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

Banka District
Bihar

मध्य पूर्वी क्षेत्र, पटना
Mid Eastern Region, Patna

भारतसरकार

Government of India

जल शक्ति मंत्रालय
Ministry of Jal Shakti
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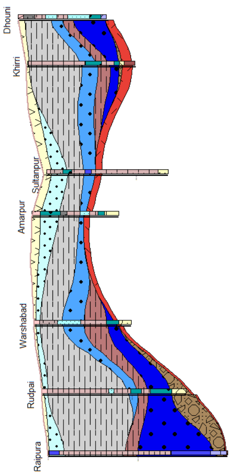
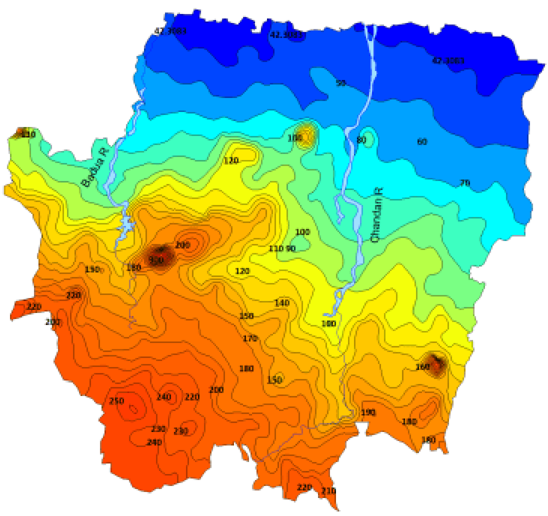
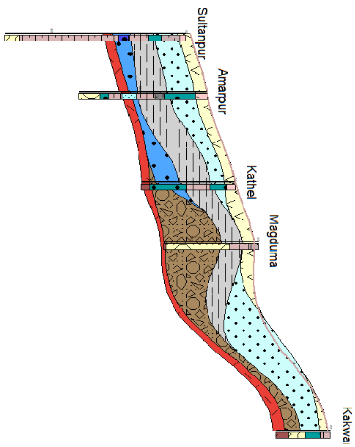
Central Ground Water Board

Aquifer Maps and Ground Water Management Plan of Banka district, Bihar

जलभृत नक्शे तथा भूजलप्रबंधनयोजना बांका जिला, बिहार







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Foreword

Banka district lies in the southern parts of the Bihar State. Geo-morphologically and geologically the district is characterised by undulating terrain of hill ranges and uplands in the southern parts with masses of forest cover and alluvial plains in the northern parts. The district witnesses water scare hard rock terrain as well as alluvial plain with abundant land and water resources. The fissured formation in hard rock area and porous formation in alluvial tracts broadly constitutes the hydrogeological frame work of the district.

Banka district is principally a rural one and economy is agrarians, however, the agriculture to a greater extent is rainfed. The scope for irrigation is moderate with cropping intensity around 144%. There is scope for irrigation development in the district from surface as well as through ground water irrigation.

In the present study, under NAQUIM activities of Central Ground Water Board, an attempt has been made to study the ground water regime in the district in detail. The generation of 2 D and 3 D aquifer maps in the hard rock and in alluvial terrain has been approached and the respective aquifers have been delineated. The major ground water related issues in the district has been revealed and accordingly suitable intervention has been proposed. Contamination of fluoride in ground water in some pockets of Banka district has also been identified which demands thoughtful attention for effective mitigation measures. Based on the present exercise and from the archive of exploratory drilling data and hydrogeological information in the district an effective management plan has been framed for intervention in drinking domestic and in irrigation sectors. Management intervention through rain water harvesting and artificial recharge has also been advocated for sustainable development in the district.

An admirable and estimable effort has been put by Shri Sanjib Chakraborty, Sc B, CGWB, MER, Patna in data generation, analysis, compilation and in preparation of this report. Effort of Ms. Manasi Bhattachrya, Sc B and Dr. S Suresh, ACH in plotting of chemical data and analysis and geophysical input by Dr. S Das Sc- B (GP) has enriched the report. Few inputs in GIS maps from Shipra Kumari, YP is also commendable. The report may be a pen sketch for State Ground Water development Authority, other user agencies and stakeholders in ground water and irrigation sectors and may aid as road map to formulate and to execute projects in a comprehensive manner for sustainable development of ground water resources in the district.

Place: Patna

Date : 17/08/2022 **(Thakur B N Singh)**

Regional Director

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CHAPTER-1

Introduction

Banka district, in the southern parts of Bihar State, was a sub-division of erstwhile Bhagalpur district and was upgraded into a full-fledged district on 21st Feburary, 1991. The city is historically very important because of Mandar Hill where Samudra Manthan was reported to have been occurred by Hindu Mythology. The district lies between north latitude 24°30'00'' to 25° 07'00'' and east longitude 86°30'00''to 87°12'00''. It covers a part of degree sheet number 72K, 72O, 72L and 72P of Survey of India. The geographical area of the district is 3020 sq km. Total rural area constitutes 2989.95 sq km. and urban area 30.05 sq km. It's district Headquarter is in Banka town. The district is bounded in the north by Bhagalpur district, in the south by Deoghar district of Jharkhand, in the east by Godda of Jharkhand, in the west by Jamui district, in the NW by Munger district of Bihar and in the south-east by Dumka district of Jharkhand. There are 11 development blocks**,** 185 Gram panchayats and 1844 villages in the district. There are two statutory towns namely Banka and Amarpur.

Total population of the district is 2034763 (as per 2011 census). The most populous block is Dhuraiya and the least populous is Phulidumar. 1963450 is rural population and 71313 is urban population. Amarpur and Banka Nagar Parisad constitute the urban agglomeration in Banka district. The administrative map of the district is given in **Figure 1.**

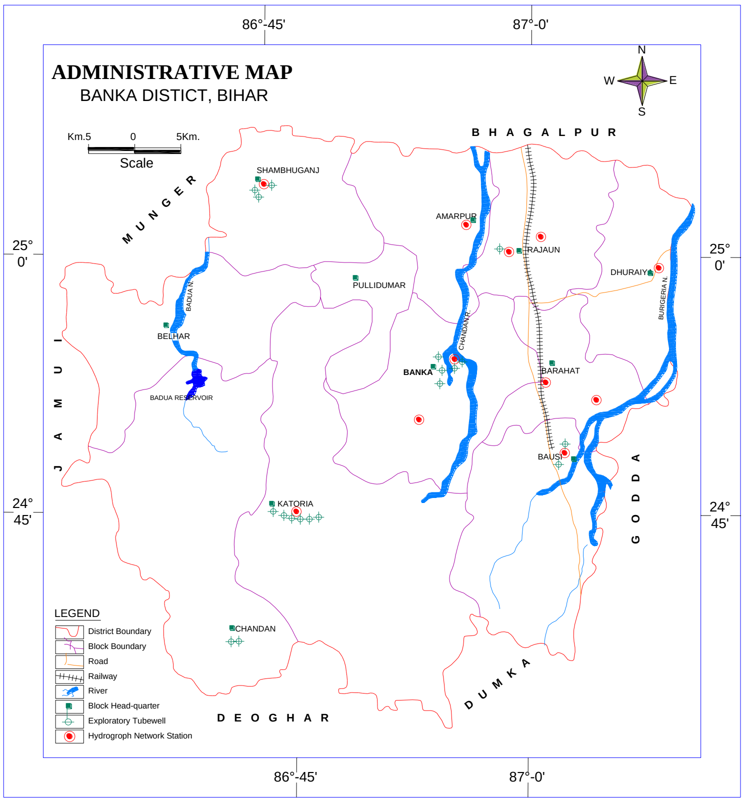

FIGURE 1.ADMINISTRATIVE MAP OF BANKA DISTRICT,BIHAR

Geo-morphologically and geologically the district is characterised by undulating terrain of hill ranges and uplands in the southern parts with masses of forest cover and alluvial plains in the northern parts. The district witnesses water scarce hard rock terrain as well as alluvial plain with abundant land and water resources. The varied geological set up of the district influences the land use pattern, agriculture activities and water resource development. The National Aquifer Mapping and Management Programme (NAQUIM) of Central Ground Water Board (CGWB) has been envisaged to focus on the aquifer disposition, occurrences, availability of ground water resources and quality and to formulate management plan of the aquifer system for the sustainable development.

Under the Annual Action Plan of 2019-20 of CGWB, MER, Patna, aquifer mapping programme and subsequent formulation of management plan were undertaken in Banka district, Bihar. The present study includes the entire district comprising a map able area of 2731 sq km. in 11 administrative blocks.

1.1 Objective

The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization
- Quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

The groundwater management plan includes Ground Water recharge, conservation, harvesting, development options and other protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan.

The main activities under NAQUIM are as follows:

a). Identifying the aquifer geometry

b). Aquifer characteristics and their yield potential

c). Quality of water occurring at various depths

d). Aquifer wise assessment of ground water resources

e). Preparation of aquifer maps and

f). Formulate ground water management plan.

The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a “Road Map” to systematically manage the ground water resources for equitable distribution across the spectrum.

1.2 Scope of Study

The scope of the present study is broadly within the framework of National Aquifer Mapping and Management Programme (NAQUIM) being implemented by CGWB. There are four major activity components viz.: (i) Data collection / compilation (ii) Data gap analysis (iii) Data generation and (VI) Preparation of aquifer maps and management plan.

Data compilation includes collection of maps, reports and information from CGWB archive and concerned agencies, such as the Survey of India, Geological Survey of India, State Government Departments, other agencies etc. Identification of Data Gap includes ascertaining requirement for further data generation (hydro-geological, geophysical, chemical, hydrological, hydro-meteorological etc.) in addition to the existing data in respect of prevailing hydrogeological subsurface geological condition in the area. Data generation includes pre and post monsoon monitoring of aquifer wise water level from the existing network monitoring wells and other available feasible wells, incorporation of observation based on field studies, data collection through ground water exploration work in the study area, collection of water samples etc.

1.3 Approach and Methodology

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

1. Compilation of existing data and reports of CGWB and other departments.
2. Identification of data gaps
3. Data generation through monitoring of pre and post monsoon water level from the NHNS stations and key observation wells in different aquifers, monitoring of water quality, preparation of lithological logs, yield and aquifer parameter data generation through construction of exploratory wells.
4. Preparation of thematic maps
5. Identification/demarcation of individual aquifer systems in the area from the available lithologs, previous literature and observation from field studies etc.
6. Preparation of 2D and 3D maps depicting the subsurface disposition of lithology, aquifer disposition in Rockworks 17 Platform.
7. Analysis of 5th Minor Irrigation Census Data for block wise compilation of number of STW, MDTW, DTW for assessment of existing draft for irrigation uses. Based on the available cultivable area and irrigation potential created so far, the further area to be brought under irrigation in the district from

the available resources has been estimated and accordingly the management plan has been proposed. The scope for rain water harvesting for artificial recharge or conservation is reviewed and accordingly suitable structures are recommended.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilization for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is summarized as below:

Compilation of existing data (Central & State Govt.)

↓

Generation of different thematic layers

↓

Identification of Primary Aquifer

↓

Identification of data gaps

↓

Data generation (water level, exploration, geophysical, hydrochemical, hydrogeological etc.

↓

Aquifer Maps with 3D disposition

↓

Preparation of Aquifer Management Plan

↓

Capacity building in all aspects of ground water through IEC Activties

1.4 Area Detail/Location, Extent and Accessibility of the study area

The district lies between $24^0$23’15” and $25^0$08’30” North Latitude and $85^0$49’30” and $86^0$38’00” East Longitude, and fall in Survey of India Degree Sheet No. 72/ G, H, K and L. Total geographical area of Jamui district is 3098 sq. km.

The district head quarter is at Banka and is well connected through road and rail network with the State capital Patna. The distance between the district HQ and State Capital is around 250 km.

1.5 Administrative Divisions and Demographic Details:

Banka district have 11 administrative blocks, 185 gram panchayats, 1844 villages.

Table 1.1: Major Administrative Division

S.No.	Name of Block	Total Geographical Area (ha)	No. of Panchayat	No. of village
1	Amarpur	19789	19	181
2	Banka	28079	16	99
3	Barahat	14724	15	74
4	Belhar	24089	18	169
5	Bausi	31527	16	153
6	Chandan	45747	17	77
7	Dhuraiya	23410	20	222
8	Phulidumar	20850	11	97
9	Katoria	56061	16	379
10	Rajaun	19754	18	207
11	Shambhuganj	17970	19	186
Total		**302000**	**185**	**1844**

In Banka block 18.87 sq. km falls under Banka Nagar Parisad, 11.18 sq.km in Amarpur Block comes under Amarpur Nagar Parisad.

The total population of Banka District is 2034763, out of which the schedule casts comprise 247858 (12.18%), schedule tribes 90432 (4.44%), other backward and general castes 1696473 (83.38%). According to census 2011 of the total population, there are 1067140 males and 967623 females with a sex ratio of 1000:907. Dhuraiya block has the highest population while Phulidumar block has the lowest population. The total numbers of households in the district is 367997. Population details of the district are as under:-

The decadal growth rate of population as per census 2011, over last decade is 26.43%. The population density of the district is 674 person/ sq. km against the population density of 533/sq km in 2001.

Table 1.2: Population Detail in the Study Area

S.No	Block	No. Of Panchayat	No. Of Village	Population			
				Male	Female	Total (5+6)	CH* (P-06)
	2	3	4	5	6	7	8
1	Amarpur	19	181	105705	95646	201351	41977
2	Banka	16	99	89334	81990	171324	39470
3	Barahat	15	74	77845	71343	149188	27528
4	Belhar	18	169	87838	79881	167719	29658
5	Bausi	16	153	96357	88643	185000	32624
6	Chandan	17	77	86251	79383	165634	31666
7	Dhuraiya	20	222	125586	114176	239762	46248
8	Phulidumar	11	97	66115	59136	125251	22930
9	Katoria	16	379	98119	88527	186646	35047
10	Rajaun	18	207	103596	94005	197601	36823
11	Shambhuganj	19	186	92351	81623	173974	31311
12	Amarpur	NP		13452	11884	25336	
13	Banka	NP		24591	21386	45977	
Total		**185**	**1844**	**1067140**	**967623**	**2034763**	**375282**

Table 1.3 Details of Category wise Population in Banka District

S.No	Block	Population								
		SC			ST			OBC/GEN		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
	2	5	6	7	8	9	10	11	12	13
1	Amarpur	15134	13879	29013	271	264	535	103752	93387	197139
2	Banka	13861	12629	26490	3547	3523	7070	96517	87224	183741
3	Barahat	7627	7139	14766	155	143	298	70063	64061	134124
4	Belhar	11229	10333	21562	6792	6655	13447	69817	62893	132710
5	Bausi	8286	7509	15795	10562	10532	21094	77509	70602	148111
6	Chandan	11097	10409	21506	8170	7900	16070	66984	61074	128058
7	Dhuraiya	11896	10742	22638	860	807	1667	112830	102627	215457
8	Phulidumar	9798	8744	18542	3254	2947	6201	53063	47445	100508
9	Katoria	9621	8696	18317	12153	11637	23790	76345	68194	144539
10	Rajaun	19153	17496	36649	31	24	55	84412	76485	160897
11	Shambhuganj	11961	10619	22580	106	99	205	80284	70905	151189
Total		**129663**	**118195**	**247858**	**45901**	**44531**	**90432**	**891576**	**804897**	**1696473**

Table 1.4 Details of Households in Banka District

S.No	Name of Block	No. of Household			
		SC	ST	OBC/GEN	Total
1	Amarpur	5165	98	32822	38085
2	Banka	4164	1320	26530	32014
3	Barahat	2969	65	25906	28940
4	Belhar	4344	2548	24733	31625
5	Bausi	3167	4450	28223	35840
6	Chandan	4139	3156	23077	30372
7	Dhuraiya	4307	344	38623	43274
8	Phulidumar	3623	1209	18800	23632
9	Katoria	3566	4490	25134	33190
10	Rajaun	7151	15	31243	38409
11	Shambhuganj	4415	39	28162	32616
Total		**47010**	**17734**	**303253**	**367997**

1.6 Land use, Agriculture, Cropping pattern and Irrigation

The geographical, topographical, hydro-geomorphological, socio-economic and cultural features of the district determine the suitability of its lands for utilisation. Similarly, factors influencing land use pattern are variable as well. The nature of the underlying soils, rainfall pattern, human factors, classes of worker etc to some extent influence the land use pattern in the area.

Out of the total geographical area of 302000 ha in the district, 42819 ha (14.18 per cent) is under forest, 36755 ha (12.17 per cent) is under other uses like industry and built up area, 75798 ha (25.10 per cent) under wasteland/fallow land, and 146628 (48.55 per cent) land is presently under cultivation. There is large scope of converting these waste land/fallow land in cultivated land and thus increasing the net and gross sown area (presently 146628 and 211041 ha, respectively) in the district. The average cropping intensity in the district is 144 per cent. Therefore, the scope of agriculture activities in the district is moderate.

Land use pattern of the district is being presented in Table.1.5

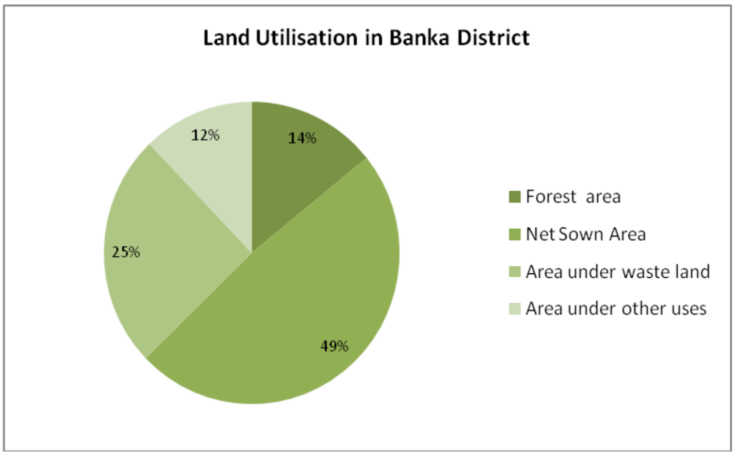

Fig.2 Land Utilisation in Banka district

Table 1.5 Block wise Land Use Pattern

Sl no	Block	Net Cropped Area in (ha)	Gross Cropped Area (ha)	Area sown more than Once (ha)	Cropping Intensity (%)
1	Amarpur	9882	17219	7337	174
2	Banka	15762	24255	8493	154
3	Barahat	9104	12857	3753	141
4	Belhar	9296	16315	7019	176
5	Bausi	18840	24341	5501	129
6	Chandan	11998	17713	5715	148
7	Dhuraiya	12364	20358	7994	165
8	Phulidumar	12804	14135	1331	110
9	Katoria	20884	29295	8411	140
10	Rajaun	13596	18644	5048	137
11	Shambhuganj	12098	15909	3811	132
Total		**146628**	**211041**	**64413**	**144**

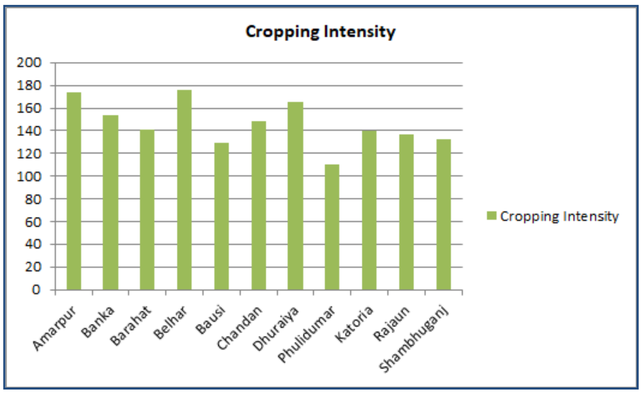

Fig.3 Cropping Intensity in Banka district

Table1.6 -: Details of Land-use pattern in the district

S.No.	Name of the Block	No. Of Panchayat	No. of villages Covered	Total Geographical Area (ha)	Area under Agriculture (ha)				Area under forest (ha)	Area under Wasteland (ha)	Area under other uses (ha)
					Gross Cropped Area	*Net Sown Area*	*Area sown more than once*	*Cropping Intensity (%)*			
1	Amarpur	19	181	19789	17219	9882	7337	174	1351	6422	2134
2	Banka	16	99	28079	24255	15762	8493	154	118	7109	5090
3	Barahat	15	74	14724	12857	9104	3753	141	0	4355	1265
4	Belhar	18	169	24089	16315	9296	7019	176	8092	4840	1861
5	Bausi	16	153	31527	24341	18840	5501	129	3642	6323	2722
6	Chandan	17	77	45747	17713	11998	5715	148	10545	15169	8035
7	Dhuraiya	20	222	23410	20358	12364	7994	165	0	7671	3375
8	Phulidumar	11	97	20850	14135	12804	1331	110	5646	1159	1241
9	Katoria	16	379	56061	29295	20884	8411	140	13403	15040	6734
10	Rajaun	18	207	19754	18644	13596	5048	137	21	3910	2227
11	Shambhuganj	19	186	17970	15909	12098	3811	132	0	3800	2072
Total		**185**	**1844**	**302000**	**211041**	**146628**	**64413**	144	**42819**	**75798**	**36755**

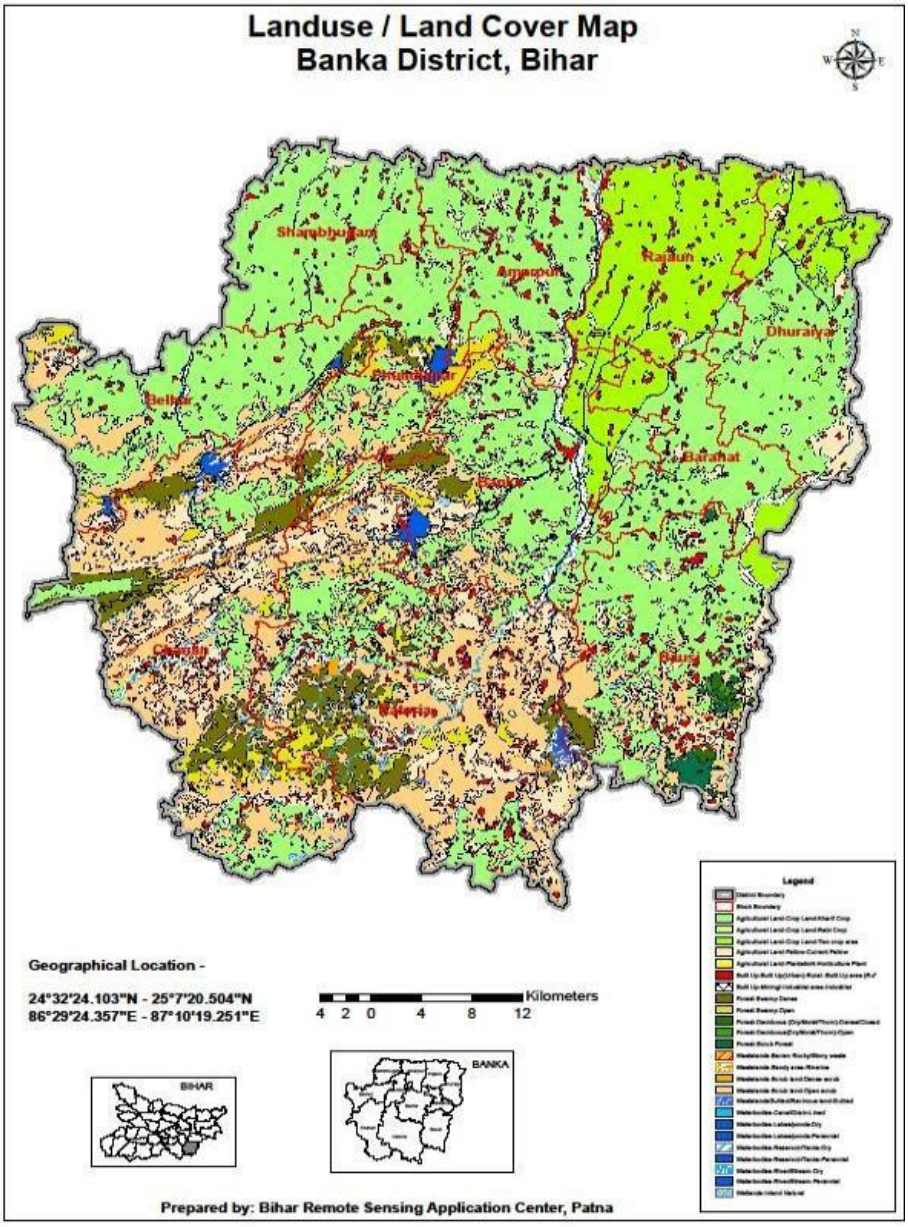

Fig. 4 Area under coverage of major land utilization in the district
(source: District Irrigation Plan, Banka, 2016-20)

Agriculture, Cropping Pattern and Irrigation

The main occupation of the people of Banka District is agriculture. A considerable area in the district is underlain by flat and fertile lands. The five Blocks Chandan, Katoriya, Phulidumar, Belhar and Bounsi constitute undulating terrain with small uplands. Even though, the economy of the district is agrarian in nature the agricultural activities depends on rain water. Kharif cultivation in the district contributes major share of agriculture activities than rabi and summer crops. It indicates the unsuitability of the major area for varied crops throughout the year and also poor irrigation network in the district. It results in low average cropping intensity of 144 % in the district.

Crops grown and cropping pattern:

Agriculture is one of the principal sources of livelihoods of the people in the area. However, in absence of adequate irrigation network in the district, the rain fed irrigation is the principal component. There are three major crop seasons which is followed in the district. The kharif season, rabi and summer crops. Kharif is mostly rain fed whereas the other two are mainly dependent on irrigation. The crops grown are grouped under cereal crops of paddy, wheat, maize etc., pulses, oilseeds, fiber and other miscellaneous crops of horticulture, plantation etc. Among the cereals, the paddy during kharif and wheat during rabi are two principal crops in the district. Less production of pulses, oilseeds is a concern for future in the district. Therefore, diversification of cropping pattern is needed in the district. Gross area under cereals is 187919 ha and coarse cereals under 11648 ha, which constitute 94.56% of total cropped area, pulses constitute 8056 ha (<4% of cropped area), oil seeds only 2411 ha (1.15% of gross area under crops), miscellaneous crops and horticulture crops constitutes about 2% of the total cropped area. Among the cereal crops, 42329 ha is under irrigation whereas 157238 ha area is rain-fed. Therefore, 21% of cereal crops are under irrigation and rest rain-fed only. So far pulses, oilseeds and other crops are not covered under irrigation facilities in the district. Total irrigated area in the district is 42329 ha whereas rain-fed irrigation is 168712 ha. Sugarcane is the most important non food crop (cash crop) of the district. The farmers of Amarpur, Rajoun and Dhoraiya circle grow sugarcane in abundance. Therefore, there are several mills to produce (Gur) Molasses from sugarcane.

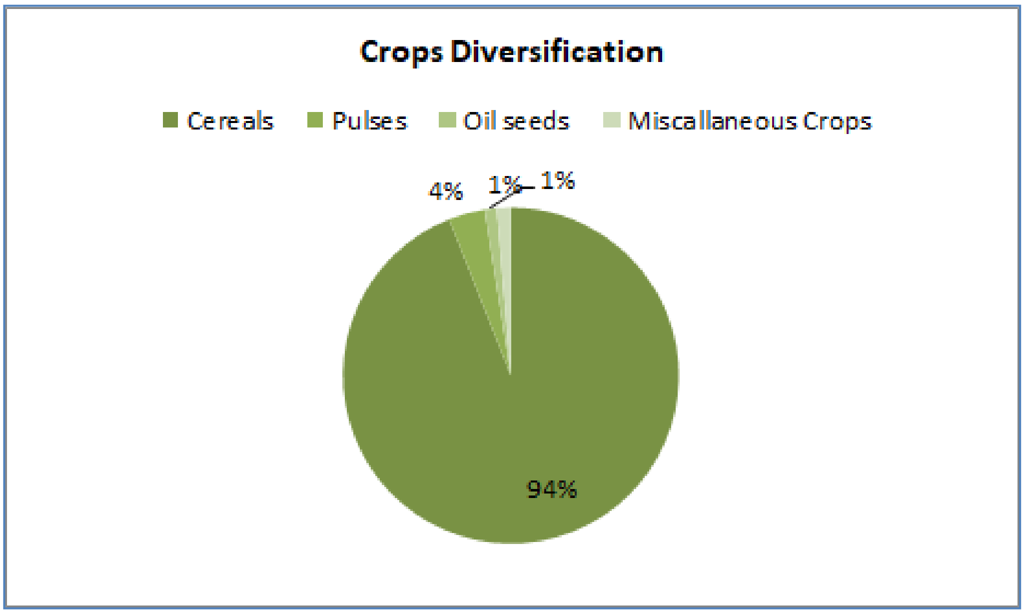

Fig.5 Different crops in the district

Irrigation

Agriculture depends mainly on the availabilities of water at proper time and in proper quantity. In the past the main source of water had been rainfall. However, on account of failure of monsoon at times or premature cessation of rainfall the need for irrigation was felt. Before the abolition of Zamindari the Zamindars used to maintain ahars and pynes which severed the twin purpose of irrigation and drainage. Besides these channels there were dug wells for irrigation purposes. After independence the government has under different five years plans drawn up and executed various schemes for irrigation. Important among the major schemes being the following

1. Chandan Reservoir Irrigation scheme.
2. Kajia Danr Irrigation Scheme.
3. Badua Reservoir Project.
4. Chandan, Belasi Irrigation Scheme - Banka
5. Orhni Reservoir Irrigation Project- Banka Fullidumer
6. Laxmipur Reservoir Irrigation Project - Bounsi

The Chandan reservoir is major irrigation project in the Banka district. Its command area falls in the Banka, Barahat, Rajaun and Dhuraiya block of Banka district. The gross command area is 1.40 m ha. and the surface water irrigation facility is available only to 0.64 m ha in kharif and 7690 ha during rabi (this is inclusive of water directed from small structures like ahar etc).

Area Wise, Crop wise Irrigation Status

Agriculture practices in large area of the district are still fully dependent on rainfall. The canal system and other irrigation sources are dependent on rainfall. Erratic and low rainfall behaviour affects the storage of reservoirs and thus groundwater recharge to a great extent. Also, vast gap between irrigation potential created and utilized is being observed in the district. As per the available statistics, only 20 per cent of the gross cropped area of Banka district is irrigated (table 1.7). Hence, there lies ample scope to increase the irrigation level in the district from agricultural development point of view.

