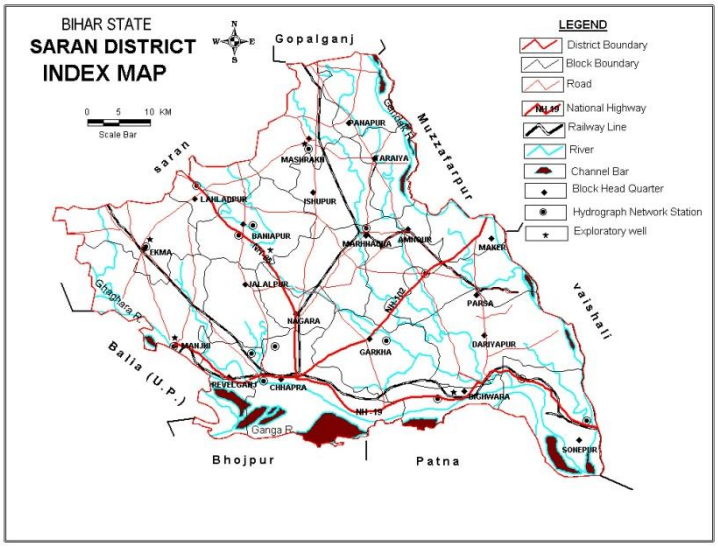
भूजल सूचना पुस्तिका

सारण जिला, बिहार

Ground Water Information Booklet

Saran District, Bihar State



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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SARAN DISTRICT AT A GLANCE

Sl. No.	ITEMS		STATISTICS
1.	GENERAL INFORMATION		
	i)	Geographical area (SqKm)	2641
		Administrative Division	3
	i)	Number of Block	20
	ii)	Number of Villages	1783
	iii)	Population (As on 2011 Census)	4943098
	iv)	Average Annual Rainfall (mm)	1075
2.	GEOMORPHOLOGY		
	Major physiographic unit :		Alluvial Plain
	Major Drainages:		Ganga, Gandak, Ghagra
3.	LAND USE (in hectares)		
	a)	Forest area:	Nil
	b)	Net area sown:	192,285
	c)	Total Cropped area:	232,691
4.	MAJOR SOIL TYPE		Younger alluvial and Calcareous alluvial soil
5.	PRINCIPAL CROPS		Paddy, Wheat, Maize, Arhar, Gram and Lentil
6.	IRRIGATION BY DIFFERENT SOURCES (Areas in hectares)		
	Dugwell		Nil
	Tubewell/Borewell		79,128
	Tank/ponds		7395
	Canals		33,149
	Other sources		-
	Net irrigated area		-
	Gross irrigated area		119,652
7.	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (2011)		15
	No of Dug wells		13
	No of Piezometers		Nil
8.	HYDROGEOLOGY		
	Major Water bearing formation		Quaternary Alluvium
	Pre-monsoon depth to water level during 2011 m bgl.		16 – 8.96
	(Post-monsoon Depth to water level during 2011) m bgl.		0.4 – 7.47
	Long term water level trend in 10 yrs (2002-2011) in m/yr		No significant change
9.	GROUND WATER EXPLORATION BY CGWB (As on 31-03-2013)		

	No of wells drilled (EW, OW, PZ, SH, Total)	5 EW, 5 OW
	Depth range (m)	50 - 168
	Storativity (S)	$0.65x10^{-4}$
	Transmissivity (m^2/day)	29 – 1776
10.	GROUND WATER QUALITY	
	Presence of Chemical constituents more than permissible limit (e.g EC, F, As, Fe)	As (In pockets of Sonepur, Dighwara, Chapra Sadar and Revelganj blocks)
	Type of water	Potable
11.	DYNAMIC GROUND WATER RESOURCES(as on 31st March 2009)- in mcm	
	Annual Replenishable Ground water Resources	764.46
	Net Annual Ground Water Draft	434.59
	Projected Demand for Domestic and industrial Uses up to 2025	85.82
	Stage of Ground Water Development	56.8%
	AWARENESS AND TRAINING ACTIVITY	Nil
	Mass Awareness Programmes organized	--
	Date:	-
	Place:	-
	No of participant:	-
	Water Management Training Programmes organized	-
	Date	-
	Place	-
	No of participant	-
13.	EFFORT FOR ARTIFICIAL RECHARGE & RAIN WATER HARVESTING	Nil
	Project completed by CGWB(No & Amount spent)	-
	Project under technical guidance of CGWB (Numbers)	-
14.	GROUND WATER CONTROL AND REGULATION	
	Number of OE Blocks	-
	Number of Critical Blocks	-
	Number of Blocks notified	-
15	MAJOR GROUND WATER PROBLEMS AND ISSUES	Regular flood, Water logging, soil salinity and As contamination of ground water in few block

Ground Water Information Booklet
Saran District, Bihar State

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1.0 Introduction

Saran district was one of the six Sarkars (Revenue Divisions) of Bihar province as per historical record in the Ain-E-Akbari. East India Company in 1765 considered Saran district as one of the Revenue divisions with in Champaran district Saran district with three sub-division viz., Saran, Siwan and Gopalganj was put in newly created Tirhut division in the year 1908. In 1972 each of the sub-divisions the Saran district was upgraded into full-fledged districts. The present Saran district has its headquarters at Chapra.

