Ground Water Resource its appraisal, Conservation and Planning : A case study of East Champaran District

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Abstract

Ground water is a precious and the most widely distributed resource of the earth and unlike any other mineral resource, it gets its annual replenishment from the meteoric precipitation. The world's total water resources are estimated at 1.37 × 108 million ha-m. Of these global water resources about 97.2% is salt water mainly in oceans, and only 2.8% is available as fresh water at any time on the planet earth. Out of this 2.8%, about 2.2% is available as surface water and 0.6% as ground water. Even out of this 2.2% of surface water, 2.15% is fresh water in glaciers and icecaps and only of the order of 0.01% (1.36 × 104 M ha-m) is available in lakes and reservoirs, and 0.0001% in streams; the remaining being in other forms -0.001% as water vapour in atmosphere, and 0.002% as soil moisture in the top 0.6 m. Out of 0.6% of stored ground water, only about 0.3% (41.1 × 104 M ha-m) can be economically extracted with the present drilling technology, the remaining being unavailable as it is situated below a depth of 800 m. Thus, ground water is the largest source of fresh water on the planet excluding the polar icecaps and glaciers. The amount of ground water within 800 m from the ground surface is over 30 times the amount in all fresh water lakes and reservoirs, and about 3000 times the amount in stream channels, at any one time. At present nearly one fifth of all the water used in the world is obtained from ground water resources. Agriculture is the greatest user of water accounting for 80% of all consumption. It takes, roughly speaking, 1000 tons of water to grow one ton of grain and 2000 tons to grow one ton of rice. Animal husbandry and fisheries all require abundant water. Some 15% of world's crop land is irrigated. The present irrigated area in India is 60 million hectares (M ha) of which about 40% is from ground water.

keywords:-Ground Water, Resource, Precipitation, Surface Water, Agriculture, Irrigation

Introduction

The name Champaran owes its origin to Champa-aranya. Champa means Magnolia and aranya means forest. Hence, Champaranya means forest of Magnolia (Champa) trees. The area was inhibited by ascetics scholars. Historically, East Champaran is a part of parent Champaran district. Champaran constituted a part of the ancient kingdom of Videha .The Aryan Videhas settled east of the Gandak or Narayani river.

Methodology

The present research work based on the observational description and observational rational methods in order to decipher the theme of the research. Various statistical and cartographic methods has applied where ever needed. The present research study based on both primary and secondary data. The primary data collected through personal observation, interview, questionnaires schedule etc. while the secondary data collected from concerned district or block headquarters. Map and diagrams, graphs etc. have been
widely used in this research papers

Objectives

1. To ensure regulated exploitation and optimum & judicious use of ground resources.
2. To implement ground water recharge programme on a large scale in an integrated manner and to bring over-exploited/critical blocks into safe category in a time bound manner.
3. To effectively implement conjunctive use of surface water and ground water.
4. To promote efficient methods of water use in the stressed areas.
5. To give priority to the river basin/watershed approach in ground water management planning and conservation.
6. To identify ground water polluted areas in order to ensure safe drinking water supplies.
7. To implement ground water conservation and recharging programmes by the concerned departments through participatory management approach in a co-ordinated and integrated manner.

Study Area

East Champaran district of Bihar state lies between N 26º 15’ 10” and 27º 01’ 30” and E 84º 30’ and 84º 17’ 50” covering an area of 3968 Sq. Km. The district is bounded in the North by Nepal, South by Muzaffarpur, part of Gopalganj, East by Sitamarhi and Sheohr and West by West Champaran and part of Gopalganj district. On 1st of December 1971, Champaran district was split up into two

districts, viz. East Champaran and West Champaran. The headquarter of East Champaran district is at Motihari.