Table 1.7 Area wise Crop Wise Irrigation Status in Banka District

S.No.	Crop Type	Kharif (Area in ha)			Rabi (Area in ha)			Summer crop (Area in ha)			Total (Area in ha)			Horticulture & Plantation Crops (Area in ha)		
		Irrigated	Rain fed	Total	Irrigated	Rain fed	Total	Irrigated	Rain fed	Total	Irrigated (3+6+9)	Rain fed (4+7+10)	Total	Irrigated	Rain fed	Total
1	2	3	4	5	6	7	8	9	10	11	12	12	14	15	16	17
1	Cereals	29730	135268	164998	7405	13724	21129	1792	0	1792	38927	148992	187919	0	1475	1475
2	Coarse cereals	1451	6640	8091	1036	1606	2642	915	0	915	3402	8246	11648	0	230	230
3	Pulses	0	727	727	0	7329	7329	0	0	0	0	8056	8056	0	0	0
4	Oil seeds	0	0	0	0	2411	2411	0	0	0	0	2411	2411	0	0	0
5	Fibre	0	0	0	0	0	0	0	0	0	0	0	0	0	140	140
6	Any other crops	0	0	0	0	796	796	0	211	211	0	1007	1007	0	503	503
Total		31181	142635	173816	8441	25866	34307	2707	211	2918	42329	168712	211041	0	2348	2348

Source: District Agriculture office (DAO), Banka

Table.1.7A. Block wise Crops and Irrigation Status in Banka District

Block	Cereals		Pulses		Oil Seeds		Any other crops/ Horticulture etc.		Total Irrigated Area under different crops	Total Rain fed Area under different crops
	Irrigated	Rain-fed	Irrigated	Rain-fed	Irrigated	Rain-fed	Irrigated	Rain-fed	Irrigated	Rain-fed
Amarpur	4870	11204		974		153		18	4870	12349
Banka	4118	19167		760		210		0	4118	20137
Barahat	2849	9129		591		198		90	2849	10008
Belhar	3482	12009		470		190		164	3482	12833
Bausi	4225	19036		763		215		102	4225	20116
Chandan	1602	15122		685		212		92	1602	16111
Dhuriya	4678	14377		919		267		117	4678	15680
Phulidumar	4427	8535		842		244		86	4427	9707
Katoria	1808	26101		869		385		132	1808	27487
Rajaun	5459	11952		911		232		90	5459	13185
Sambhuganj	4810	10606		272		105		116	4810	11099
Total	**42238**	**157238**		**8056**		**2411**		**1007**	**42238**	**168712**

Source: (District Irrigation Plan, Banka, 2016-20)

Table 1.8 Irrigation based Classification in Banka district

S.No.	Name of Block	Irrigated area (ha)		Rainfed Area (ha)		
		Gross Irrigated Area	Net Irrigated Area	Partially Irrigated / Protective Irrigation	Un-Irrigated or Totally Rain fed	Total
1	Amarpur	4870	3410	3087	9262	12349
2	Banka	4118	3420	5034	15103	20137
3	Barahat	2849	2259	2502	7506	10008
4	Belhar	3482	2605	3208	9625	12833
5	Bausi	4225	3250	5029	15087	20116
6	Chandan	1602	1425	4028	12083	16111
7	Dhuraiya	4678	3330	3920	11760	15680
8	Phulidumar	4428	3025	2427	7280	9707
9	Katoria	1808	1612	6872	20615	27487
10	Rajaun	5459	3530	3296	9889	13185
11	Shambhuganj	4810	3315	2775	8324	11099
Total		**42329**	**31181**	**42178**	**126534**	**168712**

Table 1.9 Irrigated vs Un-irrigated area in Kharif season in Banka District

S.No.	Name of Block	al Sown Area (ha)	Irrigated Area (ha)		ally/ Total Rainfed Area (ha)	
1	Amarpur	13404	3410	25%	9994	75%
2	Banka	21190	3420	16%	17770	84%
3	Barahat	11068	2259	20%	8809	80%
4	Belhar	13573	2605	19%	10968	81%
5	Bausi	20939	3250	16%	17689	84%
6	Chandan	15160	1425	9%	13735	91%
7	Dhuraiya	15558	3330	21%	12228	79%
8	Phulidumar	10758	3025	28%	7733	72%
9	Katoria	25498	1612	6%	23886	94%
10	Rajaun	14098	3530	25%	10568	75%
11	Shambhuganj	12570	3315	26%	9255	74%
Total		**173816**	**31181**	**18%**	**142635**	**82%**

Table 1.10 Irrigated vs Un-irrigated area in Rabi season in Banka District

S.No.	Name of Block	Total Sown Area (ha)	Irrigated Area (ha)		Partially/ Total Rainfed Area (ha)	
1	Amarpur	3411	1074	31%	2337	69%
2	Banka	2988	621	21%	2367	79%
3	Barahat	1639	446	27%	1193	73%
4	Belhar	2443	660	27%	1783	73%
5	Bausi	3096	687	22%	2409	78%
6	Chandan	2528	152	6%	2376	94%
7	Dhuraiya	4461	1018	23%	3443	77%
8	Phulidumar	3065	1095	36%	1970	64%
9	Katoria	3733	172	5%	3561	95%
10	Rajaun	4009	1402	35%	2607	65%
11	Shambhuganj	2934	1114	38%	1820	62%
Total		**34307**	**8441**	25%	**25866**	75%

Table 1.11 Irrigated vs Un-irrigated area in summer season in Banka District

S.No.	Name of Block	Total Sown Area (ha)	Irrigated Area (ha)		Partially/ Total Rainfed Area (ha)	
1	Amarpur	404	386	96%	18	4%
2	Banka	77	77	100%	0	0%
3	Barahat	150	144	96%	6	4%
4	Belhar	299	217	73%	82	27%
5	Bausi	306	288	94%	18	6%
6	Chandan	25	25	100%	0	0%
7	Dhuraiya	339	330	97%	9	3%
8	Phulidumar	312	308	99%	4	1%
9	Katoria	64	24	38%	40	63%
10	Rajaun	537	527	98%	10	2%
11	Shambhuganj	405	381	94%	24	6%
Total		**2918**	**2707**	93%	**211**	7%

*Source: District Agriculture office (DAO)***,** *Banka*

Table 1.12 Sources of Irrigation and water availability by different sources in Banka District

S.No.	Sources	MCM			
		Kharif	Rabi	Summer	Total
1	Surface Irrigation				
	i) Canal (Major & Medium Irrigation)	993.1	24.312	0	1017.412
	ii) Minor Irrigation Tanks	22.62	1.865	0	24.485
	iii) Lift Irrigation/Diversion	0	0	0	0
	ious Water Bodies including Rain Water Harvesting	0	0	0	0
	v) Treated Effluent Recieved from STP	0	0	0	0
	vi) Untreated Effluent	0	0	0	0
	vii) Perennial sources of water	0	0	0	0
2	Ground Water				
	i) Open Well	89.87	26.98	0	116.85
	ii) Deep Tube Well	32.81	9.846	0	42.656
	iii) Medium Tube Well	48.44	14.727	0	63.167
	iv) Shallow Tube Wells	48.63	14.59	0	63.22
Total		**1235.47**	**92.32**	**0**	**1327.79**

Source: Agriculture and Irrigation Department (Minor/Major), Banka-2015

Out of the gross cropped area of 211041 hectares in the district, 42329 hectares are irrigated by different sources of irrigation e.g. canals, tube wells, dug wells and tanks. Surface irrigation network comprises canals under major irrigation projects, minor irrigation tanks, lift irrigation etc. Traditional Ahar pyne system also comes under minor surface irrigation networks. Developed command area in the district is 46940 ha, among which Belhar, Sambhuganj , Rajun, Barhat holds major area. Ground water irrigation is based on the open wells, shallow, medium and govt. owned deep tube wells. Details of different sources of irrigation in the district and water availability through various sources is given in Table 1.12

Table 1.13 Block level statistics number of Shallow tube wells and Depth (as per 5th MI census)

District	Block/Tehsil	No. by the depth of Shallow Tubewells - 0 to 20 mts	No. by the depth of Shallow Tubewells - 20 to 35 mts	Total
Banka	Amarpur	169	294	463
	Banka	283	109	392
	Barhat	250	114	364
	Belhar	379	36	415
	Bounsi	375	23	398
	Chandan	15	2	17
	Dhoraiya	476	154	630
	Katoriya	382	423	805
	Phullidumer	195	253	448
	Rajoun	748	127	875
	Sambhuganj	492	45	537
Total		**3764**	**1580**	**5344**

As per the report of 5th MI census total number of Shallow tube wells in the district is 5344. The depth of these tube wells are within 0-35 m depth. Rajaun, Dhoraiya, Sambhuganj, Katoria holds noticeable numbers of shallow tube wells. However , total number of STW is negligible in Chandan block.

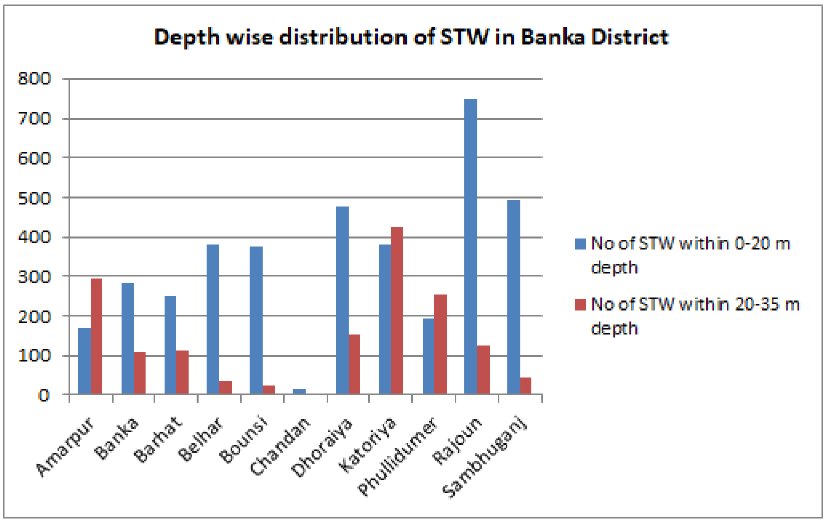

Fig.6 Distribution of STW

Table 1.14 Block level statistics of number of Medium tube wells and depth (as per 5th MI census)

District	Block/Tehsil	No. by the depth of MDTW - 35 to 40 mts	No. by the depth of MDTW - 40 to 60 mts	No. by the depth of MDTW - 60 to 70 mts	Total
Banka	Amarpur	128	100	1	229
	Banka	77	73	0	150
	Barhat	11	0	0	11
	Belhar	42	0	0	42
	Bounsi	9	6	0	15
	Chandan	0	3	0	3
	Dhoraiya	7	75	12	94
	Katoriya	7	68	1	76
	Phullidumer	0	0	1	1
	Rajoun	293	597	5	895
	Sambhuganj	16	36	3	55
Total		**590**	**958**	**23**	**1571**

As per the report of 5th MI census total number of Medium duty tube wells in the district is 1571. Depth of these tube wells are within 35-70 m depth, however, majority lies within the depth of 60 m. Amarpur, Banka, Dhoraiya, Rajaun, Smabhuganj holds the maximum num ers of MDTW in the district. However, MDTW are rare in Chandan , Phulidumar , Barhat block.

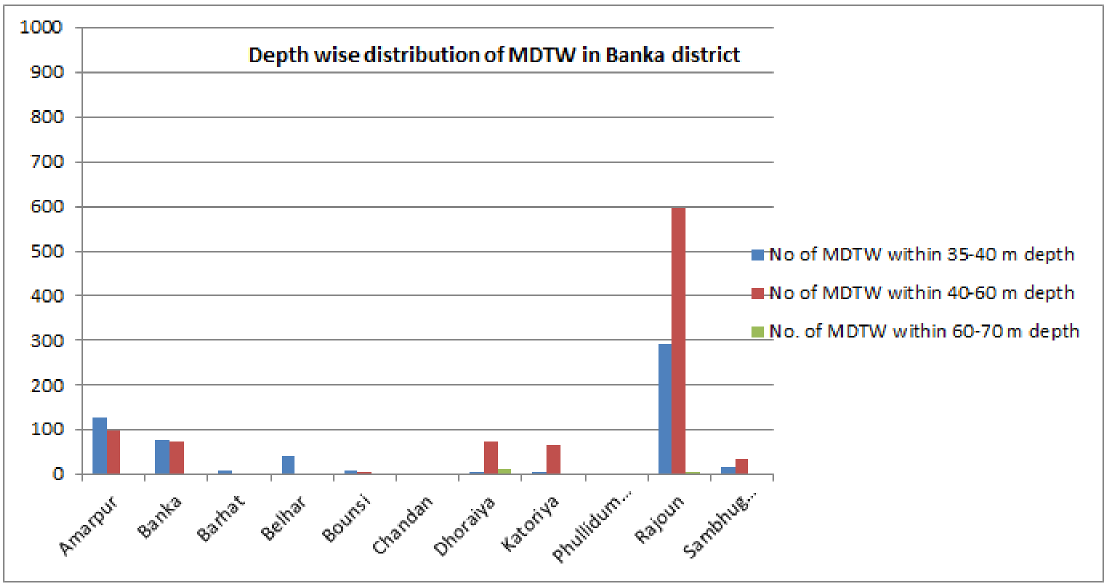

Fig.7 Distribution of MDTW

Table1.15 Block level statistics of number of Deep tube wells in the district (as per 5th MI census)

District	Block/Tehsil	No. by the depth of DTW - 70 to 110 mts	No. by the depth of DTW - 110-150 mts	No. by the depth of DTW >150 m
Banka	Amarpur			
	Banka	1	0	0
	Barhat			
	Belhar			
	Bounsi			
	Chandan			
	Dhoraiya	1	0	0
	Katoriya	1		
	Phullidumer			
	Rajoun			
	Sambhuganj	1		
Total		4	0	0

Tube wells beyond the depth of 70 m are categorized as deep tube wells as in 5th MI census data. Only 4 irrigation deep tube wells have been reported within 110 m depth in Banka district. Therefore, irrigation development through deep tube wells is limited in the district.

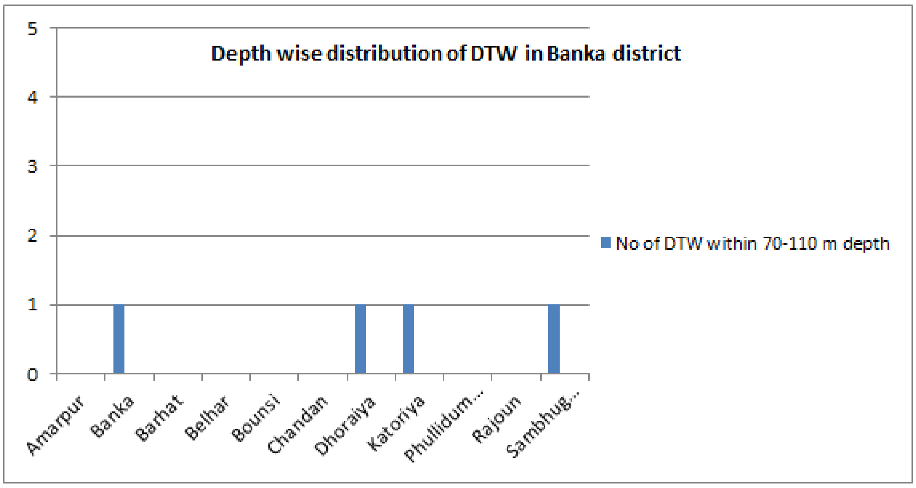

Fig.8 Distribution of DTW

1.7 Urban areas, industries and mining activities

There are two statutory towns namely Banka and Amarpur in Banka district. Few chemical and other industries are therein the district in Banka, Amarpur,Cahandan and Rajaun blocks.

1.8 Climate and Rainfall

According to the Planning Commission Classification, the State of Bihar falls in middle-Gangetic Plains region. ICAR's agro-ecological division puts it under the sub-humid ecosystem. Based on more disaggregated classification, the state is divided into three agro-climatic sub-zones. These are north-west Gangetic plains (Zone I), north-east Gangetic Plains (Zone II) and the South- Bihar Plains (Zone-III). Banka district falls under agro-climatic zone IIIA (ICAR notification).

The Climate of this district is characterized by a hot Summer and a pleasant winter season. March to June comprises the summer months while the cold season lasts from November to February. Monsoon sets in sometimes in the part of June and the rains continue till September. The district also received some winter rains. The south west monsoon generally breaks in during the second half of June. The bulk of the rainfall occurs in July and August. The average annual rain fall is 1200 mm almost uniformly throughout the district. Kark Rekha passes through North Part of the District so the temperature rises up to 45° C. In winter season average temperature is 15° C. Details of various agro-climatic data is being presented in Table 1.17.

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Table 1.16: Block wise details of temperature in Banka District

S. No.	NameofBlock	Average Weekly Temperature (⁰C)									Potential Evapo-Transpiration (PET)		
		Period									Period		
		Summer (April-May)			Winter (Oct.- Mar)			Rainy (June- Sept.)			Summer	Winter	Rainy Season
		Min	Max.	Mean	Min	Max	Mean	Min	Max	Mean			
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Amarpur	22	28	25	8	20	14	24	36	30	18	28	23
2	Banka	24	28	26	9	18	13.5	22	35	28.5	18.3	27	22.6
3	Barahat	25	26	25.5	9.5	17	13.5	23	34	28.5	19.2	25.6	25.6
4	Belhar	24	27	25.5	9	19	13.5	24	36	30	19	27.3	23.1
5	Bausi	23	27	25	8.5	20	14.5	25	35	30	18.8	27.3	23.1
6	Chandan	22	28	25	9.5	19.5	14.5	23	27	25	18.2	24.8	21.5
7	Dhuraiya	22	24	23	9	18	13.5	23	34	28.5	18	25.3	21.6
8	Phulidumar	20	24	22	9	19	13.5	23	35	29	17.3	26	21.6
9	Katoria	19	29	24	7	21	14	24	37	30.5	16.6	29	22.8
10	Rajaun	20	26	23	8	20	14	23	34	28.5	17	26.6	21.8
11	Shambhuganj	19	27	23	7.5	19.5	13.5	24	35	29.5	16.8	27.2	22

Source: District Statistical Office, Banka and Dynamic ground water resources of Bihar, Year - 2015-16

Banka district falls in agro-climatic Sub-Zone IIIA. The average annual rainfall in the district is 1200 mm. This is just sufficient for the type of agriculture practiced traditionally in this district. Due to changing climate situation, the district faces erratic monsoon behaviour. Frequent drought due to low rainfall (700-900 mm) is witnessed every alternate year. More than 90% of the total precipitation occurs during monsoon season (June-September). 60-70 per cent of the total precipitation received during the monsoon goes to main streams as runoff due to poor runoff management practices.

Table 1.17: Agro-Ecology Zone and rainfall in Banka District

Sl. no.	Name of Block	Agro Ecological Zone Type	Type of Terrain	Block Areas (ha.)	Normal Annual Rainfall (mm)	Average Monthly Rainfall (mm)	No. Of rainy days (No.)
1	2	3	4	5	6	7	8
1	Amarpur	III A	PLAIN	19789	666.4	55.53	35
2	Banka	III A	LAIN & HILLY	28079	897.2	74.77	45
3	Barahat	III A	PLAIN	14724	780.6	65.05	45
4	Belhar	III A	LAIN& HILLY	24089	648	54	45
5	Bausi	III A	LAIN& HILLY	31527	253.6	21.13	21
6	Chandan	III A	LAIN & HILLY	45747	730.6	60.68	53
7	Dhuraiya	III A	PLAIN	23410	690	57.5	34
8	Phulidumar	III A	LAIN & HILLY	20850	495.9	45.32	39
9	Katoria	III A	LAIN & HILLY	56061	915.2	76.27	46
10	Rajaun	III A	PLAIN	19754	818.6	68.22	43
11	Shambhuganj	III A	PLAIN	17970	413.4	34.45	26
District Total				**302000**	**664.50**	**55.72**	**39.27**

1.9 Geomorphology

The district can be broadly divided into two broad physiographic division viz. alluvial plain in the north and the hilly tracts in the south. The regional slope is from south to north. The land slope in the southern parts of the district is high whereas in the north low to moderate land slope is noticed. Higher slope of more than 10% is only in the hilly tract. Slope map of the area has been prepared under Arcgis platform using spatial analyst tool (fig.9a). It is understood that, in major parts of the district the slope is 0-3% or 3-5%. However, along the foothill area surrounding the highlands and along the river valley 5-10% slope is witnessed. More than 15% slope is recorded in the hilly tracts and in highlands.

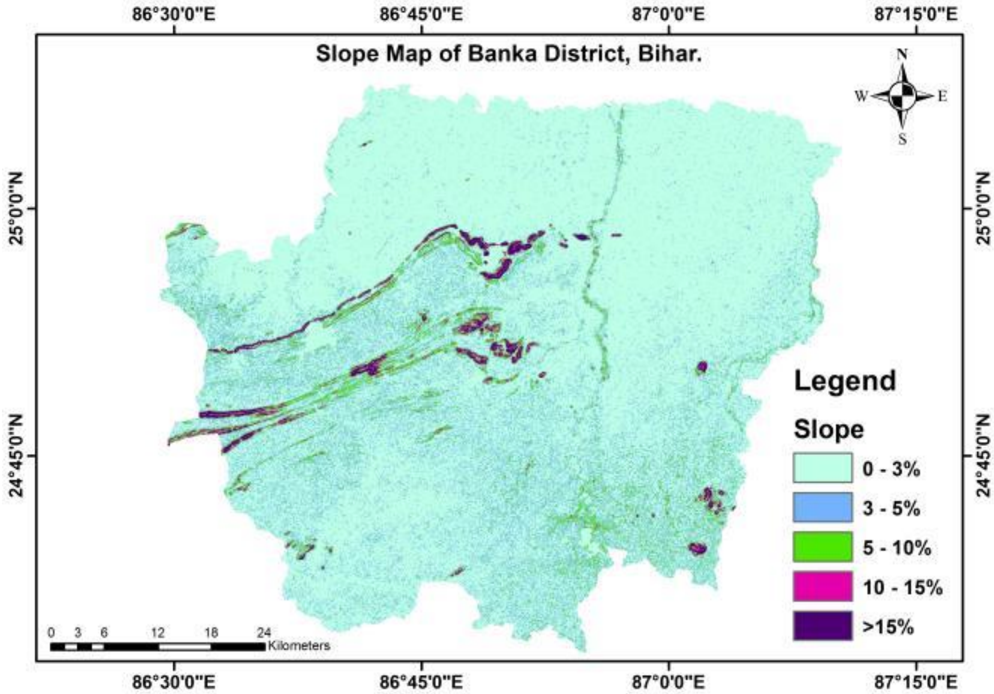


Fig.9a Slope Map ***(from DEM data)***

The west of the alluvial plain of the river Ganga is bordered by the Munger-Kharagpur hills. The hills of the district are generally moderate in height, denuded and irregularly scattered. Archean inselbergs stand as peak in otherwise flat terrain. The other prominent hillocks in the area are Mandar Hills (311 m), Baga Pahar (358 m) etc.(Fig.9b). Geo-morphologically the area is being divided into five distinct units. These units given below are in chronological order from youngest to oldest.

- Diara Surface: It is the youngest morpho-unit of the area comprising of yellow-brown to brownish-grey compact clay. It is the recent flood plain of the major rivers passing through the district.
- Belhar Surface: It is a flat alluvial low land usually free from regular annual flooding, but is prone to water logging in the patches. The surface overlies the recent flood plain surface .The soil is buff to brown colour and rich in silt, sand or silty clay.
- Sautadih Surface: The surface belongs to the older alluvial upland bordering the pediplains and the hilly area. The soil profile is well developed and characterised by deeply oxidesed yellow to brownish red clay with ferruginous concretions.
- Pediplain Surface: The surface borders the northern margin of the district. These rocky units are essentially produced by the erosional process. The surface has developed primarily on the granite gneisses and is characterized by lack of good soil profile and colluvial deposits of weathered material.

➢ Hilly /Rocky upland: This includes the hilly area of the Chotanagpur plateau, consisting of granite gneiss, quartzites, phyllites and mica schist.

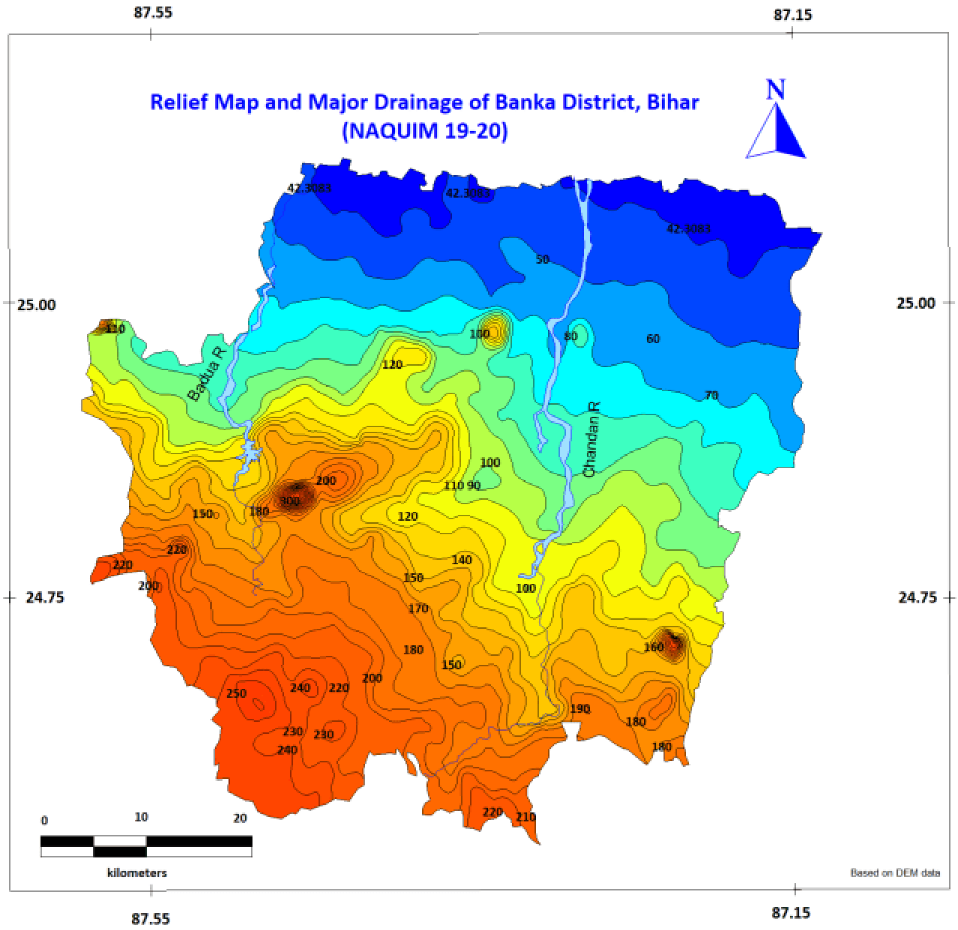


Fig.9b Elevation Map in Banka district ***(from SRTM data)***

1.10 Drainage

The entire district is a part of Gandak sub basin except the eastern most extremity of the district which comes in Bahgirathi basin (fig.10a). The district is traversed by several peninsular streams. The catchment area of these streams lies in Santhal Parganas and in Munger highlands. They are ephemeral in nature and carry meager discharge.

Chandan River originates in Deoghar district in Jharkhand flowing south_north direction through the central parts of the district is the principal drainage in the district. Other major streams include Badua River, in the western parts of the district, is flowing in the SSW-NNE direction. The rivers exhibit dendritic drainage pattern in the southern hilly terrain and it becomes flat and parallel in the northern alluvial plain. The changes in slope from south to north also mark the transition zone of hard rock and alluvial plain in the area.

The detail drainage map has been prepared under Arcgis platform from DEM data using spatial analyst tool and assigning flow accumulation, flow direction and stream ordering (fig.10b). The major streams and rivers are conforming to higher order i.e; 4^{th} or 5^{th} order streams. The lineament patterns are often found to coincide with stream lines of different orders.

