Ground Water Resource Its Appraisal, Conservation and Planning : A Case Study of West Champaran District

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Abstract

India's rechargeable annual groundwater potential has been assessed at around 431 BCM in aggregate terms. On an all India basis it is estimated that about 30 per cent of the groundwater potential has been tapped for irrigation and domestic use. The regional situation is very much different and large parts of India have already exploited almost all of their dynamic recharge. Haryana and Punjab have exploited about 94 per cent of their groundwater resources. Areas with depleting groundwater tables are found in Rajasthan, Gujarat, most of western Uttar Pradesh and in all of the Deccan states. Occurrence of water availability at about 1000 cubic meters per capita per annum is a commonly threshold for water indicating scarcity (UNDP). Investment to capture additional surface run-off will become increasingly more difficult and expensive in the future. Over time, both for surface and groundwater resources, a situation where resources were substantially under utilised and where considerable development potential existed, has transformed in little more than a generation to a situation of water scarcity and limited development options. India faces an increasingly urgent situation : its finite and fragile water resources are stressed and depleting while various sectoral demands are growing rapidly. Historically relatively plentiful water resources have been primarily for irrigated agriculture, but with the growth of Indian economy and industrial activities water demands share of water is changing rapidly. In addition increase in population and rapid urbanisation also put an additional demand on water resources. Summing up the various sectoral projection reveals a total annual demand for water increasing from 552 billion cubic meter (BCM) in 1997 to 1050 BCM by 2025.

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

Introduction

The district of West Champaran was made out in the year 1972 after the reorganization of the erstwhile Champaran district. Formerly, it was subdivision of Saran District and the then Champaran district having its headquarters as Bettiah. The Bettiah got its name from *Baint* (cane) plants commonly found in the district of Champaran. The name Champaran originated from Champaka aranya which points out to the time when the district was having lush forests of Champa (Magnolia) trees and was inhibited by solitary ascectics.

The district of Champaran constituted a part of the ancient kingdom of Videha. The Aryan Videhas settled east of the Gandak or Narayani river. Gandhiji initiated the movement known as Champaran Satyagraha Movement to end the oppression of the Britishers on indigo planters. By 1918, the long standing griefs of the indigo cultivators came to an end and Champaran became the hub of Indian National Freedom Movement and the launch pad of Gandhi's Satyagraha. The city inherits a very rich culture. It is the birthplace of famous poet Gopal Singh 'Nepali'. In 1959, when the Prime Minister Pt. Jawahar Lal Nehru visited Bettiah, said that "This city will be the fifth Metro City of the country".

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.

Administrative details

The district of West Champaran lies between N 26º 25' 07" and 27º 31' 50" and E 83º 49' and 84º 45' 55" covering an area of 4843.51 Sq. Kms. The area falls in the Survey of India Degree sheets 63M, 72A, 172B and Toposheet nos. 63M/15, 16, 72A/3, 4, 7, 8, 11, 12 and 72B/1, 5, 6, 9, 10. The district is lies between the Great Himalayan Terrain of Extra Peninsular Region and Great Gangetic Alluvium Plain of India.

The district boundaries, administrative divisions, major roads, rail, and rivers are shown in Fig 1.