The district headquarter is Motihari which is well connected to different parts of the state by all weather roads and rail. It is about 170 Km from Patna by road. Location of the district is of strategic and historical importance. The district has been the centre of communication for the border areas of Nepal. It has six sub-divisions with 27 blocks. Administrative details of East Champaran district are given below in As per the census of 2011, the district has a population of 5,082,868 with 2,674,037 males and 2,408,831 females. The population density has been found to be 1281 persons per sq. km. The male female sex ratio has been found to be 901 females per 1000 males. Literacy rate is 58.26% with 68.02% for male and 47.36% for female. Overall literacy percentage in the district is 58.26% with 68.02% of male and 47.36% of females literacy.

Basin/sub-basin, Drainage

The river Gandak or Sikrahna (Burhi Gandak) is the most important river in the the district from North West to South East. In the northern part of its course in the district, the river Gandak is known as Sikrahna and in the southern part of its course it is known as Burhi Gandak. The river Gandaj has often changed its course in the past causing floods in many parts of the district. An abandoned channel of this river, called Dhanauti, has stopped to flow because of silting up of its off–take. Presently, this channel is a sluggish drainage channel with many loops before joining with river Sikrahna at Pakridayal. The other important rivers in the district are Lal Bakeya and Bagmati. The river Lal Bakeya originates in the foot hills of Nepal and flows through the district in southern direction forming the eastern boundary of the district with Muzaffarpur before meeting river Bagmati near the village Khori Pakur. Other rivers reported from the district are Tilawe, Kachhna, Motia and Tiur.

Irrigation practices

The economy of the district mainly depends upon agriculture. The major crops of the district are Paddy (Basmati Rice), Mustard, Sugarcane, Jute, Lentis and Vegetables. The irrigation in the district is mostly influenced by the presence of canal system in the northern and eastern parts. This has greatly improved the irrigation facilities in the district. Irrigation through lifting of water by means of swing buckets, by constructing bunds on the river and distribution of the water by means of ‘Pynes’. Other irrigation means are shallow tubewells, tanks and wells. Gross irrigated area reported from the

district is 183000 hectares of land with Net irrigated area of 141000 hectares of land. Along with this, total cropped area is 390473 hectares and net sown area is 304875 hectares of land.

Studies/Activities of CGWB

Central Ground Water Board has covered the district under systematic hydrogeological survey and a major part the district has been covered under ground water management study. District hydrogeological report and ground water management study report has been issued. As per the Dynamic Ground Water Resource of Bihar State (2009) the net annual ground water availability in the district is 124861 ha.m. and net ground water availability for future irrigation development in the district is 67797 ha.m. Under exploratory programme, CGWB has drilled 7 exploratory wells and 3 observation wells. Wells upto a maximum depth of 348 mbl have been constructed in the district. The list of wells drilled is given in the table : There are 16 Hydrograph Network Stations (HNS) in the district, which are monitored four times in a year to measure the water level of the phreatic aquifer. These HNS locations are as follows:

1. Chakai
2. Ghorashan
3. Dheoraha
4. Kalyanpur
5. Dipau
6. Khajuria Chowk
7. Lakhwara
8. Motihari
9. Gobindganj
10. Patahi
11. Raxaul
12. Chhapwa
13. Turkalia
14. Nawada
15. Areraj
16. Dharampur

