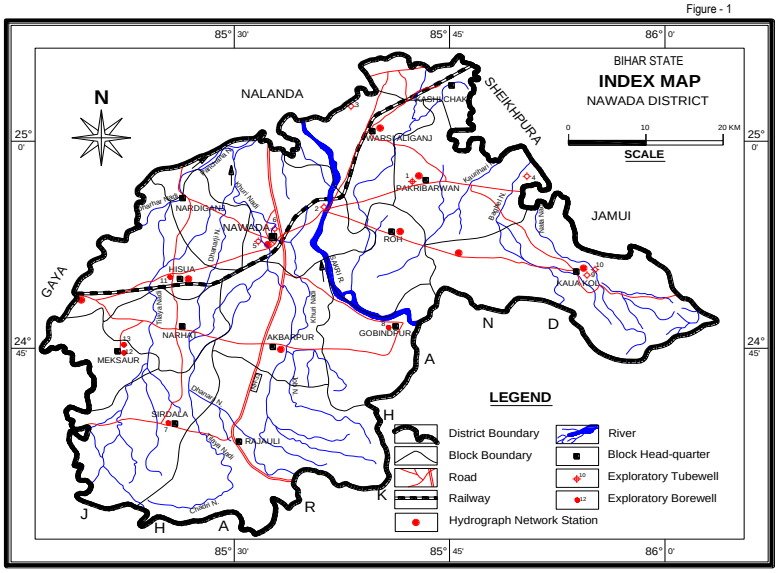
भूजल सूचना पुस्तिका

नवादा जिला, बिहार

Ground Water Information Booklet

Nawada District, Bihar State

Figure - 1



केन्द्रीय भूमिजल बोर्ड
जल संसाधन मंत्रालय
(भारत सरकार)
मध्य-पूर्वी क्षेत्र
पटना

Central Ground water Board
Ministry of Water Resources
(Govt. of India)
Mid-Eastern Region
Patna

सितंबर 2013

September 2013

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GROUND WATER INFORMATION BOOKLET,
NAWADA DISTRICT, BIHAR STATE

Sl. No.	ITEMS	Statistics	
1.	GENERAL INFORMATION		
	i) Geographical area (Sq Km)	2494	
	Administrative Division		
	i) Number of Tehsil/ Block	14	
	ii) Number of Punchyat/Villages	1075	
	iii) Population (As on 2011 Census)	Rural:2001120 Urban:215533	
	iv) Average Annual Rainfall (mm)	1037	
2.	GEOMORPHOLOGY		
	Major physiographic unit :		
	Major Drainages:	Sq km	
3.	LAND USE (Sq Km)		
	a) Forest area:	Nil	
	b) Net area sown:	637.75	
	c) Cultivable area:	1332.9	
4.	MAJOR SOIL TYPE		
5.	AREA UNDER PRINCIPAL CROPS		
6.	IRRIGATION BY DIFFERENT SOURCES (Areas Sqkm and Number of Structures)	Area	No.
	Dugwell	-	5463
	Tubewell/Borewell	490.75	17628
	Tank/ponds	Nil	-
	Canals	42.02	-
	Other sources	48.69	2900
	Net irrigated area	581.46	
	Gross irrigated area	867.43	
7.	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (2011)		
	No of Dug wells	06	
	No of Piezometers	Nil	
8.	PREDOMINANT GEOLOGICAL FORMATIONS	Quaternary Alluvium	
9.	HYDROGEOLOGY		

	Major Water bearing formation	
	(Pre-monsoon Depth to water level during 2011) m bgl.	6.46 to 10 m
	(Post-monsoon Depth to water level during 2011) m bgl.	1.0 to 6.0 m
	Long term water level trend in 10 yrs (2002-2011) in m/yr	
10.	GROUND WATER EXPLORATION BY CGWB (As on 31-03-2013)	
	No of wells drilled (EW, OW, PZ, SH, Total)	13 + 9
	Depth range (m)	80-135(A) To 117-193 (H)
	Discharge (litres per second)	8-60(A) to – 10 (H)
	Storativity (S)	2.6×10^{-4} to 6.1×10^{-5}
	Transmissivity (m^2/day)	361 to 1717
11.	GROUND WATER QUALITY	
	Presence of Chemical constituents more than permissible limit (e.g EC, F, As, Fe)	
	Type of water	Potable
12.	DYNAMIC GROUND WATER RESOURCES (as on31st March 2009)- in mcm	
	Annual Replenishable Ground water Resources	513.64
	Net Annual Ground Water Draft	221.23
	Projected Demand for Domestic and industrial Uses up to 2025	58.07
	Stage of Ground Water Development	43.1
13.	AWARENESS AND TRAINING ACTIVITY	
	Mass Awareness Programmes organized	Nil
	Date:	
	Place:	
	No of participant:	
	Water Management Training Programmes organized	Nil
	Date	-
	Place	-
	No of participant	-
14.	EFFORT OF RTIFICIAL RECHARGE & RAIN WATER HARVESTING	

	Project completed by CGWB(No & Amount spent)	Nil
	Project under technical guidance of CGWB (Numbers)	Nil
15.	GROUND WATER CONTROL AND REGULATION	
	Number of OE Blocks	Nil
	Number of Critical Blocks	Nil
	Number of Blocks notified	Nil
16	MAJOR GROUND WATER PROBLEMS AND ISSUES	

I. INTRODUCTION

1.1 Administration

Nawada is located between North Latitudes $24^0$31': $25^0$08' and East Longitudes $85^0$00': $86^0$03' and falls on Survey of India Degree sheet No. 72 H & 72 G (Fig.1). The district is bounded in north by Nalanda and Sheikhpura district, in east by Jamui district, in west by Gaya district, while southern half boundary of district is bounded by Jharkhand state boundary. The district is having a geographical area of 2494 Sq. Km and occupying 1.43% of the total geographical area of the Bihar State.

