbgl). The thickness of individual zone tapped range from 3-30 meters. The zones tapped; no exploration record.

The depth range of Aquifer-II varies from 60.95-124.96 (mbgl). The thickness of individual zone tapped range from 3-12 meters. The zones tapped; 98-104, 110-116(mbgl).

The depth rang of Aquifer-III varies from 152.39-308 (mbgl). The thickness of individual zone tapped range from 3-12 meters. The zones tapped; no exploration record.

Table-2.5: Details of aquifer disposition in Kushmandi block of Dakshin Dinajpur district.

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50- 150 mbgl)	Aquifer-III (150 -300 mbgl)
Kushmundi	Alluvium	98-104,110-116	3-30	3-24	3-60

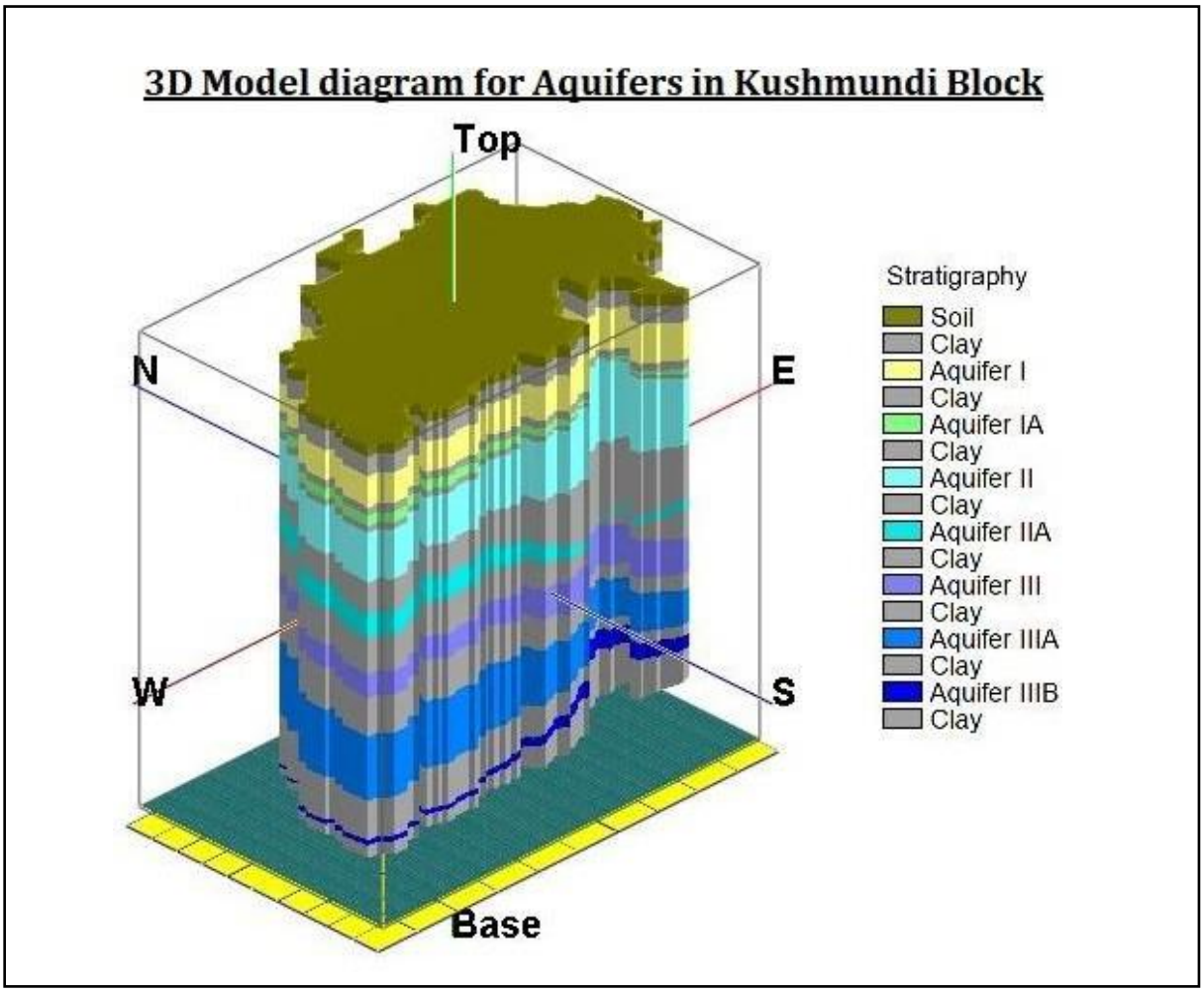

Figure-2.2: 3D aquifer disposition model diagram in Kushmandi block of Dakshin Dinajpur district.

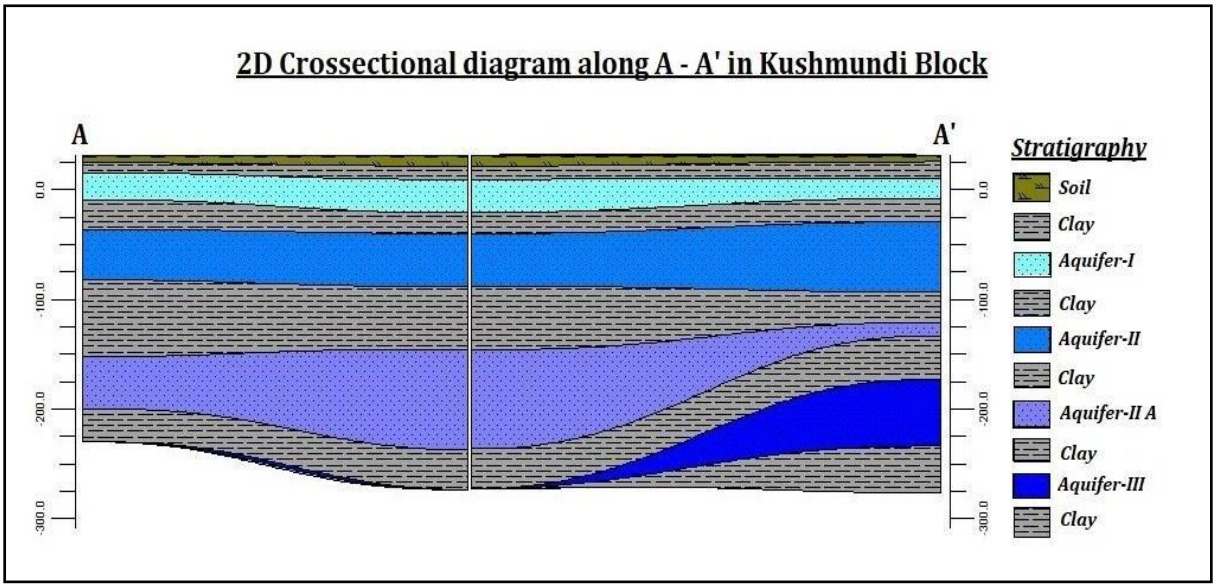

Figure- 2.3: 2D Crosssectional diagram for the aquifers along N-S direction in Kushmandi block of Dakshin Dinajpur district.

Table- 2.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018) in Kushmandi block of Dakshin Dinajpur district.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Kushmandi	I	-	-	0.070	-	-	-
	II& III	4.10-9.63	0.389	-	2.95-4.02	-	0.053

Table-2.7: Aquifer-wise depth range and parameters in Kushmandi block of Dakshin Dinajpur district.

Name of Block	Aquifer I				Aquifer II				Aquifer-III			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Kushmandi	6.09-57.91	-	-	-	60.95-124.96	1.8	37-2000	-	152.39-308	>40	37-2000	-

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table-2.8: Average concentration of chemical parameter of Kushmandi block of Dakshin Dinajpur district.

Block	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
Kushmandi	7.45 - 8.12	126 - 184	9.4 - 13.9	7.1 - 28.4	0.4 - 2.1	0.9 - 3.2	0.0 - 3.0	50 - 100

Fluoride concentration of 2.1 mg/l, which is above permissible limit and high iron content (3.00 mg/l) is recorded from Kushmandi Town area. More intensive sampling for this block is recommended and appropriate measures be taken to ensure drinking water safety of the public in general.

Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are four (4) commissioned and three (3) ongoing Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. Therefore, rainwater harvesting should be done to supplement sources for drinking purpose. The conserved rainwater however, should be utilized for drinking purpose only after filtering through Horizontal Roughing Filters.

II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area. The water from the sources however should be filtered through arsenic filtering plants before use.

III. The block shows a neither rising nor falling trend. However, for monitoring of change in ground water regime in the area, cost of construction of Observation well should be included.

Management Plan for irrigation:

Table- 2.9: Culturable Command Area created by surface and ground water in Kushmandi block of Dakshin Dinajpur district.

Block Name	Shallow Tubewell		Medium Tubewell		Deep Tubewell		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Kushmandi	3610	8475.59	5	81.6	22	880	0	0	38	660.69	9437.19	660.69	10097.88

(Source: 5th MI Census, yet to be published)

Table- 2.10: Ground Water scenario for irrigation in Kushmandi block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Kushmandi	31058	31058	6738	24320	47.16	No rise nor fall	-

I. The stage of ground water development in the block is 47.16 %, under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.

II. 24320 hectares more of land can be irrigated.

III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.

IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.

V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.

VI. To avoid the mutual interference the spacing between the tube wells should be more than 200 m between two shallow tube wells and more than 1500 m

between two deep tube wells. If possible, the farmers can prepare pumping schedule mutually.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-2.11: Area suitable for recharge in Kushmundi block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Kushmundi	31058	--

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand, the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

No structure has been constructed by CGWB till date. Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. As a whole the water level is not in alarming condition in this block. Water conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting can be considered for the block in future.

This block is not considered under artificial recharge on account of the block having no significant rise or fall in its water level trends and the water level during the post-monsoon is also less than 6 mbgl and no Artificial Recharge Structures has thus been proposed at present. The area is also prone to water logging as well.

3. GANGARAMPUR

Salient Information:

Block Name : Gangarampur

Geographical area (in sq. km) :327.15

Map able area (in sq. km) 312

District : Dakshin Dinajpur

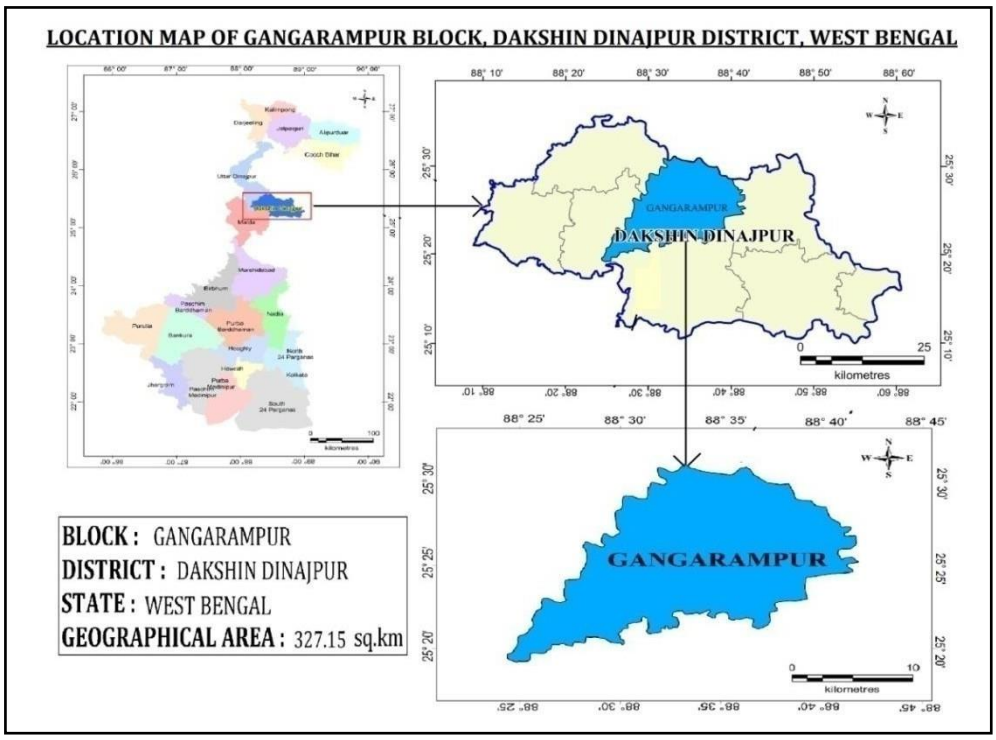

Figure-3.1: Location map for Gangarampur block of Dakshin Dinajpur district.

Population (as on 2011):

Table-3.1: Details of Population in Gangarampur block of Dakshin Dinajpur district.

Rural	Urban	Total
230612	63233	86245

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (in mm).

Table-3.2: Details of Annual Rainfall for the last five years in Gangarampur block of Dakshin Dinajpur district.

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Gangarampur	1298.4	1288.4	941	850.8	1245.1	785.9

Agriculture & Irrigation (area in ha):

Table-3.3: Salient Land use features of Gangarampur block of Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Gangarampur	32715	27689	13344.13	14344.87	6

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-3.4: Details of resource availability and draft (in MCM/Ham) in Gangarampur block of Dakshin Dinajpur district.

Resource Availability and status of ground water development in Gangarampur block	
Total Annual Ground Water Recharge (Ham)	25579.73
Static Resource (MCM)	90750.58
Annual Extractable Ground Water Recharge (Ham)	23021.76
Total Extraction (Ham)	16031.63
Net Ground Water Availability for future use	6914.85
Stage of development (%)	69.64
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	395.7

Disposition of Aquifers:

In Gangarampur, there is one principal aquifer system i.e. Alluvium. Two major aquifers are present i.e. Younger Alluvium & Older Alluvium.

The range of Aquifer-I is from 6.1-52.82 (mbgl). The thickness of individual zone tapped range from 6-15 meters. The zones tapped; 6.1-25, 26.57-33.13, 37.23-52.82 (mbgl).

The depth range of Aquifer-II varies from 54-159 (mbgl). The thickness of individual zone tapped range from 3-12 meters. The zones tapped; 54-66, 87-96, 115-127,139-142, 147-159 (mbgl).

The depth rang of Aquifer-III varies from 151-286 (mbgl). The thickness of individual zone tapped range from 3-12 meters. The zones tapped; 156-168, 172-182, 200-209, 215-221, 229-235, 240-252, 258-265, 272-275, 280-286 (mbgl).

Table-3.5: Details of aquifer disposition in Gangarampur block of Dakshin Dinajpur district.