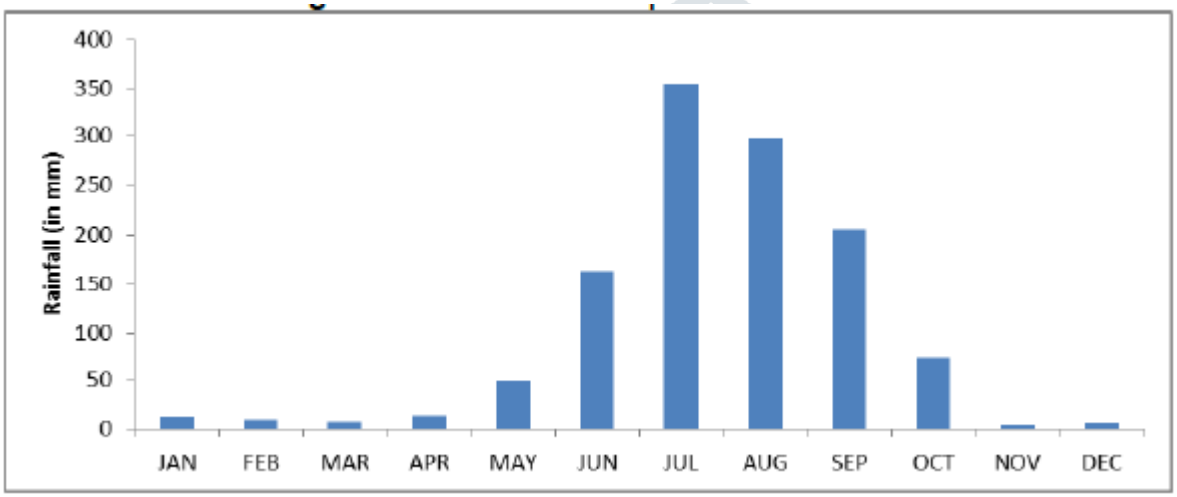
Climate and Rainfall

Flood and drought has remained a regular feature of the area. The district of East Champaran is known for its hot summers and severe winters. The summer season starts from the end of March with

average temeperature of about 35º C and maximum temperature of 46º C in the months of May and June. In winter season the temperature goes down to 4 - 5º C. Lowest temperature is reported from the end of December to January.

The rainfall in the region is received through South West Monsoon during June to end of September in the area. During the rest of the period the rainfall is sporadic or scanty. The average rainfall reported from the area is 1241.6 mm. Very heavy rainfall is reported in the month of July to September. Winter rains along with pre monsoon showers are common in the district. A plot showing month wise rainfall (in mm) of East Champaran district is given below .

Fig. 1. Month-wise rainfall plot for the district



Geomorphology and Soils

The topography of the area is fairly even and has fertile alluvial plains. These alluvial plains are divided into two tracts by the river Burhi Gandak (Little Gandak) with both the plains having remarkably different characteristics. The river Sikarahna (Burhi Gandak) divides the tract from North West to South East. The northern portion of the tract is of older alluvium and has low land area which is suited for cultivation of kharif but is unsuitable for rabi crops. The southern portion of the tract has recent alluvium deposits of the river Gandak which has changed its course moving further west. This southern portion is suited for cultivation of both Kharif and Rabi crops. The area of this region is characterized by stretches of upland varing in places by large marshy depressions known as 'Chaurs'. The major slope of the area is due south-east.

The most remarkable feature of the district is presence of a chain of nearly 40 lakes running through the centre of the district covering an area of around 350 sq. km. The important lakes are located at Sugaon, Talsaraiya, Turkaulia, Motihari, Pipra, Siraha, Nawada and Tetaria. The depth of the lakes varies from 1-5 m and remains mostly filled up with water during summers. The prevalent soil is

older alluvial type which is characteristic feature of the Gangetic plain. The soil is lighter in texture. In the northern region the soil is strong clay known locally as 'Bangar' covering an area of about two-fifth of the district. In this area, paddy crops are cultivated during sufficient rainfall seasons. In the Southern region of the river, the soil is mainly light sandy loam not suitable for kharif but yields good crops of wheat, mustard linseed etc. Major soil types found in the area are Paleustalfs, Haplaquents and Udifluvents soils.

Discussion

East Champaran district lies east of the Gandak River in the North Ganga Plain. Thick alluvial deposits down to depth of 300 m have been explored. Potential aquifers can be tapped both at shallow depth (~ 50 m bgl) as well as deeper level up to 200 m bgl in general. Discharge is high enough to meet the requirement for drinking and irrigation.