The total population of district is 22.16 Lakhs (census 2011). Density of population is 726 per Sq. Km. Nawada is its district headquarter. There are 14 development blocks with 1075 villages.

1.2 Drainage

The district of Nawada does not have any important perennial river. Those, which are worthy of mention, are the Tilaiya, Ghaghra, Khuri, Sakri and Dhanarjya. The beds of these rivers are shallow, wide and sandy. They are ephemeral in nature and are virtually in spate during the rainy season. The district of Nawada also has some important waterfalls such as Kakolat and Had-hadwa.

1.3 Irrigation Practices

The net area under irrigation in the district is 2,65,123 acres, which constitutes 43.13% of the total geographical area of the district. Barren and uncultivable land constitutes 4.99%, land put to non-agricultural accounts for 8.83% and current fallow land makes up 10.42% of the total geographical area of the district. Out of the total geographical area of the district, net area sown constitutes 50.43%. The net area under irrigation comprises, area irrigated by tubewells (23.06%), through wells (7.30%), by canals (7.37%) and other sources (62.27%).

1.4 Studies / Activities Carried out by CGWB

The southern part of the district was geologically mapped by Dr. L.A.N. Iyer of Geological Survey of India during 1939-44. Systematic geohydrological surveys of Nawada sub division in Gaya district were carried out by A. Mukherjee, Geological Survey of India in 1966. Subsequently the author has taken up reappraisal surveys in Nawada district in 1987-88. Before this B.K. Ghosh (1983) Geological Survey of India has mapped the Quaternary sediments

of the district. A total 13 exploratory wells have been drilled, out of which 6 are in Alluvial/ Marginal alluviual and 7 are in hard rock terrain.

2.0 Rainfall and Climate

Monsoon sets sometimes in the third week of June and it lasts till the end of September. The average annual rainfall in Nawada district is 1037 mm. The maximum rainfall in the district comes from South West monsoon with a little about 10% spread over the summer and winter. There is a large variation in the rainfall over year to year. Rainfall increases from Southwest to north-east.

After analysis of rainfall data it is revealed that there is a wide variation in the average annual rainfall values, least being at Rajauli and maximum at Nawada.

The climate of the district is sub-tropical to sub-humid in nature. The district experiences severe cold during winter whereas on the other hand in summer it is very hot. The summer starts from the mid of March and it continues up to mid of June, after that monsoon starts and it continues up to mid of October. The nights are generally hot from the end of May till the first break of monsoon.

The climate is generally hot and dry, the winter temperature ranges from 16^0C to as low as 4^0C whereas during the summer the mercury shoots to 46^0C. During rainy season it becomes cooler and temperature drops to 35^0C to 25^0C.

3.0 GEOMORPHOLOGY

3.1 Geomorphology

The northern and southern parts of the district constitute two distinct natural regions. The northern part is plain area underlain by alluvial soils covering Nawada, Warsaliganj, Pakhribarwan and parts of Hisua, Narhat, Govindpur, Akbarpur and Kauakol blocks. Consequently, it is densely populated and has a rich historical background. The southern part is hilly and undulating with a gentle ascend towards the south merging into hills and is part of southern fringes of the Chottanagpur Plateau. The entire southern boundary of the district is a conglomeration of ridges and spurs.

3.2 Soil

In the district there are five types of soils. These are (i) Loam, (ii) Sandy, (iii) Clay, (iv) Sandy loam and (v) Clay loam. The areas where these kinds of soils are generally found and the corresponding crops grown in these soils are described below: -

Loam – Found in Nawada, Sirdala and Akbarpur.

Sany – Available in some parts of Nawada, Sirdala and Hisua blocks. It is suited for crops like Maize, Oil seeds and Groundnut.

Clay – Available in parts of Pakribarwan, and Kauakol blocks. It is suited for paddy, grams and wheat.

Sandy Loam – Found in the development blocks of Nawada, Warsalianj, Akbarpur, Narhat and Hisua. It is useful mainly for wheat, Maize and Paddy.

Clay Loam – Available in Rajauli and Sirdala blocks. It is useful for paddy, wheat and potato.

GROUND WATER SCENARION

4.1 Hydrogeology

Geological mapping and geomorphological analysis of the district has revealed the existence of erosional hills and depositional valleys in the area (Fig.2). The erosional land systems include Rocky upland and Pediplains, where as the depositional land systems are Nawada surface and Sakri surface. This classification of land systems has been done on the basis of topographic characteristics, slope characteristics, drainage characteristics, nature of oxidation and soil formations on the sediments of the area.

Rocky Upland

Pre-cambrain rocks of Archaean age:

The crystalline rocks in the district are mica schists, granite gneiss, quartzite and quartz schist, hornblends schist and mica pegmatites etc. These rock types constitute the hill ranges and cover south and eastern parts of Rajauli block, southern parts of Sirdala block north central and southern parts of Govindpur blocks and south, south-eastern and northern parts of Kauakol block.