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50- 150 mbgl)	Aquifer-III (150 -300 mbgl)
Gangarampur	Alluvium	26.87-30.02,53-65, 72.31-78.80,83.69-86.94,96.65-104.72,106.56-109.51,117.62-130.61, 155-164, 173-194, 168.00 – 180.00,183.00 – 195.00, 176-188,191-203	4	3-12	9-21

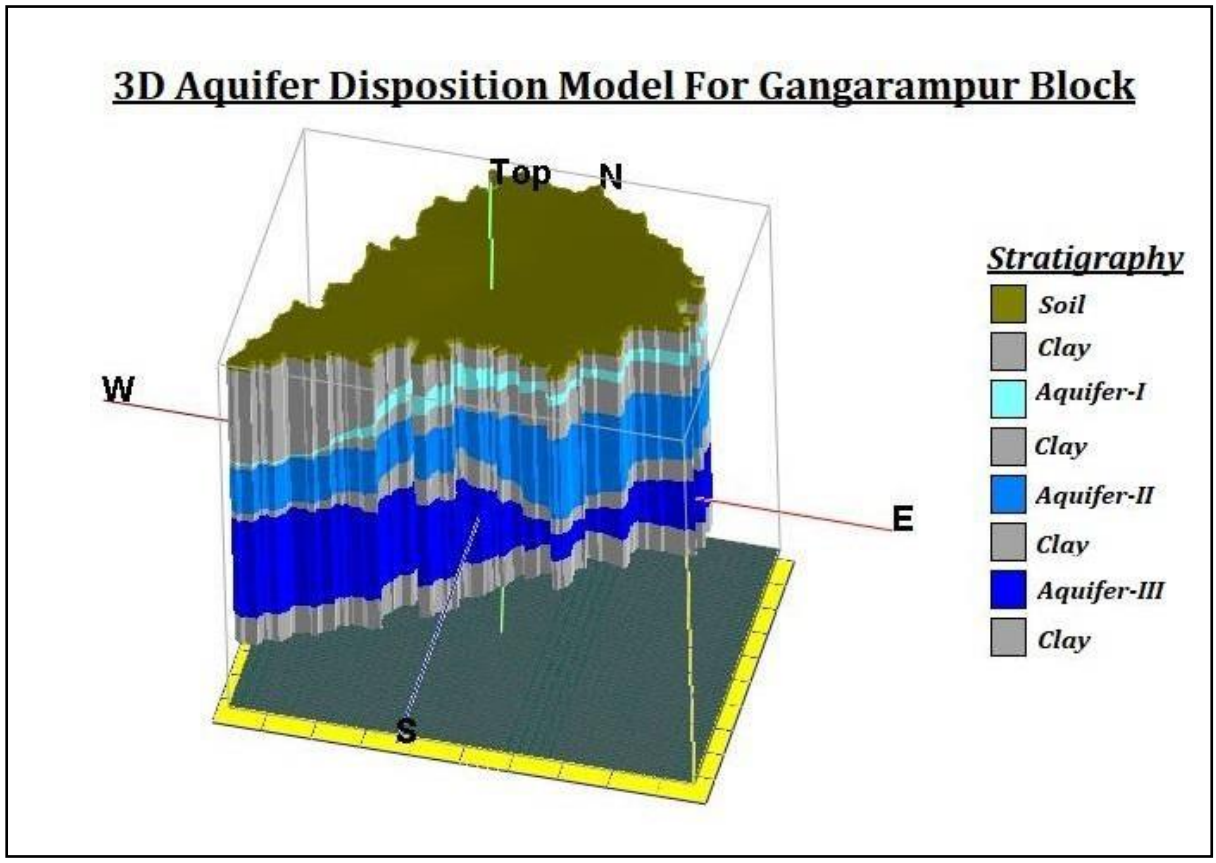

Figure-3.2: 3D model for the disposition of aquifers in Gangarampur block of Dakshin Dinajpur district.

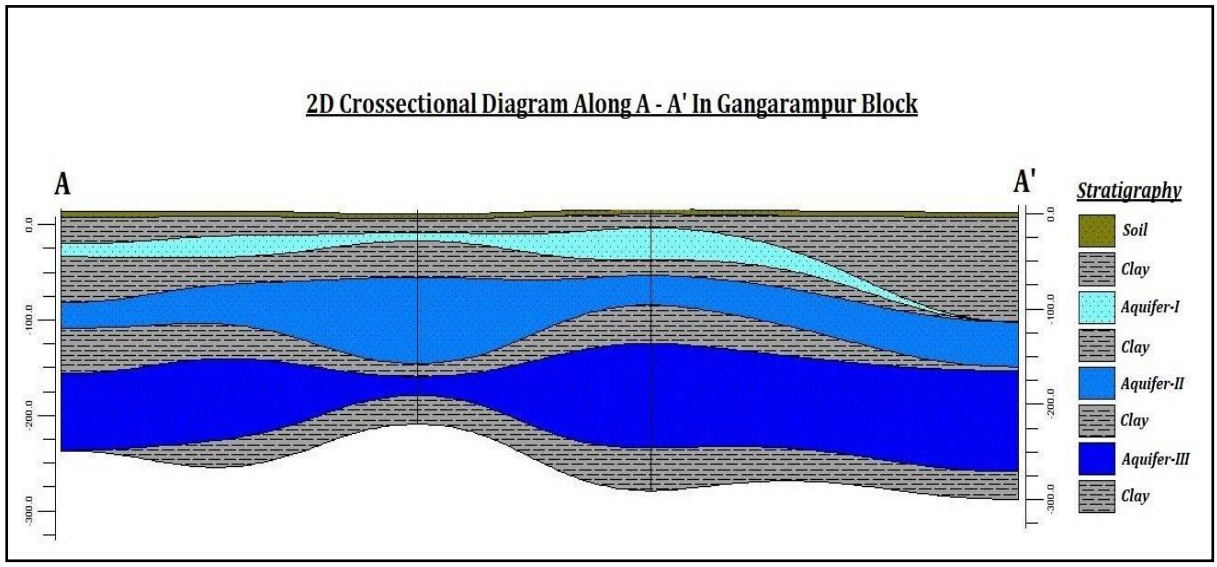

Figure-3.3: 2D crossectional diagram for the aquifers along A – A' in Gangarampur block of Dakshin Dinajpur district.

Table-3.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018) in Gangarampur block of Dakshin Dinajpur district.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Gangarampur	I	3.52-8.68	-	5.230	1.82-3.74	-	0.115
	II& III	7-10.9	-	0.49	3.82-5.15	-	0.517

Table- 3.7: Aquifer-wise depth range and parameters in Gangarampur block of Dakshin Dinajpur district.

Name of Block	Aquifer I					Aquifer II					Aquifer-III				
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Drawdown
Gangarampur	13.04 - 54.70	-	37.91	-	6-8	53-130.61	74.63	37.91	-	6-8	155-203	14.04 - 38.16	33.6	-	3.15-20

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table-3.8: Average concentration of chemical parameter in groundwater for Gangarampur block of Dakshin Dinajpur district.

Block	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness(mg/l)
Gangarampur	7.36 - 8.52	356 - 2283	26.9-148	17.7-655.8	0.2 - 2.9	0.0-20.9	0.0-6.85	95 - 740

Fluoride concentration of 2.9 mg/l, which is above permissible limit, is recorded from Nayabazar area. High iron content (6.85 mg/l) is recorded from Lalchandrapur area. As such, more intensive sampling from this block is recommended for the safety of the people on the block

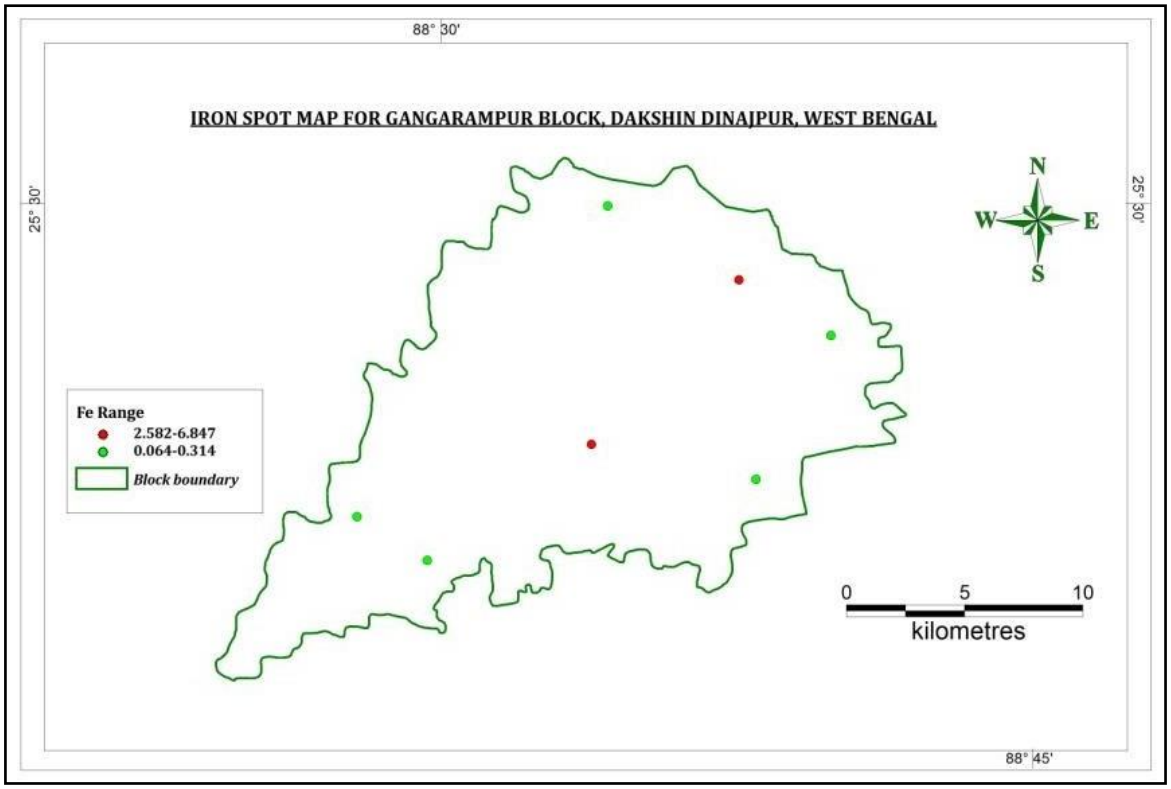

Figure-3.4: Iron spot map for Gangarampur block of Dakshin Dinajpur district.

Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are five (5) old ground water based and one (1) surface based commissioned and one (1) ongoing surface based Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. In this Barind tract area, people are facing drinking water scarcity problem especially during the summer months due to declining of water level (post-monsoon WL is 6 mbgl). The presence of impervious hard clayey soil in the upper surface permits little or no percolation, and large quantity of rain water goes as surface runoff. Therefore, conservation through Rainwater harvesting should be done to supplement sources for drinking purpose in this block.

II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to the rural areas.

III. The block shows a neither rising nor falling trend during the post- monsoon. However, for monitoring of change in ground water regime in the area in future, cost of construction of observation well should be included.

Management Plan for irrigation:

Table-3.9: Culturable Command Area created by surface and ground water for Gangarampur block of Dakshin Dinajpur district.

Block Name	Shallow Tube-well		Medium Tube-well		Deep Tube-well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Gangarampur	5076	11189.13	1	40	16	262	0	0	78	1853	11491.13	1853	13344.13

(Source: 5th MI Census)

Table-3.10: Ground Water scenario for irrigation in Gangarampur block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Gangarampur	32715	27653	8641	19012	69.64	No rise nor fall	6

I. The stage of ground water development in the block is 69.64 %, under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.
II. 19012 hectares more of land can be irrigated. At present, the main crops grown in the study area are paddy which requires a huge amount of water. The unscientific management of water in agricultural fields along with excess water during monsoon season leads to water logging in these areas. Therefore proper planning and management of excess water should be executed.
III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.
IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.
V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.
VI. The block is a part of Barind tract and the potentiality of the aquifers in Barind tract is low and the drawdown is very high. Dug wells, light duty tube wells fitted with submersible pump, medium duty tube wells are feasible for irrigation purposes. But the capacity of the pump should be decided in such a way so that drawdown may be minimized. The depth of the tube-wells may be restricted

down to the depth of 250 mbgl tapping the aquifers. Heavy duty tube wells within the depth of 250 mbgl are feasible for irrigation purpose.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-3.11: Area suitable for recharge in Gangarampur block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Gangarampur	32715	0.132184

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand, the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. The block has recorded post-monsoon water level at 6 mbgl. The water level therefore is in a condition that needs proper management and planning. Water conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting has been considered for the block.

This block has 0.040 MCM of utilizable surface run-off. Out of which 0.02 MCM has been allocated for percolation tanks, 0.008 MCM for Re-excavation of pre-existing tanks with recharge structures (REET) and 0.012 MCM for injection wells. However, the number of recharge structures and cost of their construction has not been proposed yet.

Table- 3.12 Proposed Artificial Recharge Structures, allocation and cost of construction in Gangarampur block of Dakshin Dinajpur district.

Block	Formation	Utilizable Surface Run Off (MCM)	Percolation Tank			REET with RS			Injection Well		
			Allocation of Utilizable Resource (MCM)	Structures Feasible	Cost of Structures	Allocation of Utilizable Resource (MCM)	Structures Feasible	Cost of Structures	Allocation of Utilizable Resource (MCM)	Structures Feasible	Cost of Structures
Gangarampur	Alluvium	0.047	0.02	0	0	0.008	0	0	0.012	0	0
Total cost in lakhs is rupees 0.00											

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation*

4. HILLI

Salient Information:

Block Name : Hilli

Geographical area (in sq. km):87.85

Map able area (in sq. km) : 87.85

District : Dakshin Dinajpur

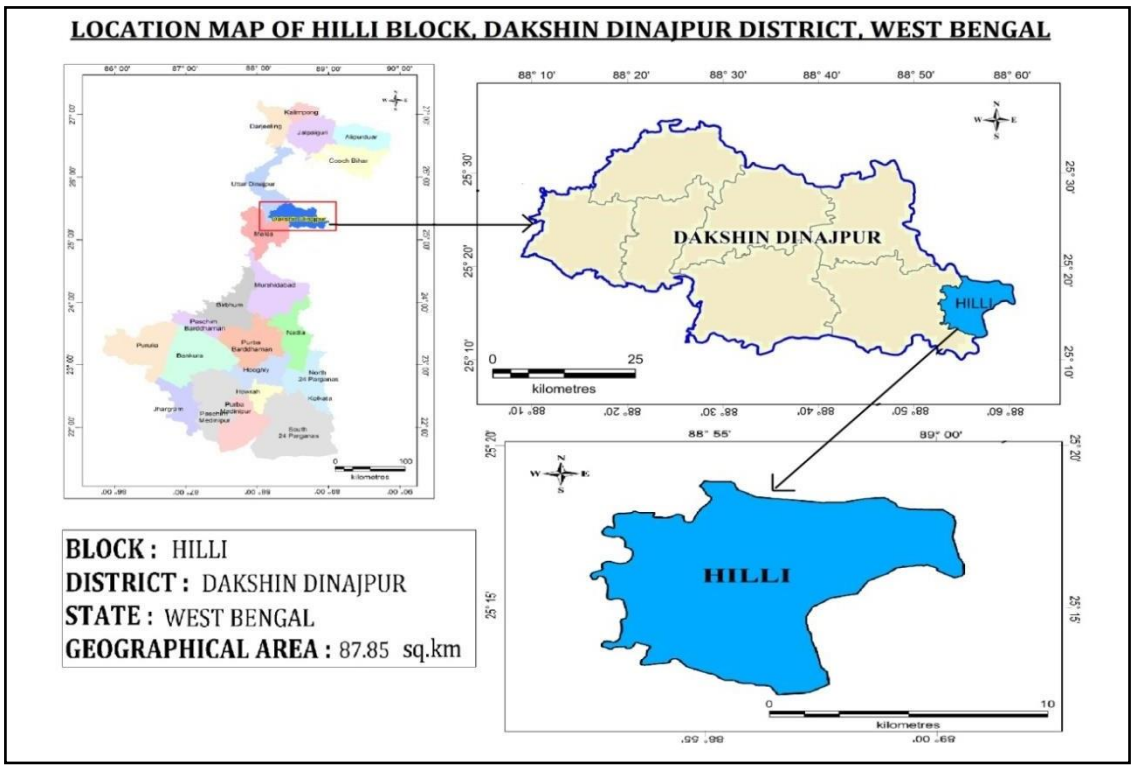

Figure-4.1: Location map for Hilli block of Dakshin Dinajpur district.

Population (as on 2011):

Rural	Urban	Total
83754	--	83754

Table- 4.1: Details of Population in Hilli block of Dakshin Dinajpur district.