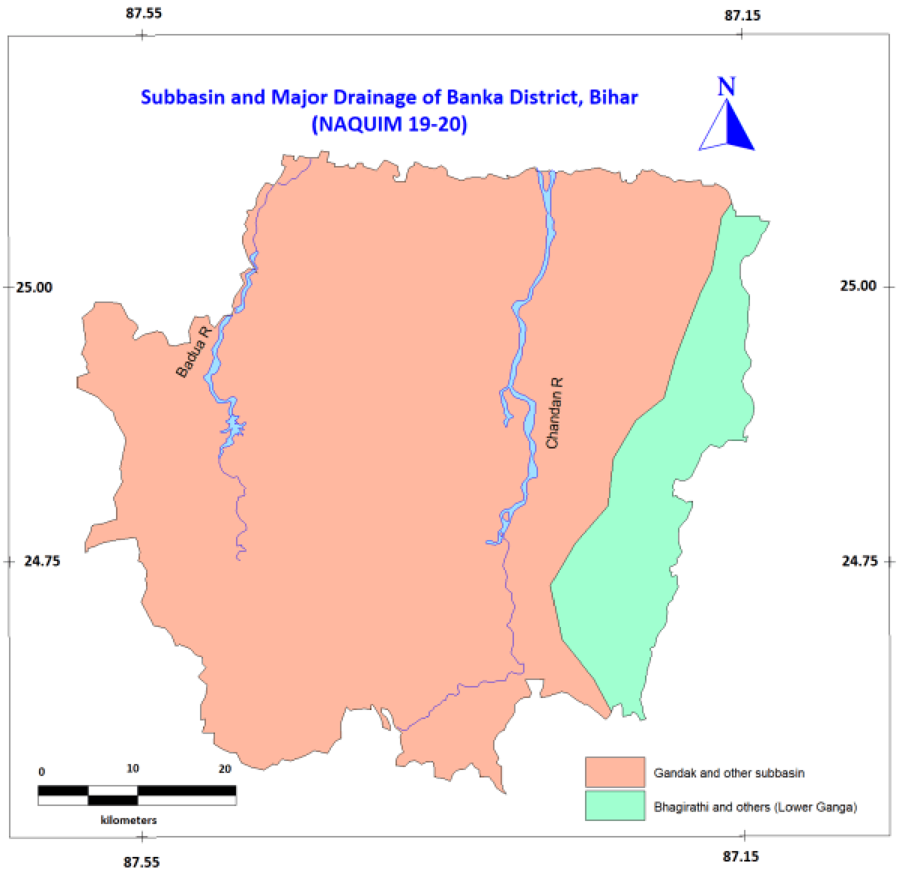


Fig.10a Sub-basin and Drainage

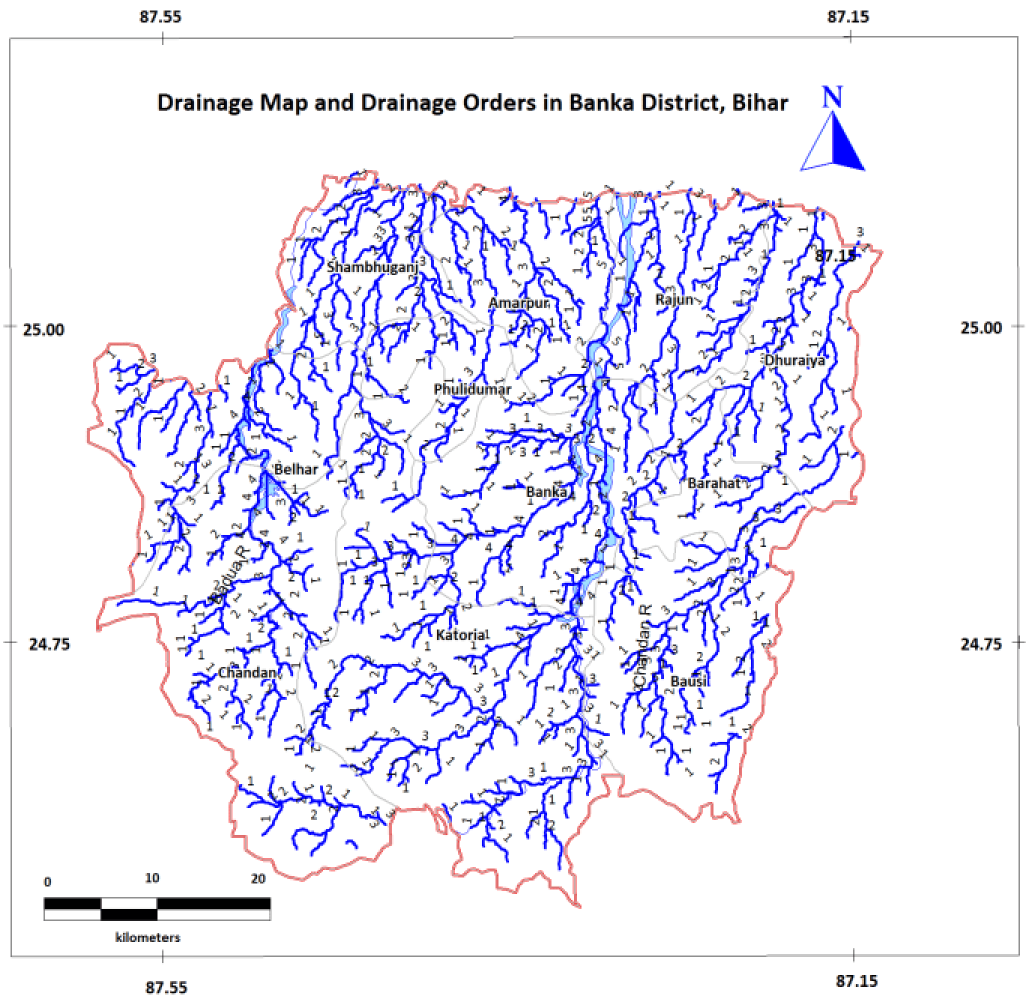


Fig.10 b Detail Drainage Map and Stream Ordering in Banka district

1.11 Soil Characteristics

Banka district is characterized by a wide variety of soils, which can be broadly grouped into two categories, the alluvial soil and hilly soil. The alluvial soil derived partly from the older alluvium deposit and partly form the newer flood plain deposit is characterized by light grey to dark grey colour and fine texture. The hilly soil derived from the weathered product of rocks is coarse grained, ferruginous, low in nitrogen ,medium to high potash and acidic in nature.

1.12 General Geology

The district is underlain by Archean to Proterojoic rocks and Quaternary sediments of Holocene age. Unconsolidated to semi-consolidated Diara, Belahar and Jamui Formation constitutes the Quaternary parts whereas the consolidated to semi consolidated Dolerite, Quatzite, Mica schist, BGC comprises Proterozoic and Archean groups of rocks. Chhotonagpur Gneissic Complex form the basement in the district. Precambrian crystalline rocks occupy the considerable area in the southern parts of the district. The Precambrian meta-sediments are overlain by Pliestocene-Holocene and late Holocene sediments. The Precambrian gneissic complex is characterised highly metamorphosed gneissic rocks, granite gneiss, biotite gneiss, hornblede, amphibolite etc. Porphyritic granites are also common in the area. The gneissic rocks are often undergoes weathering forming weathered mantle with depth of weathering 3-10 m depending on the underlying formation, local geomorphology and drainage pattern in that particular area. The Precambrian gneissic rocks are often succeeded by meta-sediments of quartzite, phyllite and schist.

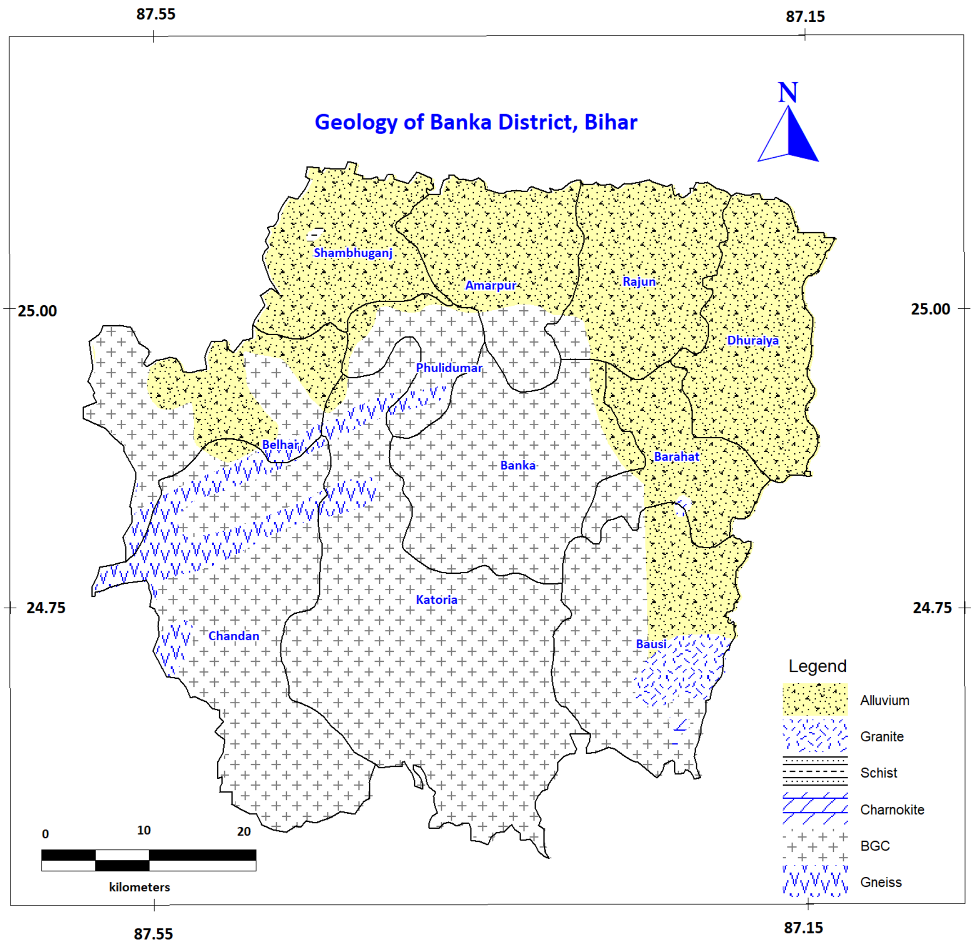


Fig.11 Lithological Map in Banka district

Quaternary formation constituting the alluvial basin in the northern parts of the district are characterised by semi-consolidated to unconsolidated sediments of sands, silts, clay, kankar etc. The Sautadih Formation, Belhar formation and Diara formation (Sinha etal 1900) comprises the continental alluvial quaternary deposits in the Chandan Badua Complex in Banka district.

The pre-Quaternary rocks in the area have undergone multiple phases of deformation resulting in complex patterns of diastrophic structures. Folds, joints, schistosity/gneissocity, lineaments etc. are common. The major structural trend is ENE_WSW in the eastern parts, NE_SW in the central parts and NE_SW to almost E_W in the western parts of the district. Lineaments affecting the pre-quaternary rocks are important in the perspective of ground water exploration and occurrences in the area.

1.13 Sub-Surface Geology

The subsurface geology of the area has been unearthed from the exploratory bore holes and tube wells data of CGWB and the water supply wells of State Govt departments and other agencies.. The lithologs of the existing available bore holes in Banka district has been compiled for preparation subsurface correlation diagram. A considerable area in the southern parts of the district being underlain by hard granitic/gneissic/ quartzite rocks, therefore, in terms of ground water prospects in the district the mapping of the depth of weathered sediments and the incidences of fractures in the bed rock definitely acquire significant roles. Keeping above in mind, the thickness of the alluvium and weathered sediments above the hard rock in the study area has been worked out from the exploratory bore hole data of CGWB and has been utilised in preparation of depth of Hard Rock map of the district (fig12). In southern parts of the district hard rock lies within 5 to 20 m depth except in area around Chandan block where alluvium thickness of 20-30 m have been reported. As we move further north, the thickness of alluvium increases progressively from 20 m to 85 m. Maximum thickness of alluvial sediments or maximum depth of bedrock have been reported in 98 m bgl at Raipura in Sambhuganj block. The thickness of alluvial sediments are appreciably high in Amarpur, Dhuariya and in Rajaun area. The detail subsurface geology has been discussed in chapter 3 of this report.

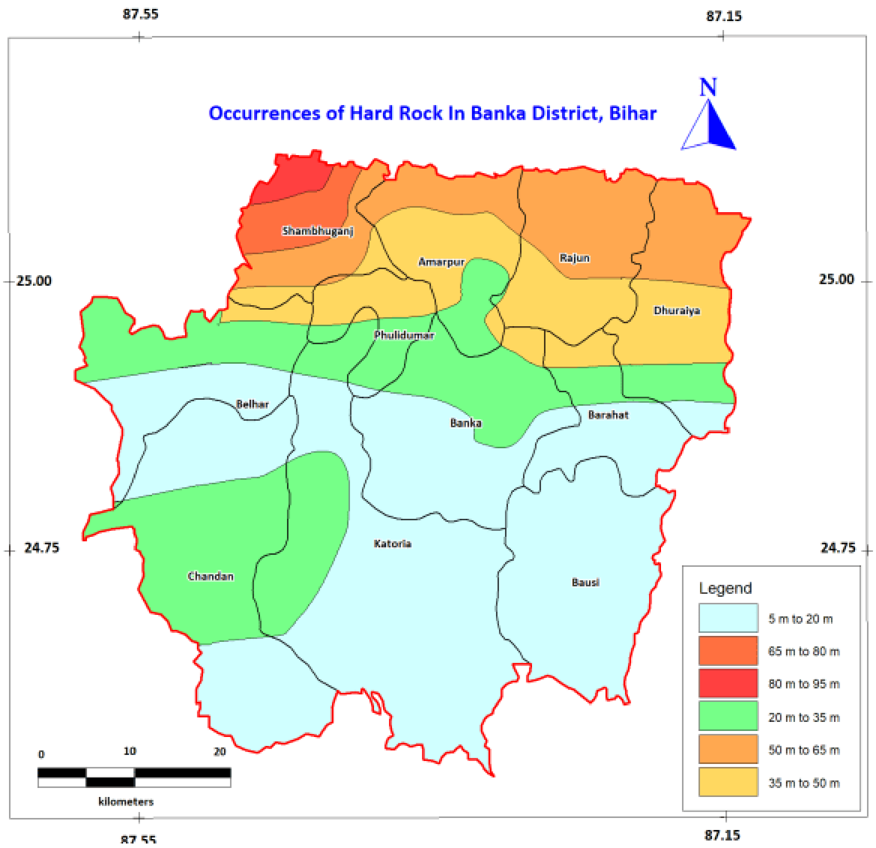


Fig.12 Thickness of alluvium and depth of Hard rock in Banka district, Bihar

CHAPTER-2

2.0 Data Collection and Generation

The primary data such as water level, quality, geophysical data and exploration details available with CGWB has been collected and utilised as baseline data. To study the behavior of ground water level and quality of ground water in the district, ground water level and quality data have been collected from NHNS and other key observation wells. To understand the sub–surface geology, identify the various water bearing horizons including their depth, thickness and to assess hydraulic characteristics such as transmissivity and storativity of the aquifers, the results of exploratory drilling programme by Central Ground Water Board in the district has been considered.

2.1 Hydrogeology

Water Bearing Formations

Ground water in Banka district is principally replenished by precipitation, however, influent seepage from canals, streams, reservoirs etc, also contributes to the ground water reservoirs. The terrain condition, geological set up of the area, rainfall pattern, occurrences and movement of ground water through primary or secondary porosity controls the hydrogeological framework of the district. The district of Banka thus, can broadly be subdivided into two predominant hydrogeological units:

Fissured Formation: The fissured formation constitutes the Chotanagpur Granite Gneissic Complex and meta sedimentary. Ground water occurs in these rocks under confined to semi-confined conditions. The secondary porosity e.g. fractures, joints and fault planes acts as aquifer and controls the storage and movement of ground water. The weathered residuum and secondary porosities developed by means of weathering and / or fracturing is the main repository of ground water in the hard rock terrain. The granular materials are 5-20 m depth which is underlain by saprolite zone of 0.5-3 m depth. The potentiality of the water bearing formation/aquifers in the area depends on the thickness of the weathered residuum, extent, size, depth, interconnection of the fractures and topographic setup. The intense tectonic movements have resulted in deep seated fractures in the area. The fractures often persists long distance and conforms the trend of major lineaments. The lineaments NW-SE and ENE-WSW are more intense. The exploratory drilling data of CGWB reveals that the potential fractures are generally encountered within the depth range of 60-80 m depth, but in few cases shallow or deeper fractures are also productive. The weathered mantle forms potential ground water repository in the low lying area where they can be effectively developed by large diameter dug wells.

Based on the above observation the aquifers in this hydrogeological unit may be grouped as shallow (1^{st}) and deeper (2^{nd}) aquifers. The shallow aquifers are chiefly constituted by weathered residuum, saprolite zone and shallow fractures within 30-40 m depth. These are generally developed by dug wells or shallow bore wells with limited command area. The deep seated fractures beyond the depth of 30 m can be a sustainable resource for ground water. These fractures are commonly encountered at 60-80 m depth, but in few cases as deep as 150 m deep fractures has also been reported. These deeper fractures can only be located through detail hydrogeological and geophysical survey.

Porous formation: The Quaternary alluvium constitutes this hydrogeological unit. It occupies the northern part of the district. The Quaternary alluvial deposits consisting of sand, silt and clay forms a good repository of the ground water. The ground water occurs in the porous material under both unconfined and semi-confined to confined conditions depending on the disposition of aquifers. The maximum thickness of the alluvial sediments of 95 m is reported in the north western parts in the district around Sambhuganj area. Thickness increases from south to north. The variation in thickness of the alluvium is also due to uneven bed-rock topography. The mounds and trough in the basement not only controls the thickness but also the nature and grain size of sedimentation. The trough generally host coarser sediments/sands and finer are deposited in the mounds. However, this formation, often constitute the prolific aquifers. Aquifers in this formation may also be grouped as shallow (1st) aquifer within 10-35 m depth which are tapped by dug wells or shallow tube wells and *deeper (2nd)* aquifers beyond the depth of 35 mbgl, which are often tapped by MDTW or DTW. The shallow aquifers are generally unconfined and deeper one is in semi-confined to confined condition.

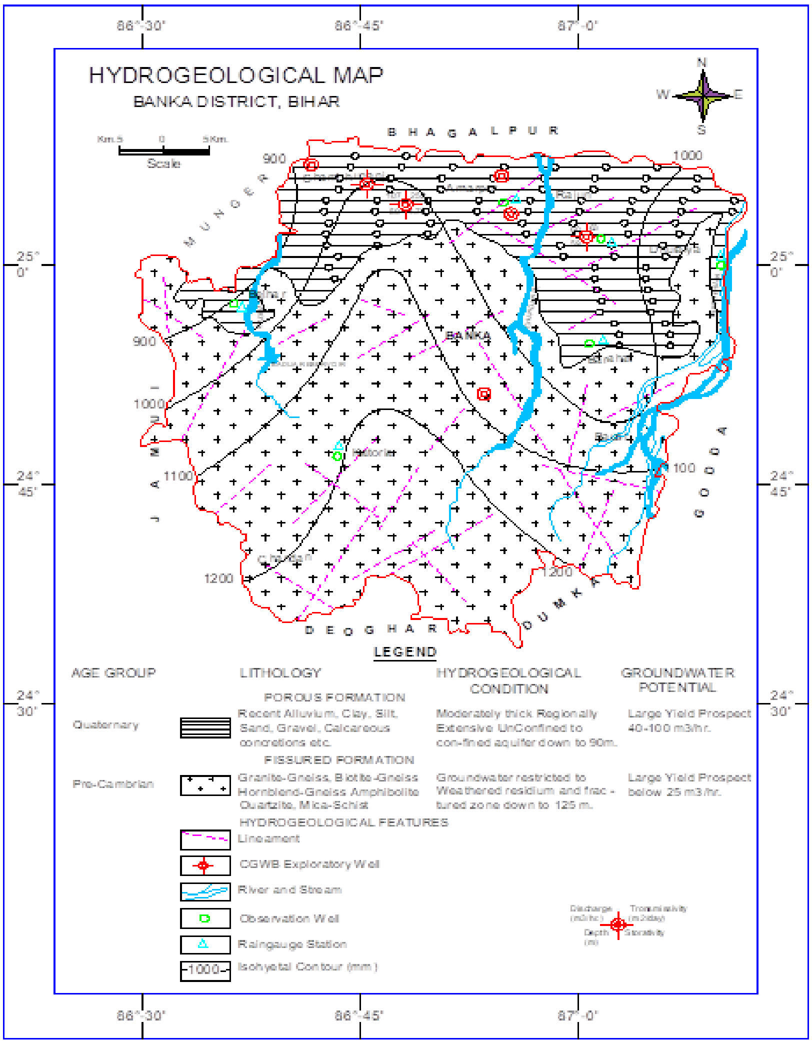


Fig.13: Hydro-geological Map of Banka District, Bihar

2.2 Ground Water Regime, Water Table, Ground Water Movement

Depth to Water Level

The shallow aquifers in the fissured formation/hard rock terrain and in the porous formation are developed by dugwells or shallow bore wells upto the maximum depth of about 30 m. The shallow aquifers which are principally developed by dugwells in hard rock area, are represented by the weathered residuum, saprolite zones and shallow fractures in few occasions , whereas in alluvial area is represented by sands of different grain sizes, clay , silts etc. The deeper aquifers (deep seated fractures) in hard rock area is developed by bore wells of 50-150 m depth and in alluvial area by shallow, medium and deep tube wells of 50-100 m depth. The shallow aquifers irrespective of hard rock or in the alluvial area are in phreatic condition whereas the deeper aquifers are in semi confined to confined condition in the district.

To study the ground water regime of prevailing aquifer system in the study area, under the data generation activity of the NAQUIM, about 40 observation wells representing shallow 1st aquifer (weathered and shallow alluvial dug wells) and deeper 2nd Aquifer (deeper fractures/ deep bore wells and medium and deep tube wells) have been monitored during the pre and post monsoon period (Table 2.1, fig.14). The observation wells are private dug wells, mark II tube wells, deep bore/tube wells of PHED, Govt. of Bihar and piezometers of Minor Irrigation Departments, Govt. of Bihar. The depth of the dug well varies from 5.5 m to 12 mbgl. These dugwells are grouped together to represent the 1st aquifer system in the district. The piezometers of Minor Irrigation department, Govt. of Bihar, both in hard rock and in alluvial area lie at the depth of about 50 mbgl. The deep bore/tube wells of PHED, Govt. of Bihar generally lie at 30-120 m depth. These two are grouped together to represent the depth of ground water level/piezometric level of the deeper aquifer in the district.

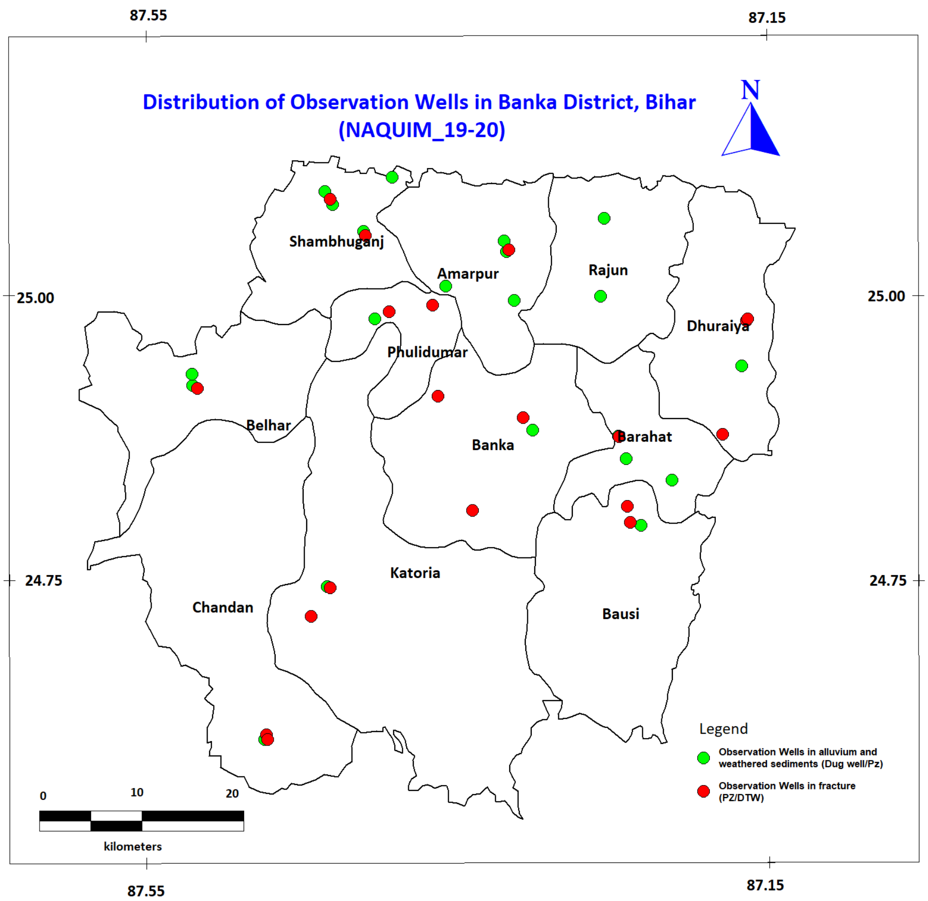


Fig.14 Location of Observation Wells

The depth to water level of ground water in the district would definitely be influenced by the topography, nature of formation, surface water bodies, development scenario etc. The pre-monsoon depth to water level map of the 1st aquifer (fig.15) representing alluvial deposits and weathered materials, witnesses the ground water level at 3.42 to 8.20 mbgl. Deeper water level is observed in the southern and in the eastern parts of the district which is mostly underlain by hard rock terrain. Moderately deeper water level of 5-7 mbgl is observed in the northern alluvial and may be correlated with the ground water development for irrigation uses from shallow aquifer in these area. However, the post monsoon depth to water map (fig16) represents shallow water level within 5 m bgl in the entire parts of the district. The deeper aquifers are measured from PZ of MI Departments, PHED DTW etc and. represents the fracture zones where pre monsoon depth to water level varies from 5-14 mbgl , however in post monsoon time water level rests at 1.75 m to 11.45 mbgl. Deeper water level is witnessed around Katoria block. The deeper water level in the hard rock area may be due to the less potentiality of the particular fractures.

Table: 2.10 Detail of Well Inventory of Key Observation Stations in Banka District, (NAQUIM 2019-20)

Sl No	Village	Block_Name	Type_of_Well	Geology	Elevation wrt msl	Depth (mbgl)	Postmonsoon SWL/mbgl	Premonsoon/SWL mbgl	Water Table Post mbgl	Water Table Pre mbgl
1	English more	Amarpur	DW/ NHNS	Alluvium	18.9	8	2.02	3.42	16.88	15.48
2	Rampur	Amarpur	DW/ NHNS	Alluvium	70.4	6.99	2.5	3.56	67.9	66.84
3	Panianath	Amarpur	DW	Alluvium	60	7	1.75	5.1	58.25	54.9
4	Amarpur	Amarpur	Pz	Alluvium	62	50	5.1	6.9	56.9	55.1
5	Banka	Banka	DW/ NHNS	Alluvium	84.4	5.9	1	4.35	83.4	80.05
6	Barhat	Barhat	DW/ NHNS	Alluvium	90.8	8.3	3.3	5.19	87.5	85.61
7	Auriya	Barhat	DW	Alluvium	91.6	9.200	1.50	3.5	90.1	88.1
8	Sabalpur	Baunsi	DW	Alluvium	91.4	7.620	3.10	7	88.3	84.4
9	Baunsi	Baunsi	DW/ NHNS	Alluvium	98.5	9	3.15	8.72	95.35	89.78

Sl No	Village	Block_Name	Type_of_Well	Geology	Elevation wrt msl	Depth (mbgl)	Postmonsoon SWL/mbgl	Premonsoon/SWL mbgl	Water Table Post mbgl	Water Table Pre mbgl
10	Belhar	Belhar	DW	Alluvium	94.8	12	5	7.75	89.8	87.05
11	Gorgamah	Belhar	PHED_MDTW	Alluvium	90	31.000	1.80	4.50	88.2	85.5
12	Chandan	Chandan	DW/ NHNS	Alluvium	16	8.6	2.6	5.3	13.4	10.7
13	Beldiha	Dhorayya	DW	Alluvium	65.2	8.5	6.6	7.5	58.6	57.7
14	Fulidumar	Fulidumur	DW	Alluvium	131	8	3.1	4.39	127.9	126.61
15	Katoria	Katoria	DW/ NHNS	Alluvium	204	8.7	2.25	8.16	201.75	195.84
16	Sanjha DTW	Rajaun	PHED_MDTW	Alluvium	53.4	30	2.9	6.85	50.5	46.55
17	Rajaun	Rajaun	Pz	Alluvium	65	50	3.45	8	61.55	57
18	Karharia	Sambhuganj	DW/ NHNS	Alluvium	43.5	**7**			43.5	43.5
19	Sambhuganj	Sambhuganj	DW/ NHNS	Alluvium	52.3	7.5	1.4	6.92	50.9	45.38
20	Mirjapur	Sambhuganj	DW/ NHNS	Alluvium	51.8	8.5	2.2	6.25	49.6	45.55
21	Kurmadih	Sambhuganj	Mk_II	Alluvium	49	35	2	6	47	43
22	Sambhuganj	Sambhuganj	Pz	Hard Rock	50.8	50	10.24	11.34	40.56	39.46
23	Amarpur	Amarpur	PHED_DTW	Hard rock	62.6	120	5.6	7.5	57	55.1
24	Bnaka DM House	Banka	Pz	Hard Rock	84	50	6.13	7.11	77.87	76.89
25	Barhat	Barhat	Pz	Hard rock	91.8	50	4.89	6.23	86.91	85.57
26	Baunsi	Baunsi	PHED_DTW	Hard Rock	111.6	120.000	8.50	10	103.1	101.6
27	Baunsi	Baunsi	Pz	Hard Rock	112	50	6.44	7.5	105.56	104.5
28	Belhar	Belhar	Pz	Hard Rock	95.2	50	3.75	6.08	91.45	89.12
29	Chandan	Chandan	TW/Subm	Hard Rock	247	100	1.75	5.1	245.25	241.9
30	Chandan	Chandan	Pz	Hard Rock	244.7	50	4.56	7.85	240.14	236.85

Sl No	Village	Block_Name	Type_of_Well	Geology	Elevation wrt msl	Depth (mbgl)	Postmonsoon SWL/mbgl	Premonsoon/SWL mbgl	Water Table Post mbgl	Water Table Pre mbgl
31	Ramkol	Dhorayya	PHED_MDTW	Hard Rock	79.1	120.000	7.50	10.2	71.6	68.9
32	Dhauriya	Dhorayya	PHED_DTW	Hard Rock	57.4	120	2.8	6.8	54.6	50.6
33	Dhauriya	Dhorayya	Pz	Hard Rock	57.5	50	3.19	8.01	54.31	49.49
34	Telia More	Fulidumur	TW/Subm	Hard Rock	75.4	76	4	5	71.4	70.4
35	Ghaotar	Fulidumur	PHED_MDTW	Hard rock	116.3	122	6.5	7.55	109.8	108.75
36	Phulidumar	Fulidumur	Pz	Hard Rock	79.7	50	2.82	3.55	76.88	76.15
37	Kakwara	Katoria	PHED_MDTW	Hard Rock	134.8	100	4.7	7.1	130.1	127.7
38	Bhairopur	Katoria	TW/Subm	Hard rock	215.2	100	7	8.75	208.2	206.45
39	Katoria	Katoria	Pz	Hard Rock	205.8	50	11.45	14	194.35	191.8
40	Mirjapur	Sambhuganj	PHED_DTW	Hard rock	50.3	75	4.1	6.25	46.2	44.05