Nawada Surface (Older Alluvium)

This is the oldest depositional geomorphic surface of the area and comprises vast stretch of alluvial landscape to the north of the main south-central NE-SW trending Rocky Upland, as well as shallow valley fill areas to the south of the Rocky Upland. The general elevation of this landscape varies between 416.6 m and 446.7 m in the southern side whereas the general slope is towards north while the elevation varies between 67 m and 91.4 m in the northern part of the Rocky Upland. The surface to the north of the Rocky Upland has been formed by alluviation of precursors of Sakri, Tilaiya Kuri and Nata rivers. The geomorphic units comprising this geomorphic surface have been obliterated by later erosional processes. The alluvial fills to the south of the Rocky Upland appear to have

formed by filling up of depressions of the valley floor. The sediments have probably been derived from the surrounding high ground.

Aquifer Geometry

The thickness of alluvial sediments varies from 20 to 40 m in the marginal alluvial areas between Sirdaha and Narhat Blocks between Rajauli and Akbarpur, between Kauakol and Kerali villages. Between Hisua-Nawada Akbarpur-Govindpur and Govindpur-Pakribarwan-Gulnni the thickness of the alluvium vary from 50 to 70 m. Between Roy and Rahya villages the thickness is maximum in the district and varies between 80 and 130 m. The weathered zone in crystallines at Sirdala and Kauakol is around 80 m in Narhat block, around 60 to 90 in Nawada and southern parts of Pakribarwan and Warsaliganj blocks. Hard rocks are encountered at depths of 100 to 130 m in Northern parts of Warsaliganj block. In brief it can be said the entire Warsaliganj block and parts of Pakribarwan block is having rich and potential ground water bearing sediments.

In the entire sequence the deposition of the alluvial materials has taken place in three different periods demarcated by these clay beds. The thickness of these clay beds varies from 2 m to as much as 40 m. In the northern part of the district the thickness of the Clay is more and in the southern blocks Narhat, Hisua, Kauakol, Govindpur the thickness of the clay varies from 5 to 15 m only.

In Nawada district, to see the water level behavior, 6 no. Hydrograph Net Work stations are being monitored regularly and as per available data the water level during pre-monsoon varies from 6.46 to 10 m bgl(Fig.-3) whereas during post monsoon it ranges between 1 to 6 m bgl (Fig-4).

4.2 Ground Water Resources

The evaluation of groundwater potential is done using the water level fluctuation approach. Measurements of water levels are taken at a point source and the change of levels in the time span is observed. Annually replenishable dynamic ground water resource of the district has been estimated (GEC-1997, norm) as on 31st March 2009 for all the blocks. The net annually replenishable ground water resource of the district is 51364 ham. The gross ground water draft for all uses is 22123 ham. The present stage of ground water development of the district as on 31st March 2009 is 43.1 %. All the 14 blocks of the district fall under safe category (Fig.-5). At present maximum ground water development is in Hisua block (76.9%), while minimum is in Roh block (18.8%). Details of ground water resources of all blocks are shown in Table 1

4.3 Quality of Groundwater

In general groundwater in the district is potable and is also used for irrigation purposes. The chemical analysis of these water samples has indicated that the ground water in the area is alkaline in nature.

The pH of the groundwater varies from 6.96 to 8.41. The chloride in ground water in the area varies from 18 ppm to as high as 270 ppm. Iso-Chlor contours are drawn for the entire area and presented in Fig.. Concentration of chlorides has been noticed more in south-west and western parts of the district, covering Hisua, west of Kauakol and north west of Rajauli blocks. The bi-carbonates in ground water vary from 195 to 488 ppm. Concentration of bi-carbonate in ground water is more in Hisua and Roh blocks and low concentration in Nawada block. The total hardness as $CaCO_3$ varies from 160 to 390 ppm, minimum at Pakribarwan and maximum being at Hisua. Calcium content in water varies from 16 to 104 ppm, the lowest at Rupau in Roh block and the highest in Hisua block, Magnesium content in these shallow water varies from 15 to 71 ppm. The lowest concentration is marked at Akbarpur and the highest at Rupau.

The overall study of the chemical contents in the shallow water of Nawada district has indicated that they are within the permissible limits for drinking and irrigational purposes as per the standard in our country, except some small patches in Rajauli block where fluoride concentration has been found beyond permissible limit.

4 Status of Ground Water Development- Block wise

The occurrence and movement of ground water is governed by geology and geomorphology. An attempt has been made to summarize block wise information on suitable well type, depths, discharge and suitable drilling method (Table. 3).

GROUND WATER MANAGEMENT STRATEGY

5.1 Ground Water Development

The most suitable area for Ground water development is alluvial plain along Sakri River in Nawada, Pakribarwan, Warsaliganj blocks. Maximum thickness of alluvial is near Kochgaon, Warsaliganj blocks.

The most suitable area for ground water development is alluvial plain along Sakri river, in Pakribawan, Nawada and Warsaliganj blocks. Maximum thickness of alluvium is 130 m near Kochgaon village in Warsaliganj block. Direct and reverse rotary drillings are suitable in unconsolidated formation. In hard rock areas ground water development can be done by drilling bore wells to a depth of 150

m. The sites of the wells should be scientifically selected after studying the geology, and analyzing satellite imageries by remote sensing and pinpointed by geophysical techniques. Depth of weathering ranges from 5 to 10m bgl in general. Detail information related to depth, discharge, drilling methods etc are given in Table 3.