The ground water information booklet of the district, prepared as a part of one of the activities of the "Water Year 2007", contains information, in brief, pertaining to administrative

.

1.1 Administration

The river Ganga constitutes the southern boundary of the district beyond which Patna and Bhojpur district lies. Siwan and Gopalganj district forms the northern and western boundaries of the district. The River Gandak forms the boundary in the east beyond which Vaishali and Muzaffarpur districts lies. This district is situated between $25^0$36' and $26^0$13' North latitude and $84^0$24' and $85^0$15' East longitude. The geographical area of the district is 2641 km^2. It comprises of 3 civil sub-division, 20 community development blocks, and 1783 villages. The total population of the district is 4943098 (Rural 3591053 & Urban 352045). There are 5 statutory towns in the district. These are Chapra, Revelganj, Sonepur, Dighwara and Marhaura. Chapra is the main town in the district. The district boundaries, administrative divisions, major roads, rivers, and HNS locations are presented in Fig 1.

1.2 Basin/sub-basin, Drainage

This district is a part of the Lower Ganga Basin. It falls in the Gandak sub-basin. Perennial rivers viz., the Ganga, the Ghagra and the Gandak, govern the drainage system in the district. The river Ganga meets the district at Kotwapatti Rampur and flow from west to east along the southern boundary of the district. The Gandak flows from northwest to southeast forming the northeastern boundary of the district. The river Gandak meets the river Ganga at Sonepur. The tributaries of the Gandak River viz., Mahi, Ghoghari and Gandaki flow roughly in the southeast direction. The Ghagra River also known as Suryu, in the adjacent state Uttar

Pradesh, flows in the southeast direction. It forms the southwestern boundary of the district. The river Ghagra meets the river Ganga near Chapra.

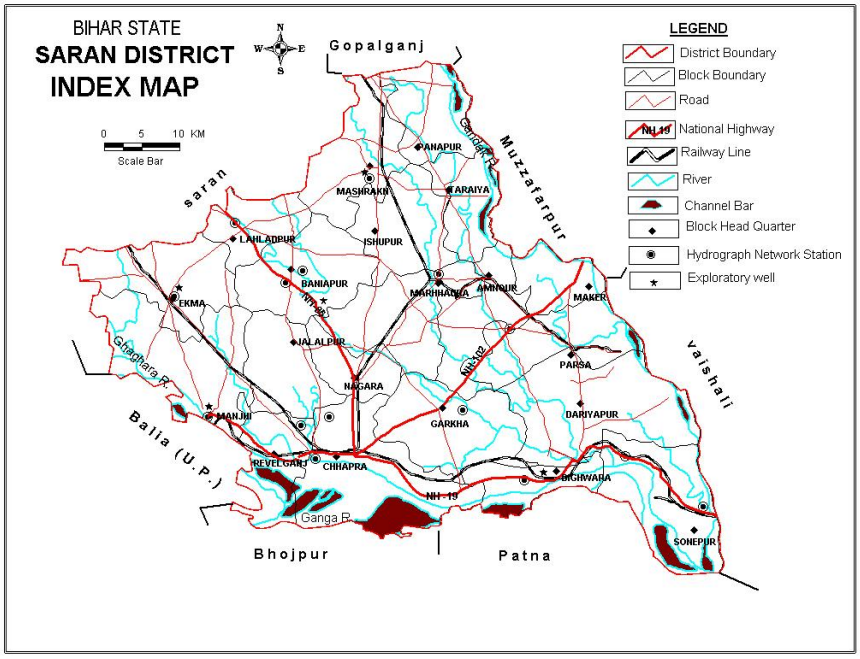

Fig. 1 Index map of Saran district

1.3 Irrigation practices

The total cropped area in the district is 232,691 hectare. The net sown area is 192,285 hectares and 40,406 hectares of land is sown more than once. The cropping pattern includes Paddy, Wheat, Maize, Arhar, Gram, Lentil, Linseed, Petil etc. The cropping intensity is 200%. The gross irrigated area is 119,652 hectares out of which irrigation from Saran Canal is 33,149 hectare. From state and private tube wells 79,128 hectares and from ponds 7,395 hectares (Govt. of Bihar, 2004-05). The irrigation from surface canal is operational since 1970, which is a part of Western Gandak Canal system and also known as Saran and Chapra canal.