Hydrogeology

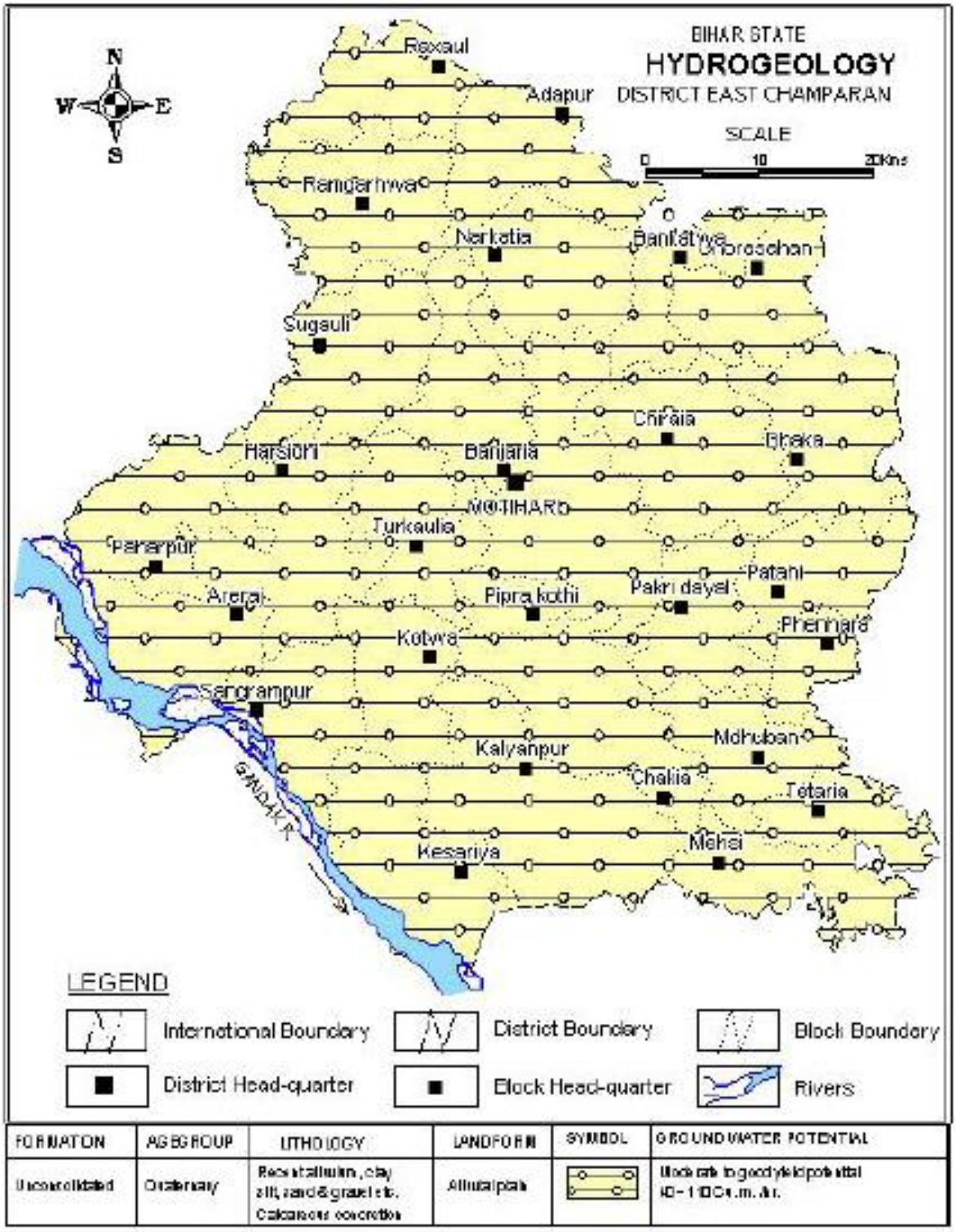
Geologically, the district has unconsolidated alluvial sediments of Quaternary age. The geological succession as per Geological Survey of India is as follows:

Group	Formation	Lithology
Quaternary	Recent alluvium	Clay, Silt and Sand gravel, Calcareous nodules (kankars)

The predominant soil is of older alluvial type which is a characteristic feature of the Gangetic plain. The entire alluvial tract is exposed to fluvial action of recent times. Ground water occurs under unconfined conditions in the phreatic aquifer, which is generally disposed within 70 m below ground. Aquifers situated at deeper levels have ground water levels under confined condition.