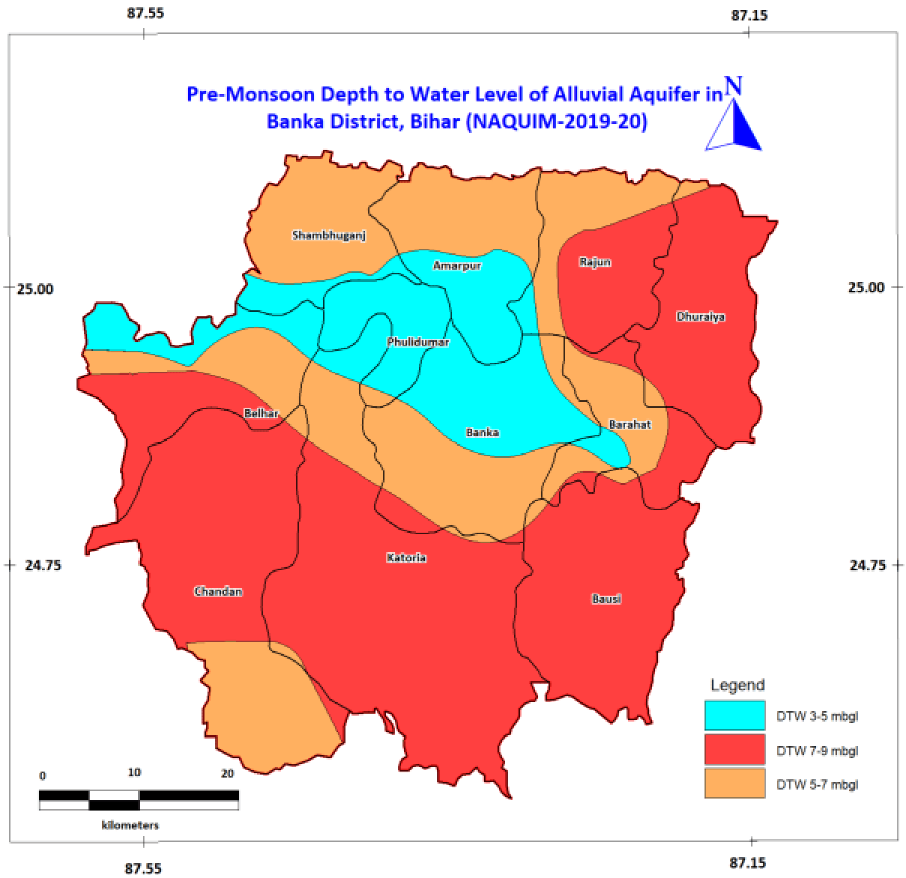


Fig.15 Pre-monsoon DTW Map of Alluvial Area in Banka Distrct

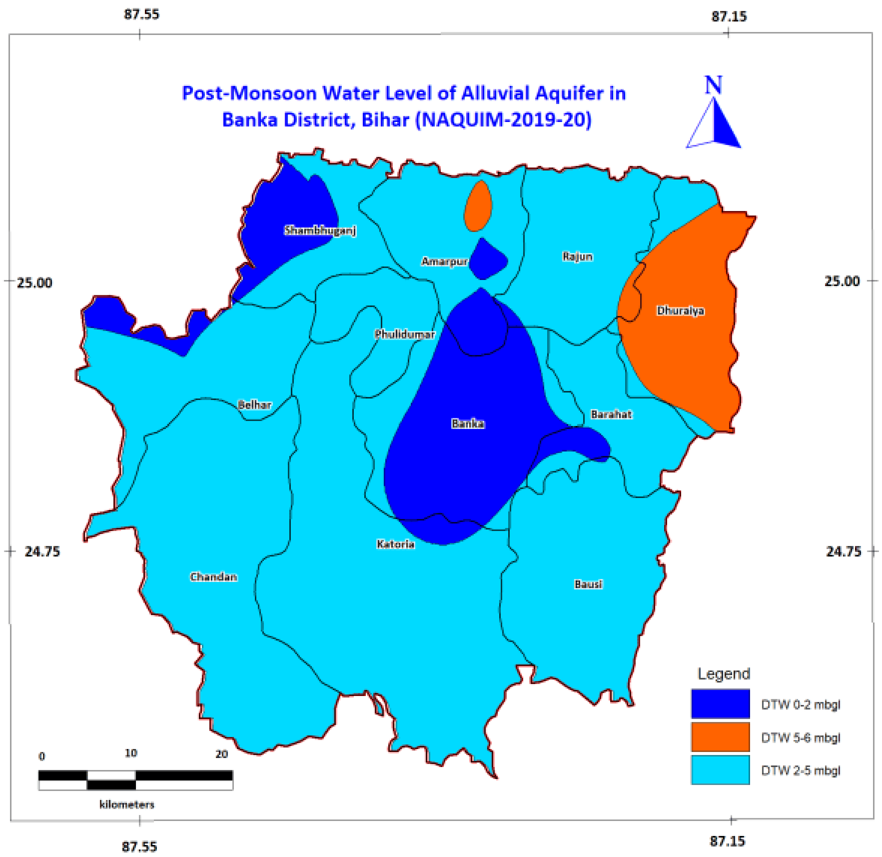


Fig.16 Post-monsoon DTW Map of Alluvial Area in Banka Distrct

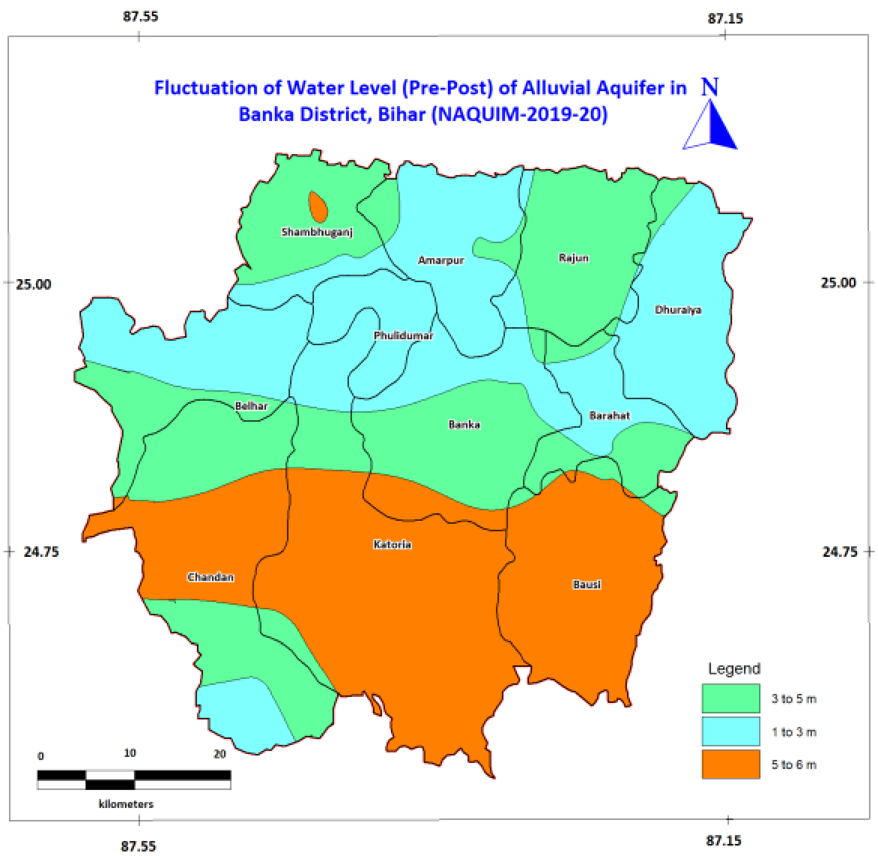


Fig.17 Fluctuation of Water level in Alluvial Aquifer in Banka district

Ground water level fluctuation, (pre-post, fig.17) of the 1st aquifer system reflects fluctuation of 2 to 6 m throughout the area, higher fluctuation of 5-6 m is recorded in the southern hard rock area whereas fluctuation is moderate to the tune of 3 to 5 m in the central and in northern alluvial terrain.

Water table and Ground Water Movements

Along with the occurrences of ground water, the movement of water in the aquifer and the gradient of movement are of utmost significance for better understanding the nature of aquifer system in an area. The pre-monsoon water level data from the shallow aquifer has been utilised to estimate the water table or the head with respect to the reduced level (fig.18, 19). The pre-monsoon water table elevation varies from 240 m above msl to 40 m above msl. The higher water table contour is observed in the southern parts in and around Chandan and Katoria block, which mostly conforms the topographic highlands. The lower water table elevation is witnessed in the northern parts of the district to the tune of 40-50 m amsl around Sambhuganj, Amarpur, Rajaun, Dhauriya block. The regional ground water flow direction from south to north and south west to north east, however local N_S flow pattern influenced by topographic elevation is observed in parts of Chandan block in the southern parts of the district.

The nature of the water table contour in Chandan River and in Badua River interfluve area represents ground water divide with ground water flow towards the respective rivers. The water divide constitutes the recharge area of the area and mostly high land area.

The steepness of the water table contour indicates the hydraulic gradient is gentler in the northern alluvial parts and along the river valley area. Decrease in hydraulic gradient is also attributed to the increase in the hydraulic conductivity and the potential of the aquifer in central and northern parts of the district.

The post monsoon water table contour depicts the similar nature with little flattening of contours (fig19).

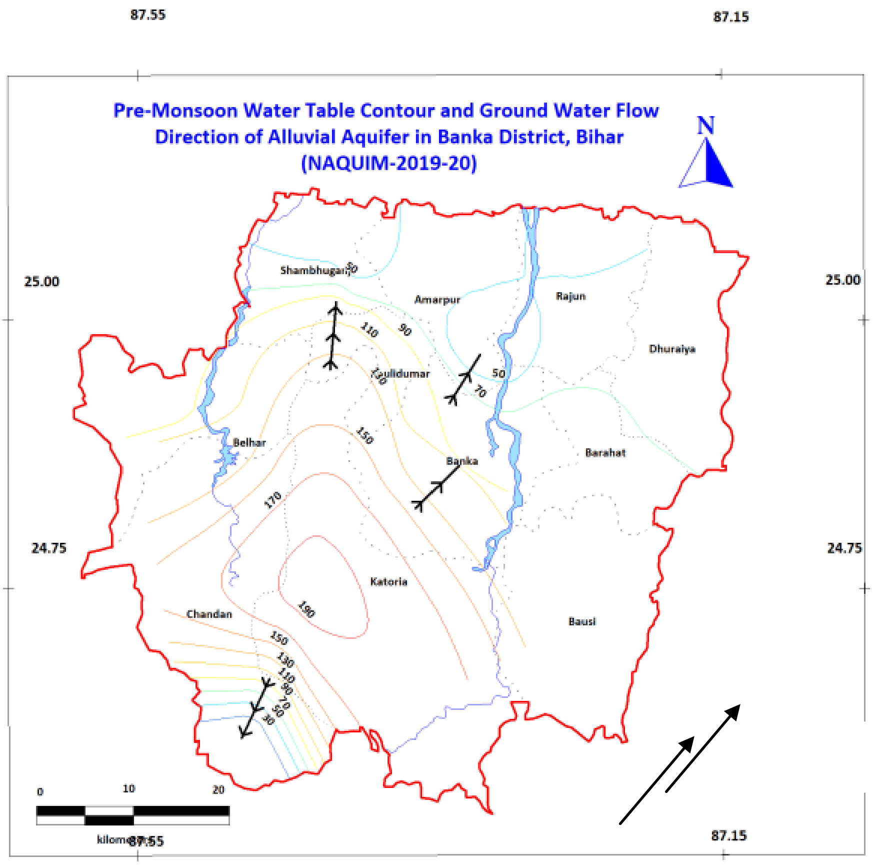


Fig.18 Pre-monsoon water Table contour Map of Banka district

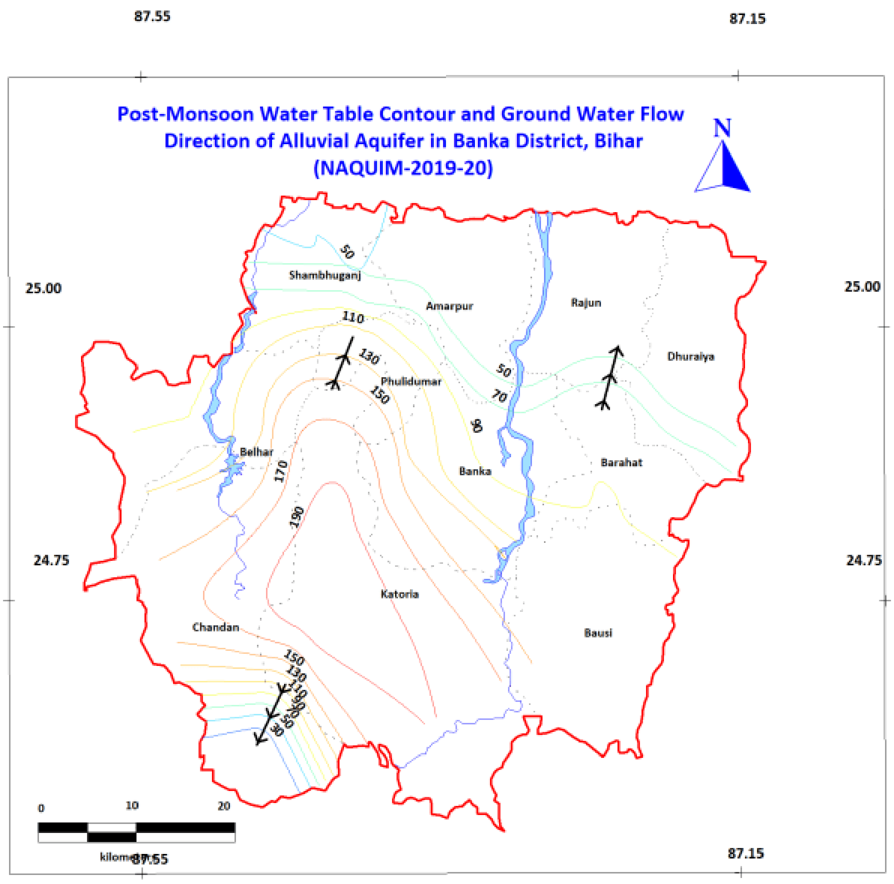


Fig.19 Post-monsoon water Table contour Map of Banka district

Long Term Water Level Trend Analysis

The historical data on water level of the observation wells/NHNS wells of CGWB in Banka district has been analyzed. The observation wells principally represent the shallow/1st aquifer system. The block wise average pre and post monsoon water level for each year has been plotted to find out the long term behavior of water level in the area. The changes in long term water level behaviors over the years are found significant in few parts of the study area. The moderate changes in long term behaviors of ground water level in the district may be the reflection of increase in ground water draft from shallow aquifers for irrigation uses

2.3 Exploratory Drilling and Yield

The potentiality of the aquifer largely depends on the nature of the underlying formation, extent of the aquifers, scope of recharge and recharge potential and on the aquifer parameters. The occurrence and movement of ground water in the marginal alluvial tract is primarily controlled by primary porosity and the permeability whereas in the fissured formation it depends on the extent of weathering and types and interconnection of fractures. The important hydraulic properties of aquifers are hydraulic conductivity, transmissivity, storativity, specific capacity which has special bearing on the hydrogeological frame work of the district. CGWB has constructed numbers of exploratory and observation wells both in alluvium and hard rock area in the district. The result of exploration with aquifer parameters are given in table 2.20. The thickness of Quaternary Alluvial deposit generally ranges from 15 m to 100 m in the northern part of the district. The maximum depth to bedrock is at Raipura which is 99 m.The sandy layers in the alluvial terrain form the main repository of ground water in the northern part of the district. The thickness of alluvial deposit increases from south to north. Ground water usually occurs under both unconfined conditions in aquifer disposed at shallower depth and under semi-confined to confined condition at deeper depths. The thickness of granular zone ranges between 18-25 m at a depth ranging between 50 and 99 m below ground level. The yield ranges between 60m^3/hr to 124 m^3/hr for a drawdown of 21 m and 8.00 m respectively. The available data indicates that in Shambhuganj block there exist a number of granular zones in shallow and deeper levels. In this block there is a wide scope of ground water development through shallow tube wells up to 50 m depth. The deep tube wells up to 100m depth may give a discharge of 75-100 m^3/hr. The exploratory data indicate that there is a wide variation of the transmissivity value which varies from 63.7 m^2/day at Khirri to 1265 m^2/day at Rudpai. The transmissivity increases towards north western part of the district, where the thickness of the aquifer is also more. The storage co-efficient value is estimated as 2.75 x 10^{-3} at Warshabad, which shows that aquifer is under semi-confined condition. In hard rock area in southern parts of the district the wells are mainly in fracture zones in granite gneiss and often produce limited yield of 3-10 m^3/hr, however in few cases higher yield of 27 m^3 /hr has also been reported in Katoria block. Yield is moderate around Banka block.

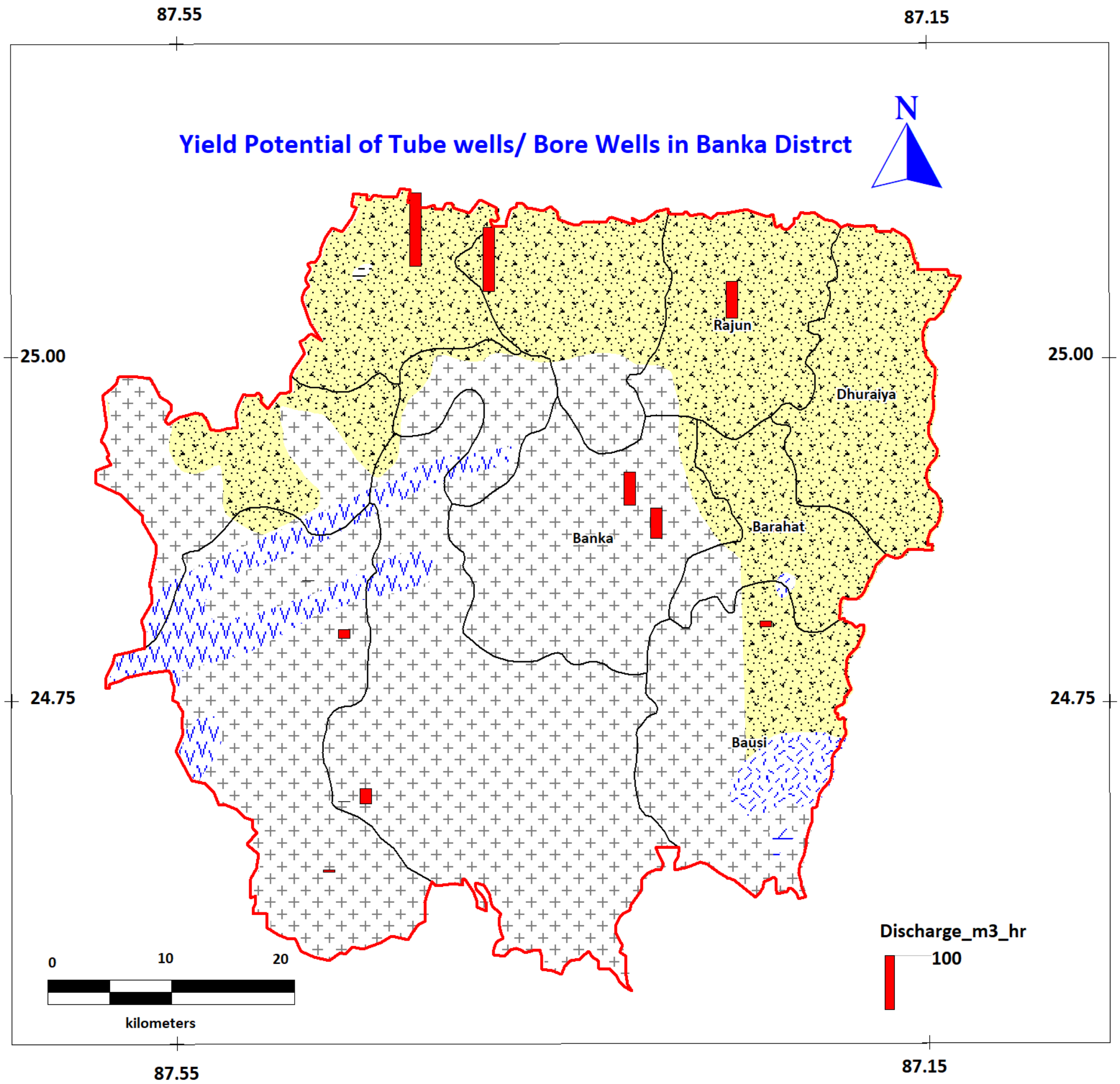


Fig.20 Yield Potential in few blocks in Banka district

Table 2.20: Yield and Aquifer Potential of Exploratory Wells of CGWB in Banka district

Sl_ No	Name	Block	Geology	Depth_of_drilling_	Granular_zones/Fractures tapped	Depth of Hard rock	Discharge m^3/hr	SWL_mbgl_	DD_in_m	Sp Capacity $m^3/hr/m$	Transmissivity m^2/day	Storativity
1	Raipura	Sambhuganj	Alluvium	99.52	69-95	96	0					
2	Warshabad	Sambhuganj	Alluvium	54	17-26,28-35,41-46	48	108	4.65	14.3	7.55	252.25	$4.75x10^{-3}$
3	Rudpai	Sambhuganj	Alluvium	80	36-40,49-59,63-72	75	124.39	2.79	8.21	15.15	1265.85	$2.75x10^{-3}$
4	Khirri	Rajaun	Alluvium	60	31-41,48-51	53	60.6	3.63	21.37	2.84	63.7	
5	Chandan	Chandan	Granite Gneiss	183		16	3.3	4.9				
6	Indravaran	Katoria	Granite Gneiss	192	/23-24,60-61	17.24	0.6	6.05				
7	Katoria	Katoria	Granite Gneiss	116	60-61,63-64,74-77	22.9	27	8.35				
8	Abrakha	Katoria	Granite Gneiss	93	57-59,77-78,82-83	33.43	17	9.5				
9	Suiapahar	Katoria	Granite Gneiss	150.68		9.3	2.37					
10	Bausi	Bausi	Granite Gneiss	150		5	8	2.66				
11	Jagatpur	Banka	Granite Gneiss	115		28	50					
12	Banka BDO	Banka	Granite Gneiss	200		29						
13	Banka Girls High School	Banka	Granite Gneiss	47		27.5	60					
14	Kathel	Amarpur	Alluvium	31.8		31.69						
15	Dhouni	Rajaun	Alluvium	48.76	33-48	48.76						
16	Amarpur	Amarpur	Alluvium	48.01		39.96						
17	Magduma	Amarpur	Alluvium	35.25		34.3						
18	Kakwara	Banka	Granite Gneiss	20.35		15.75						
19	Sultanpur	Amarpur	Schist	67.4		62.2						

2.4 Hydro-geochemistry

Ground water samples have been collected from the existing NHNS in the district during pre-monsoon time for analysis of basic parameters. The detail analysis report is given in Table 2.30. Chemical analysis report of shallow and deeper aquifers reveals that pH value ranges between 7.00-8.00 and EC from 600 to 900 micro Seimens/cm. The average range of EC in the district reveals fresh potable ground water. As per the concentration of chemical constituents given in Table 2.3, the ground water is by and large suitable for drinking and irrigation purposes.

The Major concern in the chemical quality of ground water in Banka district is occurrences of higher concentration of fluoride in ground water more than permissible limit in few blocks namely

Baunsi, Sambhuganj and in Chandan block. As per the results of chemical analysis of water samples in Banka district, Mirjapur area in Sambhuganj block and few area in Chandan block is reported with F concentration 1.5 mg/lit and 1.98 mg/lit respectively.

The piper diagram or trilinear diagram (fig.21) is a tool to represent the relative abundance of common ion in a set of sample. The Piper's trilinear diagram (Piper 1944) is most useful to understand the chemical relationships among groundwater. The chemical quality data of the investigated area are used in Piper's trilinear diagram for graphical analysis. The plot of the water samples reveals that the water samples are dominantly Ca Chloride and Ca bicarbonate water. Na-Cl type is reported in rare occasions. It reveals that water is mostly of alkaline earth exceeds alkalis. The range of concentration of major constituents in ground water is given below

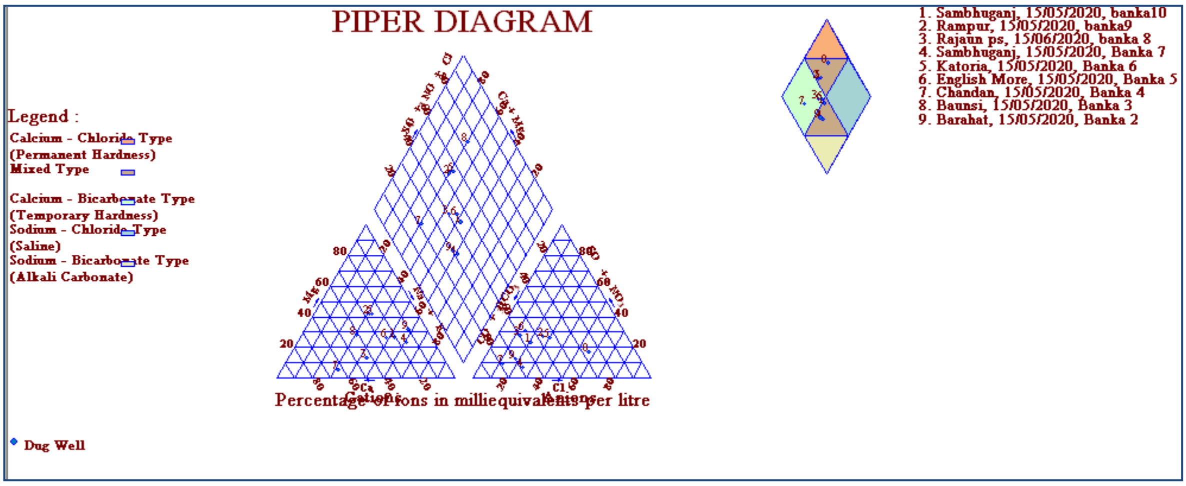


Fig.21 Piper Diagram showing relative abundances of common ion in Water Samples in Banka District

The USSL diagram best explains the combined effects of salinity hazard and sodium hazards in classification of irrigation water. It is a plot between sodium hazard (SAR) on y axis and salinity hazard (EC) along X axis which allows water to be grouped into 16 classes. In the present sample set the water is C_2S_1 to C_3S_1 type, therefore with low sodium hazard to medium salinity hazard, in few case high salinity hazard has been reported.

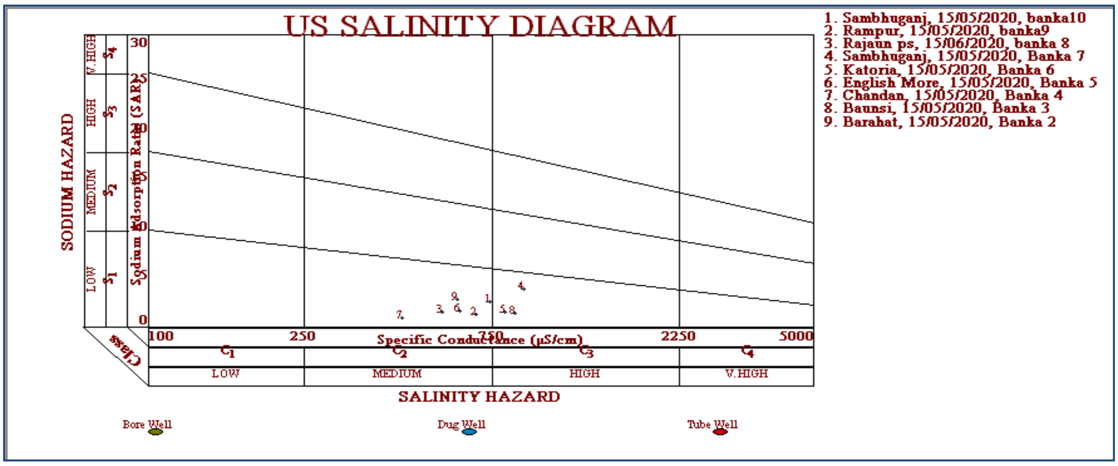


Fig.22 US Salinity Diagram explains the salinity and Sodium Hazards

Wilcox (1955) used sodium % and specific conductance in evaluating the suitability of groundwater to irrigation. Sodium percentage determines the ratio of sodium to total cations viz., sodium, potassium, calcium and magnesium. All the concentration values are expressed in equivalents per million (epm). Based on the plot (fig.23) the water samples in the district are excellent to good wrt the suitability of ground water irrigation.

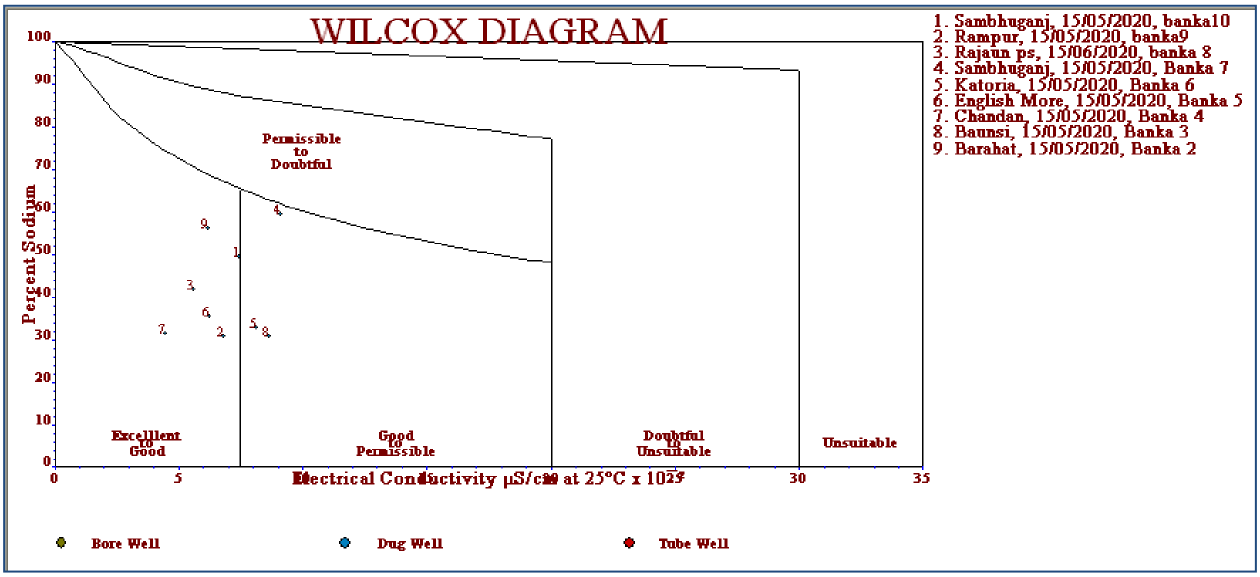


Fig.23 Wilcox Diagram explaining the suitability of Ground Water in Banka District for Irrigation

The Schoeller diagram represents a semi-logarithmic diagram of the concentrations of the groundwater samples of the study area. Concentrations of each ion in each sample are represented by points on six equally spaced lines and points are connected by a line. Fig.24 represents variation of concentration of different ions in different locations.