1.4 Studies/Activities of CGWB

Central Ground Water Board has covered the district under systematic hydrogeological survey. District hydrogeological report has been issued. Five exploratory tube wells and five observation wells have been drilled in the district.

There are 15 Hydrograph Network Stations (HNS) to monitor the water level of phreatic aquifer. These HNS are monitored 4 times in a year as a part of ground water regime monitoring.

2.0 Climate and Rainfall

The westerly wind accompanied by dust storms around middle March marks the beginning of the summer season. May is the hottest month of the year when ambient temperature shoots up to 46^0C. The summer continues upto June before onset of monsoon. The winter starts towards the middle of October and ambient temperature dips down to about 7^0C during the month of January, which is the coldest month of the year. The humidity is lowest in April and highest in August.

The monsoon is active from June mid to the end of September. The average annual rainfall in the district is 837 mm for year 2004. The monsoon rainfall is about 80 % of the annual rainfall.

3.0 Geomorphology and Soil types

The district is shaped like a triangle with its apex at the junction of the boundary of Gopalganj district and the Gandak River. The land slopes towards southeast. The area has rich and fertile alluvial plain with quite a few depressions and marshes. There are three broad geomorphic divisions.

a) The alluvial plains along the major rivers, which are subjected to periodic inundation
b) The region of uplands away from the river and not subjected to floods and
c) The "diara" areas in the beds of the river Ganges, Gandak and Ghagra.

The two types of soils dominant in the district

1) Younger alluvial soil (sub type of Entisols) is restricted in the North Gangetic plain. It is generally deficient of nitrogen and phosphoric acid but not of lime and potash. The general texture of the soil in the area is sandy to loamy sand. High soil moisture and regular flooding are causing water-logging condition in this soil type area. These are most fertile soils and eminently suitable for extensive cultivation of Paddy and Sugarcane.
2) Calcareous alluvial soils (sub type of Inceptisols) occur mostly in the central part of the area. This soil is generally enriched in potash and phosphoric acid. The calcareous material brought by Gandak and its tributaries is causing this soil type. The growth of crops is less on account of high salt content.

4.0 Ground Water Scenario

4.1 Hydrogeology

The entire district is underlain by thick unconsolidated sediment of Quaternary period. The thickness of alluvium ranges between 500 to 700 m in the district. The older alluviums of Pleistocene age occupy the higher ground and it consists of calcareous nodules. The younger alluvium of Holocene age occupies lower ground and consists of thick sequence of clay, silt and sand with occasional Kankar. On the basis of availability of litholog data from the boreholes the following litho-stratigraphic classification have been established.

System	Series	Formation	Lithology
Quaternary	Upper Holocene	Diara formation	Sand, Silt loam and their mixture
	Unclassified Holocene	Vaishali formation	Grey silt and clay alteration with fine to medium sand
----------	Unconformity	----------	
	Pleistocene-Paleocene	Hajipur formation	Yellowish brown stick clay with calcareous nodules and thick pile of older alluvium

Mode of Occurrence of Ground Water

The water bearing granular shallow zones is restricted upto a depth of 50m and deeper zones between 50m and 200m (depth of exploration). Ground water occurs under unconfined conditions in the shallow zone and under semi-confined to confined condition in the deeper zones. The irregular slope of the bed over which the sediment rests, controls the saturated thickness of the aquifer. The hydrogeological map of the district along with Ec contour is shown in Fig. 2