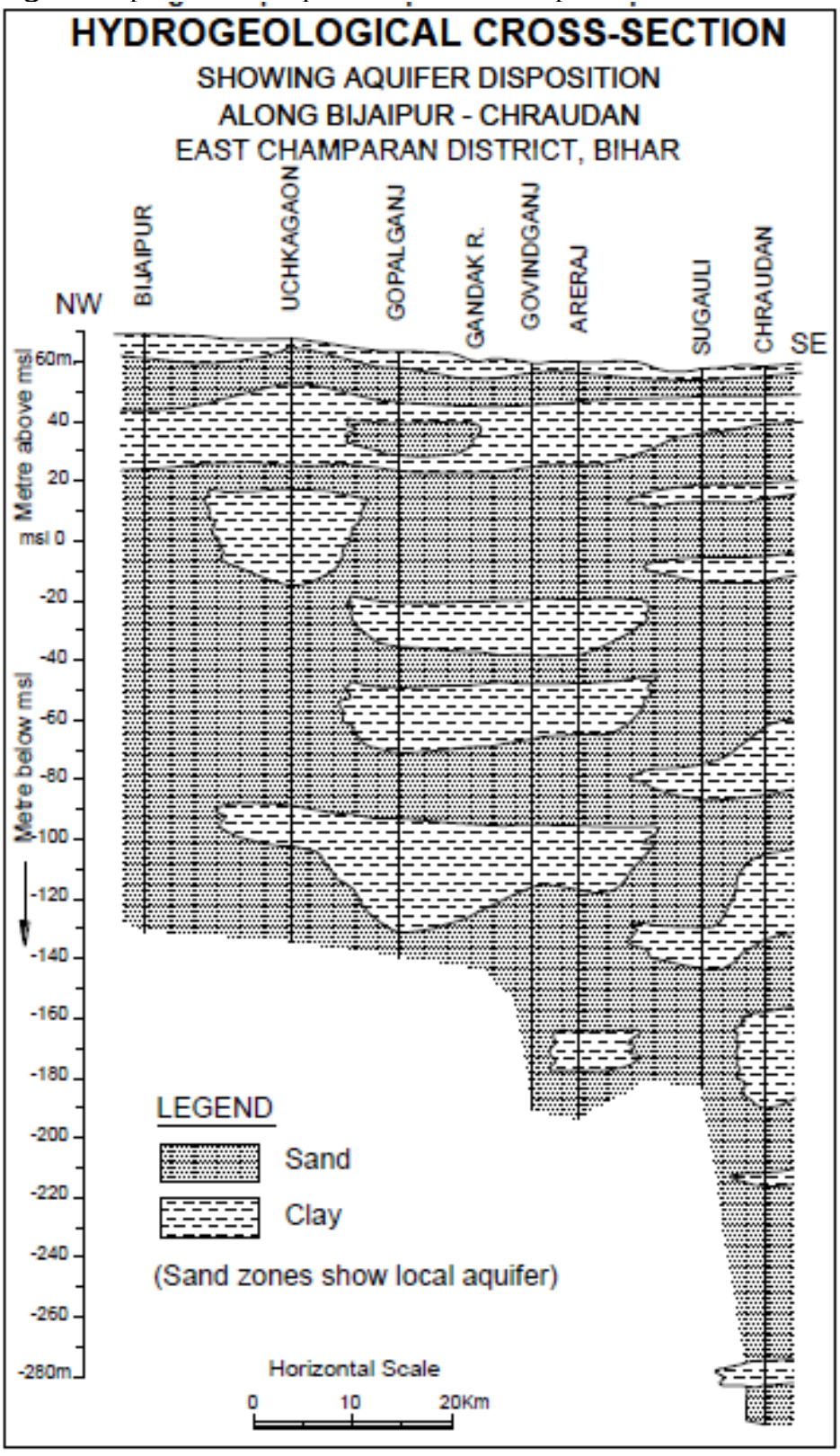
The hydrogeological map of the district is shown in .

