Ground Water Resource Its Appraisal, Conservation and Planning: A Case Study of Katihar 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

Ground water is a major source of irrigation for Bihar state. Even in canal command areas ground water is exploited heavily for irrigation. Irrigation in Katihar district is mainly depends on the ground water. In order to exploit ground water potential to increase the cropping intensity, it is essential to understand the prevailing hydrogeological system.

Administrative details

Katihar district is situated in eastern part of Bihar state. It is bounded in the north and the west by Purnea district, in the south by Bhagalpur district, Bihar, and Sahebganj districts, Jharkhand and in the east by South Dinajpur and Maldah districts, West Bengal. The district is situated between latitude 25042' – 26022' North and longitude 87010' – 88005' East and falling in the parts of Survey of India toposheet number 72/O and 72/C. The total geographical area of the district is 3057 sq. km. The district has three civil sub-divions namely Barsoi, Katihar Sadar, and Manihari. It has 16 community development blocks namely Katihar, Barsoi, Kadwa, Amdabad, Manihari, Balrampur, Korha, Falka, Alamnagar, Barari, Pranpur, Mansahi, Samaili, Kursaila, Hasanganj, Dandkhora and 1514 villages (2001 census). The total population, as per 2011 census, is 3068149 i.e. Rural 2794765 & Urban 273384 (As per 2001 census). Katihar is the main town in the district. The other urban area in the district is Manihari., Barsoi and Raghunathpur. This district is a part of the Lower Ganga basin. This district falls in the Kosi and Mahananda sub-basin. The Kosi River and the Mahananda River with their numerous tributaries like Pamar, Dhar, Kamla, Saura Nadi, Morabrandi Nadi, Fariyani Nadi and Nagar drain the district. The river Ganga passes through the southern border of district in NW-SE direction. The other important rivers the Kosi and the Mahananda pass through the district in N-S direction.

Irrigation practices

Crops are grown in the four cropping seasons— Bhadai, Aghani, Rabi and Garma. The land use land cover, Government of Bihar (2004-05) data shows net sown area in the district is 160,251 hectares. The area sown more than once is 99,556 hectares. The total cropped area in the district is 259,807 hectares. The area under forests is 1,785 hectares. The land put to non-agricultural uses is 56,037 hectares. The district forms tail-end area of Eastern Kosi Canal Command area. The gross area irrigated is 131,480 hectares. Out of total gross irrigated area, the area irrigated from ground water is 126,786 hectares. The irrigation from the ground water is mainly through the shallow tube wells. The area irrigated from canals is 4,694 hectare (Govt. of Bihar 2004-05). Central Ground Water Board is presently carrying out studies pertaining to geogenic contamination of ground water in phreatic aquifer from arsenic. Ground water samples from affected parts of the district have been collected for chemical analysis for arsenic concentration.

Climate and Rainfall

The district experiencing three seasons viz., summer from March to early June, rainy from mid June to September end, and winter from November to Feburary. Mean daily maximum ambient temperature in summer is close to 430C. The mean daily minimum ambient temperature in winter is 80C. The relative humidity is generally above 70% in major part of the year. Rainfall in the district is mainly by southwest monsoon active from mid June to September end. The average annual rainfall for the year 2004 is 2194 mm. Nearly 85% of the annual precipitation occurs during monsoon period.

Geomorphology and Soil types

The area represents flat topography with regional slope towards south. The areas towards north are at higher elevation. It gradually reduces towards south. The regional slope takes a tilt from west to east. The district has alluvial soil. The soil in the southern and western part of the district is sandy in nature. Overall the soil in the district is non-calcareous and non-saline in nature and is a mixture of clay, sand and silt in varying proportions.

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.