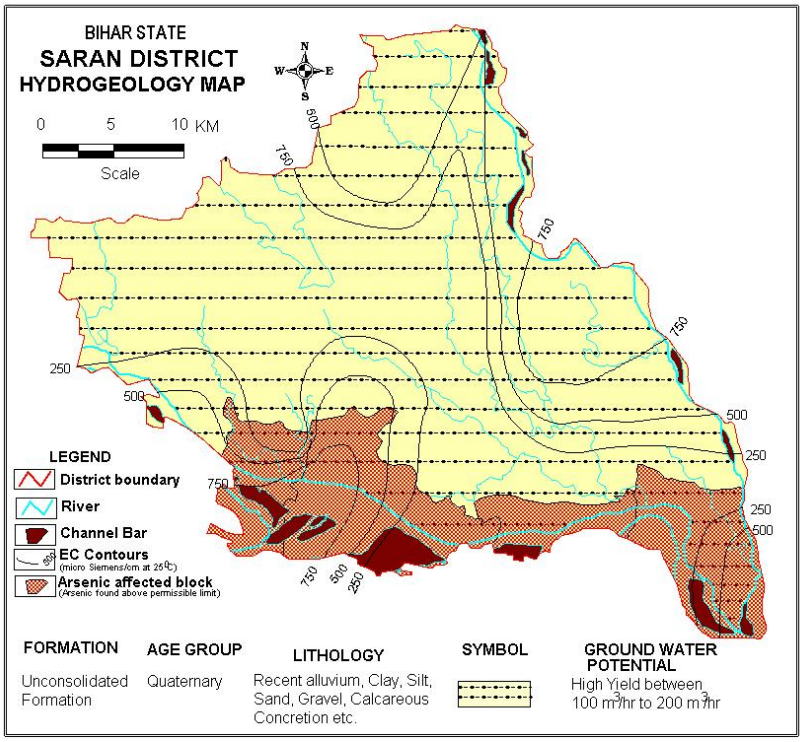

Fig 2. Hydrogeological map of Saran district

Water Level Fluctuation

The pre-monsoon (May 2011) water level generally varies from 1.6 to 8.96 mbgl in major part of the district (Fig.3). North-western and south-eastern part of the study area indicate tha water level is 2 to 5 m bgl and rest is > 5 m bgl. In post-monsoon (November 2011) water level generally varies from 0.4 to 7.47 m bgl in major part of the district water level ranges from 2 to 5 m bgl and in western part water level is also recorded . 5 m bgl (Fig.4). The May 2011 (Pre-monsoon) water level fluctuation with respect to May 2010 varies from .05 to 6.10. The November 2011 (Post monsoon) water level fluctuation with respect to November 2010 varies from .11 to 2.4. The long-term (decadal, 2001-2011) water level fluctuation shows rise of 0.16 to .45 m during pre-monsoon period, while water level fluctuation varies from .02 to 1.56 m during the post-monsoon period. The season wise, annual and decadal fluctuations of water level are given in Table 1.