Fig. 2. Hydrogeological map of the district



FORMATION	AGE GROUP	LITHOLOGY	LANDFORM	SYMBOL	GROUNDWATER POTENTIAL
Unconsolidated	Quaternary	Recent alluvium, clay silt, sand & gravel etc. Calcareous concretion	Alluvial plain		Moderate to good yield potential 40 - 100 cu.m./hr.

Fig. 3. Disposition of Aquifers in East Champaran

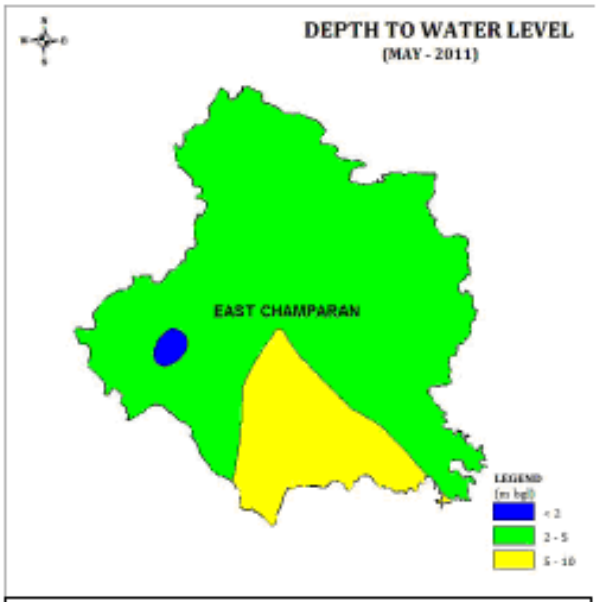


The water level fluctuation in the area can be noticed through continuous monitoring of Hydrograph Network Station (HNS) wells in the district. The HNS monitoring is being done four times a year as per the following schedules (Table No. 2):

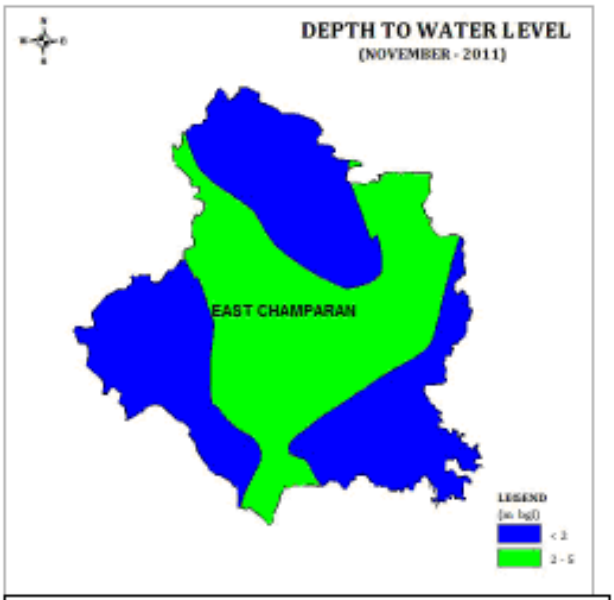
Table No. 2. HNS monitoring schedule

Sl. No.	Month	Date	Period
1	May	20 – 30	Pre-monsoon
2	August	20 – 30	Mid-monsoon
3	November	1 – 10	Post-monsoon
4	January	1 – 10	Recession

In East Champarn, most of the wells have depth range of 2-5m. The pre-monsoon (May 2011) depth to water level generally varies from 1.5 to 6 m bgl in major part of the district (Fig. 4.) The post-monsoon (August 2011) water level generally varies from 0.65 to 2.24 mbgl. Similarly, for the month of November 2011 the water level varied from 0.80 to 3.25 mbgl (Fig. 5) and in January 2012 from 1.15 to 3.50 mbgl.