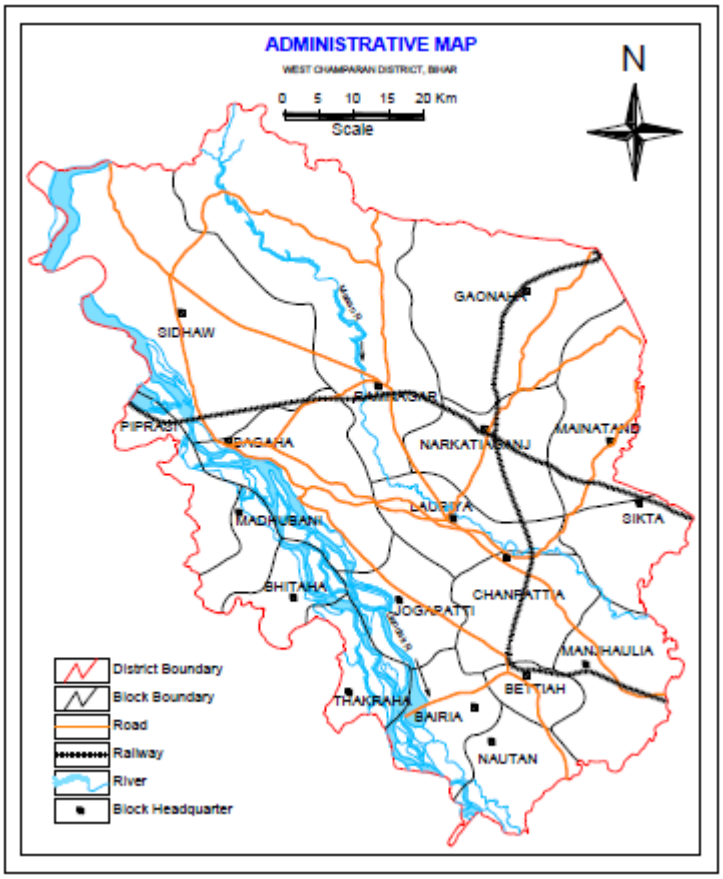


Fig. 1. Index map of West Champaran district

Study Area

The areas of the district are dominated by vast low lying denudational plains intersected by numerous streams originating from Himalayan ranges. River Gandak is the most important river of the area rising in the central mountainous basin of Sapt-Gandaki of Nepal. The Sapt-Gandaki have its origin from seven streams and finally joins to form the river Gandak. The river Gandak is snow-fed and remains torrential in the hilly regions. After coming down, it becomes wider and less turbulent. At Chautarwa Chaur another major river called Sikrahna originates, flowing in south-easterly direction through the central portion of the district. Then after, it turns southwards at Lakhaura, located north of Motihari (East Champaran). The southern portion of the river is known by the name of Burhi Gandak. The area is exposed to soil erosion, occasional floods and mild to moderate occasional droughts. Some parts of the district remain water logged. Common landscape features in the area include ox-bow lakes, back swamps or flood plains and chaur land which forms the wet area occurring mostly in Southern part of the district.

The District of West Champaran can be divided into few distinct tracts, such as, the hilly tract of Someswar and secondly, Dun range in the north at the foot hills of Himalayas. It has been noticed that the soil even at the foothills has no rocky formations. The hilly streams, brings down huge quantities of sand & destroys lot of cultivable lands. The hills contain large stretches of forests also. The economy of the district mainly is dependent on agriculture mostly. Mainly three types of crops are produced in the district which are as below:

1. Bhadai (autumn crop)
2. Aghani (kharif) and
3. Rabi (spring crop).

Bhadai crops comprise mainly Maize and Sugarcane. The main crops of Aghani season are paddy, potato etc. Rabi crop includes Wheat, Barley and Arhar (Cajamus indicus). Main crops of the low lying land in northern region of the district are paddy. The irrigation in the district is influenced by the presence of Tirhut, Tribeni and Done canals. These canals get their water from the main river of the district i.e. Gandak river at Balmikinagar which is the northern district bordering Nepal. Near about 62000 hectares of land get irrigated through canal system in the district. The total gross irrigated area reported from the district is 193000 hectares and net irrigated area is 116000 hectares. The net sown area is 278519 hectares and total cropped area is 399802 hectares. The area sown more than once is 121283 hectares.