Water Conservation and Artificial Recharge

The gross irrigated area of the district is about 26% of the total cultivable area. Though there is an overall availability of ground water, the location of a prospective site is difficult in hard rock terrain. As such, at some places shortage of water is observed. In these areas water conservation techniques could be used. The district receives average annual rainfall of 1042 mm, but most of the rain water goes as runoff. Construction of water conservation structures will help arrest runoff, recharge the aquifer and retain the soil moisture. Contour bunding, check dam, gully plug, and percolation tank are suitable structures in the hard rock areas, while recharge shaft and percolation tank are suitable structures in unconsolidated formation.

Ground Water Related Issue and Problems

There is no issue and problem reported related to ground water except fluoride problem in some parts of Rajauli block.

Mass Awareness and Training Activity

Mass Awareness Programme

Till date no mass awareness/training programme has been organised in the district.

Area Notified by Central Ground Water Authority (CGWA) / State Ground Water Authority (SGWA):

All blocks of Nawada district are under safe category for ground water development point of view. No block has been notified by CGBA/SGWA.

9.0 RECOMMENDATIONS

With the balance ground water resources available large number of shallow tubewells can be constructed in all the blocks. In addition to the shallow tubewells, large numbers of dugwells are also feasible in Gobindpur, Husia, Kauakol, Narhat and Rajauli blocks. Considering financial expenditure towards cost of deep tubewells and fragmented land holdings shallow tubewells are preferred to deep tubewells..

In the area occupied by weathered crystallines and Marginal alluvial tract large diameter open wells down to 15 m or shallow tubewells downs to 30 m can be designed to develop low to medium duty tubewells (20 to 50 m^3/hr).

Planning should be done for the construction of few check dams in the upper reaches of the river to contain the flash flood and utilise for irrigation purposes.

Planning should be done in utilising the ground water potential in more efficient manner to bring the uncultivated wasteland into production.

Frequent water level monitoring should be done in the entire basin to help assess the ground water potential and for better management of groundwater regime.

Adequate water samples should be collected from both surface and ground water sources and should be analysed chemically to study the distribution of chemical parameters.

Annexure-1

Drilling Details of Exploratory wells drilled by CGWB

DISTRICT : NAWADA

Sl.No.	Location/	Depth	Length of	Granular/	Static	Discharge	Drawdown	Specific	Trans-	Storativity	Formation
	Block	Drilled	Casing pipe/	Zone/ fracture	Water level			Capacity	missivity		
			Depth const.	Tapped							
		mbgl.	m.	m.	m. bgl.	m^3/hr.	m.	m^3/hr./m.	m^2/day		
1	2	3	4	5	6	7	8	9	10	11	13
1	PAKRIBAR-	80	80	026.00-029.00	4.56	84.2	13.76	6.11	189.3	$8.80X10^{-4}$	ALLUVIUM
	WAN/Pakr-			037.00-040.00							
	ibarwan			056.00-068.00							
	$24^0$58'00"			071.00-077.00							
	$85^0$44'00"										
	OW	82.3									
2	KADIRG-	83.2	-	038.00-040.00	5.85	222.36	11.6	19.16	1627	$2.60X10^{-4}$	-do-

	ANJ/			047.00-049.00							
	Nawada			053.00-065.00							
	Sadar			067.00-079.00							
	24^{0}54'50"										
	85^{0}36'00"										
	OW	80.5									
3	KOCHG-	134.6	127	053.50-056.50	4.93	179.56	18.91	9.49	361	$05.90X10^{-4}$	-do-
	AON/War-			059.50-065.50							
	saliganj			090.00-096.00							
	25^{0}03'00"			103.00-124.00							
	85^{0}38'00"										
	OW	29.5									
4	DHAMAUL/	80.7	73	041.00-	4.88	69.96	20.29	3.44	122.6	$04.50X10^{-}$	-do-

				044.00						^{4}	
	Pakribarwan			046.00-055.00							
	24^{0}56'00"			061.00-070.00							
	85^{0}50'00"										
	OW	74.6									
5	NAWADA	77	75	041.00-044.00	4.88	32	6	5.33	628	NO OW	-do-
	P0LICE			047.00-059.00							
	LINE/Nawada			061.00-073.00							
6	NAWADA	80.7	76	032.00-035.00	9.47	179.57	7.89	22.75	1717	$6.1X10^{-5}$	-do-
	ITI/Nawada			038.00-041.00							
	Sadar			044.00-059.00							
	24^{0}52'30"			071.00-074.00							

	$84^0$30'45"										
	OW	77.5									
7	SIRDALA/	193	-	-	2.15	18	15.57		395		
	Sirdala										
	OW	180									
8	GOVIND-	180	20.5	-	3.36	2.9					QUART-
	PUR/										ZITE
	Govindpur										
	OW	175									
9	SHOKHO-	62	42	-							
	DEORA										
	EW_1										
	Kauswakol										
10	SHOKHO-	190	-	-	7.26	17.1	17.66	-	2.7	-	GRANITE
	DEORA					(Air comp)					GNEISS
	EW_2					3.09					