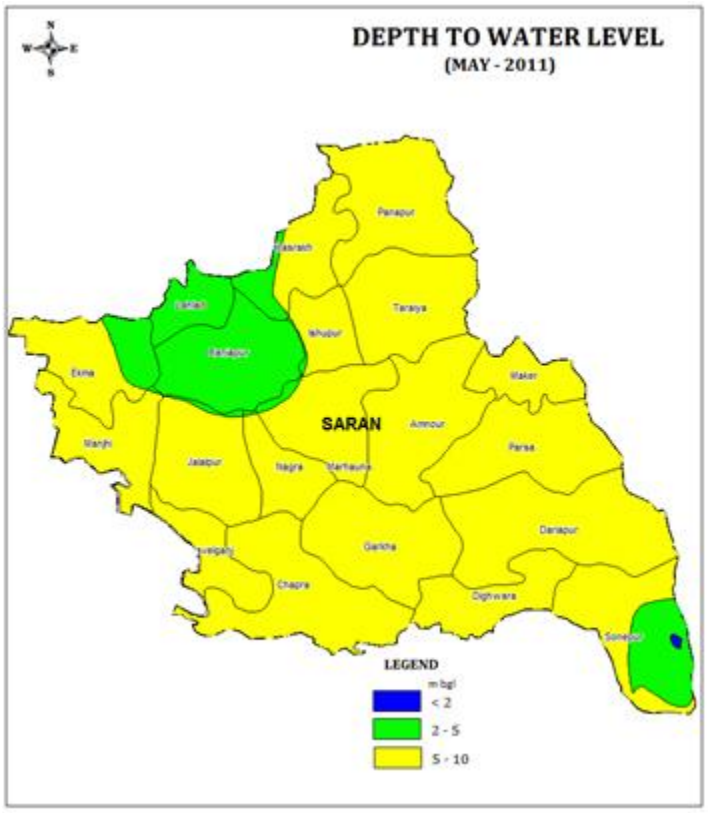

Fig 3. Pre-monsoon (May 2011) water level map of Saran district

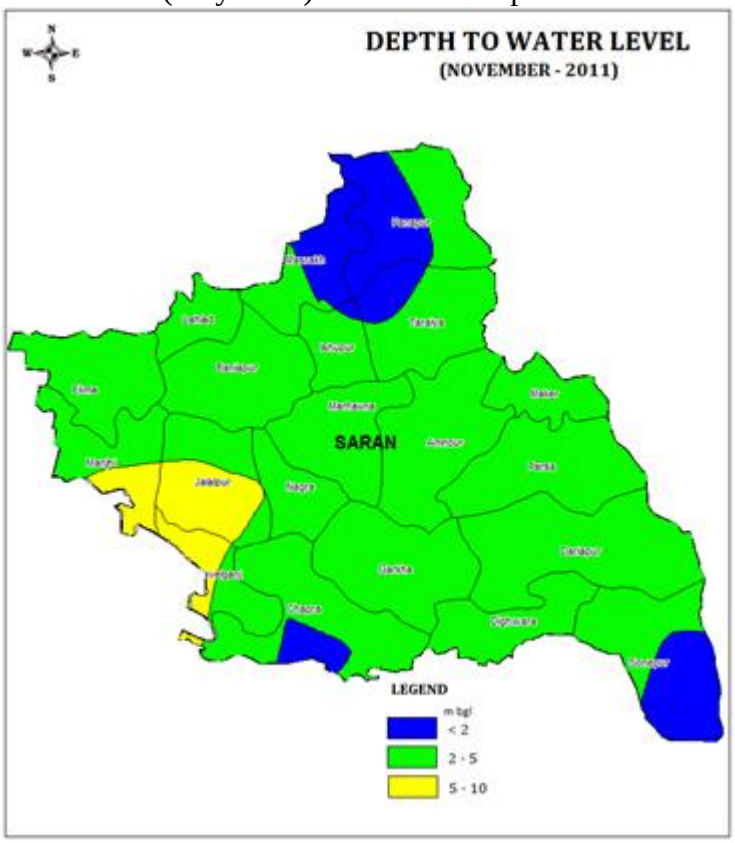

Fig 4. Post-monsoon (November 2011) water level map of Saran district

Table 1: Seasonal, Annual and Long term (Decadal) water level fluctuation of Saran district for year 2006

Seasonal Fluctuation

Sl.No.	Period	No. of wells Analysed	Range of Fluctuation				Rise						Fall					
			Rise		Fall		0-2 m		2-4 m		>4m		0-2 m		2-4 m		>4m	
			min	max	min	max	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	May 11 -Aug 11	11	0.94	7.01	.6	.6	1	9	5	46	4	36	0	0	0	0	0	0
2	May 11 -Nov 11	11	0.53	5.97	0	0	3	27	3	27	5	46	0	0	0	0	0	0
3	May 11 -Jan 12	11	0.51	5.62	0	0	3	27	5	46	3	27	0	0	0	0	0	0

Annual Fluctuation

Sl.No.	Period	No. of wells Analysed	Range of Fluctuation				Rise						Fall					
			Rise		Fall		0-2 m		2-4 m		>4m		0-2 m		2-4 m		>4m	
			min	max	min	max	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	May 11 -May 10	10	0.05	6.10	0.36	0.36	5	50	0	0	4	40	1	10	0	0	0	0
2	Aug 11 - Aug 10	12	0.42	3.14	0.16	1.35	7	58	2	17	0	0	2	25	0	0	0	0
3	Nov 11 - Nov 10	10	0.11	2.40	0	0	9	90	90	1	10	0	0	0	0	0	0	0
4	Jan 12- Jan 11	12	0.32	1.56	1.68	1.68	11	92	0	0	0	0	2	8	0	0	0	0

Long Term (Decadal) Fluctuation (2001-2011)

Sl. No.	Period	No. of wells Analysed	Range of Fluctuation				Rise						Fall					
			Rise		Fall		0-2 m		2-4 m		>4m		0-2 m		2-4 m		>4m	
			min	max	min	max	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	May mean – May11	11	0.16	.45	.21	3.15	3	27	0	0	0	0	6	55	2	18	0	0
2	Aug mean - Aug 11	13	.20	1.66	0.12	2.13	4	30	0	0	0	0	8	62	1	8	0	0
3	Nov mean - Nov 11	12	0.02	1.56	0.46	1.43	9	75	0	0	0	0	3	25	0	0	0	0
4	Jan mean - Jan 12	13	.29	2.85	0.09	.09	11	84	1	8	0	0	1	8	0	0	0	0

Ground Water Hydraulics

CGWB have drilled 5 exploratory and 5 observation wells in the district. The depth of the well varies from 50 to 168 mbgl. The shallow tube wells upto depth of 50 to 55 m tapped granular zone resting between 09-15, 16-25, 30-39 and 40-46 m. The deeper tube wells tapped zone resting between 70-110 and 120-140 m bgl. The transmissivity of the shallow aquifer varies from 29 to 646 m^2/day. The discharge in these wells varies from 6 to 24 m^3/hr for drawdown in the order of 1.5 to 8.0 m. The deep tube wells having higher discharge ranges from 150-250 m^3/hr at nominal drawdown from 2.4 to 8.0 m. The list of well drilled and their hydraulics characteristics are given in Table 2 and the location of the exploratory wells are shown in Fig. 1.