Studies/Activities of CGWB

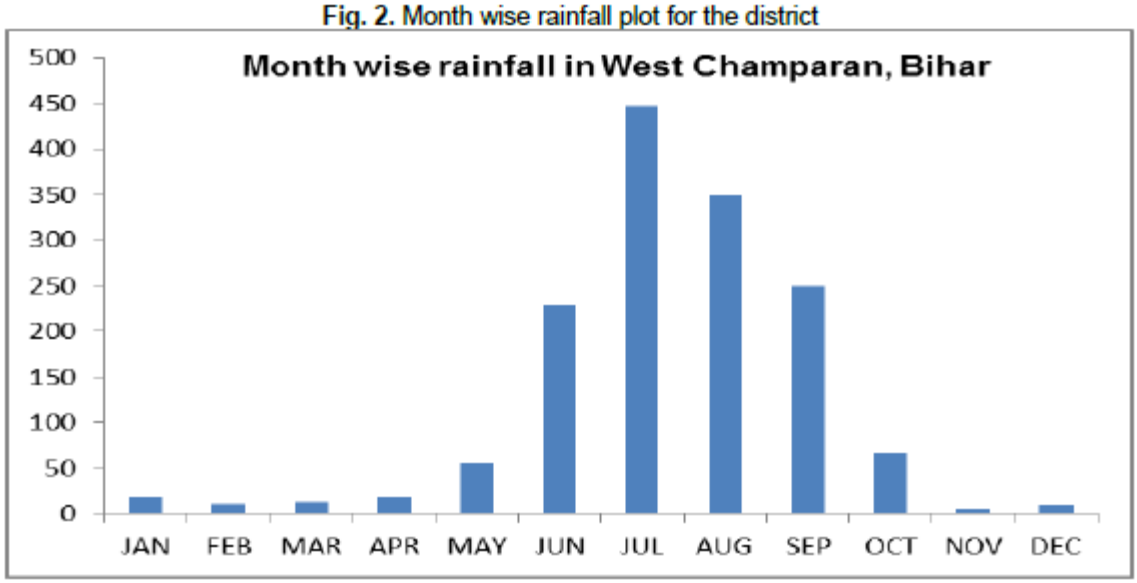
Central Ground Water Board has covered the West Champaran district under systematic hydrogeological survey. District hydrogeological report and ground water management study report has been issued. As per the Dynamic Ground Water Resource of Bihar State (2009) the net annual ground water availability in the district is 141450 ha.m. and net ground water availability for future irrigation development in the district is 101955 ha.m. The Stage of Ground Water Development in the district is 25.4%. The block wise Dynamic Ground Water Resource of West Champaran District has been summarised in Table no. 6. 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 (Table no. 5): There are 10 Hydrograph Network Stations (HNS) in the district, which are monitored four times in a year to measure the water level of the phreatic aquifer

Climate and Rainfall

The overall climatic condition of the district is Cold and Humid in nature. The foot hill zone or the terai region comprising block areas of Ramnagar, Bagaha and Narkatiyaganj is considered to be unhealthy for living. In summers, westerly winds with dust and hot wave flow through the area from mid of March. The temperature increases to a maximum of 43-44° C in the month of May which is the hottest month in the district. The monsoon starts from the mid of June and continues till the end of September. The rainfall in the region is received through South West Monsoon. The area receives heavy rainfall during monsoons. The average annual rainfall reported from the district of West Champaran is 1472 mm with Terai region receiving very heavy rainfall.. Very heavy rainfall is reported in the month of July to September. During the rest period the rainfall is sporadic or scanty. Winter rains along have also been reported from the district. A plot showing month wise rainfall (in mm) of West Champaran district is given below in Fig. 2:

The winter's starts just after the monsoon with pleasant climate. During winters the temperature going down upto 4-5° C. Lowest temperature is reported from the end of December to January.

Fig. 2. Month wise rainfall plot for the district



Geomorphology and Soils

The district of east champaran is underlain by piedmont belt i.e. bhabar of Terai consisting of a part gandak basin. The district lacks any relief feature in central and southern parts but is more undulating in the northern and north western parts and is uplifted near the Nepal border. Low hill ranges strikes along south east to north-west for a distance of about 30 km starting from north-west corner. The Dun valley lies in between the above mentioned low hill ranges and the Someshwar range extending along the whole northern boundary. The area is dipping gently towards south having maximum height of 111 m above msl (mean sea level) at Balmiki nagar. The minimum elevation reported is about 70 meters in the extreme south. The district can be divided into few distinct tracts, - firstly, the hilly tract of Someswar and secondly, the Dun range in the north at the foot hills of Himalayas. It has been noticed that the soil at the foothills has no rocky formations. The hilly streams, brings down huge quantities of sand & destroys lot of cultivable lands. The hills contain large stretches of forests also. The area is exposed to soil erosion, occasional floods and mild to moderate occasional droughts. It is seen that parts of the area remains water logged. The common landscape features present in the area are ox-bow lakes, back swamps or flood plains and chaur land which forms the wet area occurring mostly in southern part. The soil found in the district of West Champaran is highly calcareous in nature with mixtures of clay, silt and sand in varying amounts. 'Bhangar' soil is mostly found in the low lying central and southern parts of the area. Major soil types present in the district are Udifluvents, Palehunults, Haplustalfs, Paleustalfs and Rhodutalfs.