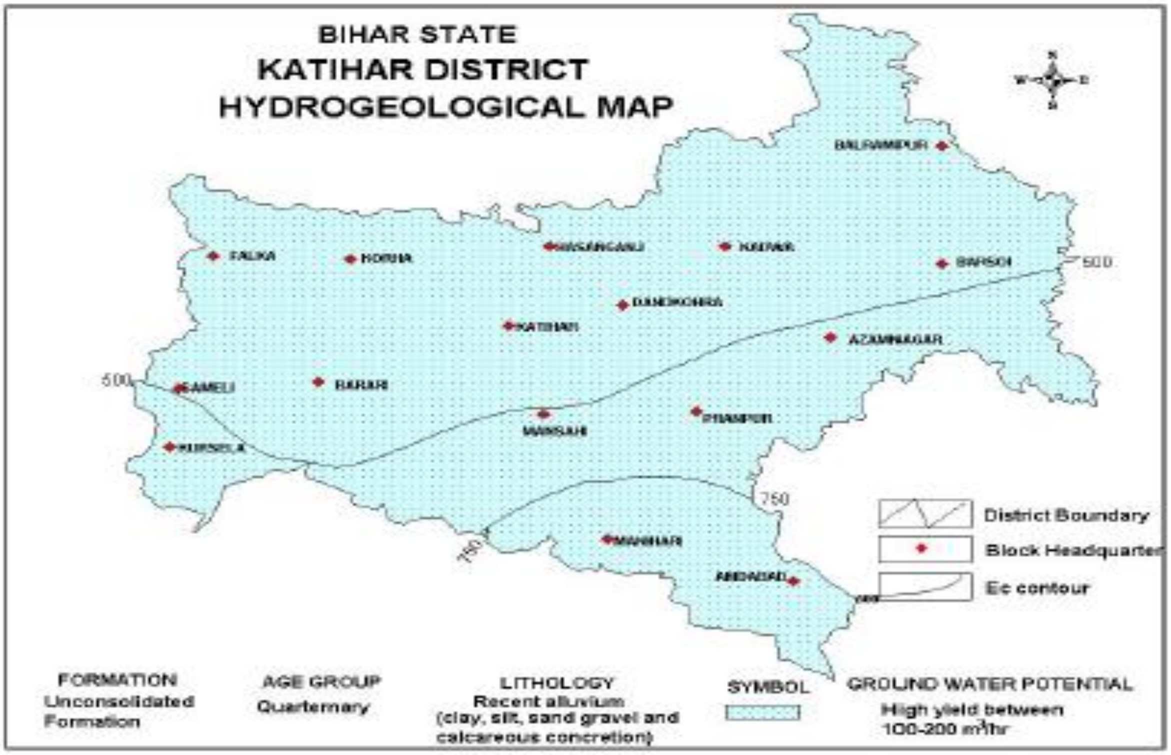
Discussion

Hydrogeology

The entire district is underlain by thick unconsolidated sediment of Quaternary period. Geological survey of India has proposed classification based on drainage and nature of alluvial deposits

Mode of Occurrence of Ground Water

Quaternary unconsolidated sediments consisting of sand, gravel and pebbles constitute potential ground water aquifer. The thickness of granular zone is about 50-70 meters within a depth of 80 meters. The persistent clay layers are absent and ground water occurs under pheratic condition in major part of the district. Though lateral facies changes have been observed, the aquifer system may be considered as single continuous one down to a depth of 80m. The aquifer is highly potential and a discharge of 100m3/hr may be obtained for nominal drawdown of 2m. The hydrogeological map and yield potential shown in Fig. 1



Water Level Fluctuation

The pre-monsoon (May 2011) water level in the district varies between 2.88 to 8.66 m bgl . In the northern and central part of the study area water level ranges between 2 to 5 m bgl and in souther part water level is > 5 m bgl.). In post-monsoon (November 2011) water level varies between 2.26 to 6.47 mbgl . In maximum parts of the area water level ranges between 2 to 5 m bgl and in in mall part of the area water level is > 5 m bgl.

Ground Water Resources

The net annual replenishable ground water resource as on 31st March'09 worked out to be 86902 ha m. The gross annual draft for all uses worked out to be 47019 ha m. Allocation of ground water for domestic and industrial use for 25 years worked out to be 7361 ha m. The stage of ground water development as on 31st March 2009 is 54.1%. The stage of ground water development is highest in Azamnagar (76.5%) and and lowest in the Manihari blocks (36.3%). The dynamic ground water resource is depicted in Fig 5. The block-wise resource is given in Table 01.