Table 2. List of Exploratory well drilled and their hydraulic characteristics

Sl. No.	Location	Depth Drilled mbgl.	Length of Casing pipe/ Depth const. m.	Granular/ Zone/ fracture Tapped m.	Static Water level m. bgl.	Discharge m^3/hr.	Drawdown m.	Trans-missivity m^2/day	Storativity
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**11**
1	**MASHRAKH**	50	28	21.50 - 24.50	2.53	6.6	14.45	29	-
2	**EKMA**	51	40	30.00 - 38.00	1.91	24.12	6.8	102.42	$06.50X10^{-4}$
3	**DIGHWARA**	55.5	48	09.00 - 15.00 16.00 - 23.00 33.00 - 39.00 40.00 - 46.00	6.59	22.54	1.48	646	$06.40x10^{-4}$
4	**VISHNUPUR**	168	143	72.00 - 74.00 90.00 - 102.00 123.0 - 135.0 136.0 - 141.0	1.25	50 (Air comp)	-	-	-
5	**MANJHI**	159.4	138	87.00 - 99.00 105.0 - 117.0 123.0 - 135.0	5.35	64.7	7.9	1776	-

4.2 Ground Water Resources

The net annual replenishable ground water resource as on 31st March'09 is worked out to be 76446 ha m. The gross annual draft for all uses is worked out to be 43459 ha m. Allocation of ground water for domestic and industrial use for the year 2025 worked out to be 9582 ha m. The stage of ground water development is 56.8 %. The stage of ground water development is highest in Parasa blocks (76.9%) and lowest in the Manihi blocks (17.6%). The dynamic ground water resource of the district is depicted in Fig 5. The block-wise resource is given in Table 03.

Table 2: Block-wise dynamic ground water resource of Saran district (As on 31st March 2009, in ha m)

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 year 2025	Net Ground Water Availability for future irrigation development (9-10--12)	Stage of Ground Water Development (12/9)*100 (%)
1	2	9	10	11	12	13	14	15
1	Amnaur	2797	375	295	670	457	1964	24.0
2	Baniapur	5435	2711	380	3092	590	2133	56.9
3	Chapra	5049	2082	592	2674	782	2185	53.0
4	Dariapur	5850	3769	400	4169	620	1461	71.3
5	Dighwara	2248	1387	278	1665	363	498	74.1
6	Ekma	4952	3247	318	3564	493	1212	72.0
7	Garakha	4997	2685	387	3073	601	1711	61.5
8	Ishupur	3213	2117	212	2329	329	767	72.5
9	Jalalpur	3919	1975	241	2216	374	1569	56.6
10	Lahladpur	1803	836	123	959	190	776	53.2
11	Maker	2207	504	133	638	207	1496	28.9
12	Manjhi	5322	540	394	935	612	4170	17.6
13	Marhaura	5156	3089	455	3544	644	1423	68.7
14	Masharakh	4476	1955	274	2230	426	2094	49.8
15	Nagra	1821	1164	169	1333	262	395	73.2
16	Panapur	3389	1597	176	1773	273	1519	52.3
17	Parasa	3554	2513	219	2732	340	701	76.9
18	Revelganj	3303	1206	285	1491	355	1741	45.1
19	Sonpur	3659	1003	495	1498	683	1972	40.9
20	Tariya	3298	2039	207	2246	321	938	68.1
	Total	**76446**	**36798**	**6661**	43459	**9582**	**30725**	**56.8**

4.3 Chemical Quality of Ground Water

Chemical quality of water is important in deciding its suitability for irrigation, industrial and drinking purposes. Chemical quality of ground water of phreatic aquifer is found suitable for drinking and irrigation purposes. The ground water is mildly alkaline in nature with pH ranging from 7.36 to 8.43. Electrical conductivity (EC) varies from 580 at Sonepur to 960 micro seimens/cm at 25^{o}C at Chapra. All major parameters are within the permissible limit. The ground water is suitable for irrigation and drinking purposes. However, Arsenic has been reported from some villages of the Sonepur, Dighwara, Chapra Sadar and Revelganj blocks. Samplings from handpumps of arsenic risk zone area has been done for arsenic concentration analysis. The arsenic contaminated water above permissible limit of 50 ppb is hazardous for human health.