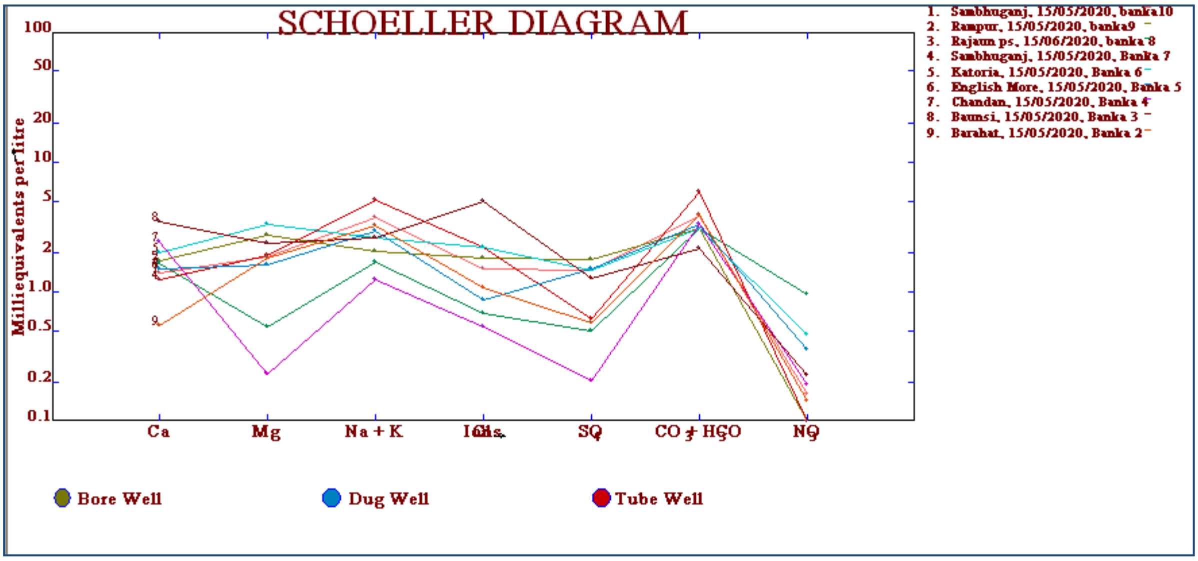


Fig.24 Schoeller Diagram explaining the variation of concentration of different ions in Ground Water Samples

(Table-2.30): Chemical parameters and range of major constituents in ground water in Banka district

S.N	District	Block	Location	pH	EC(µs/cm) at 25°C	TDS	TH	Ca2+	Mg2+	Na+	K+	CO32-	HCO3-	Cl	SO4	NO3	F
1	Banka	Barahat	Barahat	7	619	402.35	118	11	22.00	72	5.1	0	241	38	28	9	0.99
2	Banka	Baunsi	Baunsi	8	867	563.55	291	69	28.80	59	1.6	0	132	177	61	14	1.11
3	Banka	Banka	Chandan	7.3	448	291.2	134	49	2.79	28	0.9	0	200	19	10	12	0.66
4	Banka	Amarpur	English Morh	7.5	625	406.25	156	30	19.69	49	32.1	0	200	31	72	22	0.18
5	Banka	Katuria	katuria	7.3	819	532.35	267	40	41.00	59	1	0	188	78	71	29	0.32
6	Banka	Shambhuganj	Mirzapur	8.3	911	592.15	158	25	23.21	112	8	8	342	79	30	0.9	1.5
7	Banka	Rajaun	Rajaun	8	567	368.55	109	18	33.00	37	4	0	188	24	60	1	0.44
8	Banka	Amarpur	Rampur	7.8	687	446.55	225	35	33.42	46	1.2	0	187	64	85	6	0.1
9	Banka	Sambhuganj	Sambuganj	7.9	746	484.9	164	19	28.31	79	11.4	0	236	54	71	10	0.55

2.5 Geophysical Studies in Banka district

Survey Area, Geology and Hydro geological Conditions

The district is drained by three south to north flowing rivers, viz., Chandan (or Chanan) River flowing through the central part, Burigeria River flowing through the eastern part forming the district boundary with Godda and Badua river flowing through the western part of the district (Fig. 12). There are 11 reservoirs/dams in the district, of which 4 reservoirs/dams – Orhani, Hanuman, Bilasi and Fullidumar are large in area. The southern and central parts of the district are occupied by hard rock comprising granite gneiss and folded metasediments. The metasediments are exposed as a NE-SW belt in the central part. Towards north of the metasediment belt and the area between Chandan and Burigeria Rivers in the eastern part, particularly towards north of Mandar Hill near Bounsi, are occupied by alluvium. The thickness of alluvial deposit in general increases from south to north. All the 11 reservoirs/dams are located in the hard rock part, mainly in the folded metasediments. Out of these 6 reservoirs/dams are along the northern margin of the metasediments and alluvium.

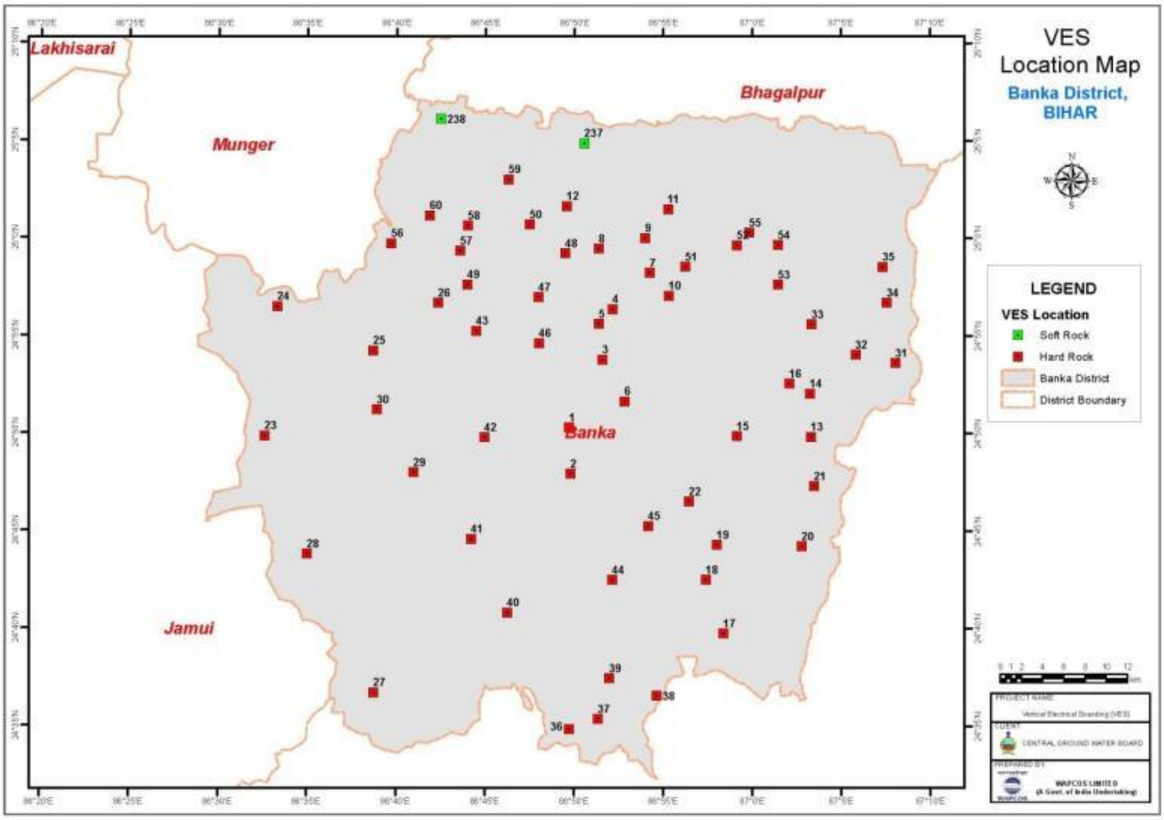


Fig. 25: Map of Banka district showing VES locations

The lithological and geophysical logs of 2 boreholes, at Kathel (DD: 31.8 m) and Dhouni (DD: 49.4 m) drilled in alluvium are available. These boreholes are about 9 km apart in E-W direction. While Kathel BH is located west of River Chandan, the Dhouni BH is located west of the river. The lithological details (Fig. 13) reveal the presence of bed rock at 31.7 m depth at Kathel and at 48. 8 m depth at Dhouni. The lithologs of both the BHs indicate the presence of 10-12 m thick fine to medium sand immediately overlying the bed rock. Therefore, in alluvial capped part of the district, while the objective of the geophysical survey would be to delineate the bed rock and the sand bed immediately overlying the bed rock, in the hard rock part it is to delineate the weathered and semi-weathered zones and the fractured zones at depth. A total of 62 VES were conducted for the purpose. The report presents the results of these VES and the hydrogeological interpretations of the geophysical signatures.

Standardization of VES Results

The site of VES 9 (English – Naksosa) is located near Kathel BH and that of VES 52 (Bhusia) is located near Dhouni BH. The lithological details of these BHs are given in Figure 3.1.2. The 64" N resistivity log of Dhouni BH is available. It reveals 18-20 ohm.m resistivity up to 26 m depth and a gradual increase in resistivity with depth beyond 26 m depth. The maximum resistivity of about 70 ohm.m is in the depth range 33-44 m against the fine to medium sand. The VES inferred resistivities are averaged resistivities over depth ranges. The VES 52 near Dhouni BH indicates clay of 7 ohm.m resistivity up to 25 m, followed by a layer of 21 ohm.m resistivity up to 55 m depth. The VES 9 located near Kathel BH reveals the presence of low resistivity (12 ohm.m) clay up to 19 m. It matches satisfactorily with the clay bottom in the BH. Further, the BH indicates presence of sand in the depth range 18-32 m. It is not distinguished as a separate layer in the VES curve. Over all, the correlation of VES with BH reveals that in alluvial area of the district the layer resistivity values around 20 ohm.m and marginally higher for a geoelectrical layer indicate presence of sands of varied grain size. Secondly, the moderately resistive sand occurring between the overlying low resistivity clay and the underlying highly resistive bed rock is distinguished in the VES curve only when it has considerable thickness and contrasting resistivity from the surrounding, otherwise it forms a part of the transitional resistivity zone and remains undetected. Therefore, in such areas it would be necessary to first interpret the VES curve for minimum-layer model and then wherever possible to interpret it with higher order model incorporating a layer of moderate resistivity below the low resistivity clay layer.

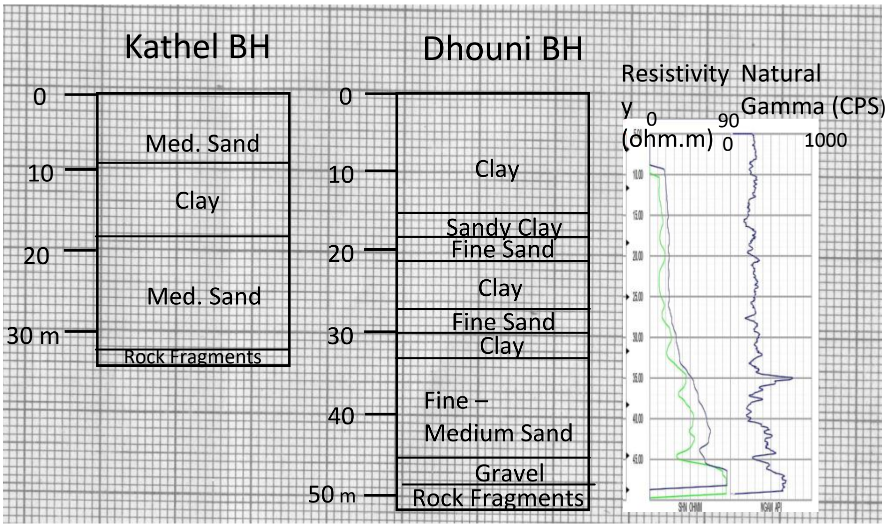


Fig. 26. Litholog of Kathel borehole and litholog and resistivity log of Dhouni borehole

Interpreted Results of VES

The interpreted results of VES are given in Table below. The VES curves are mostly of H, A and HA types revealing the presence of resistive layer at the bottom within the depth of investigation. It represents the compact formations comprising either granite gneiss or the metasediments. The resistivity of the "compact formation" ranges from 'Very High Resistivity' to about 100 ohm.m indicating a variation in lithology as well as compaction. In the area of alluvial capping which comprises sand and clay the layer resistivity varies from 5 to 30 ohm.m. It depends on the predominance of clay, sand or sand with clay. The transitional increase in resistivity with depth is observed in several VES from this area, which induces additional uncertainty in defining the layer interfaces.

Hydrogeophysical Cross-Section

Four hydrogeophysical cross-sections have been prepared utilizing the VES results. The hydrogeophysical cross-section between VES 55 at Rajauni and VES 20 at Shyambazar (Fig. 27) covers a NNW-SSE stretch of about 30 km in the eastern most part of the district. The cross-section reveals thickening of alluvial cover towards north. At most of the VES sites the top of alluvium is clay. The low resistivity clay is underlain by a layer of resistivity varying in the range of 16 to 41 ohm.m. It indicates the presence of sand and clay mixed in varied proportion. It is expected to hold thin granular zones also, which may form near surface aquifers. The resistivity values associated with the underlying compact formation is very high in the southern part where alluvial capping is thin, whereas in the northern part it is moderate where alluvial capping is thick. The variation in resistivity could be related to the variation in lithology. The compact formation with lesser resistivity could be the phyllites and schists.

In the western part of the district another cross-section in NW-SE direction has been prepared (Fig. 27). It covers a stretch of about 50 km between VES 24 (Darhe) and VES 37 (Joypur). Along this cross-section alluvial capping is absent at most of the VES sites. The weathered and semi-weathered zones are developed. The weathered zone is present at most of the VES sites whereas the semi-weathered zone is developed in patches. The fractured zones delineated qualitatively within 100 m depth are shown. The aquifer potentiality of the inferred fractured zones is to be confirmed through borehole drilling.

The other 2 cross-sections are shown in Fig. 28. More than 7 km long SW-NE cross-section between VES 135 (Madhopur of adjacent Jamui district) and VES 35 (Dhuraiya) shows an elevation difference of about 250 m. Major part of the cross-section is in hard rock with resistive (91-300 ohm.m) semi-weathered zone top whose thickness reduces as moved towards northeastern part of the cross-section at decreasing elevations. The clay top appears from VES 15 (Bhurna) and the underlying sand and clay layer commences from VES 14 (Rakauli). The thickness of sand and clay layer increases towards northeastern end of the cross-section attaining a maximum thickness of 35 m at VES 35 (Dhuraiya). In the hard rock part the qualitatively inferred fractured zones within 100 m depth are also shown.

The 50 km long NW-SE cross-section between VES 238 (Karmadih) and VES 31 (Pair) in the eastern alluvial plains of the district has an average elevation of about 60 m amsl throughout and as expected, a consistency in thickness and resistivity of the alluvial capping is observed. The thickness of alluvium increases towards NW with maximum 79 m at VES 238. Almost throughout the cross-section the resistivity of the alluvial cover is about 15-20 ohm.m indicating the possible presence of thin granular zones. The resistivity of the underlying bed rock varies from 56 to 325 ohm.m. The variation in resistivity is possibly associated with the variations in lithology within the hard rock.

Conclusions & Recommendations

A total of 62 VES were conducted in parts of Banka district occupied by alluvium capped hard rocks. Hard rocks comprise granite gneiss, and quartzite, phyllite and schist. The interpreted results of VES reveal the presence of alluvial capping mainly in the eastern part of the district and the thickness of alluvium capping increases towards north. The bottom of alluvium is maximum about 99 m at VES 237 (Laugain). At several VES sites the alluvial capping is topped by low resistivity clay. The central hard rock part of the area, west of Chandan River does not have any clay capping as reflected in VES (VES 1, 3, 5, 6, 10, 23, 28, 29, 30, 42, 43, 46 and 47) from this part. Instead, these VES show the presence of a layer of 80-200 ohm.m resistivity up to about 10-15 m depth. Among these VES, the significant finding is the presence of very thick (up to maximum about 100 m depth) layer of 100-200 ohm.m resistivity at VES 1, 5, 6 and 10. The locations of these VES follow the local trend of the folded metasediments. The reduction in resistivity (100-200 ohm.m) could be related to folding of quartzite-phyllite sequence and sulphide mineralization within it. Out of these 4 VES sites, VES 6 and 10 appear to be the suitable sites for borehole drilling to tap the fractured zones. In the alluvial covered area north of the folded metasediments, extending eastward up to VES 31 (Pair) near Burigeria River the bed rock underlying the alluvium shows much lower resistivity. It could be the effect of relatively less resistive alluvium capping the bed rock. On the basis of VES results and qualitatively inferred fractured zones, VES site-wise recommendations for drilling are given in Table 3. Since the area holds folded metasediments in addition to the granite gneiss it is likely that open fractured zones are developed and to trace these fractured zones lineament mapping followed by gradient resistivity profiling and/or resistivity imaging is necessary.

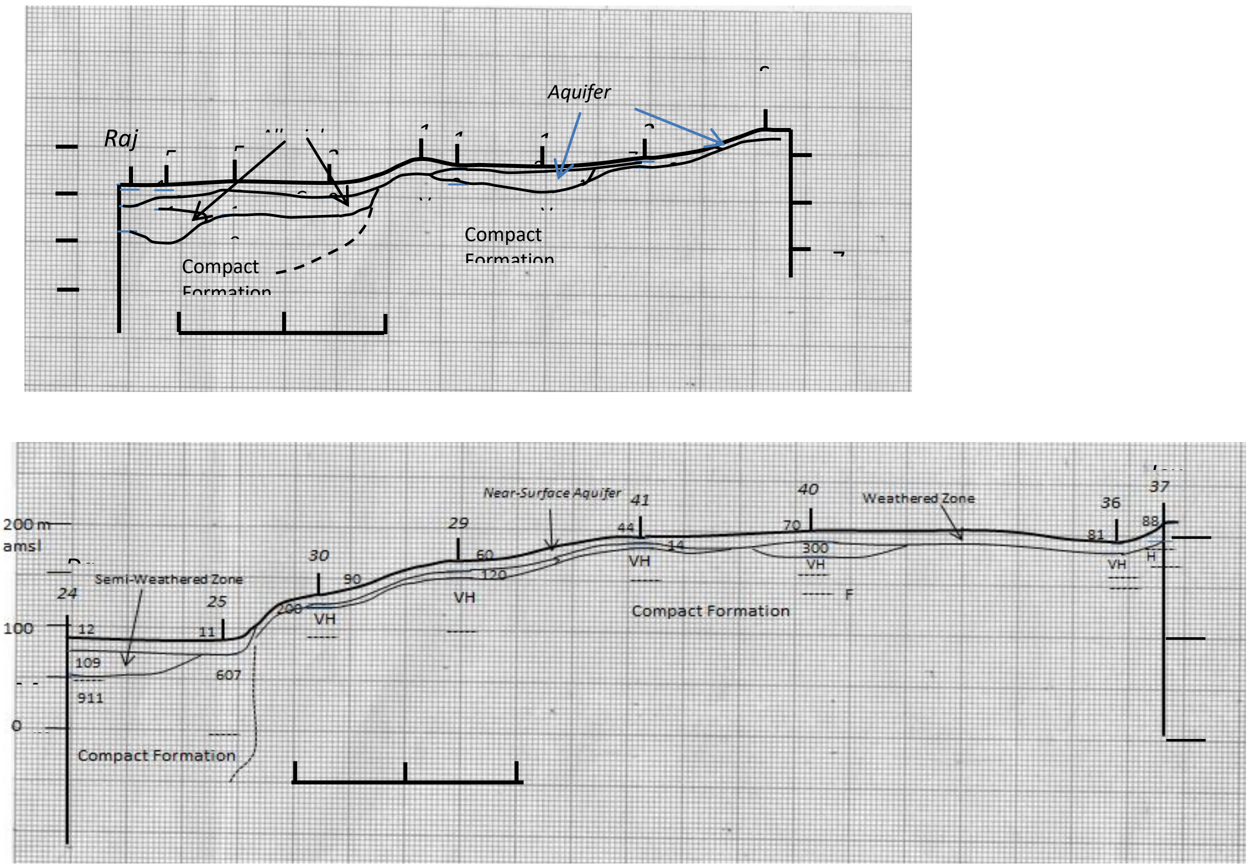
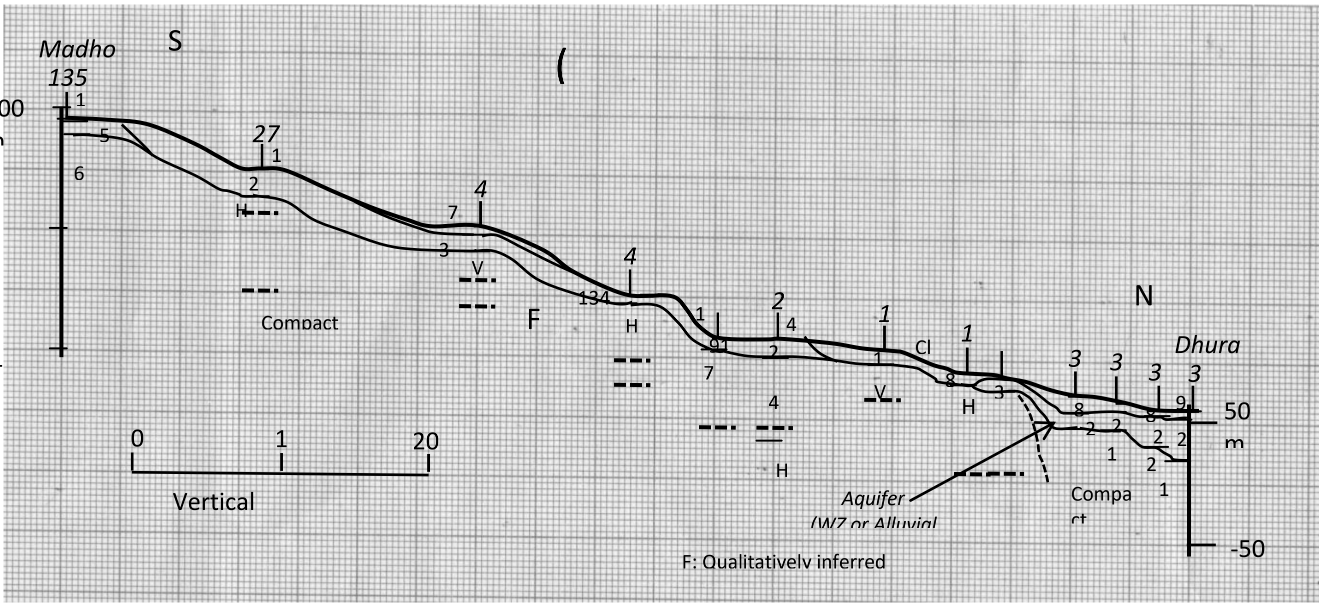


Fig.27 Hydrogeophysical cross section



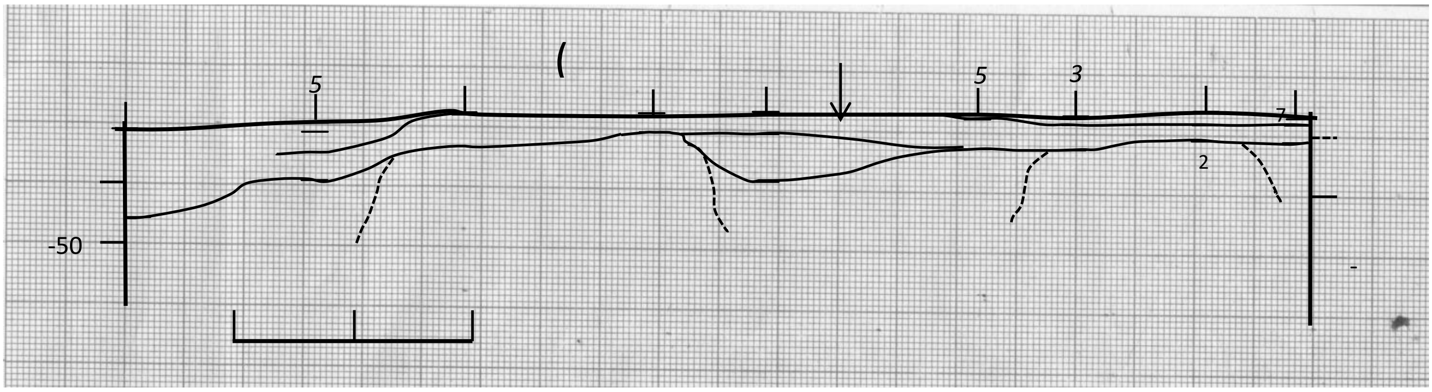


Fig. 28. Hydrogeophysical Cross-

CHAPTER 3

Data interpretation, integration and Aquifer Mapping

3.0 Lithological Disposition and Generation of Aquifer Maps

In order to frame the aquifer map of the area the detail lithological disposition in the area has been worked out from the available exploration data. The individual lithology, unconsolidated sediments, weathered materials or hard rock with fracture systems has been demarcated and accordingly lithological model, fence, sections are prepared in Rockworks 17 platform. The lithology model/ sections are interpreted and grouped to generate aquifer map of the area.

The subsurface geology of the area has been unearthed by correlation of subsurface lithological units. The lithologs of the exploratory bore holes of CGWB in Banka district has been compiled for preparation subsurface correlation diagram. The location map of the bore holes with respective elevation has been plotted in fig.29, 30.

A considerable area in the district in the southern parts being underlain by hard granitic/gneissic/ quartzite rocks, therefore, in terms of ground water prospects in the district the mapping of the depth of weathered sediments and the incidence of fractures in the bed rock definitely acquire significant roles. Keeping above in mind, the thickness of the alluvium and weathered sediments above the hard rock in the study area has been worked out from the exploratory bore hole data of CGWB and utilised in lithology model (fig.31) under Rockworks 17 platform considering actual lithology (alluvium/weathered sediments/hard rock/ fractures) encountered in each borehole and assigning same G value for the similar stuff, and thus correlating on the basis of modelling the G value.

20 bore holes data within the depth range of 35 m to maximum 190 m has been compiled in the present study. The area being undulating terrain reduced level data wrt msl has been considered for each bore hole which reveals minimum elevation of 47 m amsl in the northern parts of the district to maximum elevation of 236 m amsl in the southern parts of the district around Katoria block. The thickness of alluvium is more around Sambhuganj, Amarpur and Rajaun area in the northern parts of the district. Maximum alluvium cover of 95 m has been reported in the exploratory bore hole at Raipura in Sambhuganj block, whereas, the bore holes at Raupai in Samhuganj Block and Sultanpur in Amarpur block has been reported with alluvium thickness of 72 m and 62 m respectively. Alluvium thickness of 50 m has been observed in Rajaun area and in around Banka block the alluvium thickness of 25 m has been reported. In other parts of study area around Katoria, Chandan, Baunsi, Banka, Phulidumar area . thickness of alluvium is very less and unconsolidated

sediments mostly comprises weathered residuum of 5-30 m thick. The exploratory bore hole at Baunsi and Suiapahar in Katoria block has been reported with less than 10 m thick unconsolidated sediment of alluvium and or weathered materials. Among other controlling factors, the nature of parent rocks controls the extent and depth of weathering.

Within the bed rocks the occurrences of potential fractures are common. Areas where the thickness of alluvium or the weathered residuum is meagre, the productive fractures (fractures with sets of interconnections or connection with positive boundaries) are the only source of potential ground water yield. The exploratory bore hole data in the district reveal the occurrences of 2-3 sets of fractures within 80 m depth. Occurrences of productive fracture at 60-65 m depth are recurrent in the district. Deep seated fractures are not very common or productive as per the available exploration data in the district. However, the occurrences of fractures are discontinuous and site specific. The inhomogeneity of occurrences of fractures both laterally and vertically can never be ruled out.

Number of sections showing the disposition of alluvial sediments/ weathered materials and bed rock are portrayed in Fig 32, 33, 34. The Sultanpur_Chandan (N_S) section reveals maximum thickness of alluvium in the northern parts, which gradually decreases towards south. In and around Katoria and Chandan block the unconsolidated sediments are represented by weathered sediments of 20-30 m thick. The NW_SE section across Sambhuganj to Bausi depicts alluvium cover of about 100 m in Rudpai well at Sambuganj, whereas in and around Baunsi the unconsolidated sediments are meagre. The EW section across Suiapahar in Katoria and Baunsi also represents dominance of hard granitic basement. Unconsolidated sediments of alluvium or weathered materials are inconsistent and found to occur depending on local geomorphologic and lithological disposition.