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (in mm)

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Hilli	1298.4	1288.4	941	850.8	1245.1	785.9

Table- 4.2: Details of Annual Rainfall for the last five years in Hilli block of Dakshin Dinajpur district.

Agriculture& Irrigation (area in ha):

Table-4.3: Salient Land use features in Hilli block of Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Hilli	87.85	6986	4698	2288	--

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-4.4: Details of resource availability and draft (in MCM/Ham) in Hilli block of Dakshin Dinajpur district.

Resource Availability and status of ground water development in Hilli block	
Total Annual Ground Water Recharge (Ham)	11585.89
Static Resource (MCM)	33972.9458
Annual Extractable Ground Water Recharge (Ham)	10427.3
Total Extraction (Ham)	5583.99
Net Ground Water Availability for future irrigation use	4822.55
Stage of development (%)	53.55
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	112.09

Disposition of Aquifers:

In Hilli, there is one principal aquifer system i.e Alluvium. One major alluvium is present i.e. Younger Alluvium.

The range of Aquifer-I is from 6.09-76.2 mbgl. The thickness of individual zone tapped range from 3-40 meters. The zones tapped; 35-50 mbgl (within 86 mbgl mostly).

The depth range of Aquifer-II varies from 51.82-76.2mbgl. The thickness of individual zone tapped range from 3-12 meters. The zones tapped; no exploration record.

The depth rang of Aquifer-III varies from 152.4-243.84 mbgl. The thickness of individual zone tapped range from 6-60 meters. The zones tapped; no exploration record.

Table-4.5: Details of aquifer disposition in Hilli block of Dakshin Dinajpur district.

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50- 150 mbgl)	Aquifer-III (150 -300 mbgl)
Hilli	Alluvium	35-50 (within 86 mbgl)	3-40	3-12	6-60

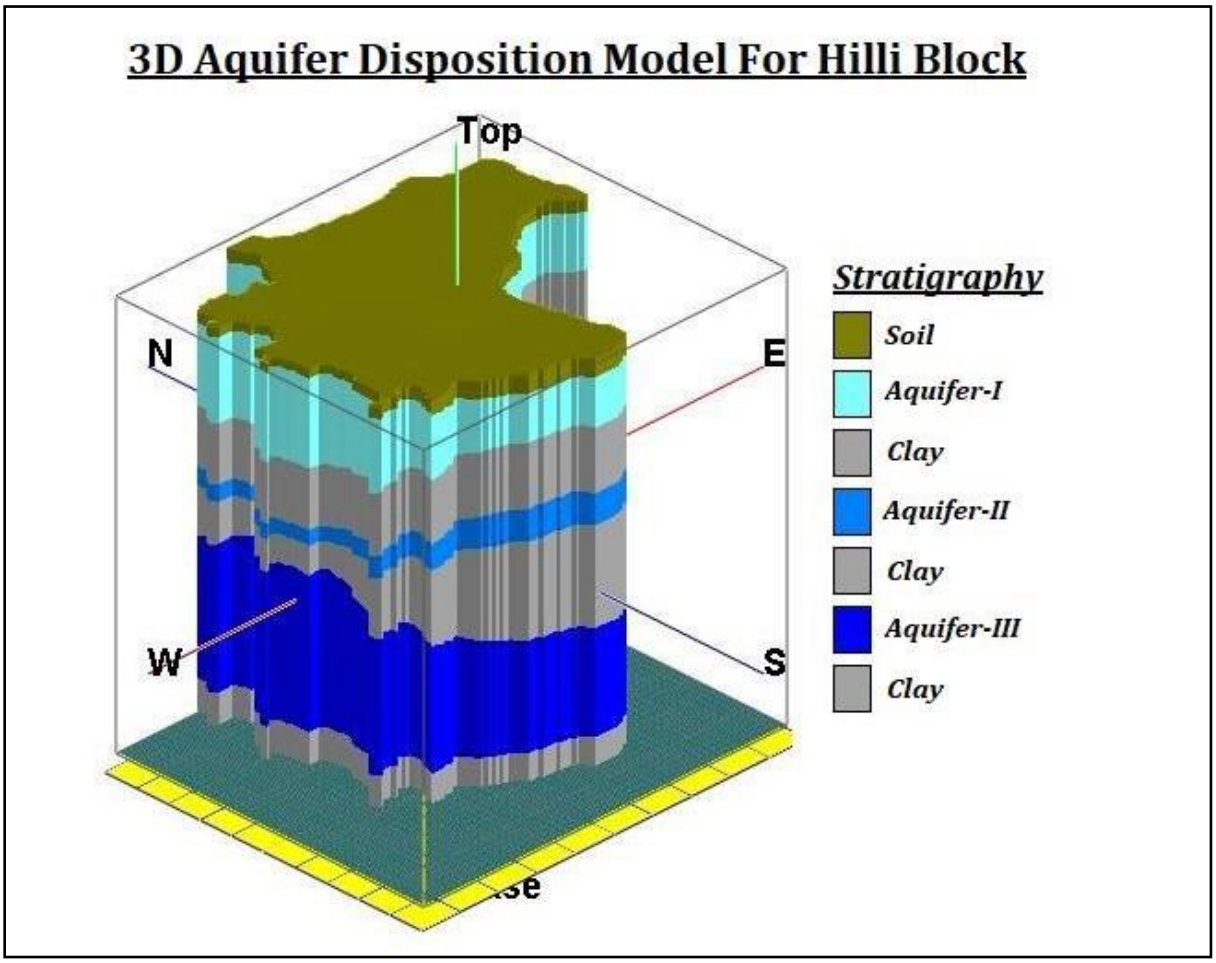

Figure-4.2: 3D model for the disposition of aquifers in Hilli block of Dakshin Dinajpur district.

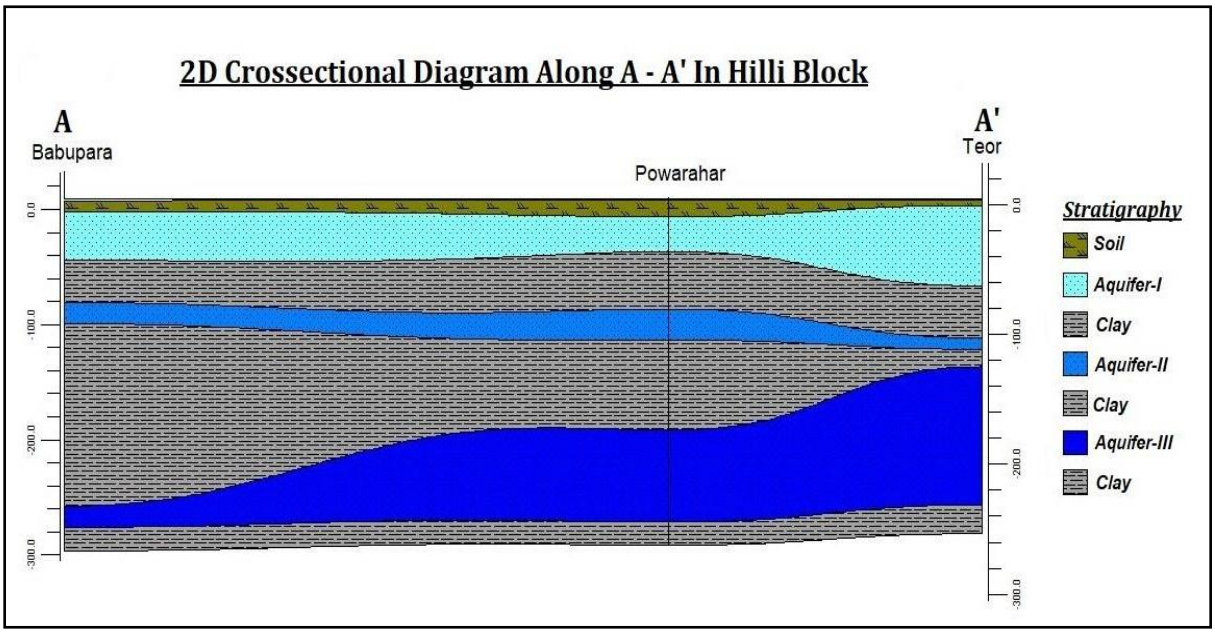

Figure-4.3: 2D crossectional diagram for the aquifers along A – A' in Hilli block of Dakshin Dinajpur district.

Table- 4.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018) in Hilli block of Dakshin Dinajpur district.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Hilli	I	9.24	-	0.43	1.66-4.36	-	0.016
	II& III	7.6-7.40	-	0.018	2.15-2.65	-	0.174

Table-4.7: Aquifer-wise depth range and parameters in Hilli block of Dakshin Dinajpur district.

Name of Block	Aquifer I				Aquifer II				Aquifer-III			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Hilli	6.09-76.2	-	-	-	51.82-76.2	>40	37-2000	-	152.4-243.84	>40	37-2000	-

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table- 4.8: Average concentration of chemical parameter of Hilli block of Dakshin Dinajpur district.

Block	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
Hilli	7.62 - 8.05	147.3 - 519	8.5 - 40	14.2 - 85.1	0.1-1.3	0.0 - 13.7	0.1 - 5.1	60 - 200

High iron content (5.1 mg/l) is recorded from Hilli Ps. More intensive sampling for this block is recommended and necessary precautions to be taken.

Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are seven (7) commissioned Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. Therefore, conservation through rainwater harvesting should be adopted to supplement sources for drinking purpose. The conserved rainwater however, should be utilized for drinking purpose only after filtering through Horizontal Roughing Filters.

II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area. The water from the sources however should be filtered through arsenic filtering plants before use.

III. The block shows neither rising nor falling trend. However, for monitoring of change in ground water regime in the area, cost of construction of Observation well should be included.

Management Plan for irrigation:

Table-4.9: Culturable Command Area created by surface and ground water in Hilli block of Dakshin Dinajpur district.

Block Name	Shallow Tubewell		Medium Tubewell		Deep Tubewell		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Hilli	1687	3658	1	40	19	760	0	0	3	240	4458	240	4698

(Source: 5th MI Census, yet to be published)

Table-4.10: Ground Water scenario for irrigation in Hilli block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Hilli	8785	6818	1727	5091	53.55	-	-

I. The stage of ground water development in the block is 53.55%, under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.
II. 5091 hectares more of land can be irrigated.
III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.
IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.
V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.
VI. To avoid the mutual interference the spacing between the tube wells should be more than 200 m between two shallow tube wells and more than 1500 m between two deep tube wells. If possible, the farmers can prepare pumping schedule mutually.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-4.11: Area suitable for recharge in Hilli block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Hilli	8785	--

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand, the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

No structure has been constructed by CGWB till date. Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. As a whole the water level is not in alarming condition in this block. Water conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting can be considered for the block in future.

This block is not considered under artificial recharge on account of the block having no significant rise or fall in its water level trends and the water level during the post-monsoon is also less than 6 mbgl and no Artificial Recharge Structures has thus been proposed at present. The area is also prone to water logging as well.

5. HARIRAMPUR

Salient Information:

Block Name : Harirampur

Geographical area (in sq. km): 248

Mappable area (in sq. km) 235

District : Dakshin Dinajpur

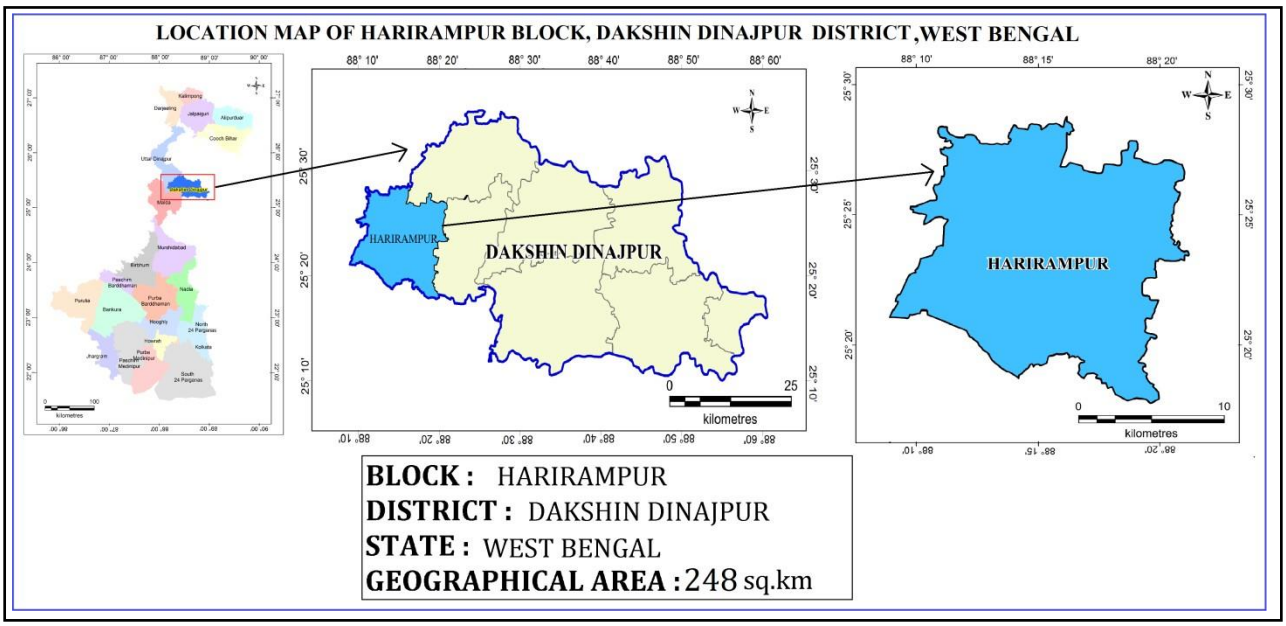

Figure-5.1: Location map for Harirampur block of Dakshin Dinajpur district.

Population (as on 2011):

Table-5.1: Details of Population in Harirampur block of Dakshin Dinajpur district.

Rural	Urban	Total
131832	5021	136853

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (in mm)

Table-5.2: Details of Annual Rainfall for the last five years in Harirampur block of Dakshin Dinajpur district.

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Harirampur	1800	1288.4	941	850.8	1245.1	785.9

Agriculture & Irrigation (area in ha):

Table-5.3: Salient Land use features of Harirampur block of Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Harirampur	324800	18694	5592.93	13101.07	-

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-5.4: Details of resource availability and draft (in MCM/Ham) in Harirampur block of Dakshin Dinajpur district.

Resource Availability and status of ground water development in Harirampur block	
Total Annual Ground Water Recharge (Ham)	13392.14
Static Resource (MCM)	--
Annual Extractable Ground Water Recharge (Ham)	12052.93
Total Extraction (Ham)	6009.84
Net Ground Water Availability for future use	5998.74
Stage of development (%)	49.86
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	193.58

Disposition of Aquifers:

In Harirampur block, there is one principal aquifer system i.e. Alluvium and one major aquifer system i.e. Younger Alluvium (Clay, sand and silt). Three aquifers are encountered in this block.

The range of Aquifer-I is from 9-54.7 (mbgl). The thickness of individual water bearing zones ranges within 8 to 38.17(mbgl).The zones are; 9-30, 16.53-54.7(mbgl). This aquifer is fresh in nature.

The range of Aquifer-II varies from 52-145 (mbgl). The thickness of individual water bearing zones ranges within 6.33 to 33 meters. The zones are; 52-8, 63.53-93.22, 110-143, 112-145, 116.67-152.29(mbgl). This aquifer is fresh in nature.

The depth range of Aquifer-III varies from 156-275 (mbgl). The thickness of individual water bearing zones ranges within 16 to 30.87 meters. The zones are; 170-186, 170.13-210, 156-210 and 255-275 (mbgl). This aquifer is fresh in nature.

Table-5.5: Details of aquifer disposition in Harirampur block of Dakshin Dinajpur district.