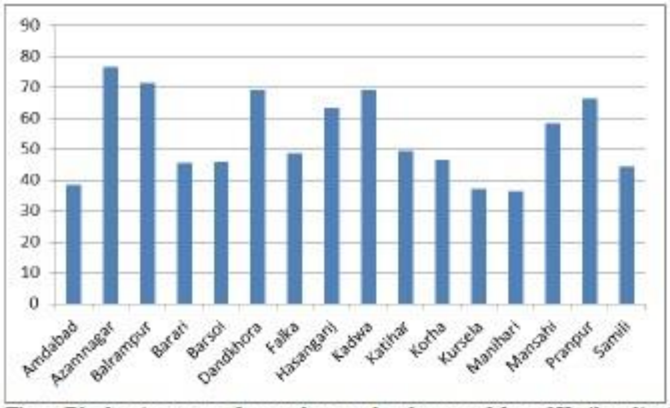


Fig : Block-wise stage of ground water development Map of Katihar district

Table : Blockwise dynamic ground water resource of Katihar 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 (9-10-13)	Stage of Ground Water Development (12/9)*100 (%)
1	2	9	10	11	12	13	14	15
1	Amdabad	4511	1484	239	1722	401	2626	38.2
2	Azamnagar	9238	6620	447	7066	750	1868	76.5
3	Balrampur	4722	3159	222	3380	372	1191	71.6
4	Barari	9236	3815	399	4214	671	4751	45.6
5	Barsoi	10164	4179	474	4653	796	5189	45.8
6	Dandkhora	2401	1565	98	1663	165	672	69.3
7	Falka	4207	1819	220	2039	369	2018	48.5
8	Hasanganj	1877	1109	78	1187	130	637	63.2
9	Kadwa	9100	5809	486	6296	817	2474	69.2
10	Katihar	2707	1108	236	1344	760	839	49.6
11	Korha	8539	3599	381	3980	640	4300	46.6
12	Kursela	2028	659	96	755	161	1208	37.2
13	Manihari	7283	2282	360	2642	591	4410	36.3
14	Mansahi	2006	1058	113	1171	190	758	58.4
15	Pranpur	4447	2745	204	2948	342	1360	66.3
16	Samili	4436	1837	122	1959	204	2395	44.2
	Total	**86902**	**42846**	**4173**	**47019**	**7361**	**36695**	**54.1**

Chemical Quality of Ground Water

Chemical quality of water is important for deciding the suitability for irrigation, industrial and drinking purposes. Ground water of phreatic aquifer is suitable for drinking and irrigation purposes. The ground water is mildly alkaline with average pH of 8.0. The pH is highest at Kadwa (8.51). . Electrical conductivity (EC) varies from 290 micro seimens/cm at Katihar to 850 micro seimens/cm at Manihari. All major parameters are within the permissible limit. Of late arsenic concentration in ground water above permissible limit has been reported from Mansahi, Kursela, Sameli, Brari, Manihari and Amdabad blocks. Manihari has the highest number of habitations affected from geogenic contamination of ground water with arsenic. The arsenic contaminated water is hazardous for human health. Iron above permissible limit is reported from the Dumer of Falka block and Manihari of Manihari block.

Status of Ground Water Development (Block-wise)

The development of ground water is mainly through shallow tube wells sunk to depth of 60 – 80 m below ground. As per the minor irrigation census, there were 34152 shallow tube wells, 67 states owned deep tube wells present in the district and 15 dug wells in the district is used for the irrigation purposes. Additional 304968 shallow tube wells were sunk in the district upto 2004 under "Million Shallow tube well" programme. The use of dug wells for the irrigation is very limited. The entire district is underlain by prolific and regionally extensive aquifers of huge thickness. It receives abundant rainfall in a year, which recharge the aquifers. About 96% of the total irrigated land is served with the ground water. The irrigation from ground water is mainly with the diesel operated pumps. The shallow tube wells drilled with bamboo boring technique is most common in the region. The shallow tube well upto depth range of 20-40 m yields 75 –100 m3/hr.