	OW	62									
11	MAJHWE	117	18	019.00-020.00	6.94	17.38	9.5	-	149	$2.24X10^{-4}$	
	Hisua			026.00-027.00							
				042.00-043.00							
				062.00-063.00							
				070.00-071.00							
				116.00-117.00							
	OW	150									
12	MESKORE	190	-	-	5.25	1.5	-	-	-	-	-
	EW_1										
13	MESKORE										
	EW_2	191									

Table: 1: Assessment of Dynamic Ground Water Resources of the Bihar state Nawada (as on 31st March, 2009)

(in hectare meter)

Sl.No	Assessment Unit/District	Net Annual Ground water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (12/9)*100 (%)
1	2	9	10	11	12	13	14	15
1	Akbarpur	5681	2498	336	2834	573	2610	49.9
2	Govindpur	3129	1079	142	1221	242	1807	39.0
3	Hisua	3952	2705	334	3039	389	857	76.9
4	Kasichak	1897	628	119	747	204	1065	39.4
5	Kawakol	5844	1003	235	1238	402	4439	21.2
6	Meskaur	1391	868	168	1036	287	236	74.5
7	Nardiganj	2709	1346	176	1522	301	1062	56.2
8	Narhat	1719	322	156	478	266	1130	27.8
9	Nawada	4551	1958	486	2443	907	1686	53.7
10	Pakribarwan	4420	906	272	1178	464	3049	26.6
11	Rajauli	5344	2189	250	2439	428	2727	45.6
12	Roh	4268	568	232	800	397	3303	18.8
13	Sirdala	2634	1071	248	1319	424	1139	50.1
14	Warsaliganj	3828	1390	438	1828	523	1914	47.8
	Total	**51364**	**18531**	**3592**	**22123**	**5807**	**27025**	**43.1**