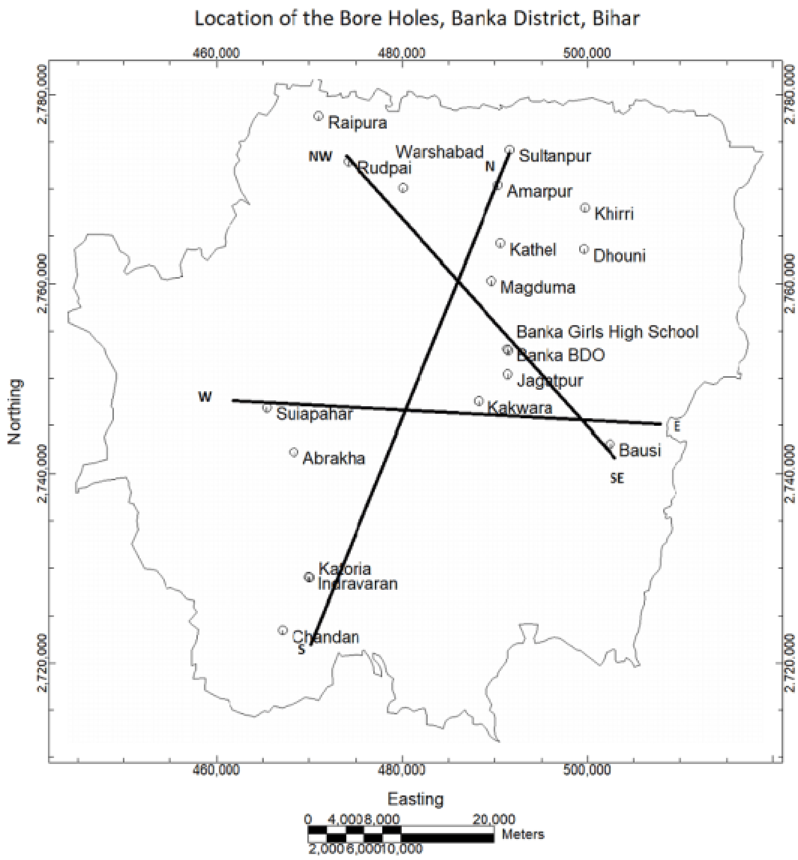


Fig.29 Location of the Bore Holes

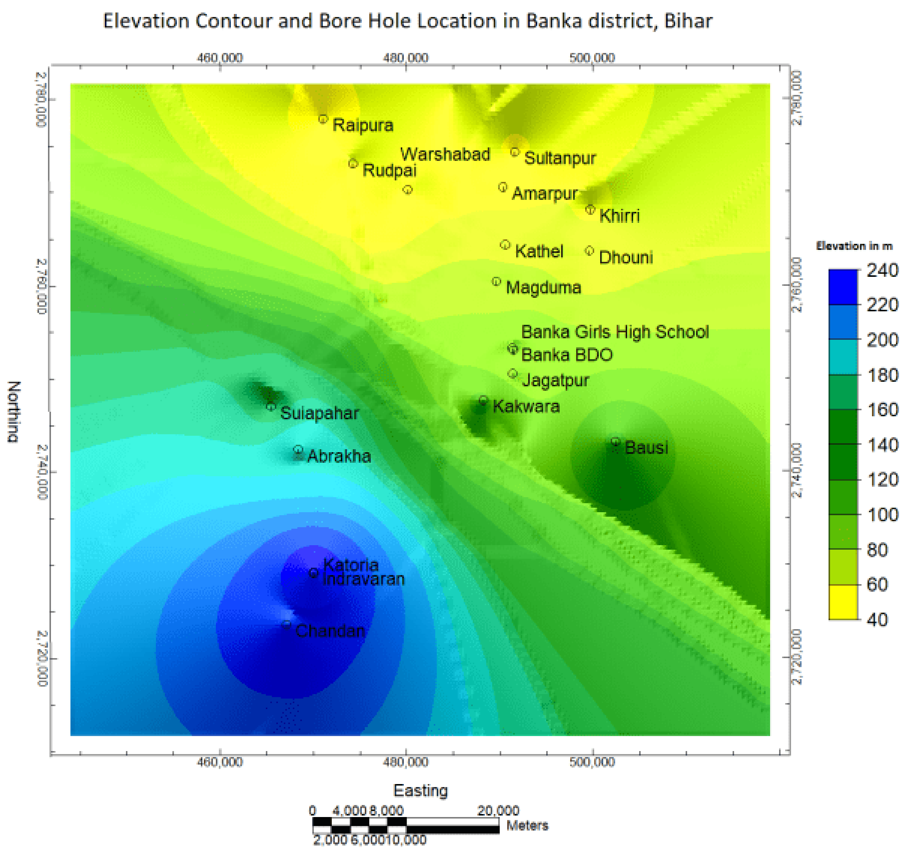


Fig.30. Location and Elevation of the Bore holes

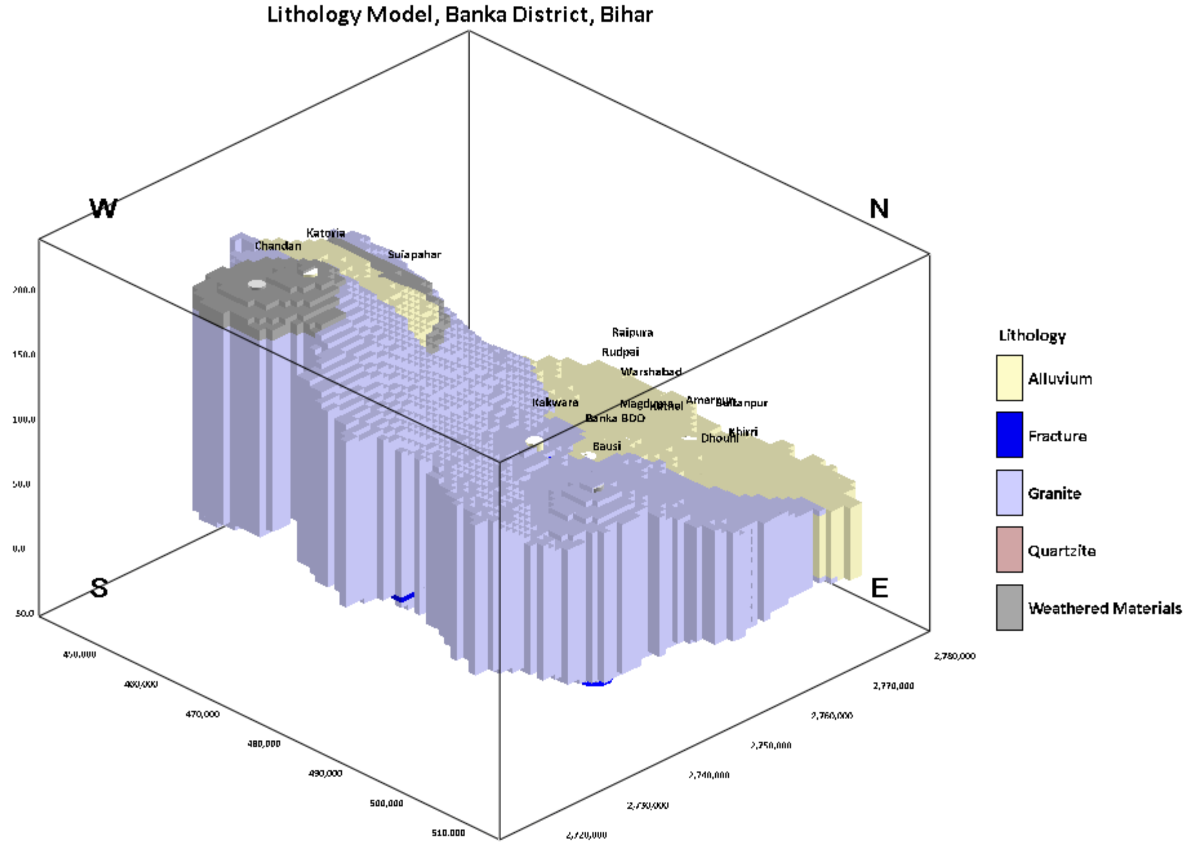


Fig.31 Lithology model in Banka District, Bihar

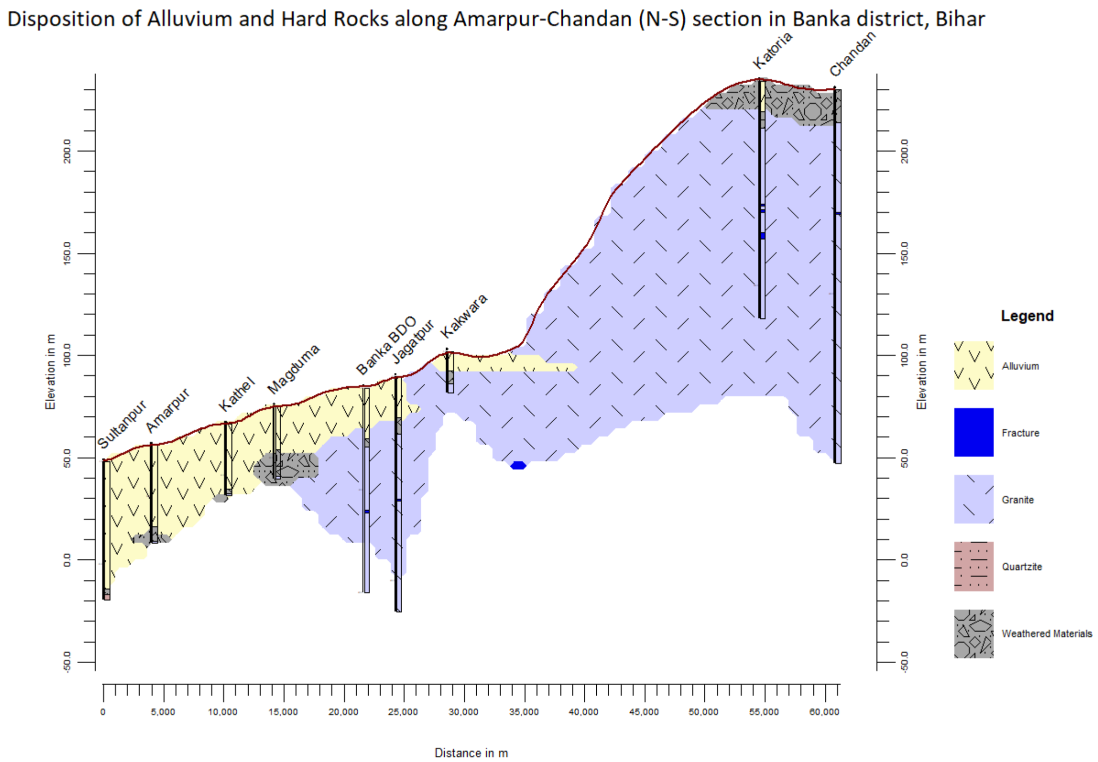


Fig.32 Sections along Sultanpur-Chandan (N-S)

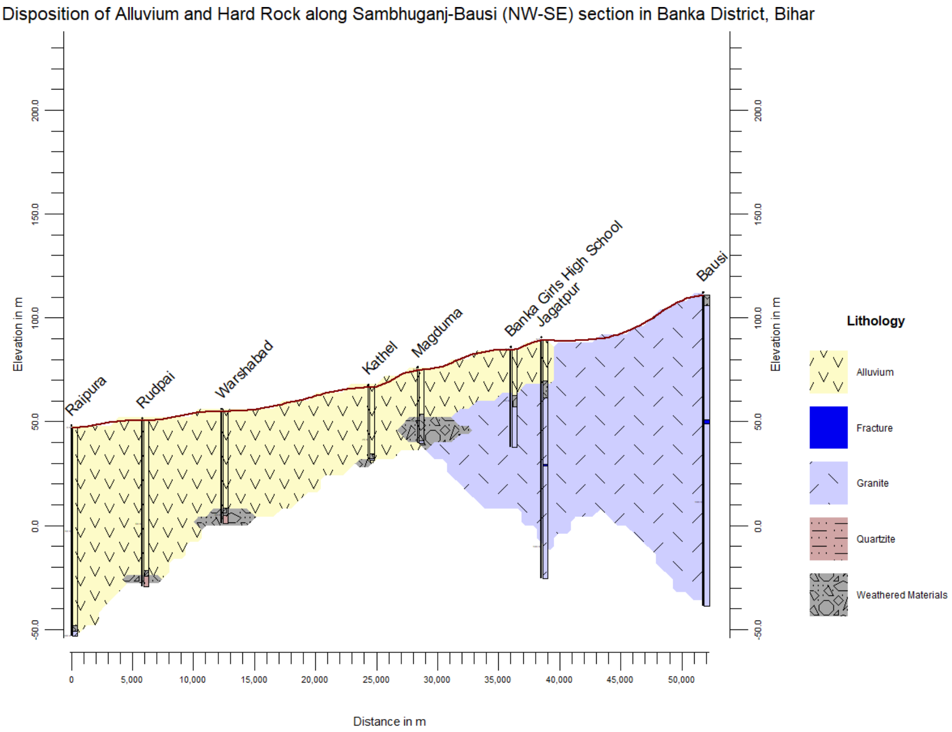


Fig.33 Sections along Raipura-Bausi (NW-SE)

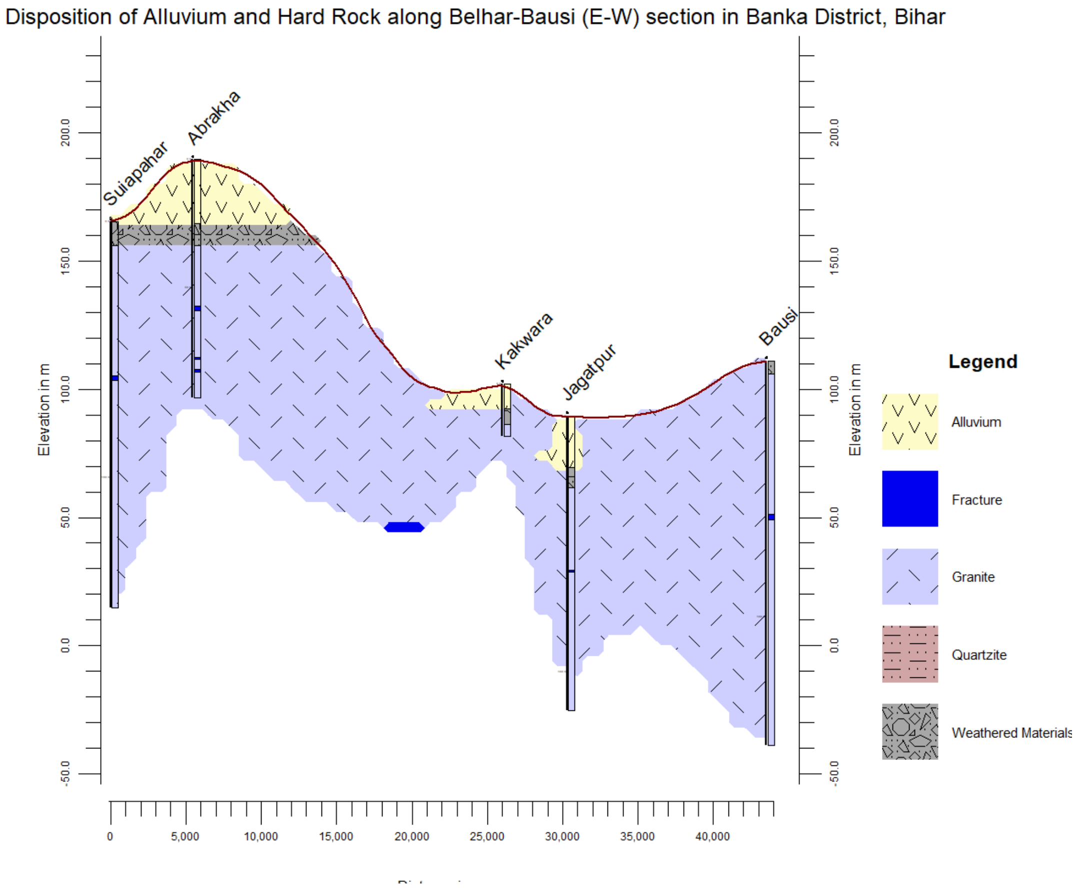


Fig.34 Sections along Suiapahar- Bausi (E-W)

Based on the exploratory drilling data the detail lithology of the alluvium area in the northern parts of Banka district has been unearthed. The area comprises Sambuganj, Amarpur, Rajaun, parts of Barhat and Dhouriya block (Fig.35). The 3D lithological model (Fig.36) in the area represents the abundance of soil, clay and silty clay in the surface. The clayey soil is often followed down by sands of different grades, gravels in few places. Surface soil, clay along with underlying fine to medium and coarse sands and gravels in few places constitute the alluvial sediments in the area. At few places in the south and south central parts weathered material are directly encountered at the surface owing to the limited or negligible thickness of alluvium cover. The lithological section (Raipura_Dhouni NW_SE, fig. 37) represents more or less consistent alluvium cover over a distance of 40-50 km from Raipura in Sambhuganj block to Dhouni in Rajhaun block in the district. However, the thickness of alluvium in the northern extremity is about 100 m where as in the south eastern part in Rajaun the thickness of alluvium is reduced to 50 m only. The other section (Sultanpur Kakwara N-S , fig.38) depicts thickness of alluvium of 70 m in the northern parts around Sultanpur , Amarpur which is sharply abridged to 20-25 m around Kakwara in Banka block over a distance of 25 km. Moreover, in the southern parts of Amarpur block the surface exposures of weathered sediments has been observed.

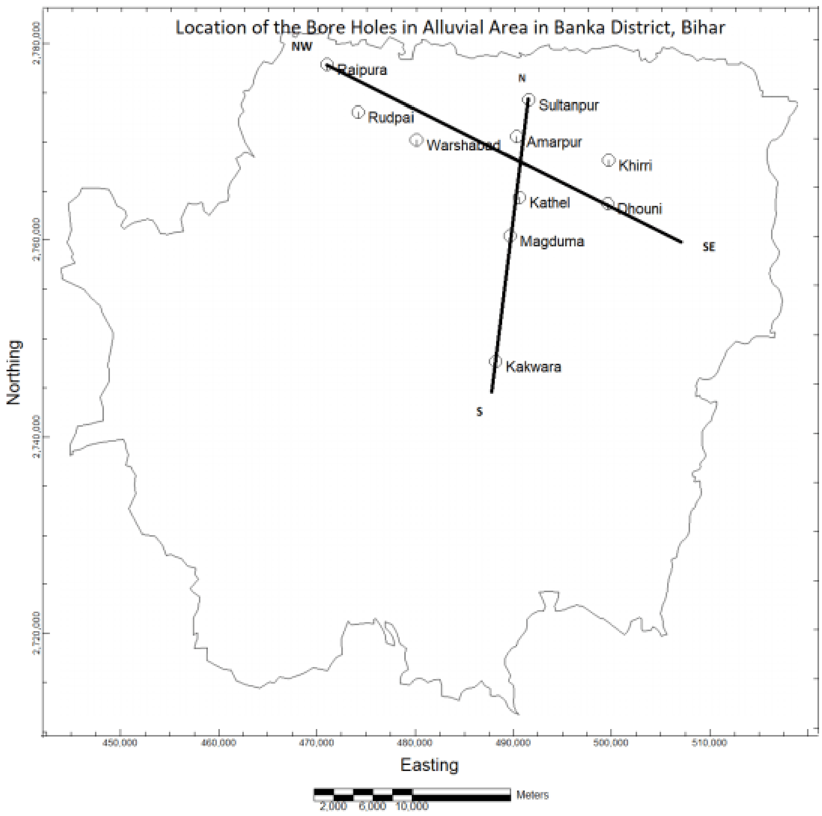


Fig.35 Bore holes in the alluvial area in northern part of Banka District, Bihar

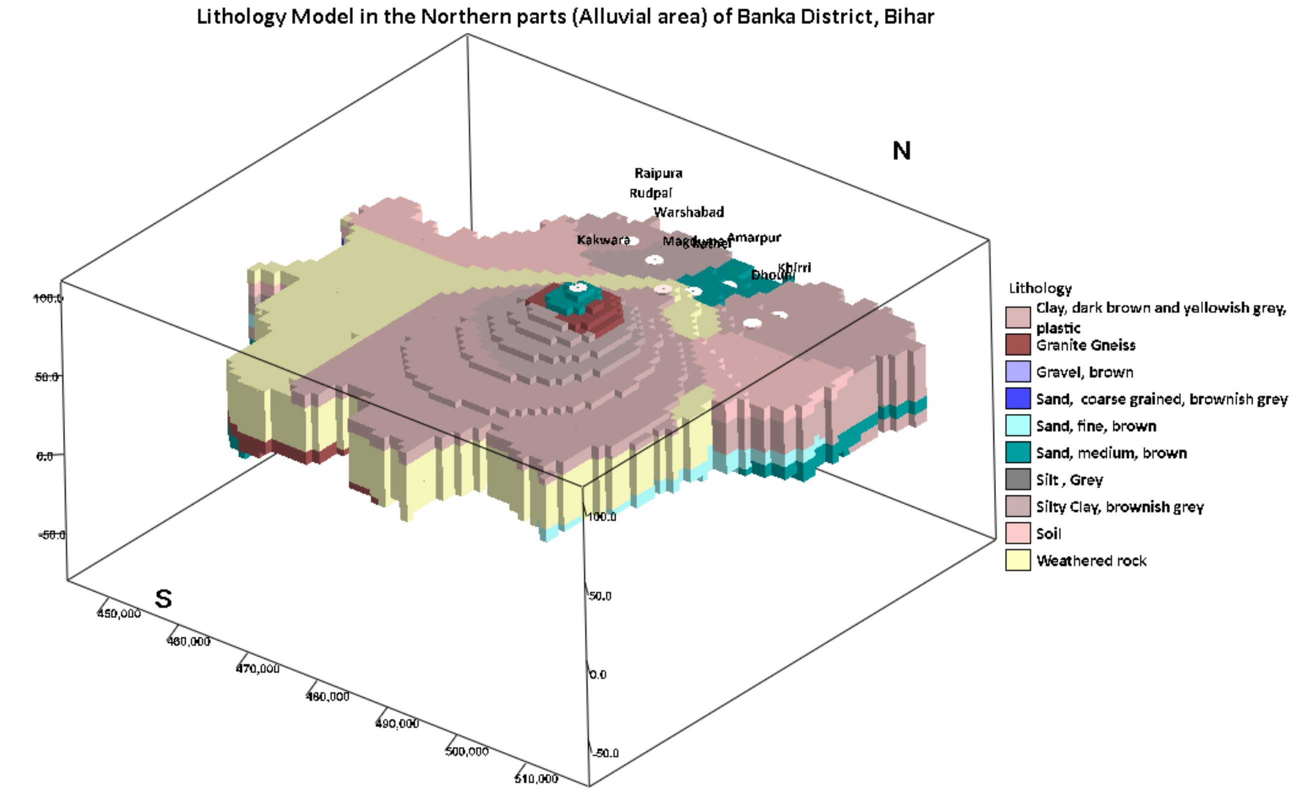


Fig.36 Lithology model in northern parts of Banka district

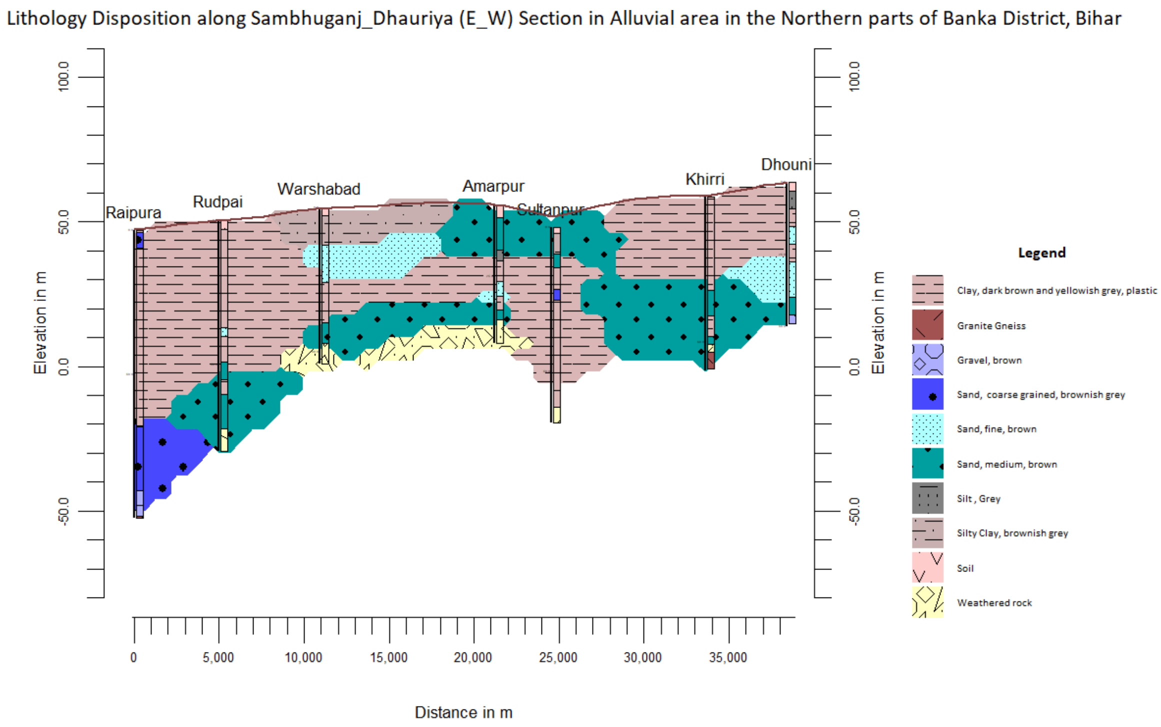


Fig.37 Lithology sections along Raipura-Dhouni (E-W)

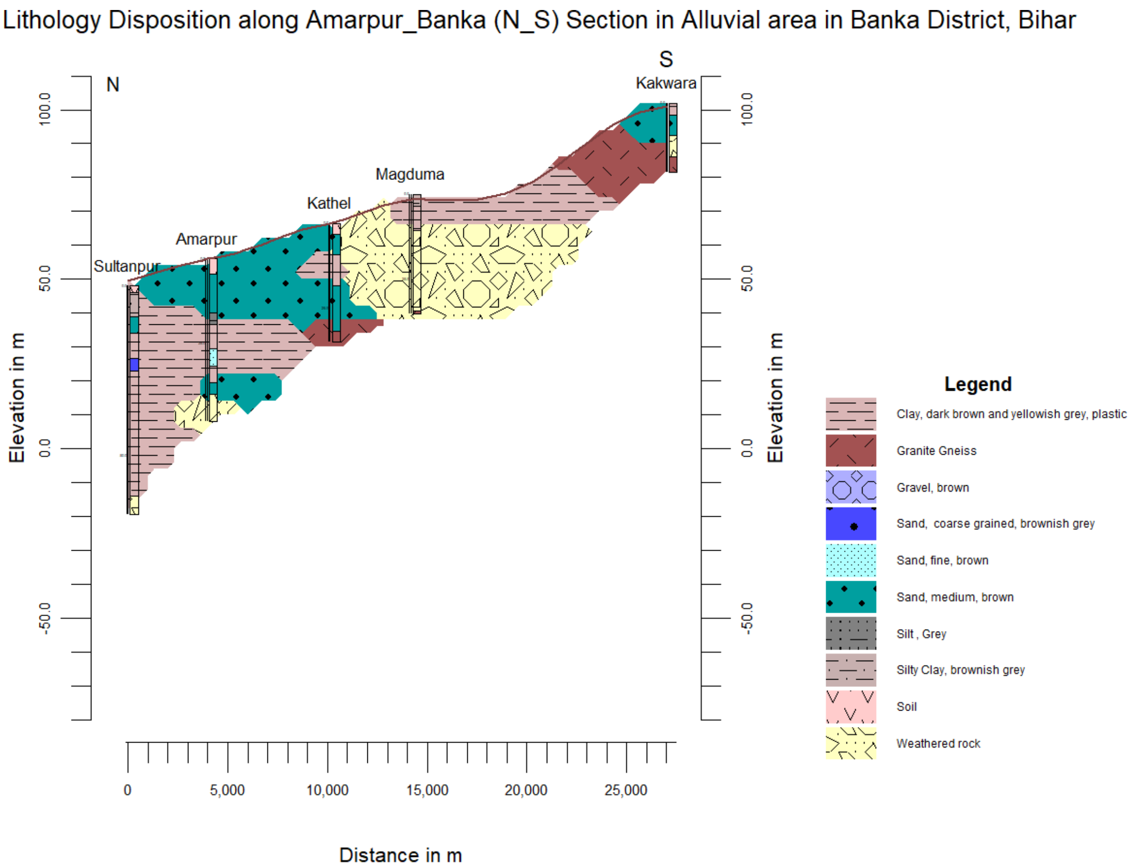


Fig38Lithology sections Sultanpur Kakwara (N-S)

3.1 Aquifer Disposition

The correlations, interpretation, generalization and subsequent grouping of the granular horizons/unconsolidated sediments and the hard basement rock with secondary porosities leads to differentiate two dominant Aquifer systems in the district. In hard rock area, the unconsolidated sediments comprising the alluvial deposits of limited thickness along with the weathered mantle constitute the 1st Aquifer system and the hard basement rock with secondary porosity constitutes the 2nd Aquifer System. In alluvial area the 1st aquifer system consists of granular zones of coarse to medium sands down to maximum depth of 30 mbgl. Below that, the deeper or the 2nd aquifer system continues till the depth of encounter of hard rock. The maximum vertical extent of 2nd alluvial aquifer system in Banka district lies within 90-100 mbgl. The 3 D aquifer model (Fig.39) represents aquifer consisting of unconsolidated weathered materials in hard rock terrain and unconsolidated alluvial sediments in alluvial area of the district. The hard granitic basement is represented as aquitard, however, hard granitic rock with potential fractures may serves occasionally as prospective aquifers. As we proceed from south to north, the thickness of the aquifer increases and the aquifer becomes regionally extensive. The variation of the thickness of the aquifer is well demonstrated in the N-S section (Fig.40) and NW_SE section (Fig.41). The aquifer of unconsolidated materials are thick in the northern parts, whereas around Katoria, Chandan Bausi area the aquifers unconsolidated sediments becomes limited thick and discontinuous. However, in these area the potential fractures in hard granitic rock which otherwise designated as aquitard, may serves as aquifers with secondary porosities.