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50-150mbgl)	Aquifer-III (150 - 300mbgl)
Harirampur	Alluvium	9-30, 16.53-54.7, 52-8, 63.53-93.22, 110-143, 112-145, 116.67-152.29, 170-186, 170.13-210, 156-210, 255-275.	9.8-38.17	6.33-33	16-30.87

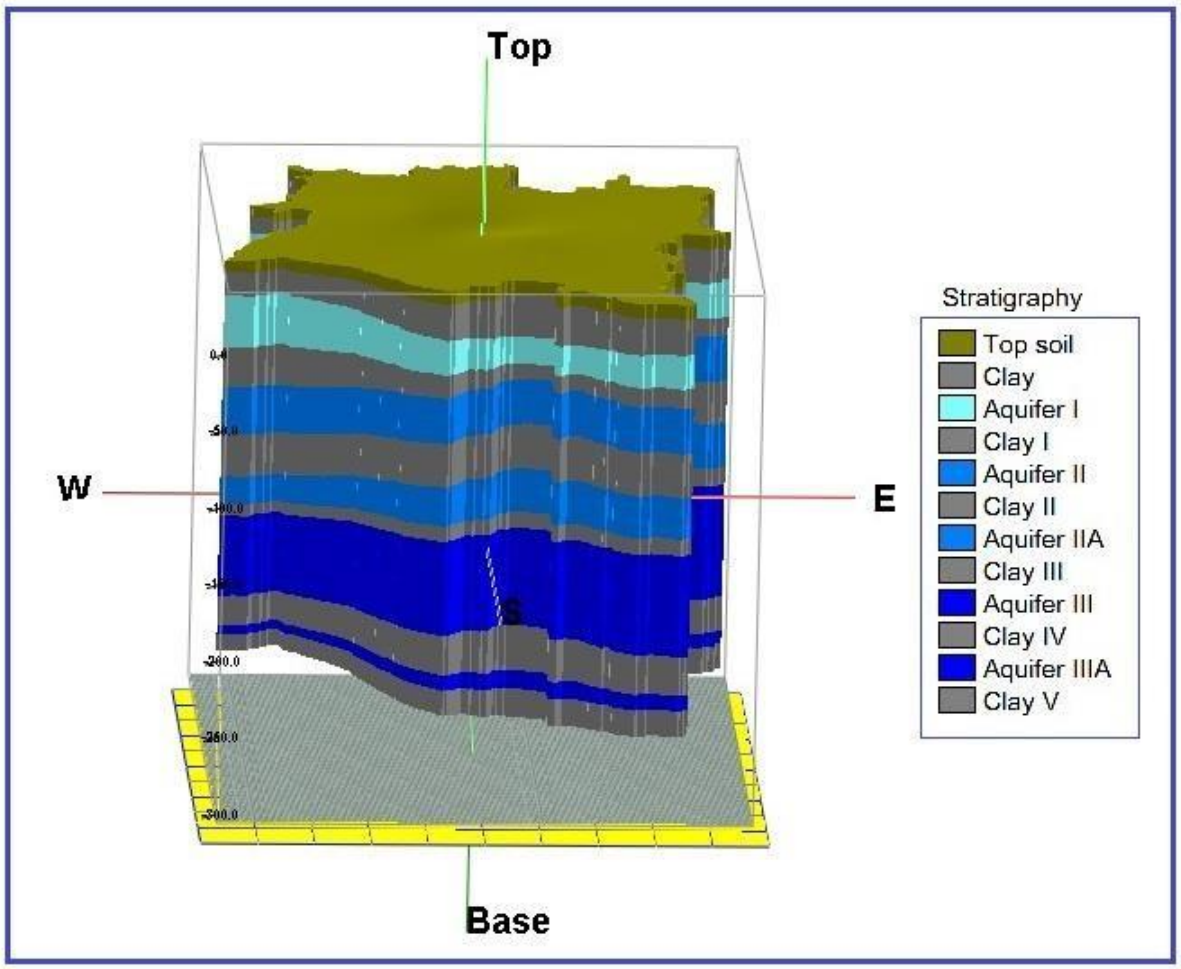

Figure-5.2: 3D model for the disposition of aquifers in Harirampur block of Dakshin Dinajpur district.

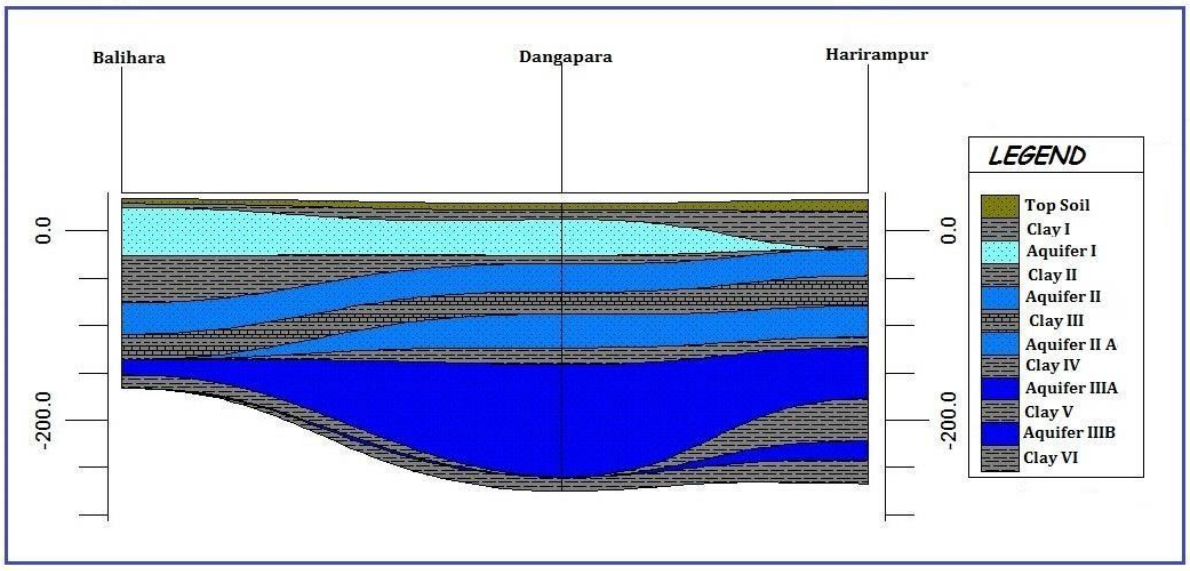

Figure-5.3: 2D crossectional diagram for the aquifers along W –E direction in Harirampur block of Dakshin Dinajpur district.

Table-5.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018) in Haririampur block of Dakshin Dinajpur district.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Haririampur	I	3.55	-	-	1.55	-	0.111
	II& III	10.44-11.42	-	-	3.14-7.20	-	-

Table-5.7: Aquifer-wise depth range and parameters in Haririampur block of Dakshin Dinajpur district.

Name of Block	Aquifer Type	Depth Range (mbgl)	Discharge (m3/hr)	Drawdown (m)	T (m2/day)	S
Haririampur	Aquifer I	3.50-39.62	-	-	-	-
	Aquifer II	51.70-146.30	>40	-	37-2000	-
	Aquifer-III	155.32-277.37	>40	-	37-2000	-

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table- 5.8: Average concentration of chemical parameter of Haririampur block of Dakshin Dinajpur district.

Block	Aquifer Type	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
Haririampur	Aquifer I	7.8	588	42.3	67.4	0.89	5.04	BDL	190

Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are eight (8) ongoing Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. Therefore, rainwater harvesting can also be done as well to supplement sources for drinking purpose. The conserved rainwater should be utilized for drinking purpose after filtering through Horizontal Roughing Filters.

II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area.

III. The block does not show an alarming falling trend in water level. However, to avoid such situations in future the number of pumping hours should be controlled and regular monitoring should be carried out.

Management Plan for irrigation:

Table-5.9: Ground Water scenario for irrigation in Harirampur block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Harirampur	36339	18643	4990.32	13652.68	49.86	Aquifer I: Fall: 0.111	-

(Source: 5th MI Census, yet to be published)

Table-5.10: Culturable Command Area created by groundwater and surface water in Harirampur block of Dakshin Dinajpur district.

Block Name	Dugwell		Shallow Tubewell		Medium Tubewell		Deep Tubewell		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Harirampur	0	0	1894	4766.33	4	120	4	160	0	0	46	546.6	5046.33	546.6	5592.93

I. The stage of ground water development in the block is 49.86 %, under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.
II. 13652.68 hectares more of land can be irrigated.
III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.
IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.
V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.

II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-5.11: Area suitable for recharge in Harirampur block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Harirampur	24800	--

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand, the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

No structure has been constructed by CGWB till date. Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. As a whole the water level is not in alarming condition in this block. Water conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting can be considered for the block in future.

This block is not considered under artificial recharge and no Artificial Recharge Structures has thus been proposed at present.

6. TAPAN

Salient Information:

Block Name : Tapan

Geographical area (in sq. km) : 419

Mappable area (in sq. km) 414

District : Dakshin Dinajpur

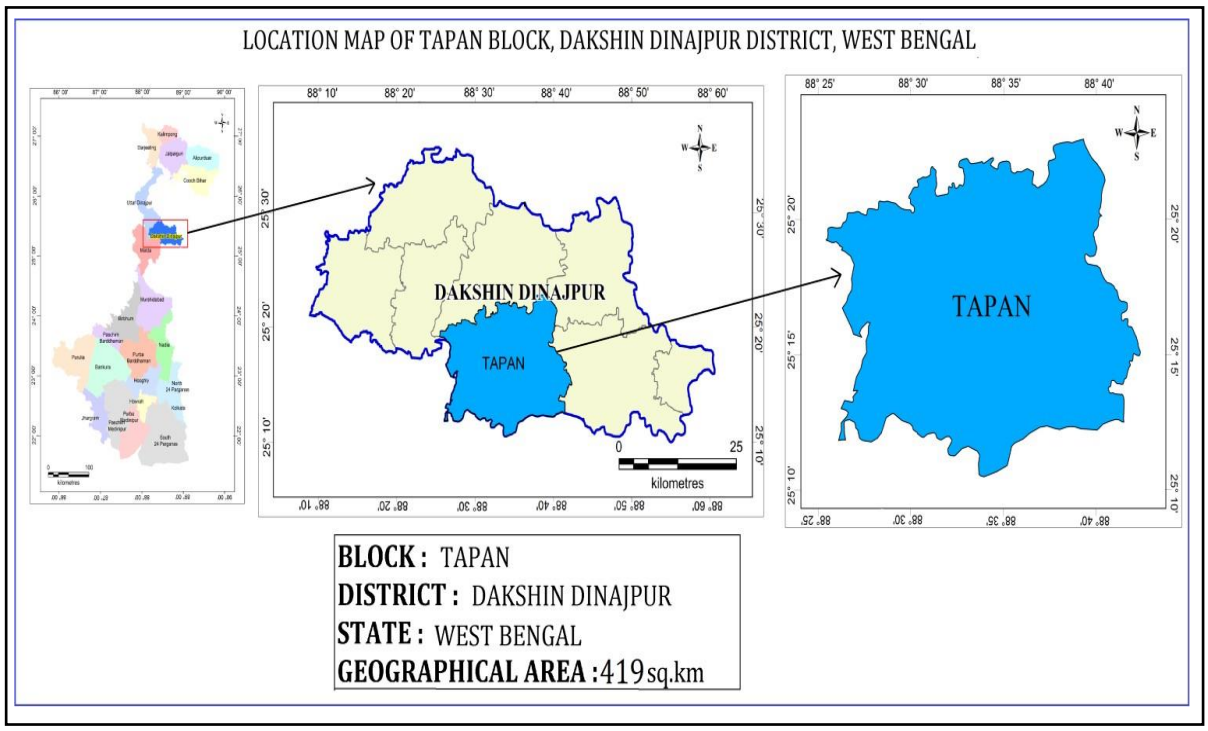

Figure-6.1: Location map for Tapan block of Dakshin Dinajpur district.

Population (as on 2011):

Table-6.1: Details of Population in Tapan block of Dakshin Dinajpur district.

Rural	Urban	Total
250504	--	250504

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (in mm)

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Balurghat	1298.4	1288.4	941	850.8	1245.1	785.9

Table- 6.2: Details of Annual Rainfall for the last five years in Tapan block of Dakshin Dinajpur district.

Agriculture & Irrigation (area in ha):

Table-6.3: Salient Land use features in Tapan block of Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Tapan	419	37971	9559.4	28411.6	369

Aquifer Wise Ground Water Resource Availability & Extraction:

Table- 6.4: Details of resource availability and draft (in MCM/Ham) in Tapan block of Dakshin Dinajpur district.

Resource Availability and status of ground water development in Tapan block	
Total Annual Ground Water Recharge (Ham)	25827.44
Static Resource (MCM)	102147.2914
Annual Extractable Ground Water Recharge (Ham)	25827.44
Total Extraction (Ham)	6284.54
Net Ground Water Availability for future use	16857.28
Stage of development (%)	27.04
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	376.04

Disposition of Aquifers:

In Tapan block, there is one principal aquifer system i.e. Alluvium and two major aquifer systems i.e. Younger Alluvium (Clay, sand and silt) and Older Alluvium (Barind tract). Two aquifers are encountered in this block.

The range of Aquifer-I is ranging between 0-50mbgl is absent in this block.

The range of Aquifer-II varies from 62-145128 mbgl. The thickness of individual water bearing zones ranges within 14 to 66 meters. The zones are; 62-128, 88-102(mbgl). This aquifer is fresh in nature.

The depth range of Aquifer-III varies from 150-301.47mbgl. The thickness of individual water bearing zones ranges within 11 to 45 meters. The zones are; 150-178, 175-186, 175-205 and 195-240 (mbgl). This aquifer is fresh in nature.

Table- 6.5: Details of aquifer disposition in Tapan block of Dakshin Dinajpur district.

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50-150mbgl)	Aquifer-III (150 - 300mbgl)
Tapan	Alluvium	62-128, 88-102, 150-178, 175-186, 175-205, 195-240.	--	14-66	11-45

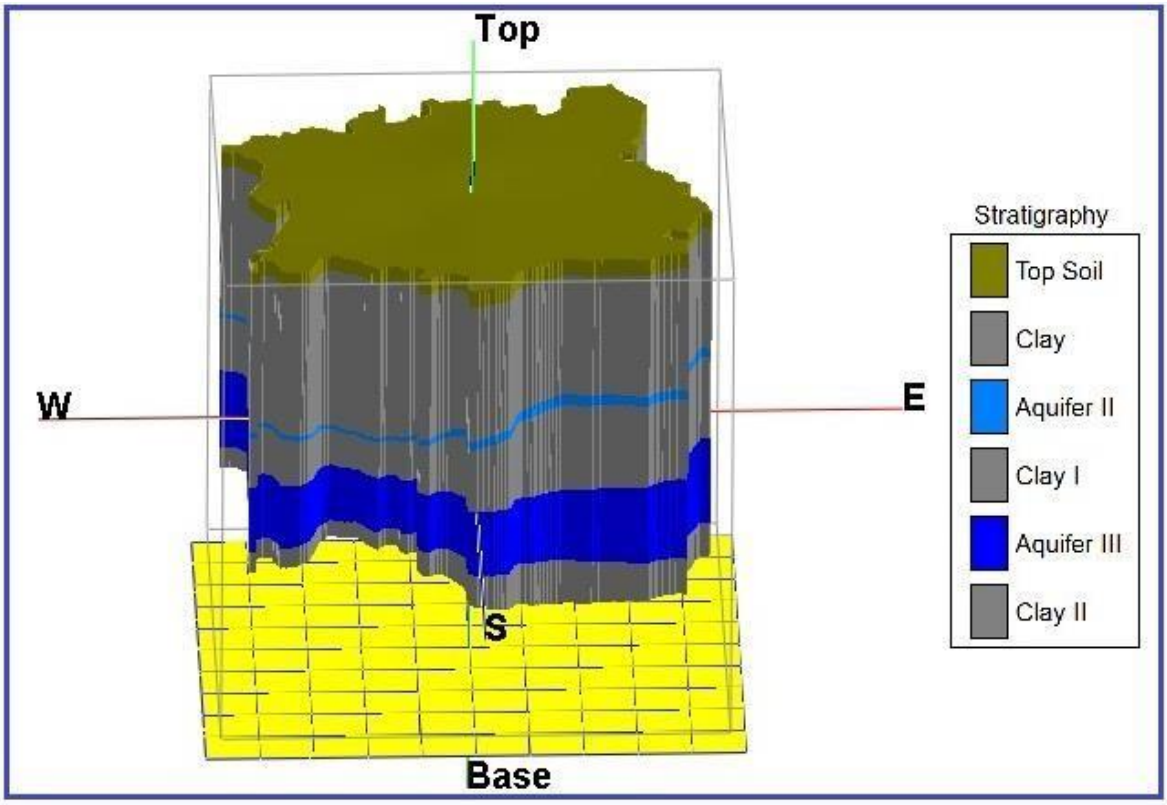

Figure-6.2: 3D model for the disposition of aquifers in Tapan block of Dakshin Dinajpur district.