Discussion

West Champaran district lies east of the Gandak River in the North Ganga Plain. Thick alluvial deposits down to depth of 200 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. In the northern part of the district, where boulder beds are encountered, the borehole can be drilled using percussion rigs.

Hydrogeology

The main aquifer of the area is formed by the thick quaternary alluvial sediments along with semi consolidated to consolidated fresh water Siwaliks. The alluvial thickness is seen to be increasing from north to south. The variability in depositional environment can be noticed from the variation in lateral and vertical extension of the

deposits in the area which comprises of sand gravel, pebbles, clay and silt. The secondary openings found in the structural features of bedding planes, joints, fractures and other weaker plane are found to be prominent sources of groundwater. In the district, springs have been noticed in the areas where water table is intersecting the ground surface. The southern part of the Siwaliks shows dry and porous tract which is striking NNE-SSW around Balmiki nagar and E-W at Sidhaw and around Gaunaha thereby consisting of hydrogeological units of Bhabhar. The southerly dipping bhabhar belt merges with the adjoining units of terrain in the south. The contact of these two units is well exhibited in the change of slopes and zone of groundwater effluents forming the spring line. The hydrogeological map of the West Champaran district is shown in Fig. 3 and in Fig. 4. aquifer disposition in the district can be seen through Hydrogeological cross section.