Figure - 1

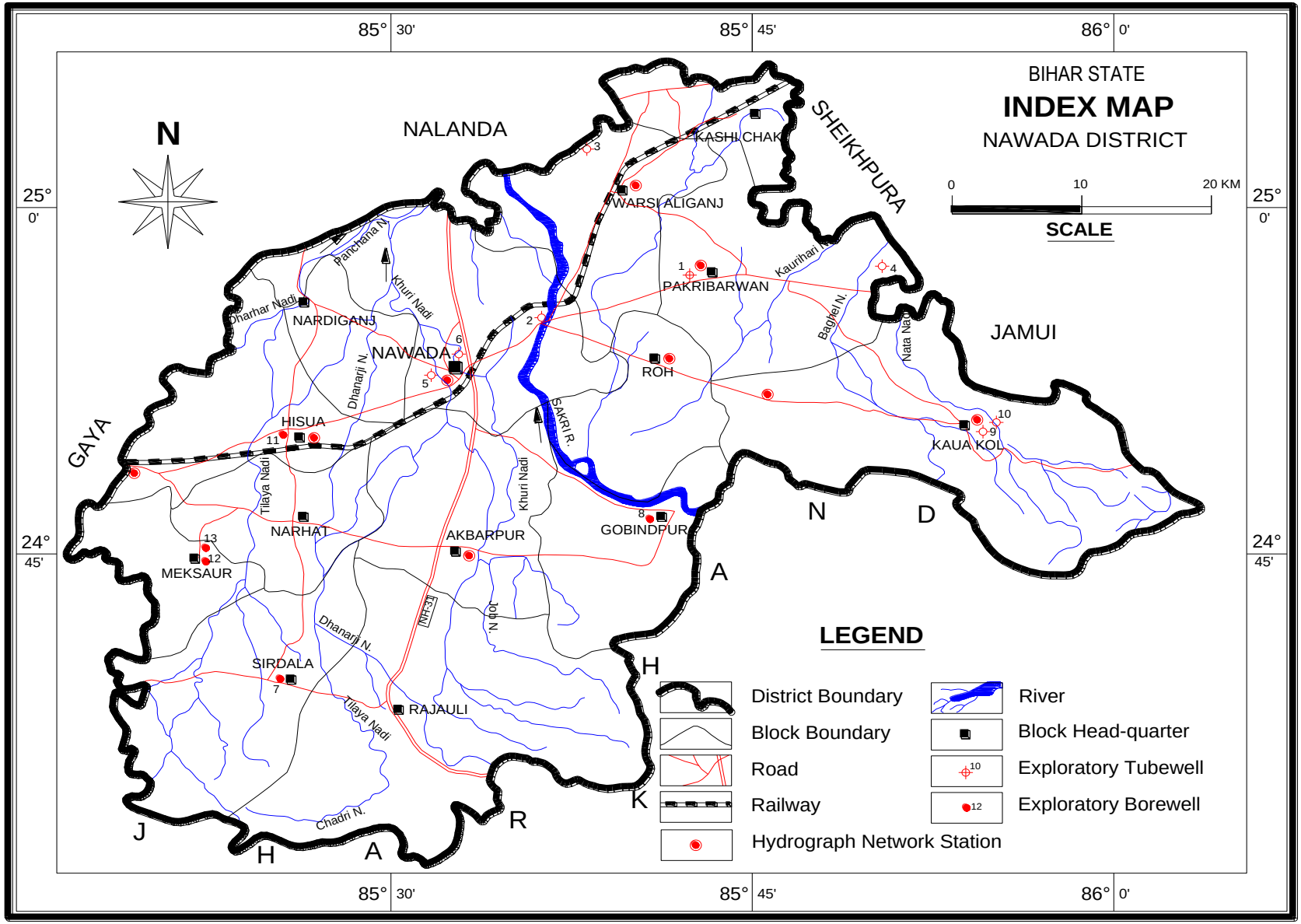
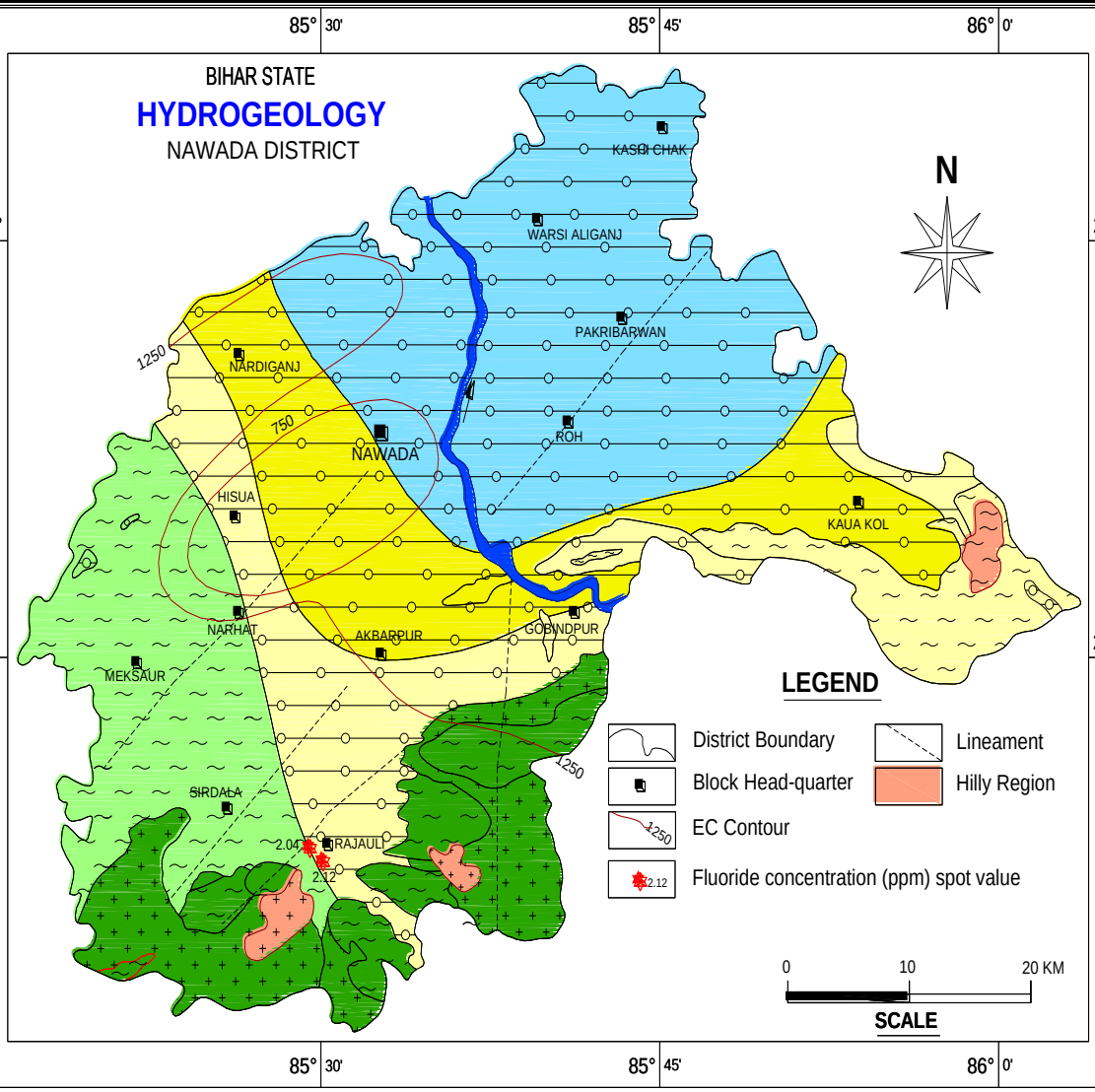

BIHAR STATE
INDEX MAP
NAWADA DISTRICT
SCALE
0
10
20 KM
N
NALANDA
SHEIKHPURA
JAMUI
GAYA
JHARKHAND
KASHICHAK
WARSALIGANJ
PAKRIBARWAN
NARDIGANJ
NAWADA
ROH
HISUA
NARHAT
AKBARPUR
GOBINDPUR
KAUA KOL
MEKSAUR
SIRDALA
RAJAULI
Panchana N.
Dharhar Nadi
Khuri Nadi
Dhanarji N.
Tilaya Nadi
Khuri Nadi
SAKRI R.
Kauriharj N.
Baghel N.
Nata Nadi
Dhanarji N.
Tilaya Nadi
Chadri N.
Top N.
NH-31
25° 0'
24° 45'
85° 30'
85° 45'
86° 0'
LEGEND
District Boundary
Block Boundary
Road
Railway
Hydrograph Network Station
River
Block Head-quarter
Exploratory Tubewell
Exploratory Borewell