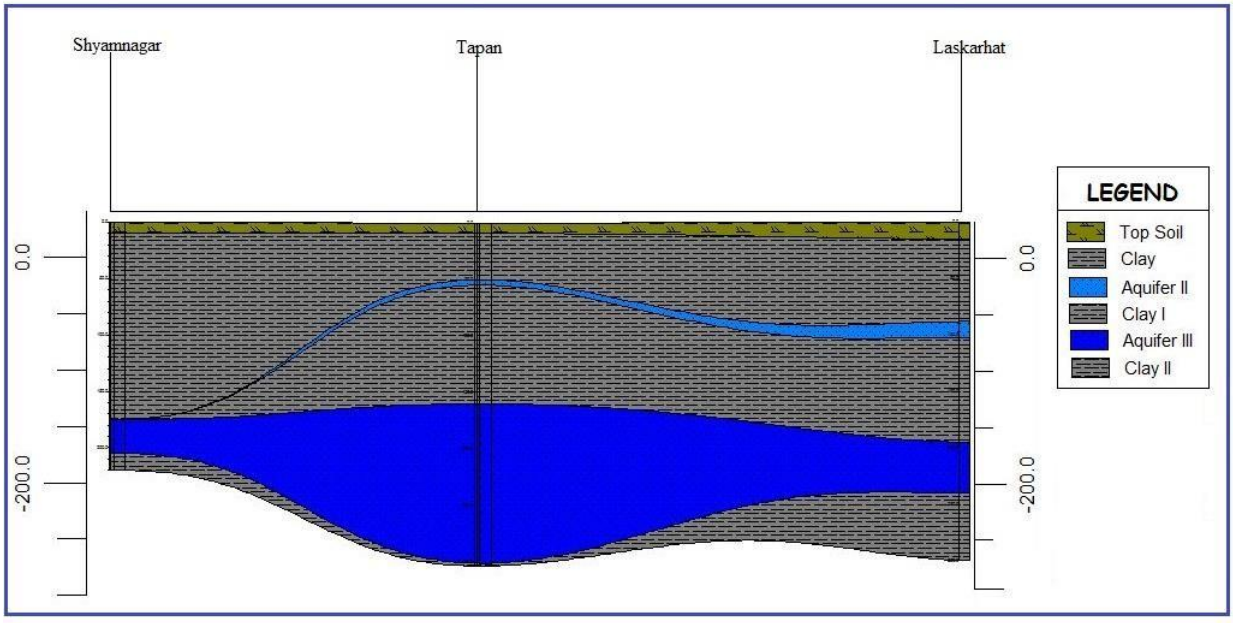

Figure-6.3: 2D crossectional diagram for the aquifers along N –S direction in Tapan block of Dakshin Dinajpur district.

Table-6.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018) in Tapan block of Dakshin Dinajpur district.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Tapan	I	2.81-18.14	-	1.003	1-4.59	-	0.330
	II& III	17.14-20.93	-	0.283	1.77-6.54	-	0.356

Table-6.7: Aquifer-wise depth range and parameters in Tapan block of Dakshin Dinajpur district.

Name of Block	Aquifer Type	Depth Range (mbgl)	Discharge (m3/hr)	Drawdown (m)	T (m2/day)	S
Tapan	Aquifer I	42.64-54.82	-	-	-	-
	Aquifer II	52-153	7.74-33.01	-	70.68-77.97	1.35x10-3to 7.23x10-4
	Aquifer III	152.25-301.47	5.4-36	-	99.3-192.66	-

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table-6.8: Average concentration of chemical parameter of Tapan block of Dakshin Dinajpur district.

Block	Aquifer Type	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
Tapan	Aquifer I	8.06	395.8	34.7	89.7	0.546	1.97	1.077	140

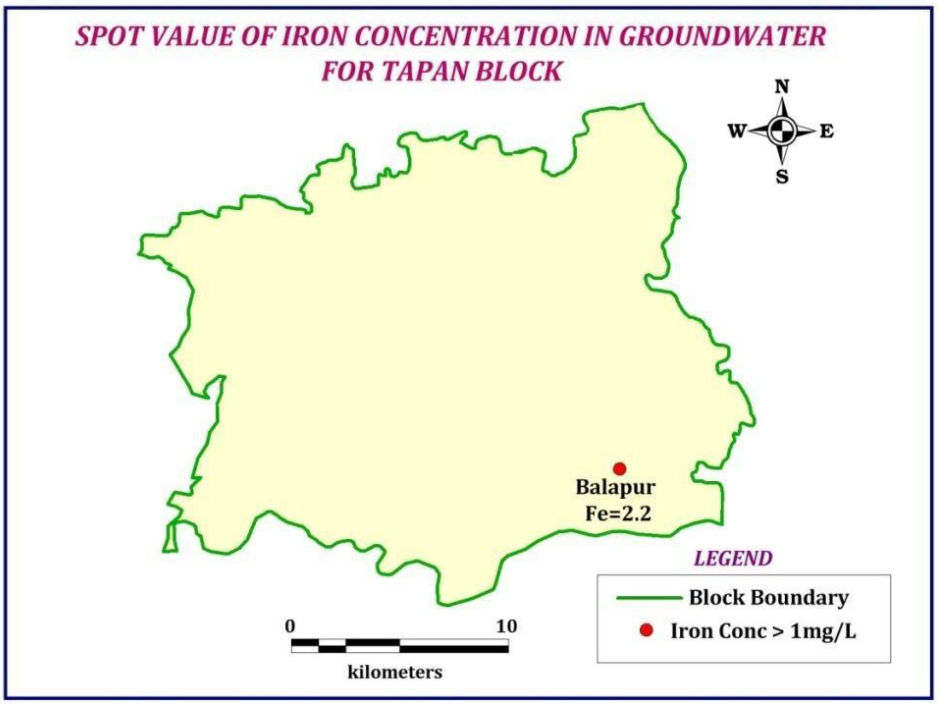

Figure-6.4: Spot map of iron concentration in Tapan block of Dakshin Dinajpur district.

High iron content (2.2 mg/l) is also recorded from Balapur area. More intensive sampling from this block is recommended.

Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are eight (8) commissioned and one (1) ongoing Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. Therefore, rainwater harvesting can also be done as well to supplement sources for drinking purpose. The conserved rainwater should be utilized for drinking purpose after filtering through Horizontal Roughing Filters.
II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area.
III. The block does not show an alarming falling trend in water level. However, to avoid such situations in future the number of pumping hours should be controlled and regular monitoring should be carried out.
IV. Iron is not prevalent in the area however it is reported from few tubewells. In such case iron filtering is required. Further sampling is necessary to determine if the iron is geogenic and present in the aquifer itself or a resultant of rusting of pipes in the tube-wells.

Management Plan for Irrigation:

Table-6.9: Culturable Command Area created by groundwater and surface water in Tapan block of Dakshin Dinajpur district.

Block Name	Dugwell		Shallow Tubewell		Medium Tubewell		Deep Tubewell		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Tapan	16	66.8	1967	6540.49	52	454.8	39	207.1	5	252	145	2038.21	7269.19	2290.21	9559.4

Table- 6.10: Ground Water scenario for irrigation in Tapan block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Tapan	41900	37883	7738.87	30144.13	27.04	Aquifer I: Fall-0.330 Aquifer II&III: Fall-0.356	-

(Source: 5th MI Census)

I. The stage of ground water development in the block is 27.04 %,under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.
II. 30144.13 hectares more of land can be irrigated.
III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.
IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.
V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.
VI. The block is a part of Barind tract and the potentiality of the aquifers in Barind tract is low and the drawdown is very high. Dug wells, light duty tube-wells fitted with submersible pump, medium duty tube-wells are feasible for irrigation purposes. But the capacity of the pump should be decided in such a way so that drawdown may be minimized. The depth of the tube-wells may be restricted down to the depth of 250 mbgl tapping the aquifers. Heavy duty tube-wells within the depth of 250 mbgl are feasible for irrigation purpose.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-6.11: Area suitable for recharge in Tapan block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Tapan	41900	104.38

It has been estimated that the utilizable surface runoff produced is **104.38** MCM. This surface runoff is proposed to be utilized to recharge the depleted aquifer in the block. As per the available storage space, **9.394** MCM water is required to fill the deeper aquifers in the block. Therefore, **31** injection wells with roof top rainwater harvesting structures are recommended in the block.

The remaining surface runoff, **21.92**MCM is recommended to be utilized in storage tanks for generation of irrigation potential and thus **94** storage tanks have been proposed. The roof top rain water harvesting structures with suitably design injection wells may be proposed to construct in the census town areas in primary phases and subsequently may be extended to the rural areas.

Table-6.12: Artificial recharge priority area-structures feasible and their cost of construction for the study area.

Block	Utilizable surface runoff	Allocation of utilizable resources (MCM)			Structures Feasible (Nos)			Cost of Structures (in Lakhs)			Total Cost (in Lakhs)
		Percolation tank	REET with RS	Injection Well	Percolation tank	REET with RS	Injection Well	Percolation tank	REET with RS	Injection Well	
Tapan	31.314	15.657	6.263	9.394	31	63	31	248	252	93	593

***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation.*

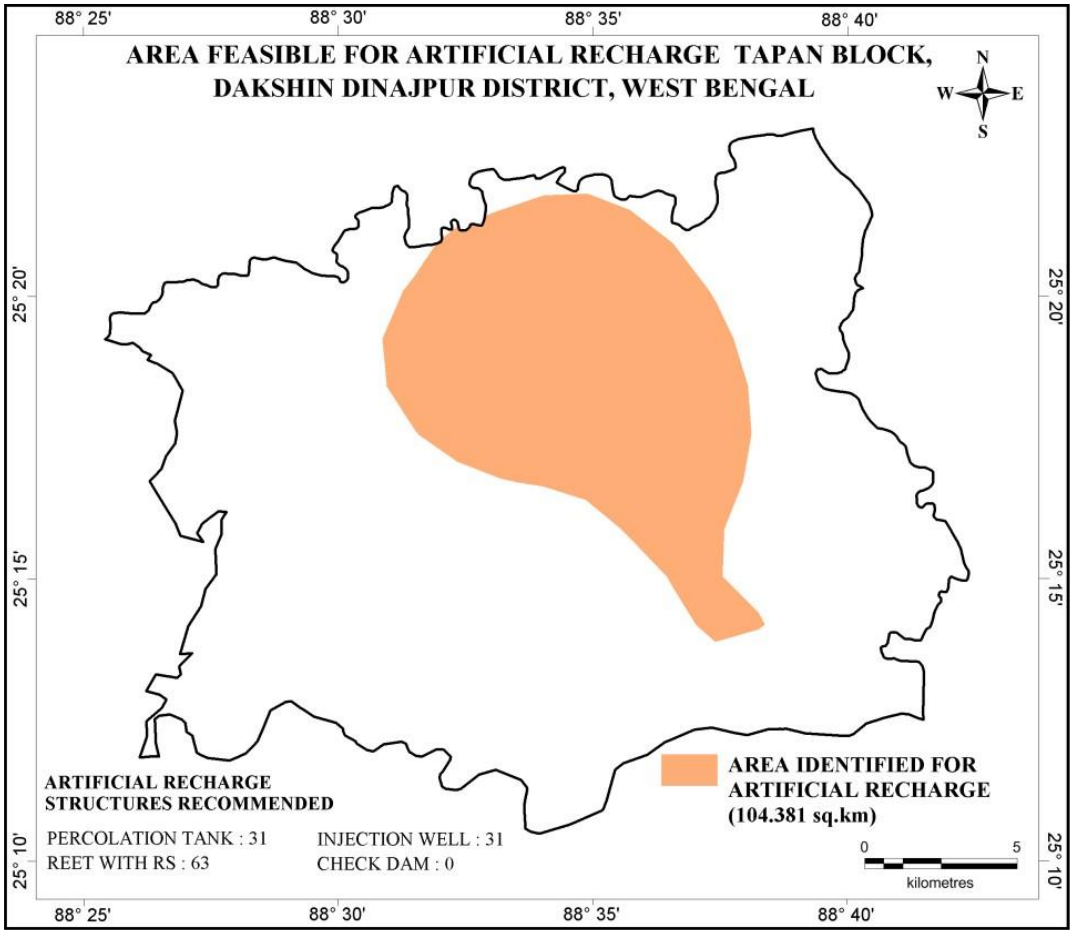

Figure-6.5: Artificial Recharge map for Tapan Block of Dakshin Dinajpur district.

7. BANSIHARI

Salient Information:

Block Name : Bansihari

Geographical area (in sq. km) : 206

Mappable area (in sq. km) 203

District : Dakshin Dinajpur

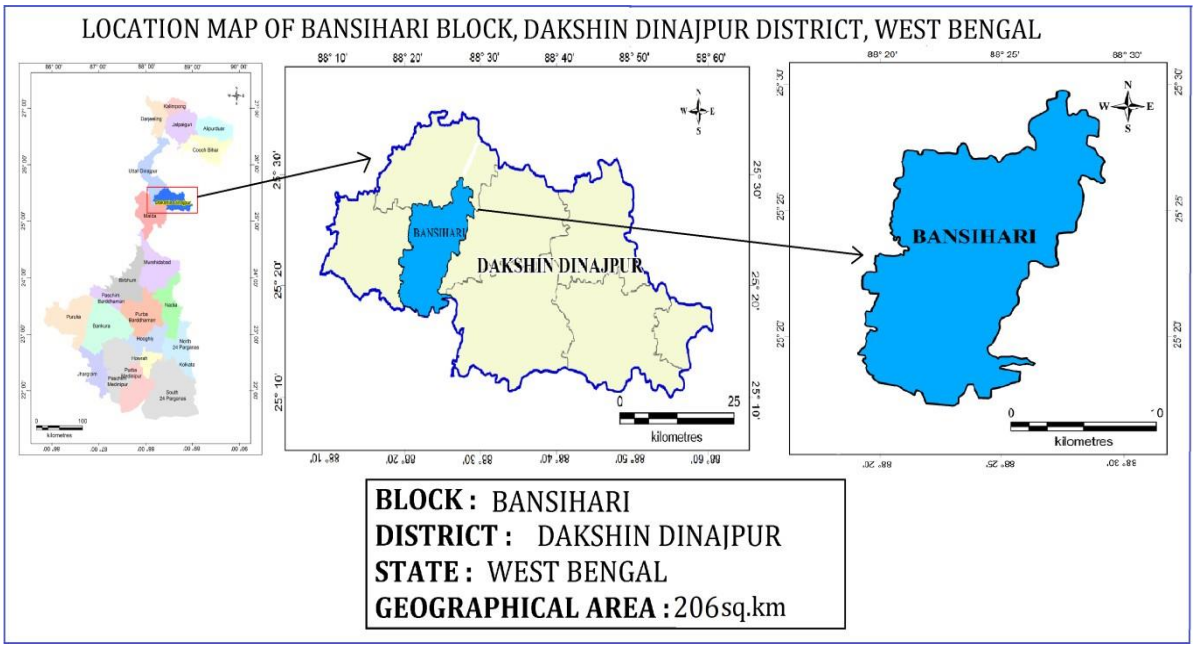

Figure-7.1: Location map for Bansihari block of Dakshin Dinajpur district.