Fig. 3. Hydrogeological map of West Champaran district

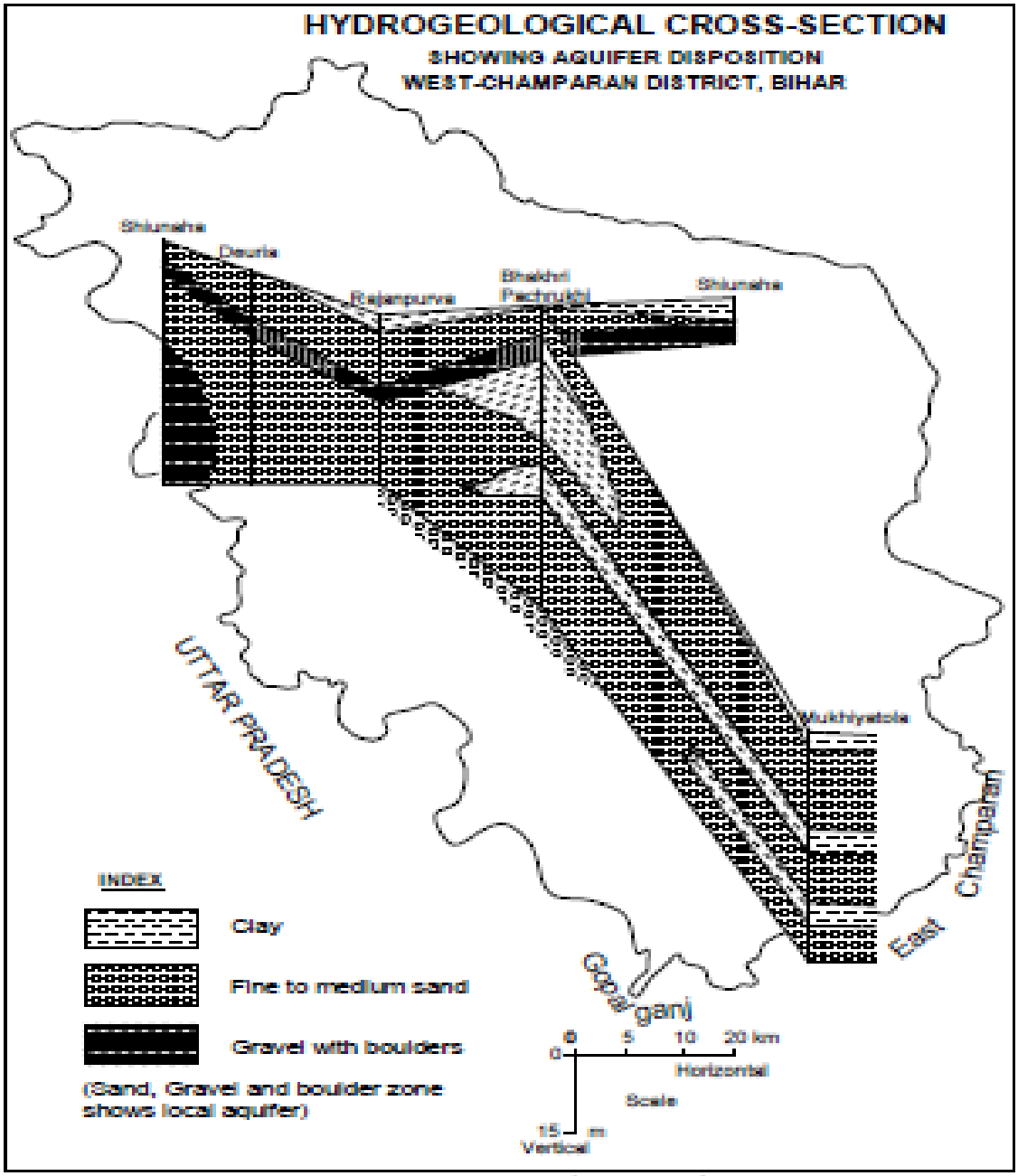


Fig. 4. Aquifer disposition in West Champaran

Ground water is generally found under unconfined to semi confined conditions at a depth of 50-70 m below ground. The sand, silt and clayey soil supports open dug wells with 3 to 4 m groundwater in the western parts with variation of 5 to 6 m in the rest of area. The water level fluctuation in the area can be noticed through continuous monitoring of Hydrograph Network Station (HNS) wells in the district. The depth to water table map show the water levels in the shallow aquifers during pre and post monsoon period (Fig. 5 & 6) as monitored through HNS in the year 2011-12.

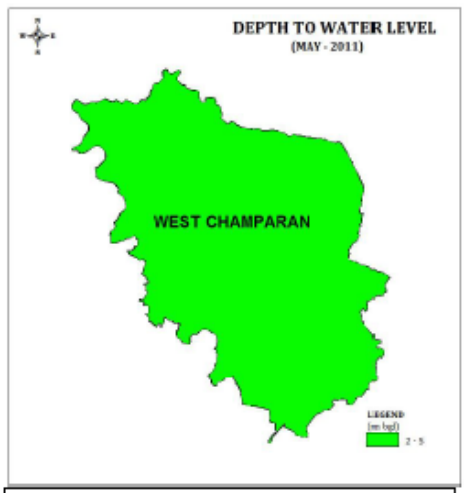


Fig. 5. Depth to Water Level map (May 2011)

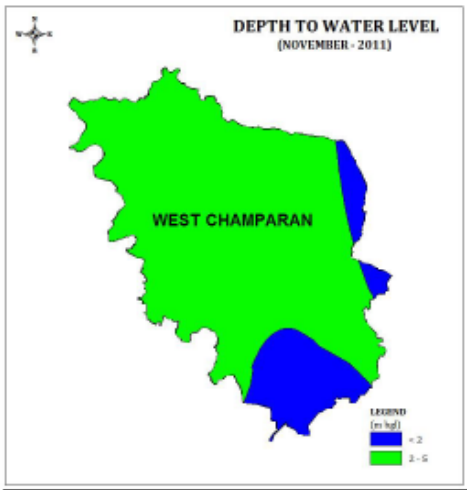


Fig. 6. Depth to Water Level map (November 2011)

In West Champarn, most of the wells have a depth range of 2 - 5m. The pre-monsoon (May 2011) depth to water level generally varies from 1.48 to 5.16 m bgl (Fig. 5.) The post-monsoon (August 2011) water level generally varies from 0.45 to 2.69 mbgl. Similarly, for the month of November 2011 the water level varied from 1.20 to 3.97 mbgl (Fig. 6) and in January 2012 from 1.65 to 5.03 mbgl. On compaing the water level fluctuation of May 2011 and August 2011, it is seen that there is rise of 2.80 m 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 2.32 m. 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 1.30 m. Taking into consideration, the long-term decadal (2001-2011) water level fluctuation for pre monsoon, there is a variation in water level upto 0.32 m and for post monsoon, it shows variation in water level between 0.03 to 0.28 m. During pre and post monsoon all the wells showed rise in water level.