Figure - 5



AGE GROUP	LITHOLOGY	SYMBOL	HYDROGEOLOGICAL CONDITIONS	GROUND WATER POTENTIAL	COLOUR	GROUND WATER STRUCTURE FEASIABLE
Quarternary	Recent Alluvium, Clay, Silt, Sand, Gravel etc.		Thick unconfined & confined aquifers, Thickness varies from 40 - 130 m.	Large yield prospect 100 -200 m^3/hr.		Heavy duty tubewells (Deep)
				Moderate yield prospect 50 -100 m^3/hr.		Medium duty & shallow tubewells.
				Poor yield prospect 20 - 50 m^3/hr.		Shallow tubewells & dugwells
Archaean	Weathered zone (weathered granites gneisses & schists)		Thin unconfined aquifer thickness varies from 10 -20 m.	Large to moderate yield prospects 5 -30 m^3/hr.		Dug - cum - Borewell
	Granite, Gneiesses		Graundwater restricted to fracture zones having secondary porosity.	Limited yield prospect below 5m^3/hr.		Dugwells
	Mica Schists, Quartz schists.					

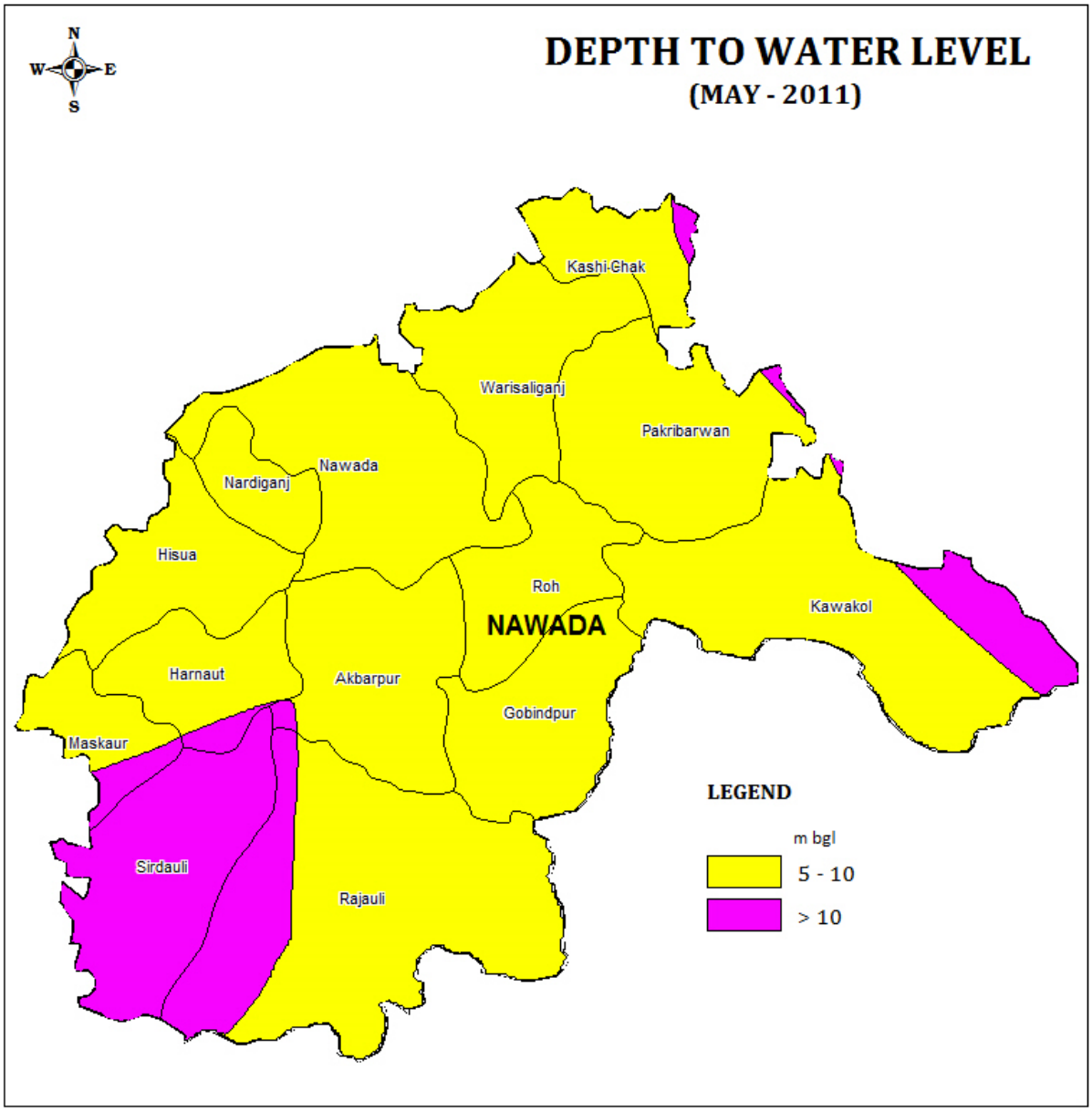


Fig. 3 Depth to water level map for pre-monsoon 2011.