Population (as on 2011):

Table-7.1: Details of Population in Bansihari block of Dakshin Dinajpur district.

Rural	Urban	Total
141286	--	141286

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (in mm)

Table-7.2: Details of Annual Rainfall for the last five years in Bansihari block of Dakshin Dinajpur district.

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Bansihari	1800	1288.4	941	850.8	1245.1	785.9

Agriculture& Irrigation (area in ha):

Table-7.3: Salient Land use features of Bansihari block of Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Bansihari	20600	16606	5118	11488	7

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-7.4: Details of resource availability and draft (in MCM/Ham) in Bansihari block of Dakshin Dinajpur district.

Resource Availability and status of ground water development in Bansihari block	
Total Annual Ground Water Recharge (Ham)	13488.21
Static Resource (MCM)	88110.3432
Annual Extractable Ground Water Recharge (Ham)	12139.39
Total Extraction (Ham)	4986.09
Net Ground Water Availability for future use	7113.11
Stage of development (%)	41.07
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	194.25

Disposition of Aquifers:

In Bansihari block, there is one principal aquifer system i.e. Alluvium and one major aquifer system i.e. Younger Alluvium (sand, silt, clay etc.). Three aquifers are encountered in this block. The range of Aquifer-I is from 5-42.5 (mbgl). The thickness of individual water bearing zones ranges within 7 to 12(mbgl).The zones are; 5-15, 20.5-42.5, 20.72-27.73 (mbgl). This aquifer is fresh in nature.

The range of Aquifer-II varies from 56-148 (mbgl). The thickness of individual water bearing zones ranges within 21-39.93 meters. The zones are; 56-89, 67-88, 69.8-109.73, 108-136.6 and 117-148 (mbgl). This aquifer is fresh in nature.

The depth range of Aquifer-III varies from 163-289 (mbgl). The thickness of individual water bearing zones ranges within 7-40.5 meters. The zones are; 163-196, 231.16-243.84, 217-258, 266.1-273.1 (mbgl). This aquifer is fresh in nature.

Table-7.5: Details of aquifer disposition in Bansihari block of Dakshin Dinajpur district.

Block	Geology	Water bearing zones/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50-150mbgl)	Aquifer-III (150 - 300mbgl)
Bansihari	Alluvium	5-15, 20.5-42.5, 20.72-27.73, 56-89, 67-88, 69.8-109.73, 108-136.6, 117-148, 163-196, 231.16-243.84, 217-258, 266.1-273.1.	7-12	21-39.93	7-40.5

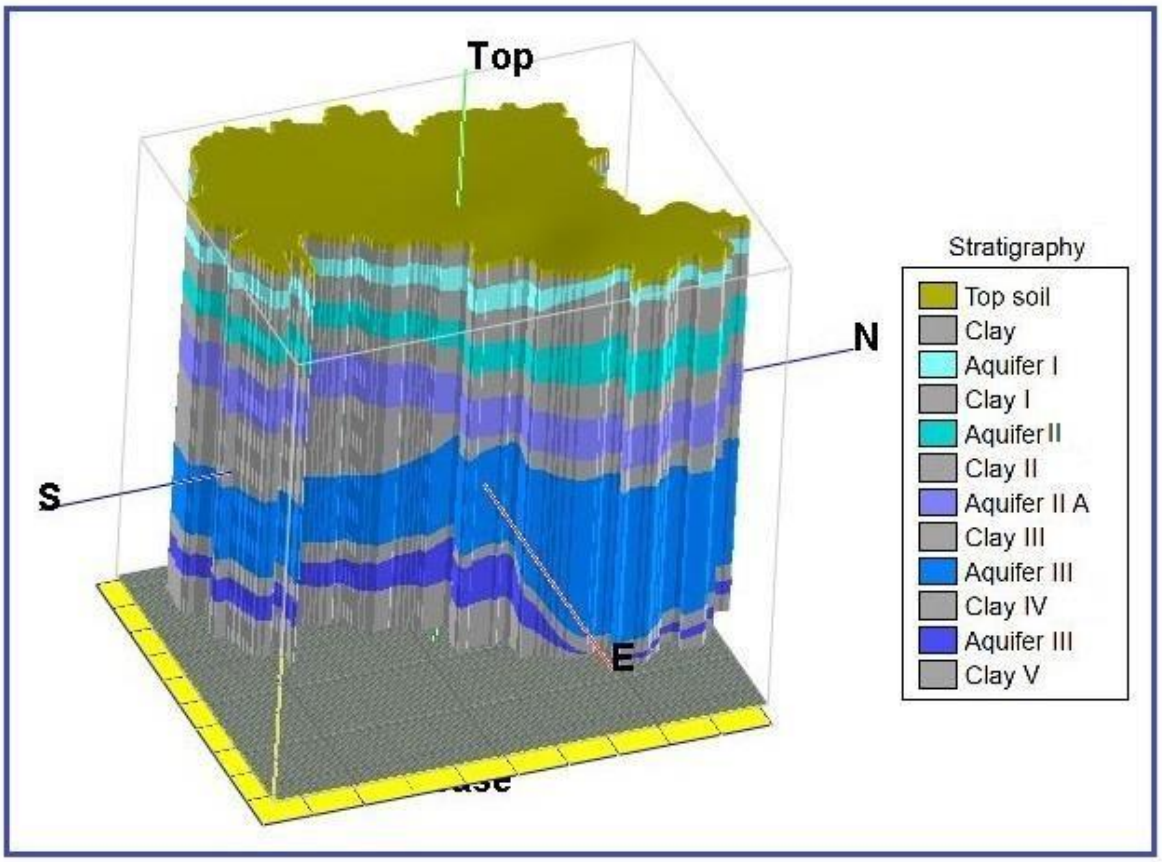

Figure-7.2: 3D model for the disposition of aquifers in Bansihari block of Dakshin Dinajpur district.

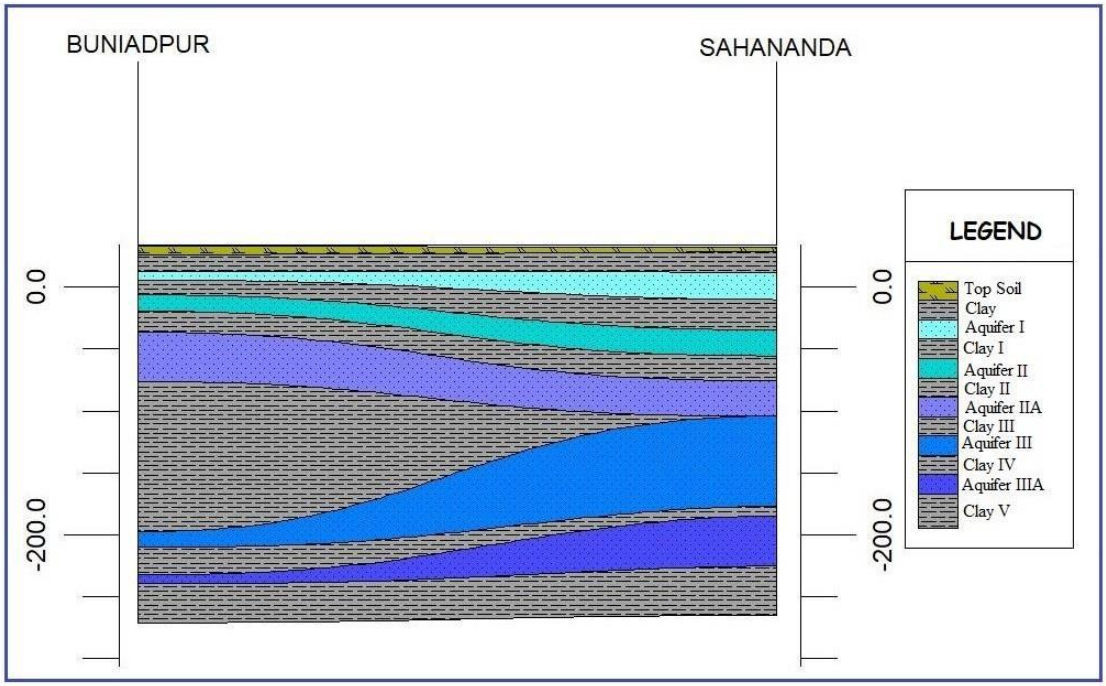

Figure-7.3: 2D crossectional diagram for the aquifers along NE –SW direction in Bansihari block of Dakshin Dinajpur district.

Table-7.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018) in Bansihari block of Dakshin Dinajpur district.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Bansihari	I	-	-	0.159	-	-	0.036
	II& III	6.36-13.58	0.258	-	4.23-7.40	-	0.279

Table-7.7: Aquifer-wise depth range and parameters in Bansihari block of Dakshin Dinajpur district.

Name of Block	Aquifer Type	Depth Range (mbgl)	Discharge (m3/hr)	Drawdown (m)	T (m2/day)	S
Bansihari	Aquifer I	9.14-53.47	-	-	-	-
	Aquifer II	51.81-149.34	5.4-115.81	8.06	75.65	-
	Aquifer III	152-283.44	5.4-115.81	8.06	75.65	-

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table-7.8: Average concentration of chemical parameter of Bansihari block of Dakshin Dinajpur district.

Block	Aquifer Type	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
Bansihari	Aquifer I	7.76	1313.35	137.6	267.65	0.28-1.4	0.84	0.2	312.5
	Aquifer II & III	7.89	289.2	70.7	17.7	2.5	4.35	0.389	90

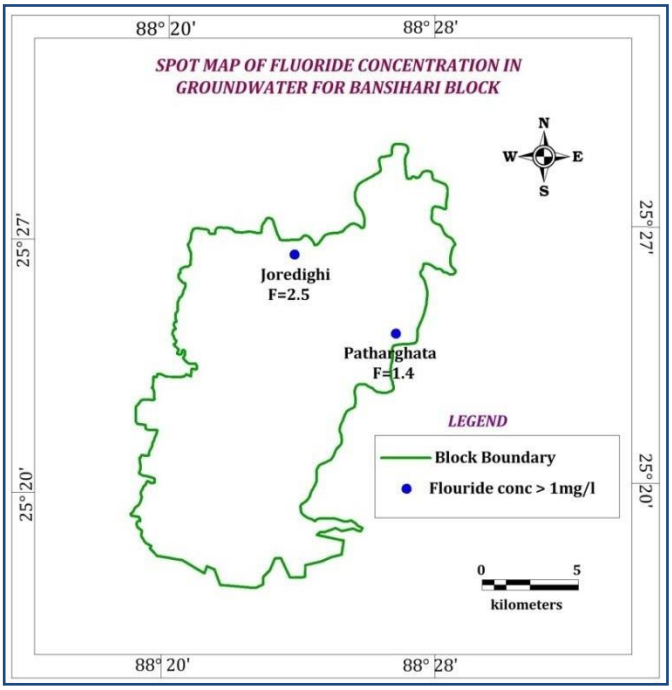

Figure-7.4: Spot map of fluoride concentration in groundwater for Bansihari block of Dakshin Dinajpur district.

Fluoride concentration of 1.4-2.5 mg/l, which is above permissible limit, is recorded from this block. More intensive sampling from this block is recommended.

Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are four (4) commissioned and nine (9) ongoing Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. Therefore, rainwater harvesting can also be done as well to supplement sources for drinking purpose. The conserved rainwater should be utilized for drinking purpose after filtering through Horizontal Roughing Filters.
II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area. The water from the sources however should be filtered before use.
III. To mitigate the problem of fluoride in groundwater, De-fluoridisation or fluoride filtering must be carried out for before use
IV. The block does not show an alarming falling trend in water level. However, to avoid such situations in future the number of pumping hours should be controlled and regular monitoring should be carried out.

Management Plan for irrigation:

Table-7.9: Culturable command area created by groundwater and surface water in Bansihari block of Dakshin Dinajpur district.

Block Name	Dug-well		Shallow Tube-well		Medium Tube-well		Deep Tube-well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Bansihari	0	0	1565	4232	0	0	3	120	2	40	36	726	4352	766	5118

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Table-7.10: Ground Water scenario for irrigation in Bansihari block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Bansihari	20600	16544	4137	12407	41.07	Aquifer I: Fall-0.036 Aquifer II& III: Fall - 0.279	--

I. The stage of ground water development in the block is 41.07%,under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.
II. 12407hectares more of land can be irrigated.
III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.
IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.
V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-7.11: Area suitable for recharge in Bansihari block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Bansihari	20600	--

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand, the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

No structure has been constructed by CGWB till date. Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. As a whole the water level is not in alarming condition in this block. Water conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting can be considered for the block in future.

This block is not considered under artificial recharge and no Artificial Recharge Structures has thus been proposed at present.

8. KUMARGANJ

Salient Information:

Block Name : Kumarganj

Geographical area (in sq. km) : 288

Mappable area (in sq. km) 288

District : Dakshin Dinajpur

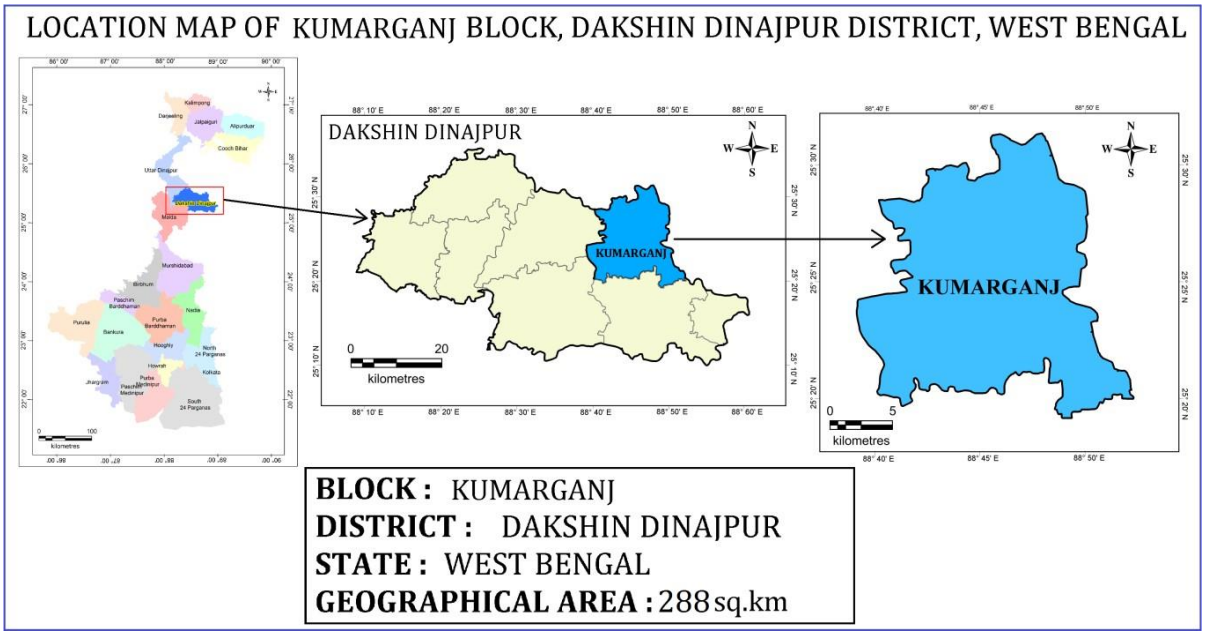

Figure-8.1: Location map for Kumarganj block of Dakshin Dinajpur district.