Appraisal of 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 141450 ha.m. The gross annual draft for all uses works out to be 35964 ha.m. Allocation of ground water for domestic and industrial use for 25 years works out to be 9275 ha.m. The stage of ground water development is 25.4%. The stage of ground water development is highest in Nautan (43.3%) and lowest in Piprasi (13.7%). As stages of ground water development in all the blocks are less than 70% and there is no long-term decline in water levels, all the blocks are under safe category. The stage of ground water development is depicted in Fig. 7. The block-wise ground water resource is given in Table 5.

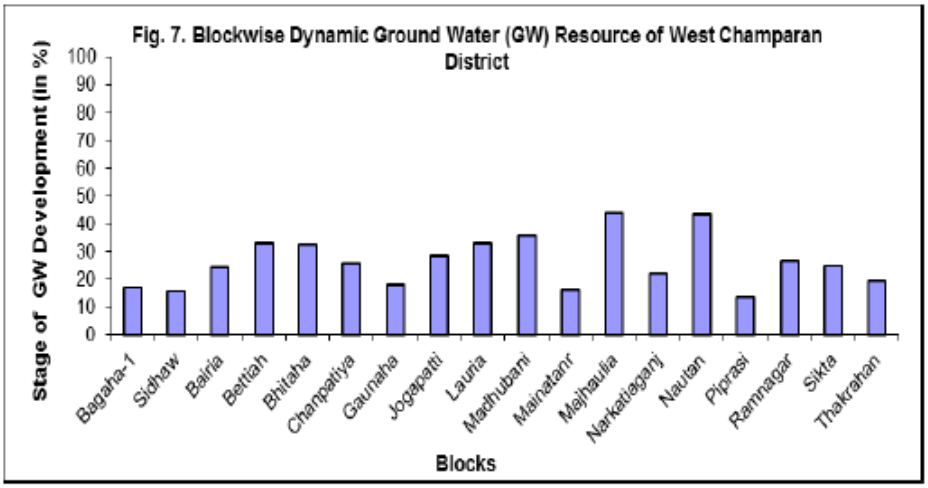


Table no. 5. Blockwise Dynamic Ground Water Resource of West Champaran District (2008-09)

(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	Bagaha-1	15211	2084	570	2653	951	12177	17.4
2	Sidhaw	14401	1857	426	2283	707	11837	15.9
3	Bairia	7766	1621	287	1909	476	5668	24.6
4	Bettiah	2126	364	337	701	567	1195	33
5	Bhitaha	3912	1175	94	1268	156	2582	32.4
6	Chanpatiya	9731	2028	503	2530	838	6865	26
7	Gaunaha	5869	789	284	1072	470	4610	18.3
8	Jogapatti	8388	2075	333	2408	552	5761	28.7
9	Lauria	7746	2249	323	2573	536	4961	33.2
10	Madhubani	3941	1285	118	1403	196	2461	35.6
11	Mainatanr	8837	1181	260	1440	431	7226	16.3
12	Majhaulia	10676	4240	457	4697	758	5678	44
13	Narkatiaganj	13041	2341	527	2868	877	9824	22
14	Nautan	6910	2676	316	2993	525	3709	43.3
15	Piprasi	4173	514	57	571	94	3565	13.7
16	Ramnagar	8056	1640	514	2155	581	5835	26.7
17	Sikta	6846	1432	260	1693	432	4982	24.7
18	Thakrahan	3819	669	79	748	131	3019	19.6
	Total	**141450**	**30220**	**5744**	**35964**	**9275**	**101955**	25.4

Ground Water Exploration

Under exploratory programme, CGWB has drilled 1 exploratory wells and 1 observation wells in the district down to a depth of 249 m. The drilling data show that there are four to five granular zones of different grades of sand within the depth of 185 m bgl (Table No. 6). The well yield varies from 80 – 95 m3/hr with a water level between 2 to 3 m below ground level indicating thereby that ground water in the area occurs under unconfined to semi confined condition. Based upon exploratory drilling it is inferred that ground water development over the district can be done through medium/deep tubewells tapping a cumulative thickness of 50 m to 70 m down to a depth of 200 m below ground with a discharge of 40 to 100 m3/hr. Geological sections show that about 4 to 5 aquifer zones are present in the area.