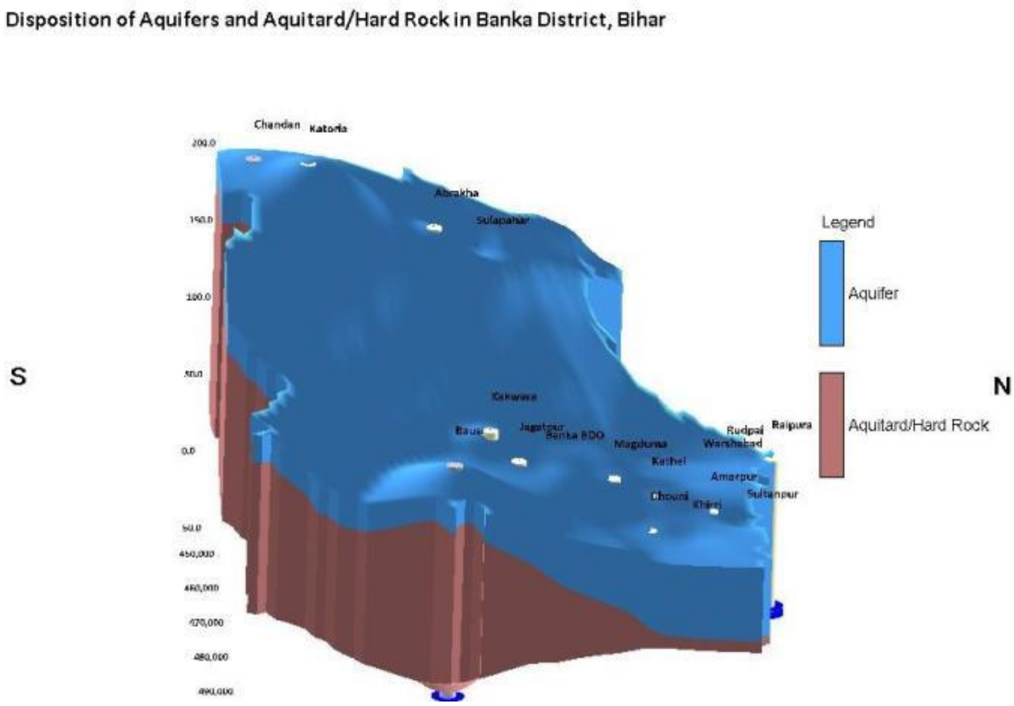


Fig.39 3 D Aquifer model in Bnaka District

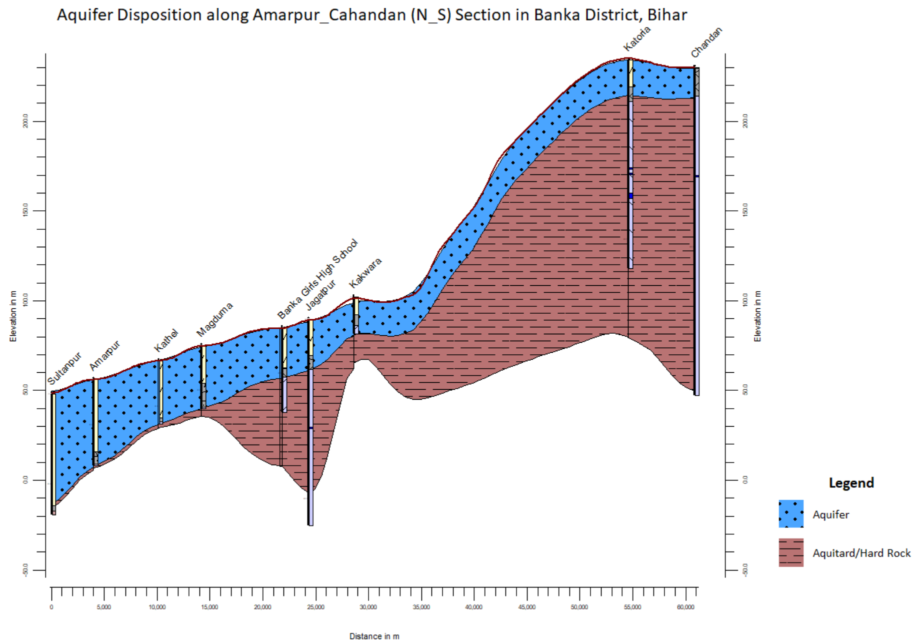


Fig.40 Aquifer Disposition along N_ S section

Aquifer Disposition along Sabhuganj_Bausi (NW_SE) Section in Banka District, Bihar

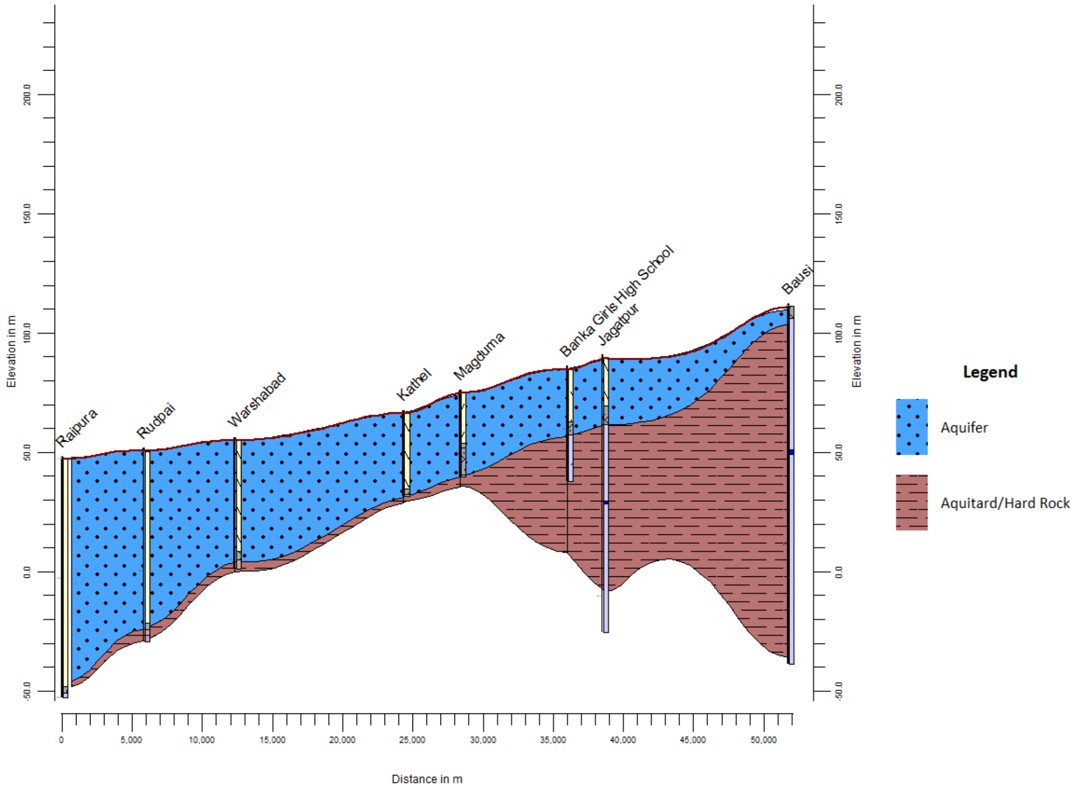


Fig.41 Aquifer Disposition along NW_ SE section

3.2 Aquifer Disposition in Northern Alluvial Area of the District

The 3 D aquifer disposition has been portrayed through interpretation, grouping and correlation of detail lithology in the northern and north central parts of the district comprising Sambhuganj, Amarpur, Rajaun blocks (fig42). The entire are is overlain by surface soil, which is underlain by **three local aquifers**. The Aquifer 3 often merges with weathered a material which acts as potential aquifer too. The distinctive disposition of three aquifers and the weathered materials are well depicted in Sultanpur_Kakwara (N-S) section and Dhouni_Raipura (E_W) section (Fig.43 & 44). It is observed that in both the sections the aquifer 1 is consistent with thickness varies from 10-20 m and mostly constitutes the dug well zones and is under phreatic condition. Aquitard 1 is more significant and the thickness of the clay and silty clay even more than 30 m thick. Aquifer 3 in few cases becomes insignificant due to occurrences of hard granitic rock in the shallow depth; within 40 m below ground level. Depending on nature of hard rock and local geo-morphological setup the depth of weathering also varies. At Magduma, thick weathered sediments constitute the major unconsolidated aquifer.

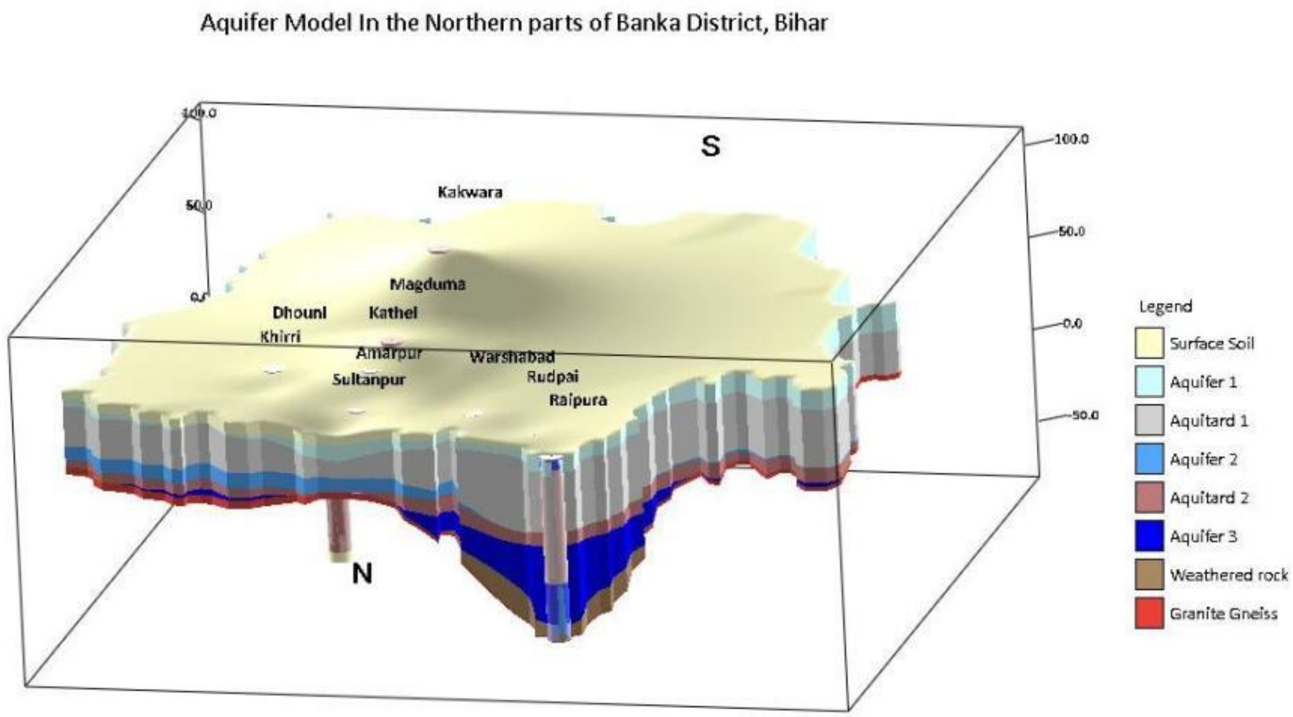


Fig.42 3 D Aquifer disposition in Northern alluvial blocks in Banka district

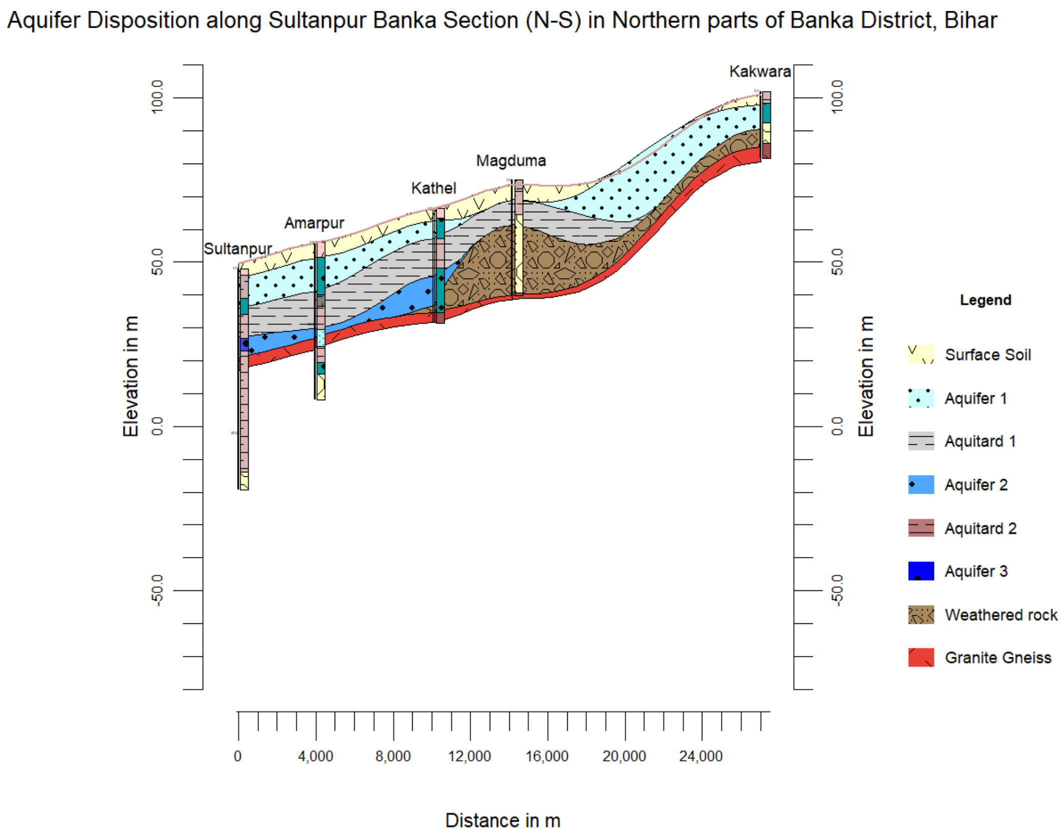


Fig.43 Detail disposition of Alluvial aquifers (N-S section)

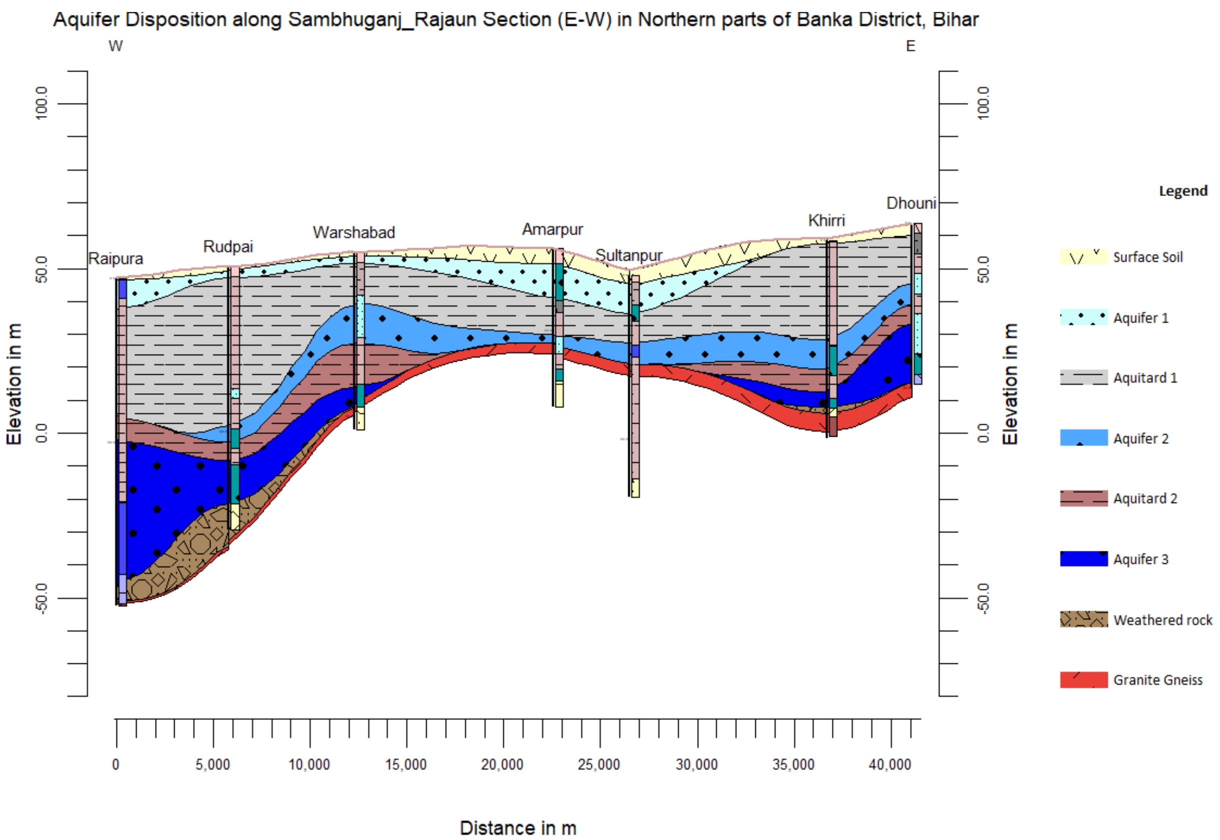


Fig.44 Detail disposition of Alluvial aquifers (E-W section)

3.3 Aquifer Characterization

The transmissivity value in alluvial area varies from 63.7 m^2/day to 1265 m^2/day. The higher transmissivity value is recorded in Sambhuganj block. The lower transmissivity value indicates limited extent and thickness of the aquifer materials. Lower value transmissivity around Khirri in Rajaun may be due to the occurrence of thick clay underneath. The transmissivity of the aquifer in the hard rock terrain is further low. However, in the southern hard rock are the wells in the fracture zones in granite gneiss often produce limited yield of 3-10 m^3/hr, however in few cases higher yield of 27 m^3 /hr has also been reported in Katoria block. The storativity value in the alluvial terrain indicates the semi confined nature of the aquifers (Table 2.20).

CHAPTER-4

Ground Water Resources

4.1 Dynamic Ground Water Resource

Dynamic ground water resources for Aquifer I, the phreatic aquifer in alluvial and in hard rock area in the district has been assessed following the methodology of GEC-2015. The 11 administrative blocks has been taken as the unit of the assessment. Total recharge worthy area in the district is 267300 ha against total geographical area of 301924 ha. The hilly area and the area with more than 20% of slope has been identified and not considered as the potential area for recharge of phreatic aquifer. The total annual recharge has been estimated based on the recharge due to rainfall in monsoon and non monsoon seasons and recharge due to other sources like return seepage from surface irrigation networks, return seepage from ground water irrigation or percolation from tanks, ponds etc. As per the norms recommended by GEC-2015, the annual extractable ground water recharge has been estimated after subtracting unaccounted natural discharge, which goes out of the aquifer as base flow etc. The total annual extractable ground water recharges for Banka district is 46835 Ha m or 468 MCM. The gross annual extraction of ground water in the district is 162 MCM under irrigation, industrial and domestic draft. Irrigation draft contributes almost 73% of total annual draft in the district. The irrigation draft has been assessed on the basis of 5th MI census data of the shallow, medium and deep tube wells and their unit draft. The ground water for irrigation uses has been reported 86 % of gross draft for all uses in Rajaun block, followed by Katoria 80%, Sambhuganj 74%. Minimum irrigation uses in comparison to the gross draft is recorded in Chandan block with 22%. Net ground water availability for future uses in the district is 330 MCM. Therefore, a major share of net ground water availability in the district is still available for future development in the district. The stage of ground water extraction on an average in the district is 35%, lowest being 7.55% in Chandan block and maximum of 57% in Rajaun block. All the blocks are categorised as safe in terms of level of ground water development. Table 4.10 and fig.45 describes the assessment unit wise comparative attributes of ground water resources in the district.

Table 4.10 Dynamic Ground Water Resources in Banka district,2017

Sl. No	Assessment Unit Name	Predominant Rock formation	Total area (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Recharge (Ham)	Current Annual Ground Water Extraction(Ham)				Net Ground Water Availability for future use ham	Stage of Ground Water Extraction	Categorization (OE/Critical/Semicritical/Safe)
						Irrigation Use	Industrial Use	Domestic Use	Total Extraction			
1	Amarpur	Alluvium / Hard rock	18625	18625	4522.94	1058.60	91.74	456.57	1606.91	3240.45	35.53	Safe
2	Banka	Hard rock/Alluvium	29962	29962	3911.14	900.73	87.26	509.08	1497.07	2796.47	38.28	Safe
3	Barahat	Alluvium / Hard rock	14728	14728	1915.09	683.26	46.44	245.59	975.29	1098.42	50.93	Safe
4	Bausi	Hard rock/Alluvium	31533	23471	3740.21	846.59	57.56	304.54	1208.69	2728.21	32.32	Safe
5	Belhar	Alluvium / Hard rock	23658	17768	3714.83	761.81	51.89	276.09	1089.79	2803.35	29.34	Safe
6	Chandan	Hard Rock	45747	30763	4955.72	83.71	17.81	272.66	374.18	4757.64	7.55	Safe
7	Dhuraiya	Alluvium	23414	23414	5255.24	1165.61	78.01	394.68	1638.30	3871.85	31.17	Safe
8	Katoria	Hard Rock	56057	56057	6116.34	1555.17	93.12	307.25	1955.54	4359.24	31.97	Safe
9	Phuliduma r	Hard rock	20504	14786	2412.73	834.22	52.02	206.18	1092.42	1453.46	45.28	Safe
10	Rajun	Alluvium / Hard rock	19751	19751	5949.77	2930.46	162.78	325.28	3418.52	2741.33	57.46	Safe
11	Shambhuganj	Alluvium	17975	17975	4341.57	988.38	63.74	286.39	1338.51	3188.02	30.83	Safe
Total				**267300**	**46835.58**	**11808.54**	**802.37**	**3584.31**	**16195.22**	**33038.44**	**35.51**	

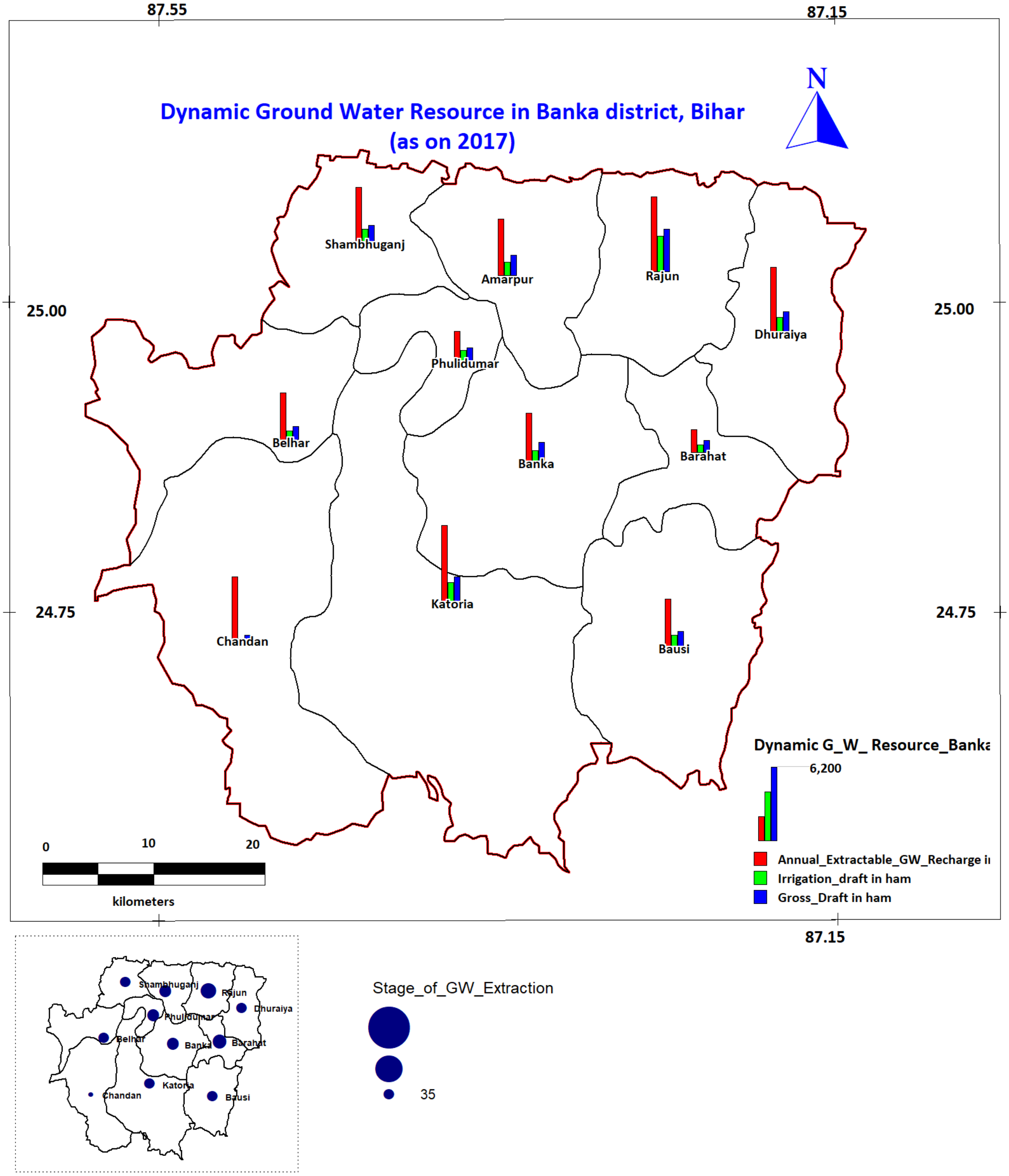


Fig.45 Dynamic Ground Water Resources in Banka district, Bihar

CHAPTER-5

5.1 Major Ground Water Related Issues in the Area

- Among 11 blocks in the district, substantial parts of 6 blocks are underlain by hard rock of banded gneissic complex. granite gneiss, granite, schist, quartzite etc. The occurrence of ground water in these blocks are limited and primarily depends on the thickness of the weathered residuum or the occurrences of shallow or deep seated potential fractures. The existing exploration data in the hard rock terrain of the district reveals that the yield of the wells are often less and around 3-10 m^3/hr, specific capacity and transmissivity are also reported low. Therefore the potentiality of the aquifers is limited which causes water scarcity in the area particularly during lean period.
- The porous formation which constitutes the Quaternary Alluvium of marginal tract is confined to the northern and north eastern parts of the district with alluvium thickness 20-100 m. The thickness of the alluvium also varies considerably depending upon the bedrock configuration. The area over the mounds in bedrock witnesses less thick alluvium resulting in significant lowering of the potentiality of the alluvial aquifers too. The limited thickness of the potential granular zones and nature of granular materials controls the potentiality of the aquifers. The very high drawdown in the order of 14.5 m to 22 m has been witnessed in Sambhuganj and in parts of Rajaun blocks.
- As per the 5th MI census data, there are 5344 STW and 1571 MDTW in the district among which about 75% of the STW and 90% MDTW are restricted to the alluvial blocks. The depth of occurrences of 77% wells is confined within the depth range of 30 mbgl and 99% well within 60 m depth. Therefore, the alluvial aquifer of limited thickness experiences stress on the particular zone.
- The deep tube wells for irrigation uses of more than 70 m depth are rare in the district.
- The feasibility of STW/MDTW/DTW for irrigation uses is constrained in hard rock terrain. The dug wells sometimes are used in irrigation but with very limited command area.
- Surface Irrigation network in the district is covered under Chandan Reservoir Schemes, Badua Reservoir Projects etc. Although the major irrigation through canal networks constitutes appreciable irrigation water of 80% during Kharif time but during Rabi seasons the water availability through the major irrigation networks constitute only 26% of total irrigation water availability. Therefore, the balance irrigation facilities' are sustained through minor irrigation networks of dug wells, shallow , medium and deep tube wells. Therefore, in absence of proficient surface irrigation network during rabi and summer seasons, failure and unfavorable tube well irrigation in many places resulting in overall poor irrigation development in the district, which registers only 144% of cropping intensity.
- Domestic and industrial draft in the district principally achieved from ground water only. Domestic and industrial draft comprises 27% of the total ground water draft. Domestic water supply,

particularly in hard rock area largely depends on the bore wells in fracture zones. Tracing of potential sustainable fracture zone in water scare hard rock terrain often poses difficulties.

- Even in alluvial terrain due to the concentration of irrigation tube wells spatially both laterally and vertically (within a limited depth range) and due to the absence of thick potential sediments, the alluvial aquifers sometimes are not sustainable which results in long term lowering of post monsoon water level to the tune of 5 cm/yr to 10 cm/yr particularly in Amarpur, Sambhuganj, Rajaun etc.
- The perusal of the relief map of Banka District reveals that the southern, central and south eastern parts is characterized by topographic highlands and undulating terrain with elevation of 250-180 mams with considerable slopes. This high lands tends to merge with topographic low lands /valleys in the northern parts which has elevation of 50-40 mamsl. Therefore, the higher gradient/slope in the area impedes ground water to recharge the underlying granular zones rather produce very high runoff which goes off as waste unless arrested by effective harvesting mechanisms. Higher slopes of 8-25 % is observed in Belhar, Chandan , Bausi, Katoria, Phullidumar blocks.
- The major concern in the chemical quality of ground water in Banka district is occurrences of higher concentration of fluoride in ground water more than permissible limit of 1.5 mg/l in few blocks namely Baunsi, Sambhuganj and in Chandan block, the maximum concentration of F is reported as 1.98 ppm in Chandan block**.**

CHAPTER-6

Management Strategies

Aquifer Management Plan

On the basis of interpretation of Aquifer disposition/Aquifer Maps and reviewing the potentiality and scope for further development of ground water in Banka district an effective Aquifer Management Plan is proposed to address the above said issues. Both supply and demand side management options have been considered. Attempt has been made to accommodate the issues considering the disposition and potentiality of the underlying aquifers, available resource, existing development, future scope for further development, present irrigation potential from ground water resources in the district, existing cropping pattern , cropping intensity and moreover the quality.

6.1 Ground Water Management Plan for Drinking and Domestic Sectors/ An Approach of Demand Side Management

In Bihar, Public Health Engineering Department (PHED), Govt. of Bihar is entrusted with the water supply to the population in rural and urban area. The source of drinking water supply is hand pumps and pipe water supply schemes. The dependence on ponds, river and streams has declined during the last 10 years (2001-2011) from 10.7% to 3.06%. Hand pumps remain the major source of drinking water in rural areas supplying water to 91.4% households (Census 2011). One hand pump is designed for 200-250 population whereas the pipe water supply covers 1000-1500 population. Bihar, however, witnesses very high volume of hand pumps of more than 6, 00,000 in the state. However, the tap water supply based on pipe water supply schemes is not adequate. As per census data only 1.4% of the households used to get tap water in 2001 in rural areas which increased to 2.5% in 2011 (CIMP Report,2013). The percentage share of household using hand pumps and wells as source of drinking water in Banka district is around 80%. On the other hand the percentage share of households using tap water from WSS as source of drinking water fall much below and stands at 2.6 % for State average figure (Bihar State Water and Sanitation Mission). It is to be noted that the tube wells within the premises of the individual households are mostly shallow within 30-40 feet depth. Therefore, these are mostly affected by contamination from surface leaching and microbial contamination. It has been estimated that a huge some of investment in the sector of drinking water supply would be required to realize the goal of covering 100% of rural population of the State under pipe water supply coverage.

The pipe water supply scheme in Bihar is categorised under Mini water supply scheme for 1000-1500 population, Single village water supply scheme for 5000-15000 population and Multi village water supply scheme for more than 50000 population covering number of villages. Each considers 40 lpcd water supplies for drinking and domestic needs. The multi village water supply schemes are designed mainly from surface water sources.

As per the census 2011, total population of Banka district is 2034763. The projected population for 2021 based on the previous decadal growth rate is 2572551. Although the population covered under PWSS is much less in the State as wells in Banka district, for present estimation it is assumed that 10% of population in Banka district has already covered under PWSS. Therefore, 248242 populations has already been covered in Banka district and to cover the rest population the water requirement in the district in drinking and domestic water sectors is 33.80 mcm (Table 6.10). Depending upon the proportion of the block area under alluvium or hard rock the requirement has been assessed for individual blocks and units. Based on the prevailing hydrogeological condition and the yield of exploratory wells the average discharge of blocks are considered 30 m^3/hr to 50 m^3/hr for alluvial area and 20 m^3/hr for hard rock area and accordingly the annual unit draft of one tube well has been arrived for 8 hours running per day.. Total 458 wells may be required to bring the entire population under coverage of pipe water supply schemes. The block wise required number of tube wells is given in table 6.20.

Both the 1st and the 2nd aquifer in the district may be assigned for the desired requirement of drinking water needs and development plan may accordingly be prepared keeping site specific hydrogeology, yield and potentiality of the water bearing zones. In area of thick alluvial cover the deeper 2nd aquifer system with appropriate granular zones may be tapped for supply of drinking water. In hard rock area the potential fractures with sufficient interconnection may be suitable solution to get the desired discharges. However, keeping the possibility of contamination of fluoride in ground water in the area, water from each drinking water well must be tested before handing over for water supply. The potentiality of the aquifer in Banka district is not much profuse; hence, further development may affect the ground water regime in the area. Therefore, installation of tube wells/bore wells for drinking water, being foremost priority as per National Water Policy, may not be avoided, but keeping in view the significant effects on ground water regime, if any, the installation should always be implemented in phases with precaution. Any installation should always be compensated by construction of suitably design artificial recharge structures in respective aquifers.

It is to note that, under “Har Ghar Nal Jal “ scheme in Bihar a considerable number of water supply schemes have been installed and in the process of installation in Banka district. Thus, these numbers of structures may be accounted for further planning and design of installation of pipe water supply schemes in the district.