Depth to Water Level map (May 2011)



. Depth to Water Level map (November 2011)

On compaing the water level fluctuation of May 2011 and August 2011, it is seen that there is rise of 3.58 mbgl of water level. The depth range of the wells showing rise in water level ranged from 2-4m. Similarly, comparing the water level fluctuations of May 2011 and November 2011, there is rise of water level upto 3.41 mbgl. This rise in water level varies from 2 to 4 mbgl. On comparing the water level fluctuations of May 2011 and January 2012, there is rise of water level upto 3.17 mbgl. Taking into consideration, the long-term decadal (2001-2011) water level fluctuation for pre monsoon, there is a variation in water level from 0.50 to 1.18 mbgl and for post monsoon, it shows variation in water level between 0.26 to 2.18 mbgl. During pre-monsoon nearly 28.5% of the wells showed rise and

71.4% of wells showed falling trend in water level whereas during post monsoon 50% of the well showed rise and rest 50% of the well showed fall trend in water level.

Ground Water Resources

As per the dynamic ground water resources calculated for the districts, as on 31st March 2009, the net annual replenishable ground water resource works out to be 124861 ha.m. The gross annual draft for all uses works out to be 52836 ha.m. Allocation of ground water for domestic and industrial use for 25 years works out to be 11754 ha.m. The stage of ground water development is 42.3%. The stage of ground water development is highest in Madhuban (79.7%) and lowest in Kesaria (24%). As stages of ground water development in all the blocks are less than 70% except Mahduban (79.7%), Phenhara (77.5%), Piparikothi (76.2%) and Tetaria (73.3%), and there is no long-term decline in water levels, on the basis of stage of ground water development and water long term water level trend all the blocks are categorized under safe category. The stage of ground water development is depicted in Fig. 7. The block-wise ground water resource is given in Table 3.

Table 3. Block wise Dynamic Ground Water Resource of East Champaran district (2008-09)
(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 year 2025	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	Adapur	4975	1837	278	2114	446	2693	42.5
2	Areraj	5676	1391	337	1728	409	3877	30.4
3	Bankatwa	2475	929	161	1090	258	1288	44
4	Banjharia	3366	1379	217	1596	348	1639	47.4
5	Chakia (Pipra)	4963	1681	386	2067	677	2605	41.6
6	Chhouradanu (Narkatiya)	5028	1734	231	1966	372	2921	39.1
7	Chiraiya	6083	1427	376	1803	604	4052	29.6
8	Dhaka	5272	1746	597	2343	746	2780	44.4
9	Ghorasaran	3342	1283	240	1523	386	1673	45.6
10	Harsidhi	7287	2873	302	3175	485	3929	43.6
11	Kalyanpur	9443	3022	385	3407	619	5802	36.1
12	Kesaria	6929	1403	262	1665	421	5105	24
13	Kotwa	3519	1024	227	1251	365	2129	35.6
14	Madhuban	3329	2432	219	2652	352	544	79.7
15	Mehsi	4183	2509	235	2743	377	1297	65.6
16	Motihari	6678	2444	541	2985	980	3254	44.7
17	Paharpur	6571	2040	250	2290	401	4130	34.8
18	Pakaridayal	3354	1928	197	2125	316	1109	63.4
19	Patahi	3295	1591	222	1813	357	1347	55
20	Phenhara	1621	1153	103	1255	165	303	77.5
21	Piparikothi	1422	979	104	1083	167	276	76.2
22	Ramgarhwa	5181	1146	278	1424	447	3587	27.5
23	Raxaul	4747	1027	317	1344	552	3168	28.3
24	Sangrampu	3486	1190	207	1397	333	1963	40.1

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25	Sugouli	5309	1847	469	2316	549	2914	43.6
26	Tetaria	2154	1441	139	1580	223	490	73.3
27	Turkaulia	5172	1853	247	2101	398	2921	40.6
Total	**124861**	**45309**	**7527**	**52836**	**11754**	**67797**	42.3	

Ground Water Exploration

The district having an area of 3968 sq km lies between north latitude 260 15' 10": 270 01' 30"and east longitude 840 30': 850 17'. The district is mainly drained by Gandak and Sikrahna rivers. Geologically, the district is occupied by unconsolidated alluvial sediments of Quaternary age. The Quaternary sediment of the district has been divided into two groups (a) Newer alluvium and (b) Older alluvium. The Newer alluvium occupies the low lying area restricted to flood plains whereas older alluvium occupies the high grounds. The lowest water table contour value is 50 m above MSL and maximum value is found to be 74 m above MSL.