Ground Water Quality

In current scenario, the quality of ground water is equally important as its quantity. The quality of ground water 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 decided by the discharge containing pollutants, which get mixed with them. Quality of ground water for different purposes is expressed with reference to the needs i.e. drinking, industrial and irrigation. The physical and chemical constituents of ground water are determined and are compared with the standard ones that are recommended for drinking, industrial and irrigations purposes.

Chemical quality- In West Champaran, the ground water quality in general is potable and found as per specifications of Bureau of Indian standards.

Finding and Conclusion

The district of West Champaran is underlain by prolific and regionally extensive aquifers of huge thickness. The aquifers of good capacities are confined in medium to coarse grained sand layers in the alluvial sequences. Open or Dug wells with a diameter of 1 to 3 metres, upto a depth range of 2 to 6 mbgl are tapping the upper part of the zone of saturation. The stage of ground water development in the district is 25.4% and all the blocks are under safe category. The strategy for ground water management is designed with reference to ground water development scenario in the various blocks/parts of the district under consideration. The strategy also includes planning for conservation of water and artificial recharge, if any, required in the area.

Ground Water Development

As per the resource evaluation of 2009, the stage of ground water development is 25.4% in the district of West Champaran. The net ground water availability for future irrigation is 101955 ha. m. This indicates that there is immense scope for ground water development to increase the irrigation intensity in the district. The potential aquifers of the district are capable of supplying drinking water needs for rural and urban population.

Ground water in the district can be developed through shallow tube wells in the range of 30-50 m below ground which can yield upto 40-70 metre cube per hour. The deep tubewells of 120 m-130m 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 by enlarge is 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) has yet to be organized in this district. All the blocks falls in safe category. As such no block has been notified under CGWA / SGWA.

Suggestion and 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.

References

• Jha B.M.. (2007) , Management of Ground water resources for Ensuring Food Security in India, National Ground Water Congress, New Delhi

• Central Ground Water Board (2002), Master Plan for Artificial Recharge to Groundwater in India. New Delhi. 2

• Central Ground Water Board (2006), Dynamic Ground Water Resources of India . New Delhi.

• Das, S. (2006), Groundwater overexploitation and importance of water management in India – Vision 2025. Tenth IGC foundation lecture. The Indian Geological Congress, Roorkee.

- Dakshinamurti ,C; Michael , A.M. & Mohan , S, (1972) : Water Resources of India and their utilization in Agriculture , IARI , Monograph No-3 , New Delhi

- Ground Water Information Booklet, West Champaran District, Bihar State (CGWB)

- Hydrogeology and Ground Water Resources Development plan of West Champaran District Bihar, 2013.

• Llamas, M. Ramon, Mukherjee, Aditi and Shah, Tushaar (2006), Guest editors' preface on the theme issue "Social and economic aspects of groundwater governance. Hydrogeology Journal, vol. 14(3), pp. 269-274.

• Ministry of Water Resources (2002), National Water Policy. New Delhi.

• Minor Irrigation Division (1993), Report on Census of Minor Irrigation Schemes – 1986-87. Ministry of Water Resources, New Delhi.
Ministry of water Resources (Government of India) Mid-Eastern Region, Patna, September 2013.

• Minor Irrigation Division (2001), Report on Census of Minor Irrigation Schemes – 1993-94. Ministry of Water Resources, New Delhi.

• Minor Irrigation Division (2005), Report on 3rd Census of Minor Irrigation Schemes – 2000-01. Ministry of Water Resources, New Delhi.

• National Institute of Hydrology, Roorkee and Central Ground Water Board (2006), An operational model for groundwater pumping at Palla Well Fields, NCT Delhi – Project Report.

• Planning Commission (under publication), Ground water ownership in the country. Draft report of the Expert Group.

• Romani, Saleem (2006), Groundwater Management – Emerging challenges. Groundwater Governance – Ownership of Groundwater and its Pricing. Proceedings of the 12th National Symposium on Hydrology. November 14-15, 2006. New Delhi.

• Shah, Tushaar and Shilp Verma (2007), Real-time Co-management of Electricity and Groundwater: An assessment of Gujarat's Pioneering Jyotigram Scheme - Discussion paper. International Water Management Institute (IWMI).

• Ground water governance in the Indo-Gangetic and yellow River Basins - Realities and Challenges. Edited Vol. Aditi Mukherjee et.al, IAH selected papers.