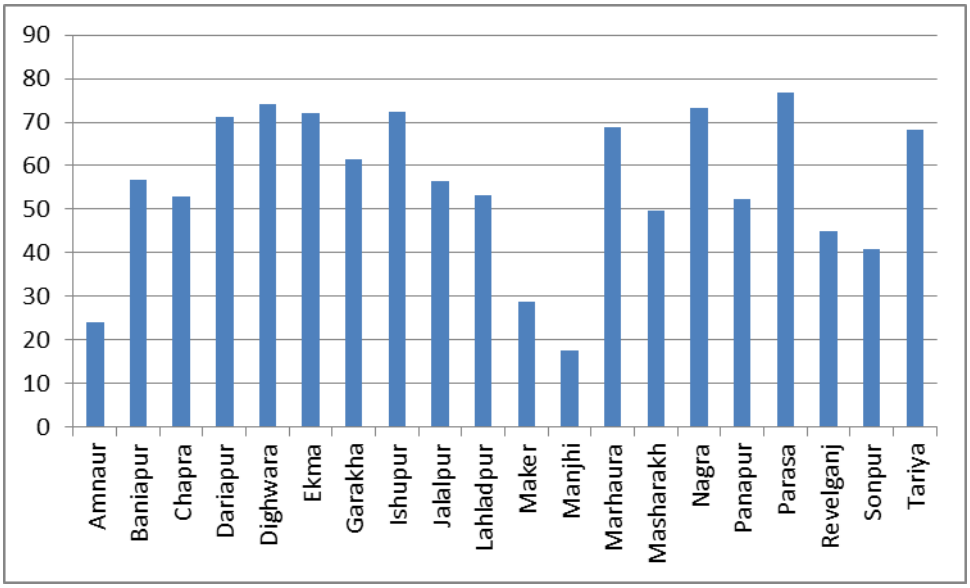

Fig 5. Block-wise stage of ground water development map of Saran district

4.4 Status of Ground Water Development (Blockwise)

The development of ground water is mainly through shallow tube well sunk to depth of of 60 – 80 m below ground. As per the Govt. of Bihar (2000–01) minor irrigation census data, there were 23,012 shallow tube wells, 151 state owned deep tube well and 11,981 dug well were available for the irrigation.

5.0 Ground Water Management Strategy

There is need to adopt an integrated approach of development of ground water resources dovetailed with ground water augmentation to provide sustainability to ground water development

5.1 Ground Water Development

The aquifer system present in the district is highly potential. Dug wells of diameter 1.5 to 3.0m upto depth range of 10m may yield upto 15 m^3/hr. The saturated thickness varies from 20-30 m in shallow aquifer. A shallow tube well to the depth range of 50m, in the blocks of Ekma, Mashrakh and Dighwara tapping 10 to 20m of granular zones may yield 20 to 25 m^3/hr. A well assembly of 76 mm diameter or 102 mm diameter with 10 to 20m of slotted pipes can be used for construction of tube wells in the depth range of 50-80 m bgl. A deep well down to a depth of 150 m may yield 150-250 m3/hr for nominal drawdown of 3 to 8m. The slot opening for medium to coarse-grained sand may be 1/16”. The wells should be properly shrouded with pea size gravel of 2 to 5 mm. The distance between two shallow tube wells should be 150 to 200 m and between two deep tube wells may be 500 to 600m for safe discharge.

In the arsenic affected blocks shallow aquifer upto 60m may be cement sealed to avoid the vertical mixing of arsenic contaminated and fresh water. Deep aquifer below 80 m may be tapped to get arsenic free water (i.e., arsenic below permissible limit of 50 ppb).

5.2 Water conservation and Artificial Recharge

All the blocks of the district fall under the safe category. However, in 6 blocks viz., Amnaur, Dighwara, Maker, Marhaura, Nagra and Parasa stage of ground water development is above 65%. In these blocks it is advisable to adopt water conservation and artificial recharge measures. The water conservation and artificial recharge to ground water by rainwater harvesting may be adopted in the Manjhi block where even post-monsoon water level falls below 8 m bgl. As the entire district is covered by the alluvial formation, contour bunding and recharge ponds are most suitable structure in the rural areas of the blocks. Artificial recharge measures can also be adopted in the arsenic affected blocks especially in arsenic affected habitations. It may help in dilution of arsenic concentration in ground water. The block-wise stage of development and suitable block for artificial recharge and rain harvesting is shown in Fig 6