Population (as on 2011):

Table-8.1: Details of Population in Kumarganj block of Dakshin Dinajpur district.

Rural	Urban	Total
169102	--	169102

Rainfall:

Average annual rainfall (Dakshin Dinajpur district) for the period 2014 -18 is 1022.24 (in mm)

Table- 8.2: Details of Annual Rainfall for the last five years in Kumarganj block of Dakshin Dinajpur district.

Block	District Normal	District Actual (Annual)				
		2014	2015	2016	2017	2018
Balurghat	1298.4	1288.4	941	850.8	1245.1	785.9

Agriculture & Irrigation (area in ha):

Table-8.3: Salient Land use features of Kumarganj block of Dakshin Dinajpur district.

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Kumarganj	28800	21880	14271.38	7608.62	22

Aquifer Wise Ground Water Resource Availability & Extraction:

Table- 8.4: Details of resource availability and draft (in MCM/Ham) in Kumarganj block of Dakshin Dinajpur district.

Resource Availability and status of ground water development in Kumarganj block	
Total Annual Ground Water Recharge (Ham)	23888.19
Static Resource (MCM)	124328.115
Annual Extractable Ground Water Recharge (Ham)	21499.37
Total Extraction (Ham)	13199.59
Net Ground Water Availability for future use	8258.81
Stage of development (%)	61.40
Category	Safe
Annual GW Allocation for Domestic and Industrial Use as on 2042	225.36

Disposition of Aquifers:

In Kumarganj block, there is one principal aquifer system i.e. Alluvium and two major aquifer systems i.e. Younger Alluvium (Clay, sand and silt) and Older Alluvium (Barind tract). Three aquifers are encountered in this block. The range of Aquifer-I varies from 7-51.82 (mbgl). The thickness of individual water bearing zones ranges within 10.44 to 27.432 (mbgl). The zones are; 7-30, 18.6-48, 24.38 -51.82(mbgl). This aquifer is fresh in nature.

The range of Aquifer-II varies from 75.48-153.88 (mbgl). The thickness of individual water bearing zones ranges within 17.74 to 41.65 meters. The zones are; 75.48-93.22, 79.45-115.69, 119.57-161.22, 124.34 -153.88(mbgl). This aquifer is fresh in nature.

The depth range of Aquifer-III varies from 161.54-240.79 (mbgl). The thickness of individual water bearing zones ranges within 23.95 to 79.35 meters. The zones are; 161.54-240.79, 167.13-191.08, 171.96 -229.91 (mbgl). This aquifer is fresh in nature.

Table-8.5: Details of aquifer disposition in Kumarganj block of Dakshin Dinajpur district.

Block	Geology	Water bearing zone/zones tapped	Aquifer Thickness (m)		
			Aquifer-I (within 50 mbgl)	Aquifer-II (50-150mbgl)	Aquifer-III (150 - 300mbgl)
Kumarganj	Alluvium	7-30, 18.6-48, 24.38-51.82,75.48-93.22, 79.45-115.69, 119.57-161.22, 124.34-153.88, 161.54-193, 167.13-191.08, 171.96-229.91	13.82-29.4	17.74-41.65	23.95-57.95

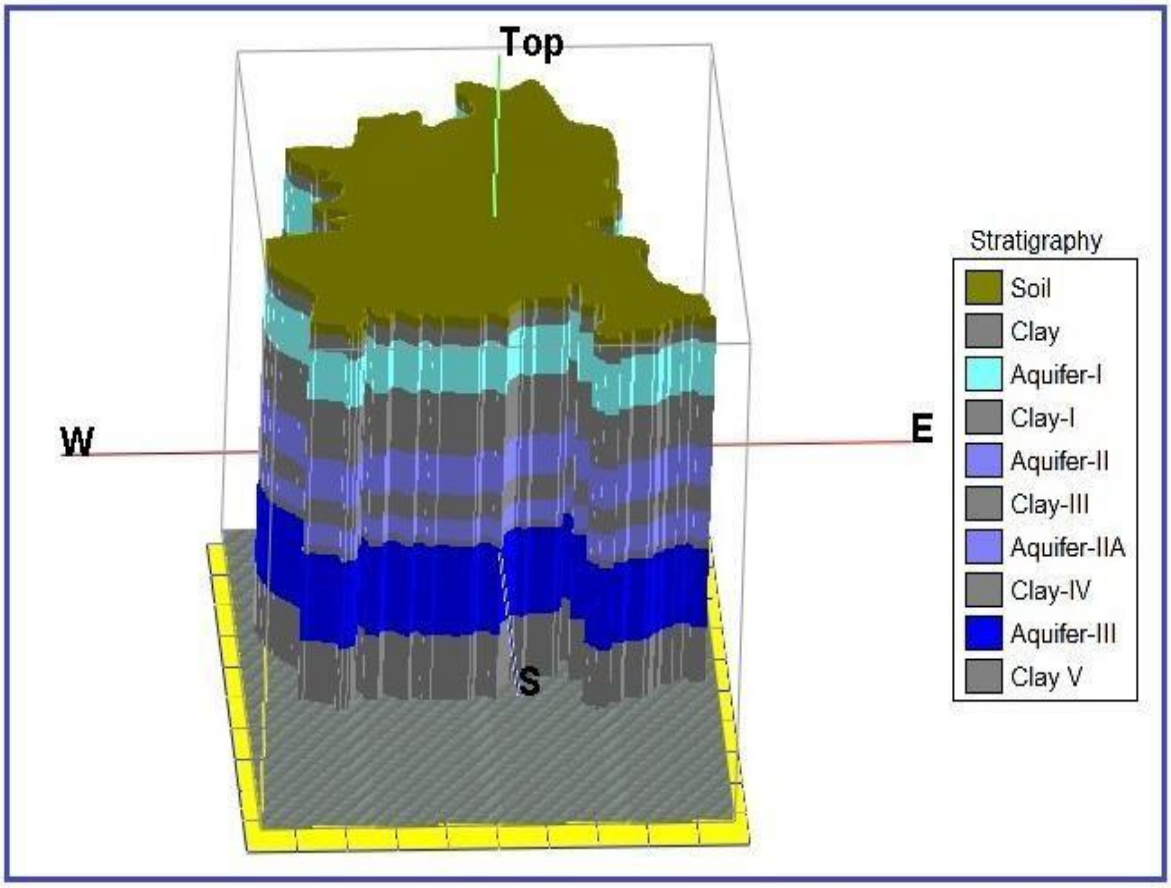

Figure-8.2: 3D model for the disposition of aquifers in Kumargram block of Dakshin Dinajpur district.

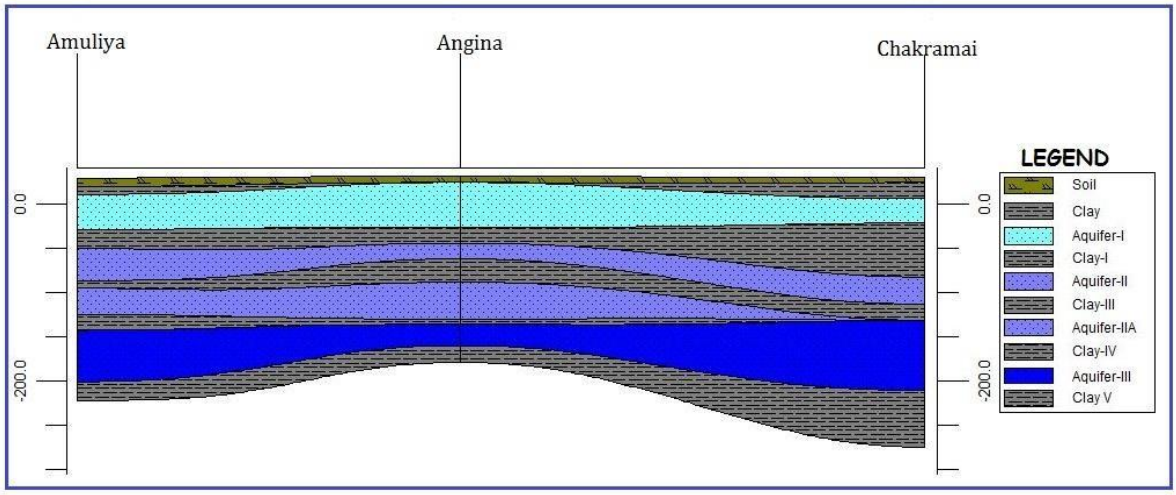

Figure-8.3: 2D crossectional diagram for the aquifers along N –S direction in Kumargram block of Dakshin Dinajpur district.

Table- 8.6: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2009 to 2018)in Kumargram block of Dakshin Dinajpur district.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Kumarganj	I	5.08-12.80	0.229	-	1.25-2.19	0.106	-
	II& III	9.37-13.11	5.090	-	2.50-2.71	0.198	-

Table-8.7: Aquifer-wise depth range and parameters in Kumarganj block of Dakshin Dinajpur district.

Name of Block	Aquifer Type	Depth Range (mbgl)	Discharge (m3/hr)	Drawdown	T (m2/day)	S
Kumarganj	Aquifer I	7-58.44	-	-		-
	Aquifer II	52.53-150.88	>40	-	37-2000	-
	Aquifer III	150.88-202.3	>40	-	37-2000	-

Ground water quality and issues:

Based on NHNS data, the range of chemical parameter for the block is given below.

Table- 8.8: Average concentration of chemical parameter in groundwater for Kumarganj block of Dakshin Dinajpur district.

Block	Aquifer Type	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
Kumarganj	Aquifer I	8.01	194.5	7.5	53.2	1.2	1.09	3.5	190

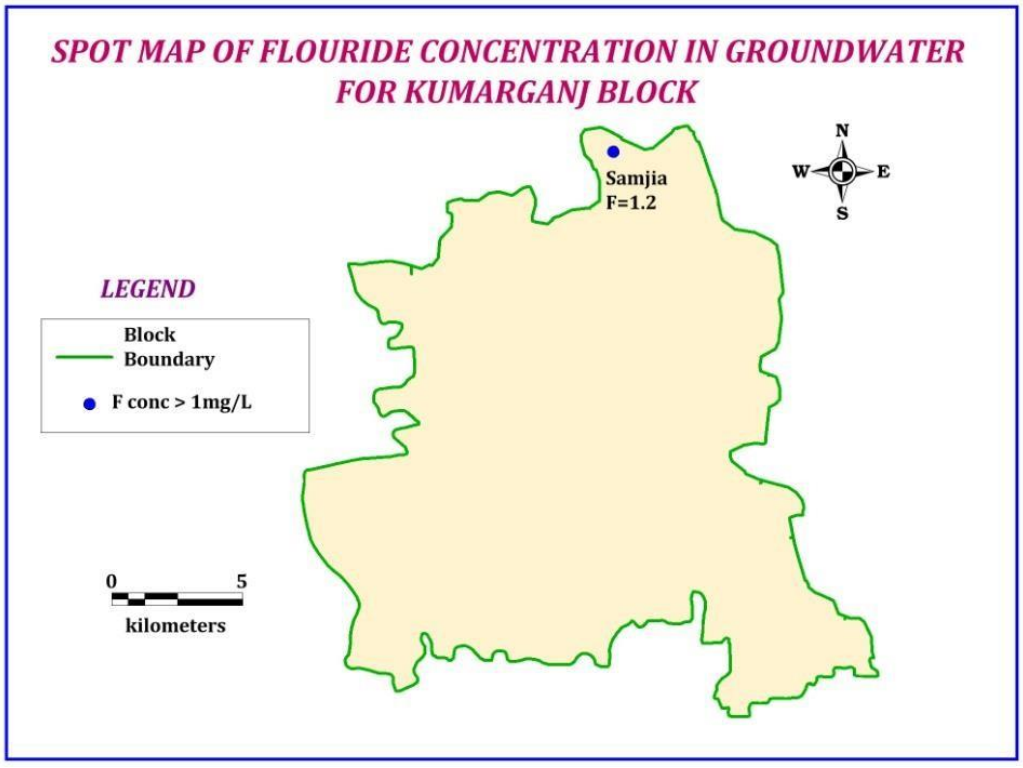

Figure-8.4: Spot map of Flouride concentration in Kumarganj Block of Dakshin Dinajpur district.

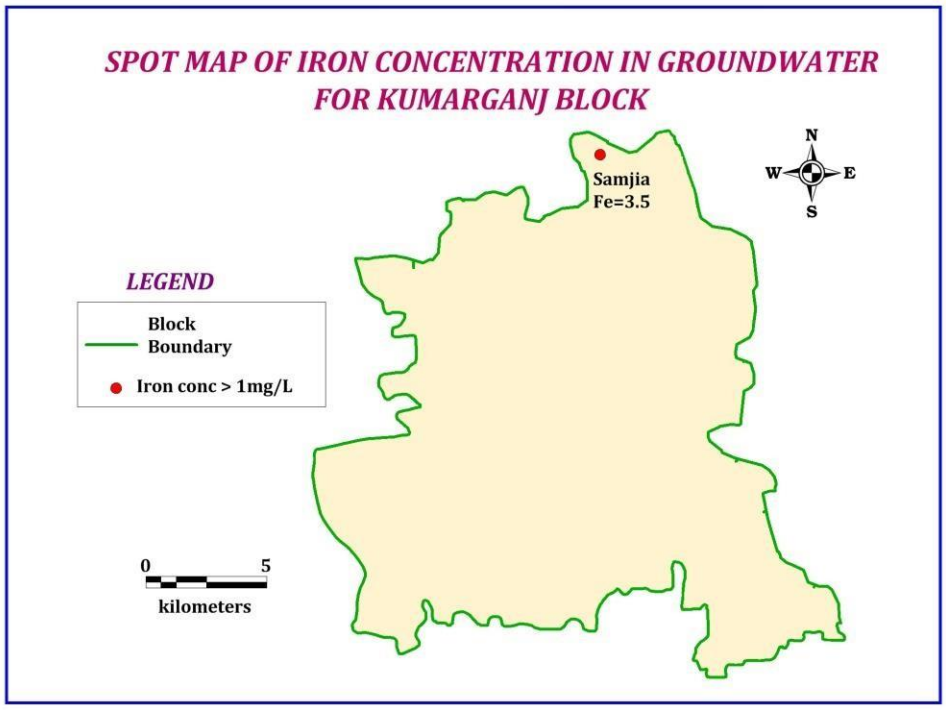

Figure- 8.5: Spot map of Iron concentration in Kumarganj Block of Dakshin Dinajpur district.

Fluoride concentration of 1.2 mg/l, which is above acceptable limit, is recorded from Samjia area. High iron content (3.5 mg/l) is also recorded from the same area. More intensive sampling from this block is recommended.

Ground Water Resource Enhancement & Management Plan:

Ground Water Management Plan for drinking purpose:

I. There are two (2) commissioned Piped water supply schemes by PHED which provides drinking water in the block. The Block receives sufficient rainfall during the monsoon as well. Therefore, rainwater harvesting can also be done as well to supplement sources for drinking purpose. The conserved rainwater should be utilized for drinking purpose after filtering through Horizontal Roughing Filters.

II. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area.

III. The block does not show an alarming falling trend in water level. However, to avoid such situations in future the number of pumping hours should be controlled and regular monitoring should be carried out.