Table.6.10.Annual Resource required to cover 100% population with PWSS in the District

Sl.No.	CD Block/Town	Population as per census 2011	Present Population	Population already covered under PWSS (10% of total population)	Population to be covered under PWSS with terget of 100% coverage	Annual Resource required to cater the 100% of uncovered population @40lpcd (mcm)
1	Amarpur	201351	254568	25457	229111	3.3450206
2	Banka	171324	216605	21661	194944	2.8461824
3	Barahat	149188	188618	18862	169756	2.4784376
4	Belhar	167719	212047	21205	190842	2.7862932
5	Bausi	185000	233896	23390	210506	3.0733876
6	Chandan	165634	209411	20941	188470	2.751662
7	Dhuraiya	239762	303131	30313	272818	3.9831428
8	Phulidumar	125251	158355	15836	142519	2.0807774
9	Katoria	186646	235977	23598	212379	3.1007334
10	Rajaun	197601	249827	24983	224844	3.2827224
11	Shambhuganj	173974	219955	21996	197959	2.8902014
12	Amarpur Nagar Parisad	25336	32032	3203	28829	0.4209034
13	Banka Nagar Parisad	45977	58129	5813	52316	0.7638136
	Total	**2034763**	**2572551**	**248242**	**2234148**	**33.8032778**

Table: 6.20 Development Proposal of TW/BW in the district to cater the drinking water need through PWSS

Sl.No.	CD Block/Town	Geology	Annual Resource required to cater the 100% of uncovered population @40lpcd (mcm)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day running)	No of Tube well/bore wells
1	Amarpur	Alluvium	3.3450206	0.146	23
2	Banka	Alluvium	0.28461824	0.0876	3
3	Banka	Hard rock	2.56156416	0.0584	44
4	Barahat	Alluvium	2.23059384	0.0876	25
5	Barahat	Hard rock	0.24784376	0.0584	4
6	Belhar	Alluvium	1.25383194	0.0876	14
7	Belhar	Hard rock	1.53246126	0.0584	26
8	Bausi	Alluvium	1.22935504	0.0876	14
9	Bausi	Hard rock	1.84403256	0.0584	32
10	Chandan	Hard rock	2.751662	0.0584	47
11	Dhuraiya	Alluvium	3.9831428	0.0876	45
12	Phulidumar	Hard rock	2.0807774	0.0584	36
13	Katoria	Hard rock	3.1007334	0.0584	53
14	Rajaun	Hard rock	3.2827224	0.0584	56

Sl.No.	CD Block/Town	Geology	Annual Resource required to cater the 100% of uncovered population @40lpcd (mcm)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day running)	No of Tube well/bore wells
15	Shambhuganj	Alluvium	2.8902014	0.146	20
16	Amarpur Nagar Parisad	Alluvium	0.4209034	0.146	3
17	Banka Nagar Parisad	Hard rock	0.7638136	0.0584	13
	Total				**458**

6.2 Ground Water Management Plan for Irrigation Sectors; Demand and Supply Side Interventions

Agriculture is one of the principal sources of livelihoods of the people in the area. The major crops in the area are cereals which include paddy, wheat, maize etc. Other major crops are pulses, oilseeds, other horticulture crops, plantations etc. Three crop seasons are predominant in the district kharif, rabi and summer. Major share of kharif cultivation is rainfed although irrigation is provided as per need. Total cultivable area (net sown area in present case) in the district is 146628 ha. Total irrigated area constitutes 42328 ha, thus 29% total cropped area has so far been covered under irrigation by all means (Table 6.40). The major irrigation through canal networks covers 80% irrigation during kharif, however during rabi and summer seasons due to lack of proper irrigation by canal networks or by ground water causes drastic drop in total sown area. Total sown are during kharif constitutes 172816 ha, whereas during rabi it becomes 34307 ha, which becomes further reduced to 2918 ha during summer seasons. It is observed that pulses, oilseed and other miscellaneous cultivation in the district falls much below than cereals crop. The irrigation water supply towards cultivation of pulses, oilseed etc. is almost inattentive. Attempt to bring less water intense crop like pulses; oilseeds etc. will generate effective irrigation potential in the district which ultimately increases the coverage of irrigation. This will also lead to effective crop diversification practices. The tentative water column required for different crops is given in Table 6.3.

Table 6.3 Crop Water Requirements

Crop	Water Requirement (mm)	Crop	Water Requirement (mm)
Rice	1000-2000	Chilies	500
Wheat	450-650	Sunflower	350-500

Crop	Water	Crop	Water
Sorghum	450-650	Castor	500
Maize	500-800	Bean	300-500
Sugarcane	1500-2500	Cabbage	380-500
Groundnut	500-700	Pea	350-500
Cotton	700-1300	Banana	1200-2200
Soybean	450-700	Citrus	900-1200
Tobacco	400-600	Pineapple	700-1000
Tomato	600-800	Gingerly	350-400
Potato	500-700	Ragi	400-450
Onion	350-550	Grape	500-1200

In addition to the existing irrigation facilities in the district 104300 ha area are needed to be brought under assured irrigation in the district. The irrigation networks are poorly developed in Chandan, Katoria, Bausi, Banka blocks. Other blocks also witnesses low to moderate irrigation facilities.

Table 6.40. Irrigated area and area to be brought under irrigation

Block	Cultivable area (ha)	Irrigated Area (ha)	Area to be brought under Irrigation (ha)	% of cultivable area under assured irrigation
Amarpur	9882	4870	5012	49
Banka	15762	4118	11644	26
Barahat	9104	2849	6255	31
Belhar	9296	3482	5814	37
Bausi	18840	4225	14615	22
Chandan	11998	1602	10396	13
Dhuraiya	12364	4678	7686	38
Phulidumar	12804	4427	8377	35
Katoria	20884	1808	19076	9
Rajaun	13596	5459	8137	40
Shambhuganj	12098	4810	7288	40
Total	**146628**	**42328**	**104300**	**29**

As represented in the table 1.70, it is observed that the area under pulses and oilseeds are much below, as compared to the cereal crops. Therefore, further irrigation may be extended for creation of irrigation potentials for pulses/oilseeds and other miscellaneous crops. The requirement of water column for these crops may be assumed as 50 cm which is less as compared to the cereals crops. Thus, the volume of additional water required to extend irrigation to the remaining area has been calculated from crop water requirement taking delta factor 0.5 m. It is observed that to bring the entire cropped area under assured irrigation through ground water additional 52150 ham water may be required, which is considered appreciably high as compared to the existing ground water draft in the district for all uses. In addition to that the water required to cater the drinking water need by PWSS in the district has been assessed as 3380 ham and therefore, the cumulative requirement for drinking-domestic and irrigation sector is 55530 ham (Table 6.50).

Table 6.5 Total Requirement in Drinking–Domestic and Irrigation Sectors

Block	Cultivable area (ha)	Area to be brought under Irrigation (ha)	Irrigation Water Requirement for ham (Delta factor:50 cm) for Pulses/oilseeds	Drinking and domestic sector requiremnt in ham	Total requirement in ham
Amarpur	9882	5012	2506	376.59	2882.59
Banka	15762	11644	5822	361.00	6183.00
Barahat	9104	6255	3127.5	247.84	3375.34
Belhar	9296	5814	2907	278.63	3185.63
Bausi	18840	14615	7307.5	307.34	7614.84
Chandan	11998	10396	5198	275.17	5473.17
Dhuraiya	12364	7686	3843	398.31	4241.31
Phulidumar	12804	8377	4188.5	208.08	4396.58
Katoria	20884	19076	9538	310.07	9848.07
Rajaun	13596	8137	4068.5	328.27	4396.77
Shambhuganj	12098	7288	3644	*289.02*	3933.02
Total		**104300**	**52150**	**3380**	**55530**

As per the Dynamic Resource of Ground Water Resource Assessment, 2017 in Banka district, total annual extractable ground water recharge in the district is 46836 ham and considering maximum 70% development capping, the annual ground water availability becomes 32785 ham. Existing draft for all uses is 16195 ham, remaining 16590 may be considered for future development. Among which 3380 ham is for further development in drinking and domestic sectors. The available resource therefore can be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc. As per the block wise availability of ground water 26419 ha irrigation potential may further may be created which on an average constitute coverage in 27% of uncovered area under irrigation. Effective management in surface irrigation network is required to bring the remaining 77881 ha area under assured irrigation. The available ground water resource may be effectively utilized to create significant irrigation potential in the following blocks in Amarpur, Dhauriya, Sambhuganj, Chandan and in Belhar blocks where more than 40% remaining area is proposed to be covered under irrigation (Table 6.6).

Surface irrigation network or the harvesting of rain water or surface runoff may be practiced in the water deficit blocks for further enhancement of irrigation potential (Fig.46).

Table 6.6 Area can be brought under Irrigation with available Ground Water Resources

Block	**Area to be brought under Irrigation (ha)**	**Total Annual Extractable Ground Water in ham**	**Present Gross Draft for all uses in ham**	**Annual Ground Water Availability considering 70% development**	**Water can be available in future for further development in ham**	**Water can be available in future for further irrigation development in ham**	**Area can be brought under irrigation with available resources in ha**	**Remaining Area in ha**	**% of area which can be brought under irrigation with available GW resources**
Amarpur	5012	4522.94	1606.91	3166	1559	1183	2365	2647	47
Banka	11644	3911.14	1497.07	2738	1241	880	1759	9885	15
Barahat	6255	1915.09	975.29	1341	365	117	235	6020	4
Belhar	5814	3714.83	1089.79	2600	1511	1232	2464	3350	42
Bausi	14615	3740.21	1208.69	2618	1409	1102	2204	12411	15
Chandan	10396	4955.72	374.18	3469	3095	2820	5639	4757	54
Dhuraiya	7686	5255.24	1638.3	3679	2040	1642	3284	4402	43
Phulidumar	8377	2412.73	1092.42	1689	596	388	777	7600	9
Katoria	19076	6116.34	1955.54	4281	2326	2016	4032	15044	21
Rajaun	8137	5949.77	3418.52	4165	746	418	836	7301	10
Shambhuganj	7288	4341.57	1338.51	3039	1701	1412	2823	4465	39
Total	**104300**	**46836**	**16195**	**32785**	**16590**	**13209**	**26419**	**77881**	**27**

The available volume of water may be utilized to create additional irrigation potential through construction of large diameter dug wells and shallow/medium deep tube wells in hard rock and in alluvium area respectively. Based on the prevailing geology in individual blocks the available resource are allocated proportionally for suitable structures The unit draft for one large diameter dug well (LDDW) may be considered as 0.7 ham for 5-7 m^3/hr yield for 8 hr/day run in 120 irrigation days. The unit draft of STW/MDTW is considered 1.44 ham to 2.88 ham based on the prevailing hydrogeological condition in the respective blocks for yield varies from 15 m3/hr to 30 m3 / hr for 8 hr/day run for 120 irrigation days. The block wise requirement of LDDW and STW/MDTW has been estimated. 10198 LDDW and 3013 STW/MDTW may be required for the purpose (Table 6.70). However, installation of proposed structures should always be implemented in phases as per the actual site specific feasibility. 4-5 number of LDDW and 1-2 STW/MDDW in each village in the district would satisfy the requirement. Proposed structures can bring additional 26419 ha irrigation potential in the district which accounts for 27% additional irrigation potential wrt to the uncovered area.

However, the strategic action plan for irrigation in the district under PMKSY is under progress. The project proposes to converge different activities of major Irrigation, minor irrigation, lift irrigation, ground water development, micro-water shed developments, water conservation and harvesting structures like firm ponds, check dam, nala bunds, percolation tanks etc. Development of further irrigation potential with the available ground water resources in Banka district and rain water harvesting and artificial recharge management intervention may be considered under PMKSY project in the district.

Table: 6.70 Proposed Number of LDDW, STW/MDTW for management intervention in Irrigation sector

Block	Geology	Volume of water available for future Irrigation development (ham)	Volume of water needed for 30% -70% irrigation to be provided by LDDW (ham)	Unit draft of LDDW (ham)	Volume of water needed for 70% -30% of required irrigation to be provided by STW/MDTW (ham)	Unit draft of STW/MDTW (ham)	Required no of LDDW	Required no of STW/MDTW
Amarpur	Alluvium	1183	355	0.7	828	2.88	507	287
Banka	Hard Rock & Alluvium	880	616	0.7	264	1.44	880	183
Barahat	Hard rock	117	82	0.7	35	1.44	117	24
Belhar	Alluvium and Hard rock	1232	616	0.7	616	2.4	880	257
Bausi	Hard rock and Alluvium	1102	771	0.7	331	1.44	1102	230
Chandan	Hard	2820	1974	0.7	846	1.44	2820	587

Block	Geology	Volume of water available for future Irrigation development (ham)	Volume of water needed for 30% -70% irrigation to be provided by LDDW (ham)	Unit draft of LDDW (ham)	Volume of water needed for 70% -30% of required irrigation to be provided by STW/MDTW (ham)	Unit draft of STW/MDTW (ham)	Required no of LDDW	Required no of STW/MDTW
	rock							
Dhuraiya	Alluvium	1642	493	0.7	1149	2.4	704	479
Phulidumar	Hard rock	388	272	0.7	117	1.44	388	81
Katoria	Hard Rock	2016	1411	0.7	605	1.44	2016	420
Rajaun	Alluvium	418	125	0.7	293	2.4	179	122
Shambhuganj	Alluvium	1412	423	0.7	988	2.88	605	343
Total							**10198**	**3013**

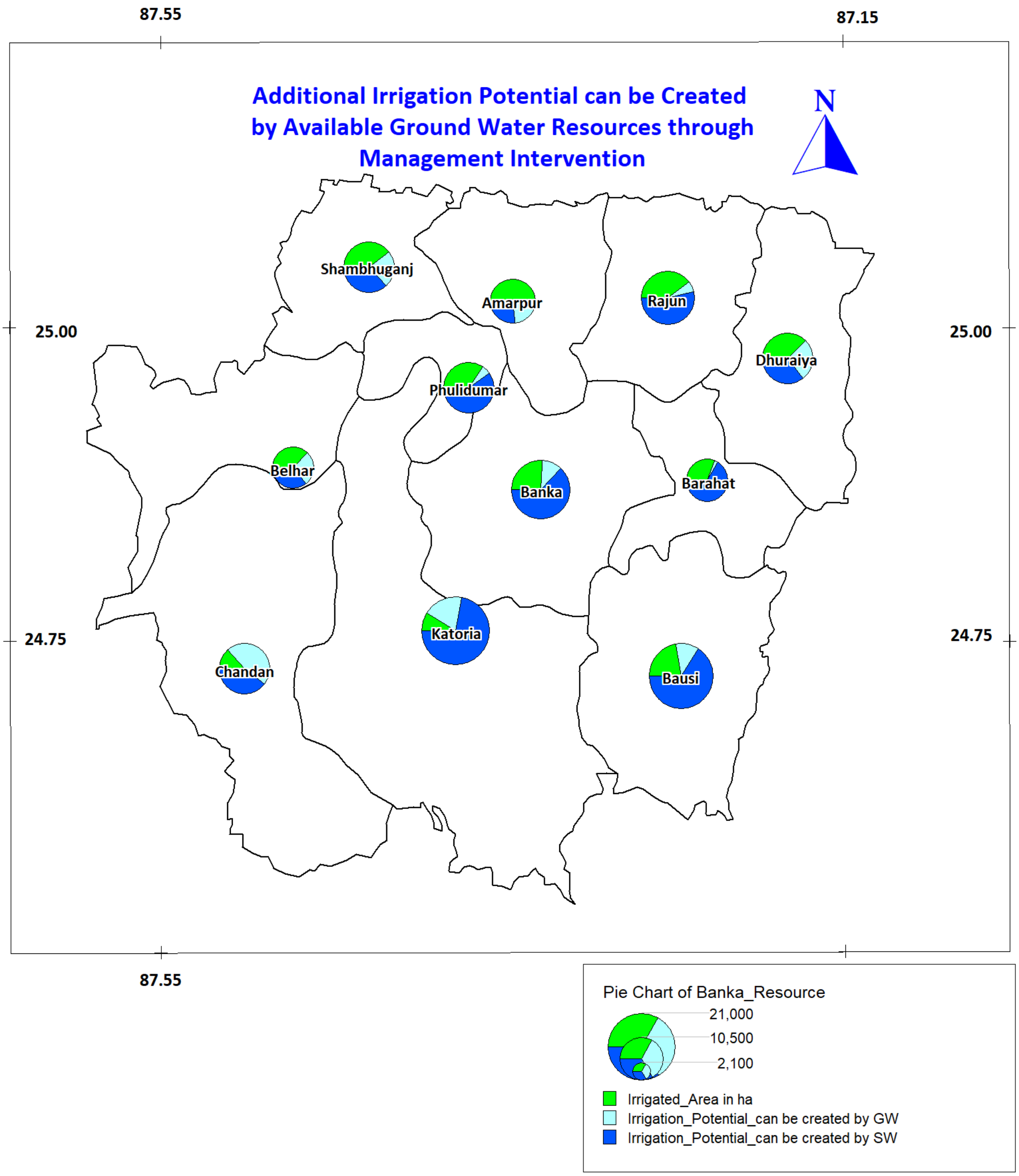


Fig.46 Additional Irrigation Potential that can be created by management intervention in irrigation sector

6.3 Management Interventions through Rain Water Harvesting and Artificial Recharge; an intervention of Supply Side Management

The district receives average annual rainfall of 1100 to 1200 mm. However, bulk of the amount is recorded during the 4 monsoon months. Thus, undistributed rainfall causes huge amount of water to drain to the sea. On the other hand, the area being undulating hilly terrain in the southern parts, high runoff is expected for land slope more than 5%. 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. Combined effect of proliferation of ground water development by stakeholders of various sectors, specially agri-irrigation sector, coupled with deficit rainfall pattern during recent years has already resulted in substantial decline of ground water level in noteworthy area both in hard rock terrain as well as alluvial areas in the district. Central Ground Water Board, MER, Patna has prepared a Master Plan for Artificial Recharge to Ground Water in Bihar State based on 2019 data. The Master Plan broadly identified areas which needs urgent attention. Based on this, block level plan has been proposed considering the detail variation in lithological characteristics in Banka district. Based on terrain type of identified areas, various artificial recharge structures have been proposed and a tentative number of each structure has been arrived at.

Identification of the area suitable for artificial recharge has been done on the basis of depth of post-monsoon water level and ground water level trend. Using GIS tools, post-monsoon (November, 2019) depth-to-water level map and long-term (2007-2017) trend of ground water level map has been superimposed over administrative boundary to identify feasible areas for recharge. Using the prepared map, feasible areas are identified, subject to fulfilling the below mentioned conditions

a) Areas showing water levels between 3 and 6 m bgl and declining trend of > 10 cm /yr;

b) Areas with Depth-to-Water levels between 6 and 9 m bgl and declining trend;

c) Areas with Depth-to-Water levels > 9 m bgl with or without declining trend.

An area of 1028.28 sq km has been identified in Banka district as suitable area for recharge.The available storage column/space (post-monsoon) for has been calculated for respective blocks by computation of average depth of unsaturated zone below 3 m water level in post monsoon time. Total volume of available storage space is calculated by multiplying storage area by specific yield. Considering the efficiency of the structure as 75%, the total water required to fill the storage space has been assessed. Total volume of unsaturated zone is 199 MCM. A volume of 306.67 mcm water may be required to fill the unsaturated space.

Availability of non-committed source water for the purpose of artificial recharge to groundwater is the primary concern. 60% of the normal monsoon rainfall for identified feasible areas is considered as available non- committed surface runoff. The water required to fill the storage space in the identified area has been compared with that of the available non committed runoff and accordingly least of the two volumes has been allocated in different proposed rain water harvesting and artificial recharge structures. The available non committed source water is 1950 mcm in the district, which is sufficient to meet the requirement to fill the unsaturated zone.

Considering local hydrogeological diversities, geomorphological set up and relative groundwater potentialities in the district, various types of artificial recharge / conservation structure is possible for augmentation and conservation of ground water resources in alluvial and hard rock terrain. In alluvial terrain de siltation of existing tanks, traditional Ahar-Pyne system renovation, injection wells and in hard rock area percolation tanks, gulley plugging, contour bunds, check dams etc. are considered as effective water harvesting and recharge structures in the district. However, actual field condition, available area identified for recharge in the particular blocks has been given due importance to decide source water allocation for individual structures in respective blocks. Based on the recharge allocation for individual structures and gross storage capacity the number of proposed structures has been decided. Proposed number of each water harvesting structures in the district is given in table 6.9.

6.8 Storage Capacity and tentative dimension of proposed structures

Terrain Type	Recharge Structure Type	Storage Capacity (MCM)	Number of Filling	Dimension
Hard Rock Area	Percolation Tank	2.0	01	100 m x 4.5 m (03 Sq. Km Catchment)
	Gully Plug	0.05	05	10 m x 2 m
	Contour Bunding & Trenching	0.05	05	300 – 400 m
	Check Dam	0.20	02	15 m x 3 m
Alluvial Area	De-silting of existing tank /pond /talao	0.20	02	100 m x 80 m x 6 m
	Injection Well in Village Tank	0.03	02	100 m x 100 m x 3 m Tank with 40 m Boring
	Renovation of traditional Ahar-Pyne System	0.10	01	As per Existing Structure / Km

Besides the traditional recommended rain water harvesting and artificial recharge structures in hard rock and in alluvial terrain emphasis has been given on renovation of old alluvial contour bunding (*Ahar - Pyne* System), which is very common in south Bihar. Such systems are in existence since long and occasional repairs are undertaken by local farmers. These structures, if revitalized would assist immensely in water conservation as groundwater recharge in in the district. Desiltation of existing village ponds/ tanks/ talao, particularly in alluvial area has also given due importance.

Table 6.9 Feasible number of Different types of Rain Water Harvesting Structures in Banka district, Bihar

District	Percolation Tank	Gully Plug	Contour Bunding & Trenching	Check Dam	Nala Bunding	Contour Bunding & Trenching	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	De-silting of Mauns (Ox-bow lake) (Sq. km)	Injection Well in Village Tank	Renovation of traditional Ahar-Pyne System (km)
	Hard Rock				***Marginal Alluvial Area***				***Alluvial area***			
Banka	8	121	121	6	7	59	118	6	216	0	288	118

Rapid increase in population in urban area has already put a thrust on the ground water level for domestic and drinking need. The urban clusters, Banka (NP) and Amarpur (NP) has been chosen for implementation of roof top rain water harvesting for conservation or recharge based on the available non committed runoff. Considering average annual rainfall of 1000 mm and 100 sq m roof area with 90% efficiency the volume of water harvested from one structure has been decided. As per the present master plan 30000 m^2 roof area is proposed to be brought under the project in the urban clusters of Banka and Amarpur. The schemes in urban sector of the district may produce a recharge potential of 0.189 mcm.

6.4 Management Interventions for Ground Water Quality Improvement

Numbers of blocks in Banka district have been reported with higher concentration of fluoride in ground water above permissible limit of 1.5 mg/l. Proper mitigation measures may be adopted from Govt initiative and through community participation. Domestic and community fluoride removal plants with schedule maintenance arrangements may be effective. Regular monitoring and surveillance of water quality for fluoride contamination may be planned. Shifting of tube well sites and relocation of wells sometimes may be worth. The dilution of fluoride contaminated water may reduce the harmful effects. Identification of patients with dental fluorosis or with symptoms of skeletal fluorosis may lead to the fluoride hotspots and accordingly suitable remediation may be planned. The rain water harvesting structures for artificial recharge in the fluoride affected aquifer may be very effective management intervention to lower the concentration of fluoride through dilution.

CHAPTER-7

7.0 Summary and Findings:

- The district is characterised by undulating terrain , high lands, small hillocks in the southern parts with masses of forest cover and alluvial plains. The district witnesses water scare hard rock terrain as well as alluvial pain with ample land and water resources.
- Granite, granite gneiss, quartzite, schist, pegmatite of Pre-Cambrian age constitutes the hard rock parts whereas the quaternary sediments is represented by unconsolidated sands, silts and clay.
- Even though, the economy of the district is agrarian in nature the agricultural activity in much extent dependent on kharif cultivation, rabi and summer crops are inadequately cultivated. Cropping intensity is around 144%. Crops diversification is also less, cereals crops are the main share constitutes 95% of total crops. Cultivation of pulses, oil seeds and other horticulture crops are meagre.
- Surface Irrigation network in the district is covered under Chandan Reservoir Schemes, Badua Reservoir Projects etc. Although the major irrigation through canal networks constitutes appreciable irrigation water of 80% during Kharif time but during Rabi seasons the water availability through the major irrigation networks constitute only 26% of total irrigation water availability. Therefore, the balance irrigation facilities' are sustained through minor irrigation networks of dug wells, shallow , medium and deep tube wells. Therefore, in absence of proficient surface irrigation network during rabi and summer seasons, failure and unfavorable tube well irrigation in many places resulting in overall poor irrigation development in the district. The STW and MDTW are concentrated within the depth range of 30-60 m, causing much stress on a particular aquifer.
- In hard rock area the 1st aquifer is represented by weathered residuum and shallow fractures and deep seated potential fractures 75-150 m depth constitutes the 2nd aquifers. However, the 2nd aquifers are inconsistent and local. Aquifers in alluvial formation may also be grouped as shallow (1st) aquifer within 10-35 m depth which are tapped by dug wells or shallow tube wells and *deeper (2nd)* aquifers beyond the depth of 35 mbgl, which are often tapped by MDTW or DTW.
- The post monsoon water level in the district in the 1st aquifer of unconsolidated sediments (weathered and alluvium) lies within 2-5 mbgl. However ,comparatively deeper water level of 5-9 m has been observed in pre-monsoon time in the hard rock area particularly. Development from dug wells in alluvial area is less. The deeper water level in fractured aquifer depends on the potentiality and interconnection of fracture zones.
- The dominant regional ground water flow from SW towards NE. However, local reversal of flow has been recorded in parts of Chandan block in the southern parts of the district. Decrease in hydraulic gradient has been observed from southern parts towards north eastern parts. The decrease in

hydraulic gradient is also attributed to the increase in the hydraulic conductivity and the potential of the aquifer in northern and north eastern parts of the district.

- The thickness of the alluvium and weathered sediments above the hard rock and fractures in hard rocks have been demarcated from the exploratory bore hole data of CGWB and utilised in lithology model/fence under Rockworks platform to generate aquifer disposition in the area. The thickness of alluvium is maximum in alluvial area in Sambhuganj and in Amarpur blocks. Maximum alluvium cover of 100 m has been reported. In southern hard rock area the thickness of alluvium/weathered mantle is very less. The lithological model diagram and fence clearly demonstrate the occurrences of at least 2-4 sets of fractures which includes both shallow (within 80 m depth) and deep seated fractures.
- In hard rock area, the unconsolidated sediments comprising the alluvial deposits of limited thickness along with the weathered mantle constitute the 1st Aquifer system and the hard basement rock with secondary porosity constitutes the 2nd Aquifer System. In alluvial area the 1st aquifer system consists of granular zones of coarse to medium sands down to maximum depth of 30 mbgl. Below that, the deeper or the 2nd aquifer system continues till the depth of encounter of hard rock. The maximum vertical extent of 2nd alluvial aquifer system in Banka district lies within 90-100 mbgl. The 3 D aquifer disposition in the northern and north central parts of the district comprising alluvial area in Sambhuganj, Amarpur, Rajaun blocks reveals presence of 2-3 local aquifers separated by clay layers. The shallow aquifer 1 within 10-20 m bgl is consistent throughout the area and constitutes the dug well zone in the district.
- The optimum yield of the wells in alluvium tract is moderate to high and varies from 60.00- 120 m^3/hr with reference drawdown 4-9 m, whereas the yield in hard rock terrain varies from 3-10 m^3/hr . The transmissivity value in alluvial and hard rock area varies from 63.7 m^2/day to 1265 m^2/day The transmissivity of the aquifer in the hard rock terrain is further low.
- The Major concern in the chemical quality of ground water in Banka district is occurrences of higher concentration of fluoride in ground water more than permissible limit in few blocks namely Baunsi, Sambhuganj and in Chandan block, the maximum concentration of F is reported as 1.98 ppm in Chandan block. Along with other mitigation measures dilution of concentration of Fluride by artificial recharge techniques has been proved to be helpful in short term measures.
- Total annual extractable ground water recharges for Banka district is 468 MCM. The total annual extraction of ground water in the district is 162 MCM under irrigation, industrial and domestic draft. Irrigation draft contributes almost 72% of total annual draft in the district. The stage of ground water extraction on an average in the district is 36%, lowest being 8% in Chandan block and

maximum of 57% in Rajaun block. All the blocks are categorised as safe in terms of level of ground water development.

- For effective management intervention for sustainable ground water uses in drinking-domestic and irrigation sectors few measures have been put forward for implementation in phases or in conjunction with ongoing schemes of Govt. of India (PMKSY etc.) and Govt. of Bihar (Jal jiban Hariyali etc.). In an attempt to cover 100% present population in the district under PWSS schemes total 458 bore wells or tube wells have been proposed which may be implemented based on the prevailing hydrogeological conditions, requirements etc. However, keeping in view the significant effects on ground water regime, if any, the installation should always be implemented in phases with precaution.
- 29% of the cultivable area in the district has been brought under assured irrigation. To boost crop diversification and to encourage less water intense crops further irrigation may be extended for creation of irrigation potentials for pulses/oilseeds/other horticulture crops. Thus, 26419 ha additional irrigation potential may be created with the surplus ground water resources. Therefore, 27% of the uncovered area may be brought under irrigation coverage with the available resources for which 10198 LDDW and 3013 STW/ MDTW is recommended in the district to achieve the target. 4-5 numbers of LDDW and 1-2 STW/MDDW in each village in the district would satisfy the requirement. The effective surface irrigation networks may be extended for remaining uncovered area.
- Based on deeper post monsoon water level and long term reflection on ground water regime, 1028.28 sq. km in the district has been identified as suitable area for artificial recharge to ground water. 199 MCM available storage space is proposed to be augmented in the district with available non committed runoff. 306 MCM of source water for recharge purpose would be required which are diverted back to the aquifer through different structures. In hard rock and marginal alluvium area of Banka district 14 percolation tanks, 121 gully plugs, 180 contour bunding and trenching, 13 check dam/nala bunds and 118 recharge shafts has been proposed. In alluvial terrain 216 tanks de-siltation and erection of 288 injections well in village tanks are recommended. Renovation 118 km traditional Ahar- Pyne system has been recommended. As per the present master plan 30000 m^2 roof area is proposed to be brought under the roof top rain water harvesting project in the urban clusters of Banka and Amarpur. The schemes in urban sector of the district may produce a recharge potential of 0.189 mcm.

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