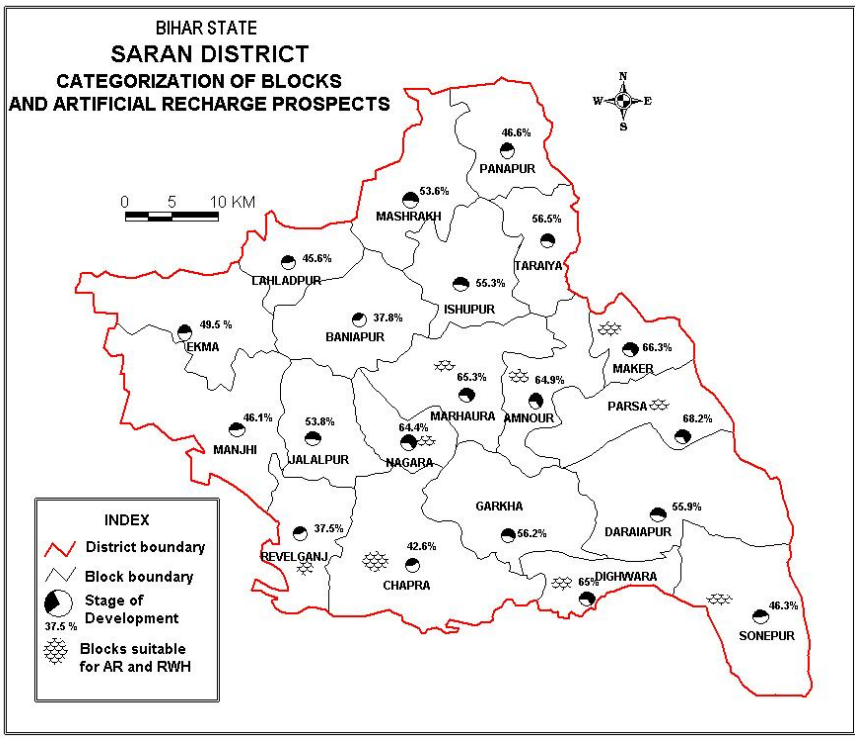

Fig 6: Categorisation of blocks and artificial recharge prospects

6.0 Ground Water Related Issue and Problems

Flooding , surface water logging, soil salinity and Geogenic contamination of ground water of shallow aquifer with arsenic is major ground water related issues in the district. Flood in the monsoon period is a major problem with agriculture. Out of the 20 blocks six blocks viz., Sonepur, Dighwara, Revelganj, chapra, Manjhi and Dariyarpur are regularly affected by flood, and another six blocks viz., Garkha, Parsa, Marhaura, Amanpur, Jalalpur and Ekma are partially affected by the flood. The remaining 8 blocks are free from the flood and available for cultivation in monsoon period.

The surface water logging and soil salinity problems in parts of Mashrakh, Parsa and Ekma blocks of the district is another major issue. This issue occurs due to violation of cropping pattern and irrigation benefits in the upper reaches of canal.

Geogenic contamination of ground water of shallow aquifer with arsenic in a few villages of Sonepur, Dighwara, Chapra sadar and Revelganj came out as a major ground water issue. Public Health Engineering Department, Government of Bihar has painted the mouth of Arsenic affected hand pump with Red colour and safe hand pump with blue colour in the arsenic affected blocks of the district. The arsenic contaminated water in general, restricted with in the shallow aquifer (50 m).

7.0 Mass Awareness and Training Activity

Mass Awareness Programme (MAP) and Water Management Training Program (WMTP) has yet to be organized in this district.

8.0 Area notified by CGWA / SGWA

As such no block has been notified under CGWA/ SGWA.

9.0 Recommendation

1. Ground water development in the district can be done with the help of shallow tube well, bamboo borings and deep tube well.
2. The overall stage of ground water development is 56.8%. Therefore, there is scope for the development of ground water.
3. Ground water potential of the district can be exploited to increase the cropping intensity of the district.
4. Arsenic is found above permissible limit in few blocks of the district. Construction of Arsenic free deep tube-well in the habitations where, arsenic is found above permissible limit is necessary.
5. Drinking water supply to the villagers of the arsenic affected blocks from deep tube wells.
6. Shallow aquifer upto 50 m depth must be cement sealed, while constructing deep tubewells in the Arsenic affected blocks
7. Changing cropping pattern in the upper reaches of the Saran and Chapra canals may reduce the water logging condition.
8. Use of ground water from shallow and deep tube wells in the water logged area.
9. Changing of cropping pattern in the regularly and partial flooded blocks.
10. Water conservation and Artificial Recharge measure should be adopted in the highly exploited blocks.
11. Diesel operated pump sets enhances the lifting cost of tubewell water. In order to reduce financial burden, alternative low cost energy should be provided for the energisation of pumps.
12. Non-conventional energy resource can be used for the energisation of pumpsets, where it seems feasible