Ground Water Management Strategy

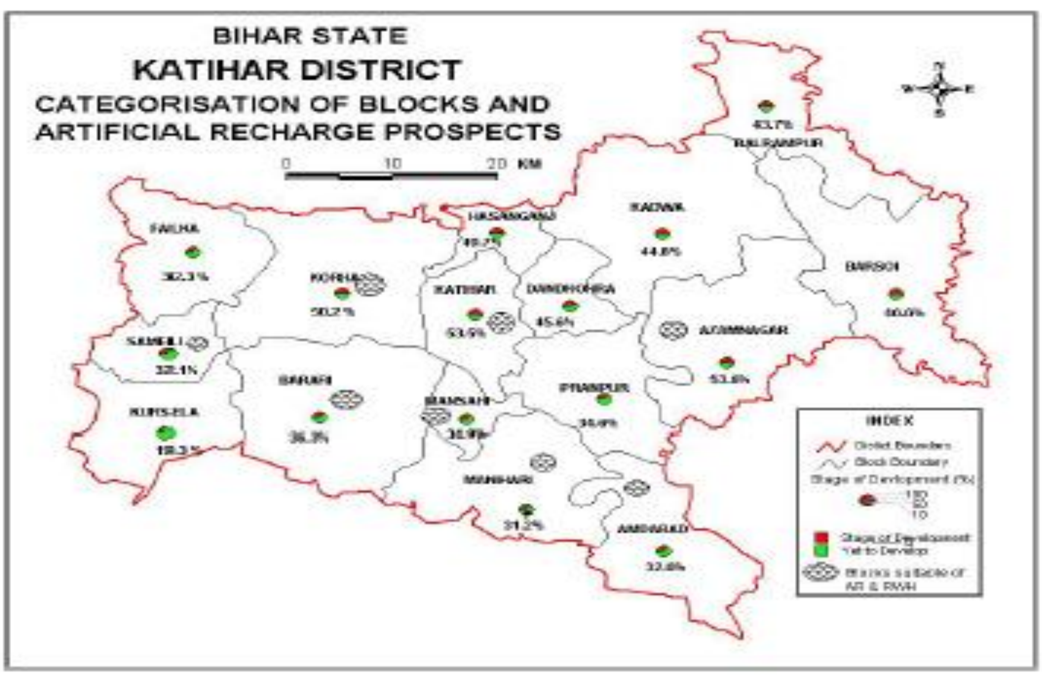
Ground water has special significance in the agriculture of the district. Thus, there is need to adopt an integrated approach of development of ground water resources dovetailed with ground water augmentation to provide sustainability to ground water development.

Ground Water Development

The aquifer system present in the district is highly potential. A shallow tube well to the depth range of 20-40 m, tapping granular zone of 10-15 and 25-30 m respectively may yield as high as 75 m3/hr. A well assembly of 76 mm diameter or 102 mm diameter with 5 to 10 m of slotted pipes can be used for construction of tube wells. Deep tube wells can be constructed by tapping potential aquifer present in the depth range of 50-80 m bgl. A well down to a depth of 70-80 meters tapping aquifer of 50-70 m can yield an average of 100 m3/hr for nominal drawdown. The distance of separation between two shallow tube wells should be 150-200 m and between two deep tube well should be 500 – 600m. Rotary rigs can be use for drilling of shallow and deep tube wells. Bamboo borings can also be used in shallow aquifer. All the blocks are underlain by thick, prolific, and regionally extensive aquifer, which can be exploited through shallow tube wells and bamboo borings as detailed above. In the arsenic affected blocks shallow aquifer upto 60 m may be sealed and deeper aquifer below 80m may be tapped to arsenic free water (i.e., arsenic below permissible limit of 50 ppb).

Water conservation and Artificial Recharge

All the blocks of the district fall under safe category. Artificial recharge and Rainwater harvesting technique may be adopted in the Azamnagar and Katihar blocks where stage of ground water development is high. 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 blockwise stage of development and suitable block for artificial recharge and rain harvesting is shown in

Fig 3.

Ground Water Related Issue and Problems

Arsenic is present above permissible limit in Mansahi, Kursela, Sameli, Brari, Manihari and Amdabad blocks of the district along the command area of river Ganga. The arsenic occurrence is sporadic in these blocks of the district. Maximum number of habitation in Manihari blocks is in risk zone of arsenic contamination. Central Ground Water Board, Mid-Eastern Region is doing sampling from these blocks to monitor the arsenic contamination in the ground water. The study of arsenic distribution in other districts of Bihar reveals that the arsenic is found above permissible limit in the shallow aquifer up-to depth of 60m. The iron above permissible limit is found at Dumer (7.0 mg/l) in Falka block and at Manihari (3.45 mg/l) in Manihari blocks. The stage of ground water development is low in many blocks of the district. The stage of ground water development is lowest in Kursela (19.3%). Therefore, huge scope is available for the ground water development in the district to increase the cropping intensity. There are no other major ground water related issues and problem in the district. Mass Awareness Programme (MAP) and Water Management Training Program (WMTP) yet to be organized in this district. The entire blocks falls safe category there is no significant long-term decline in ground water level in any of the HNS located in the districts. As such no block has been notified under CGWA / SGWA.

Conclusion and 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 54.1%. 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. Arrangement should be made for arsenic free pipe water supply of drinking water to the arsenic affected habitations.

6. 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.

7. Non-conventional energy resource can be used for the energisation of pumpsets, where it seems feasible.

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