IV. Iron is not prevalent in the area however it is reported from few tube-wells. In such case iron filtering is required. Further sampling is necessary to determine if the iron is geogenic and present in the aquifer itself or a resultant of rusting of pipes in the tube-wells.

V. Flouride concentration is also found to be towards higher side in few locations. To avoid fluoride intake in groundwater, flouride filtering or de-flouridisation should be carried out before water supply.

Management Plan for Irrigation:

Table- 8.9: Culturable command area created by groundwater and surface water in Kumarganj Block of Dakshin Dinajpur district.

Block Name	Dugwell		Shallow Tube-well		Medium Tube-well		Deep Tube-well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
Kumarganj	0	0	4155	8594.42	3	60	22	792	1	42	102	4782.96	9446.42	4824.96	14271.38

Table-8.10: Ground Water scenario for irrigation in Kumarganj block of Dakshin Dinajpur district.

Block	Geographical area in ha	Net sown area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Post monsoon WL Trend in cm/yr	Average Post monsoon WL in mbgl
Kumarganj	28800	21759	8430.56	13328.44	61.40	Aquifer I: Rise-0.106 Aquifer II: Rise-0.198	-

(Source: 5th MI Census, yet to be published)

I. The stage of ground water development in the block is 61.04 %, under safe category. However, further development should be done in planned manner to harness the additional available resource for more sustainable development.
II. 13328.44 hectares more of land can be irrigated.
III. Water applied for irrigation should not be wasted. An effective water management technique should be taken into account through modern agricultural management maintaining minimum pumping hours and selecting most appropriate cropping pattern. The application of modern techniques like sprinkler and drip irrigation will help increase crop yield and consequently conserve ground water.
IV. Crops with low water requirement should be preferred. For this, percentage of area under paddy cultivation in the area should be reduced to some extent.
V. Heavy duty/medium duty tube wells can be constructed by Govt. agencies as they may help for irrigation in large perspective. Installation and maintenance cost of heavy-duty tube well is high and it will be difficult for individual or small farmers to maintain. Therefore, heavy-duty tube wells can be constructed by local government agencies and after installation of pumps it can be handed over to the local co-operative based farmers for its operation and maintenance.
VI. The block is a part of Barind tract and the potentiality of the aquifers in Barind tract is low and the drawdown is very high. Dug wells, light duty tube-wells fitted with submersible pump, medium duty tube-wells are feasible for irrigation purposes. But the capacity of the pump should be decided in such a way so that drawdown may be minimized. The depth of the tube-wells may be restricted

down to the depth of 250 mbgl tapping the aquifers. Heavy duty tube-wells within the depth of 250 mbgl are feasible for irrigation purpose.

Management Plan for Industrial Purpose:

I. There are no big industries in the block as such at present except some small scale industries. All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
II. All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are required to make 90 % quantum of recharge to that of ground water withdrawal by them.
III. The competent authority should issue NOC and monitor its compliance.
IV. Regular analysis for fluoride content in water should be carried out.

Management Intervention through Rain water Harvesting (Roof top and Surface Runoff) and Artificial Recharge:

Table-8.11: Area suitable for recharge in Kumarganj block of Dakshin Dinajpur district.

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in post-monsoon and showing 2m/yr or more-long term falling trend)
Dakshin Dinajpur	Kumarganj	28800	--

The area receives plenty of rainfall but due to lack of proper rainwater harvesting structures and un-distributed rainfall causes huge amount of rainwater to drain into the sea. On the other hand,the area being predominantly underlain by clay, direct rainfall infiltration is very less, resulting high volume of runoff. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area.

No structure has been constructed by CGWB till date. Generally water conservation and artificial recharge is feasible is such area where water level is more than 3 mbgl in post monsoon period. As a whole the water level is not in alarming condition in this block. Water conservation of rainwater by different structures like percolation tank, roof top rainwater harvesting can be considered for the block in future.

This block is not considered under artificial recharge and no Artificial Recharge Structures has thus been proposed at present.

PART – III

DATA GAP ANALYSIS FOR DAKSHIN DINAJPUR DISTRICT

DATA GAP ANALYSIS FOR DAKSHIN DINAJPUR DISTRICT

INTRODUCTION:

The study area comprises of 8 blocks of Dakshin Dinajpur district. The present study area covers a total of 2162 sq. km. geographical area. It is bounded by the north latitudes 26˚35'15" and 25˚10'55" &east longitudes of 89˚00'30" & 87˚48'37" in Survey of India toposheet no.s 78C/7, 78C/8, 78C/11, 78C/12, 78C/15, 78C/16, 78D/1, 78D/5. Data Gap in terms of exploratory wells (EW), water level monitoring stations (key wells), geophysical studies viz. Vertical Electrical Sounding (VES), additional water quality monitoring stations etc. to study the aquifers in the area has been tabulated quadrant wise in different toposheets.

A. Data Gap for Exploratory Wells:

Exploratory wells constructed by CGWB, ER, Kolkata and wells outsourced by private company have been considered for the study. After plotting the existing exploratory wells and following the guidelines it is seen that a total of 14 Exploratory wells (EW), 4 Observation wells (OW) and 2 Well Fields are required in the study area.

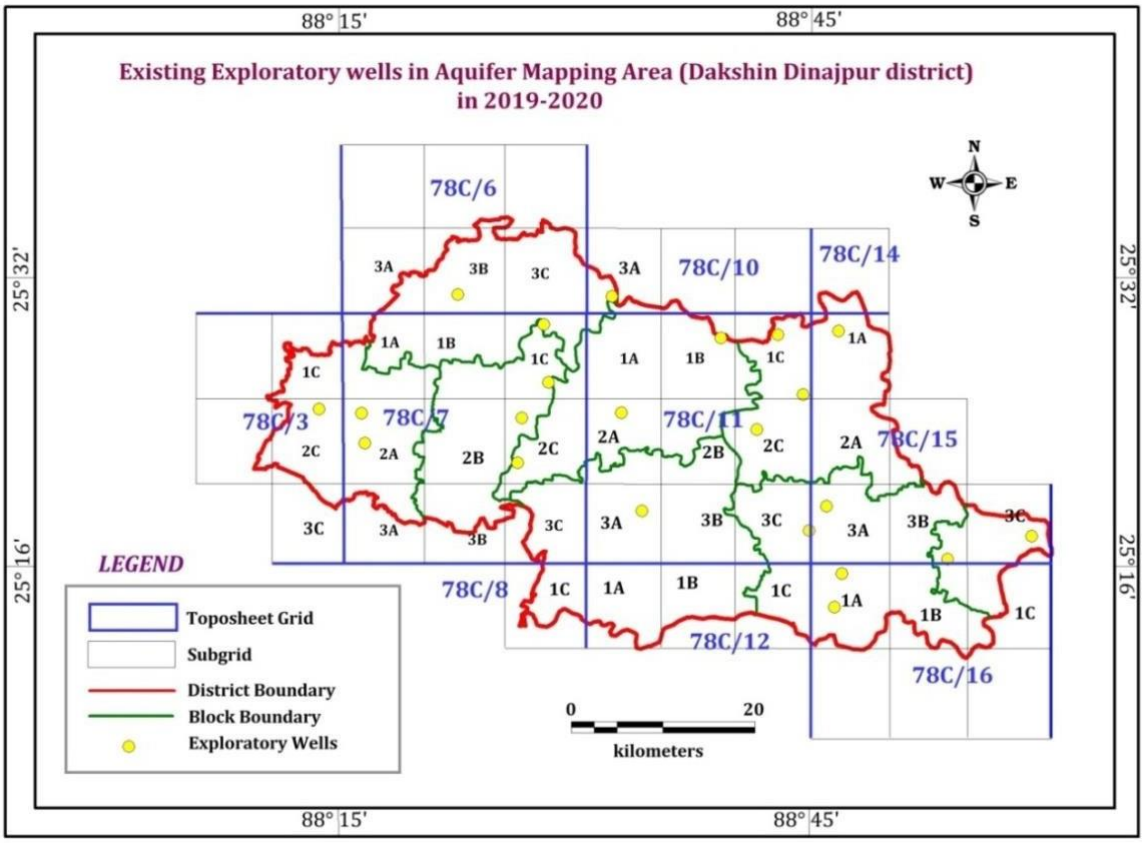

Figure-1: Map of existing exploratory wells in Dakshin Dinajpur district of West Bengal.

Toposheet No.	Quadrant	No. of Additional EW/OW required	Depth of Drilling (Meters)
78C/3	1C	1 EW	200
78C/6	3C	1 EW	200
78C/7	1A	1 EW	200
	2B	2 EW	200, 300
		2 OW	200, 300
		1 Well Field	300
	3C	1 EW	200
78C/8	1C	1 EW	200
78C/11	1A	1 EW	200
	2B	2 EW	200, 300
		2 OW	200, 300
		1 Well Field	300
	3C	1 EW	200
78C/12	1A	1 EW	200
	1C	1 EW	200
78C/16	1C	1 EW	200

Table-1: Table suggesting extra Exploratory wells and their depths for Dakshin Dinajpur district of West Bengal.

B. Data Gap for Monitoring stations (Key wells):

Monitoring wells in terms of key wells were plotted for data gap analysis. The NHS monitoring wells of CGWB and SWID (State Water Investigation Directorate) has been combined for the study. It has been found that an extra of 42 wells tapping Aquifer- I, 23 wells tapping Aquifer-II and 15 wells tapping Aquifer-III are required for future monitoring.

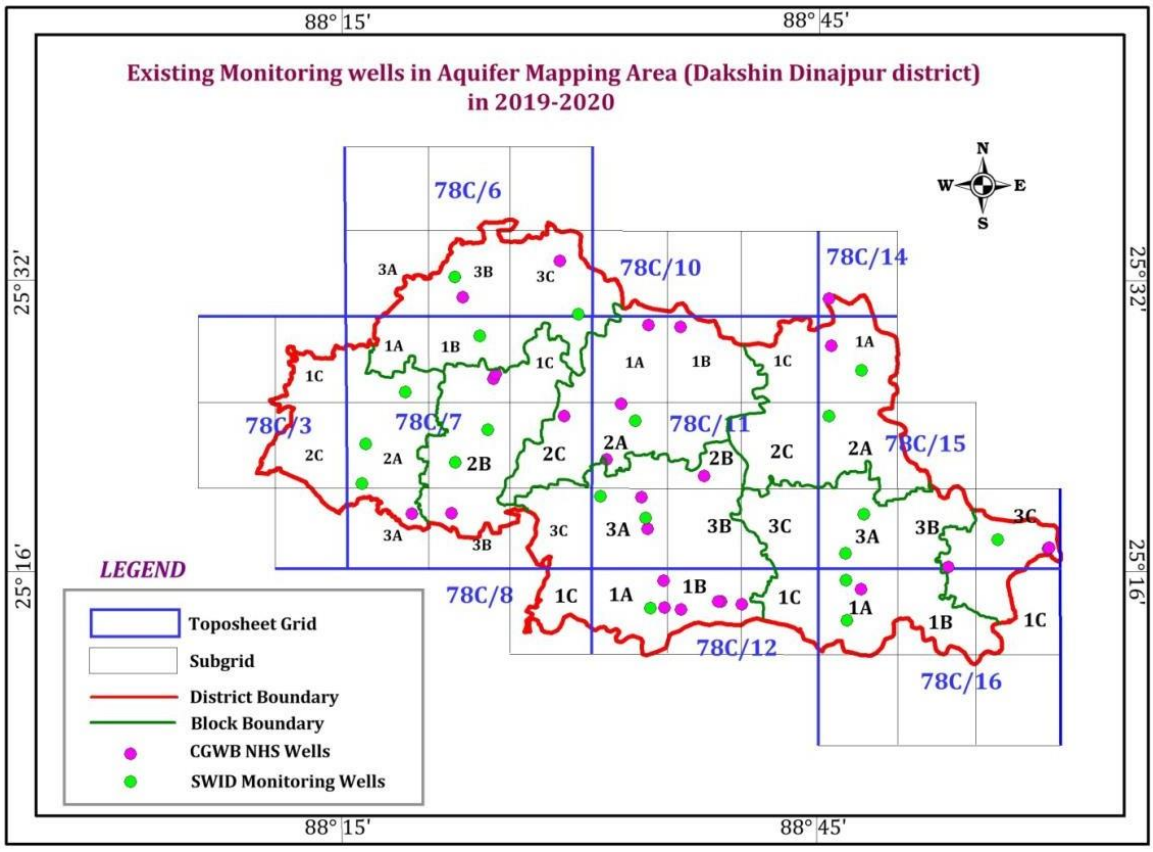

Figure-2: Map of existing Key Wells in Dakshin Dinajpur district of West Bengal.

Toposheet No.	Quadrant	No. of Additional Key Wells required Aquifer wise
78C/3	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
78C/6	3B	Aquifer I: 0, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
78C/7	1A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 1
	1B	Aquifer I: 0, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 1
	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 1
78C/8	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
78C/11	1A	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
	1B	Aquifer I: 1, Aquifer II: 2, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 1
	2B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3A	Aquifer I: 0, Aquifer II: 0, Aquifer III: 1
	3B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 1
78C/12	1A	Aquifer I: 0, Aquifer II: 0, Aquifer III: 1
	1B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
78C/15	1A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	2A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 1
	3B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 0, Aquifer II: 0, Aquifer III: 1
78C/16	1A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 1
	1B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0

Table-2: Table suggesting aquifer wise extra key-wells for Dakshin Dinajpur district of West Bengal.

C. Data Gap for Ground Water Quality monitoring stations:

Water quality monitoring stations are required to study the chemical property of groundwater viz. pH, EC, TDS, Total Hardness, F, Na, K, As, Fe, Cl etc. It has been found that an extra of 42 wells tapping Aquifer- I, 23 wells tapping Aquifer-II and 15 wells tapping Aquifer-III are required for future monitoring.

Toposheet No.	Quadrant	No. of Additional Water Quality stations required Aquifer wise
78C/3	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
78C/6	3B	Aquifer I: 0, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
78C/7	1A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 1
	1B	Aquifer I: 0, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 1
	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 1
78C/8	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
78C/11	1A	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
	1B	Aquifer I: 1, Aquifer II: 2, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 1
	2B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3A	Aquifer I: 0, Aquifer II: 0, Aquifer III: 1
	3B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 0, Aquifer II: 0, Aquifer III: 1
78C/12	1A	Aquifer I: 0, Aquifer II: 0, Aquifer III: 1
	1B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 1
78C/15	1A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	2A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 1
	3B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	3C	Aquifer I: 0, Aquifer II: 0, Aquifer III: 1
78C/16	1A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 1
	1B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0

Table-3: Table suggesting Aquifer wise extra water quality monitoring stations for Dakshin Dinajpur district of West Bengal.

D. Data Gap for Geophysical studies (VES):

CGWB has not carried out any VES in the study area. A total of 86 VES is suggested to carry out in the study area. The details of numbers of VES required are explained quadrant wise in the following table.

Toposheet No.	Quadrant	No. of VES required within the quadrant
78C/3	1C	2
	2C	3
78C/6	3B	3
	3C	3
78C/7	1A	3
	1B	3
	1C	3
	2A	3
	2B	3
	2C	3
	3B	1
	3C	2
78C/8	1C	1
78C/11	1A	3
	1B	3
	1C	3
	2A	3
	2B	3
	2A	3
	3A	3
	3B	3
	3C	3
78C/12	1A	3
	1B	2
	1C	2
78C/15	1A	3
	2B	3
	3A	3
	3B	3
	3C	1
78C/16	1A	3
	1B	2
	1C	1

Table- 4: Suggested no. of VES stations for Dakshin Dinajpur district of West Bengal.

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