GROUND WATER QUALITY

Quality of ground water is just as important as its quantity. This is well-recognized part and accepted fact in present day world. Quality of ground water in nature mostly depends on the geological formations holding it i.e. Aquifers. All ground water contains salts in solution that are derived from the locations, and rocks through which it moves. In addition ground water contamination is caused by discharge containing pollutants, which get mixed with them. Quality of ground water is described with reference to the needs i.e., drinking, industrial and irrigation to assess the quality of ground water for different purposes. The physical and chemical constituents are determined and are compared with the standard ones, recommended each for the drinking, industrial and irrigations requirements.

Chemical quality--Ground water quality in general is potable and found as per specification of Bureau of Indian standards. Table No. 6 below shows the general range of chemical parameter of East Champaran district (major chemical parameters of ground water samples of HNS collected during pre-monsoon 2011 in Bihar State).

1. Electrical conductivity: of ground water of parts of East Champaran District ranges between 510 – 1520 micro siemens /cm. at 25OC.

2. PH: Ground water of the parts of Ranchi districts are slightly alkaline in nature where PH varies between 7.68 to 8.30.

3. Chloride: concentration of chloride varies between 4 to 121 mg/l.

4. Bicarbonate: concentration of bicarbonate is between 342 to 598 mg/l.

5. Calcium: Calcium is found between 26 to 42 mg/l.

6. Magnesium: It occurs between 12 to 114 mg/l.

7. Sodium and Potassium: concentration of sodium is between 18 to 132 mg/l while potassium occurs between 1 to 84 mg/l.

Finding and Conclusion

The district of East Champaran is underlain by prolific and regionally extensive aquifers of huge thickness. The aquifers of good repositories are confined in medium to coarse grained sand layers in the alluvial sequences. Open wells or Dug wells with a diameter of 1 to 3 metres, upto depth range 2 to 7 m bgl, are tapping the upper part of the zone of saturation. The stage of ground water development in the district is 42.3% overall however in the four blocks namely Kotwa, Phenara, Piprikothi and Tetaria the stage of development has exceeded 70%. In these blocks, further ground water development should be done in a careful manner. As per the resource evaluation of 2009, the stage of development is 42.3%. The net ground water availability for future irrigation is 67797 ha. m. This indicates that there is a vast scope for ground water development to increase the irrigation intensity in the district. The potential aquifer of the district is capable of supplying drinking water need for rural and urban population.

Ground water in the district can be developed through shallow tube well in the range of 30-50 m below ground which can yield upto 40-70 metre cube per hour. The deep tubewell can be of 125 m depth will be capable to yield 100 to 150 metre cube per hour by tapping aquifer for about 18-24 m. No water conservation or artificial recharge structure has been constructed by CGWB in the district. The district is by enlarge underlain by potential, unconsolidated quaternary aquifers with good recharge potential. No measure ground water related problem has yet been reported from the district. In local scale, fluoride exceeds the limit for drinking as reported Mass Awareness Programme (MAP) and Water Management Training Program (WMTP) yet to be organized in this district. **8.0 Area notified by CGWA / SGWA** All the blocks falls either in safe or semi critical category. As such no block has been notified under CGWA / SGWA.

Recommendations

1. Sufficient scope exists for development of ground water for agriculture. Exploitation of ground water can be done through shallow and deep tube wells. Small and marginal farmers can opt for shallow tubewells. Cooperative approach can be taken for high discharge tubewells.

2. Conjunctive use of surface and ground water can be a better option for the district.

3. Non conventional energy sources can be used for energization of tubewells.

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