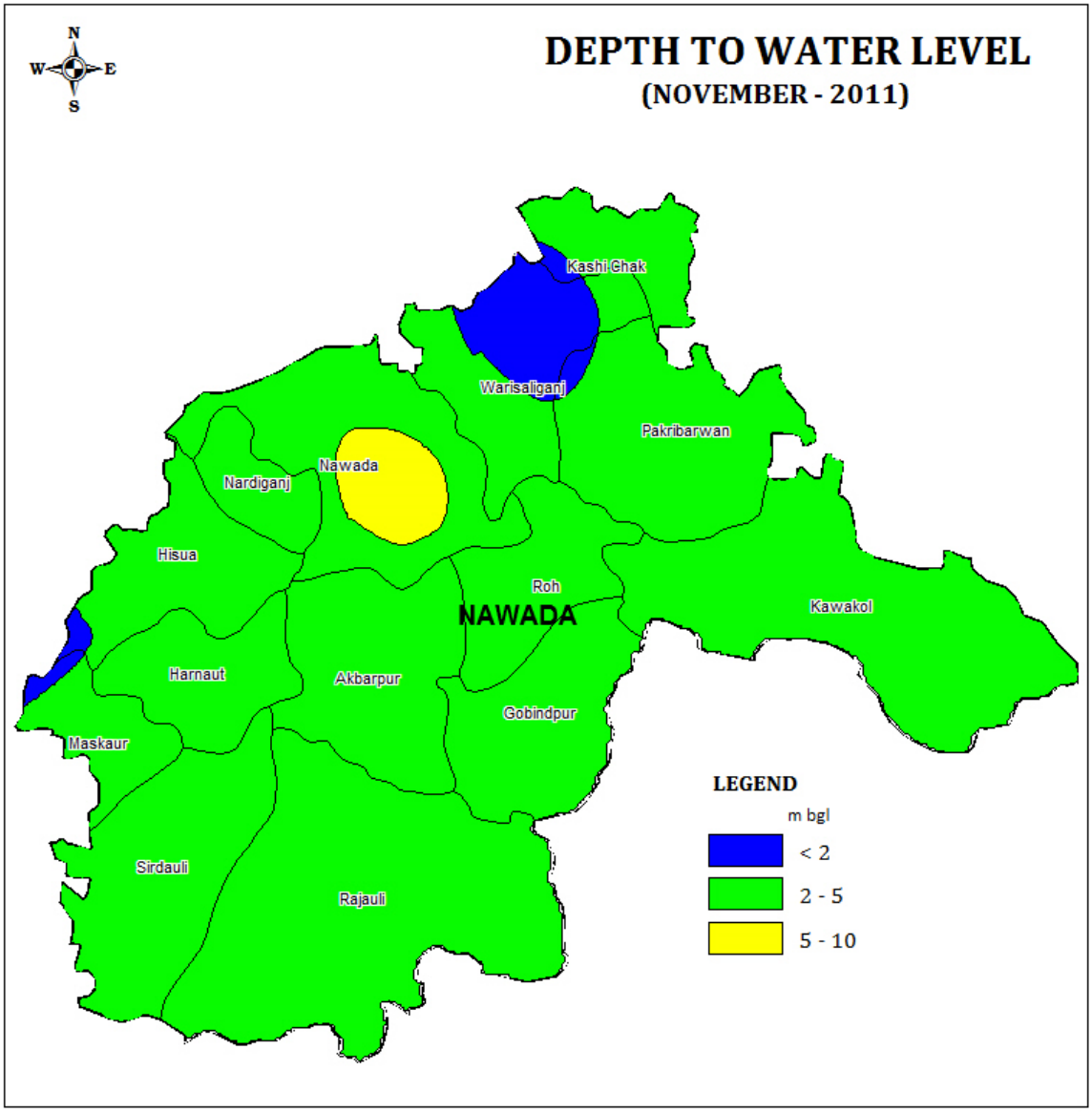


Fig. 4 Depth to water level map for post-monsoon 2011.

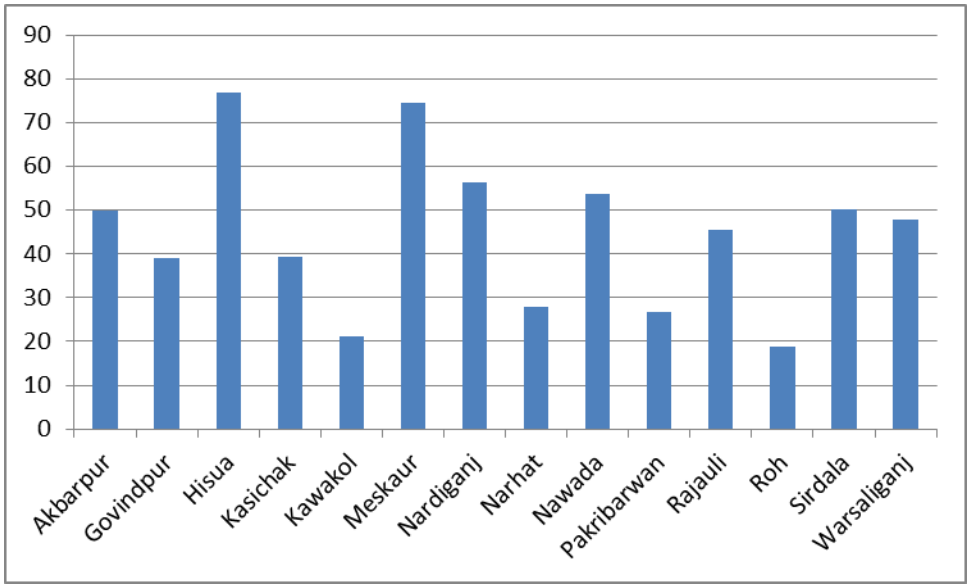


Fig. 5. Blockwise stage of ground water development of the area