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Availability, Scarcity and Potentiality of Groundwater Resources in Puruliya District of West Bengal: An Appraisal

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Abstract

Puruliya district is located in western boundary of West Bengal. It is situated within 22°42´23´´North to 28°45´North latitudes and 85°45´East to 87°East longitudes. Geographically the district is part of ancient plateau of Chotanagpur where ancient crystalline rocks prevails at large. It is one of the most backward districts of the state in terms of economic and human developments. Notably the district possess second highest scheduled tribe population in the state. Water belonged at the epicenter of the socio-cultural activities of the people of Puruliya from a distant part, particularly its scarcity. Although, district receives 1400 mm of average rainfall during monsoonal months, most of it is drained through Kumari-Kangsaboti river systems. Low retention capacity of soil and presence of hard crystalline rocks beneath the ground create constraints to groundwater development.

In Puruliya district, ground water occurs in four hydro-geological conditions i.e. weathered mantle, saprolitic zone, and fractured zones on hard rocks and in unconsolidated sediments. Total dynamic ground water reserve of Puruliya district is assessed as 70147 hector meters (ha m). Only 9666 ha m or 13.78% of the net ground water availability is currently abstracted. Distribution of ground water reserve varies greatly among different blocks of Puruliya district, so as the utilization. Sixteen out of twenty blocks of the district belong to low groundwater utilization class. So, a huge groundwater potential is left unutilized in Puruliya district. It is intentional in some blocks while in others, low yielding capacity of the aquifers restricted proper ground water development.

Ground water in Puruliya is neutral to slightly alkaline in nature, with pH ranging between 7.6 and 8.2. Electrical conductivity value varies from 141 to 2830 micromohs/cm at 25ºc. Chloride value ranges between 11 and 355 mg/l. Iron concentration varies from 0.01 to 1.9 mg/l. Fluoride concentration varies from 0.43 to 1.9 mg/l. Micro-watershed planning, particularly rain water harvesting seems to be the viable solution to the water scarcity in Puruliya district. Besides modern techniques of ground water abstraction and proper utilization of available water with pre-fixed sectoral priorities are urgently needed.

Introduction

The land bounded by the administrative boundary of district Puruliya is situated at the western border of the state West Bengal. Geographically the region is located between 22º42´23´´North and 28º45´North latitudes

and 85º45´East and 87ºEast longitudes. Administratively Puruliya district shares its boundary with three other districts of West Bengal i.e. Burdwan in North-East, Bankura in East and Midnapur in South-East. South-Western and Western parts of the district share boundary with the state of Jharkhand while Northern part is bounded by the state of Bihar. Geologically the region is a part of ancient plateau of Chhotonagpur (Census-1991).

In ancient Jain, Buddhist and Hindu literatures the land is called –in full or a part- as 'Bajrabhumi', 'Shumbho Bhumi' , 'Shikhar Bhum' ,'Radha' 'Manbhumi' etc (Roy, 2007). Undulated plains dotted with numerous residual hills made of old Granite and Gneiss dominates the morphology. Some great rivers of 'Rahr Bengal' either originated or passé through the district Damodar, Dwarkeswar, Kangsaboti, Kumari, Shilaboti, and Subarnarekha etc. are the main rivers of the region. These ephemeral and non-perennial streams, except Subarnarekha, are the western tributaries or sub-tributaries of the great river Bhagirathi-Hooghly. Rainfall is scanty but enough for the growth of dense forests. Sal, Palash, Kusum, Mohua, Bamboo and different type of grasses grow in abundance over the unfertile lateritic 'Tanr' soil. Lack of cohesiveness within the soil gives rise to vast badlands along the courses of the main rivers and their tributaries.

The land was the habitat of aboriginal Austro-Dravidian tribal people for a very long time. Santhal, Munda, Bhumij, Kora, Sadak, Oraon, Birhore etc.are some eminent tribal groups of this region (Ghosh, 1973). Puruliya is one of the most backward districts of West Bengal in terms of economy and human development. This district ranks 15th in West Bengal according to population size and 5th in its land surface area. Notably the district has the second highest concentration of Scheduled Tribe population in West Bengal (Census-2011).

Water, particularly its scarcity, belonged at the epicenter of socio-cultural activities of the people in Puruliya from a distant past. Recurrent droughts are common in this part of West Bengal so, access and availability of water certainly have great influence in people's life. Scarcity of water is illustrated in numerous folksongs i.e. Tusu,Vadu, Jhumur etc. and folklores (Gangopadhaya, 2003). The rivers running through the district, i.e. Shilaboti, Kangsaboti, Dwarkeswar, Kumari, Bandu, Hanumata etc. are ephemeral in nature. After a short spell of runoff in the monsoon, their flat courses remain dry and sandy like a desert land (ibid).

Objectives:

The main objectives of the present study are;

I. To assess the present status of the water resources in Puruliya district;

II. To identify the root causes of water scarcity in Puruliya district; and.

III. To bring out the potentiality of groundwater resources for future development.

Methodology

To satisfy the afore said objectives the following methodology have been followed in the present study-

- Information gathered from different secondary sources, mostly books and journals, about the magnitude of the problem of water scarcity in Puruliya district.
- Different Government reports were consulted to build up the hypotheses.
- The hypotheses were tested through extensive field surveys.
- Necessary changes were made based on ground truth verification and spatio-temporal changes were reflected in cartographic exercises with interpretation.

Scarcity of water: Puruliya have a long history of water scarcity. Deficient rain clubbed with low moisture retention capacity of soil and faulty agricultural practices led to a situation where the gap between demand and supply of water is widening day by day. Rapid increase in population in last two decades enhanced the pressure on the existing water supply while there are no sign of planned groundwater abstraction policy that can bridge the gap efficiently.

Ancient rulers of Puruliya had excavated many fresh water lakes, locally called ‘Bandh’. ‘Ranibandh’ in Jaypur, ‘Shambandh’ in Cheliyama, ‘Barabandh’ in Manbazar and ‘Dakaibandh’ of Hura are some of them (Roy, 2003). In monsoonal months, rainwater used to accumulate and store in those dug-storages that facilitated groundwater recharge and provided yearlong fresh water supply for nearby residents. Where this type of lakes was not available, there was another process of expelling water. Large holes were excavated on the courses of ephemeral ‘jhore’, ‘jhar’ and rivers to accumulate the seepage water. These water expelling holes were locally called ‘Chuya’. Even today, in extreme water scares parts of Puruliya, this kind of water collecting process is still practiced (Adhikary, 2003). Excavation of ‘Sahebbandh’ of Puruliya town was started in 1843 under supervision of

English Deputy Commissioner Col. Tickel and was completed in 1848. This was only potable water source for the residents of Puruliya town till 1958. The 'Sahebbandh' of Adra and Anara towns bare almost same history (ibid).

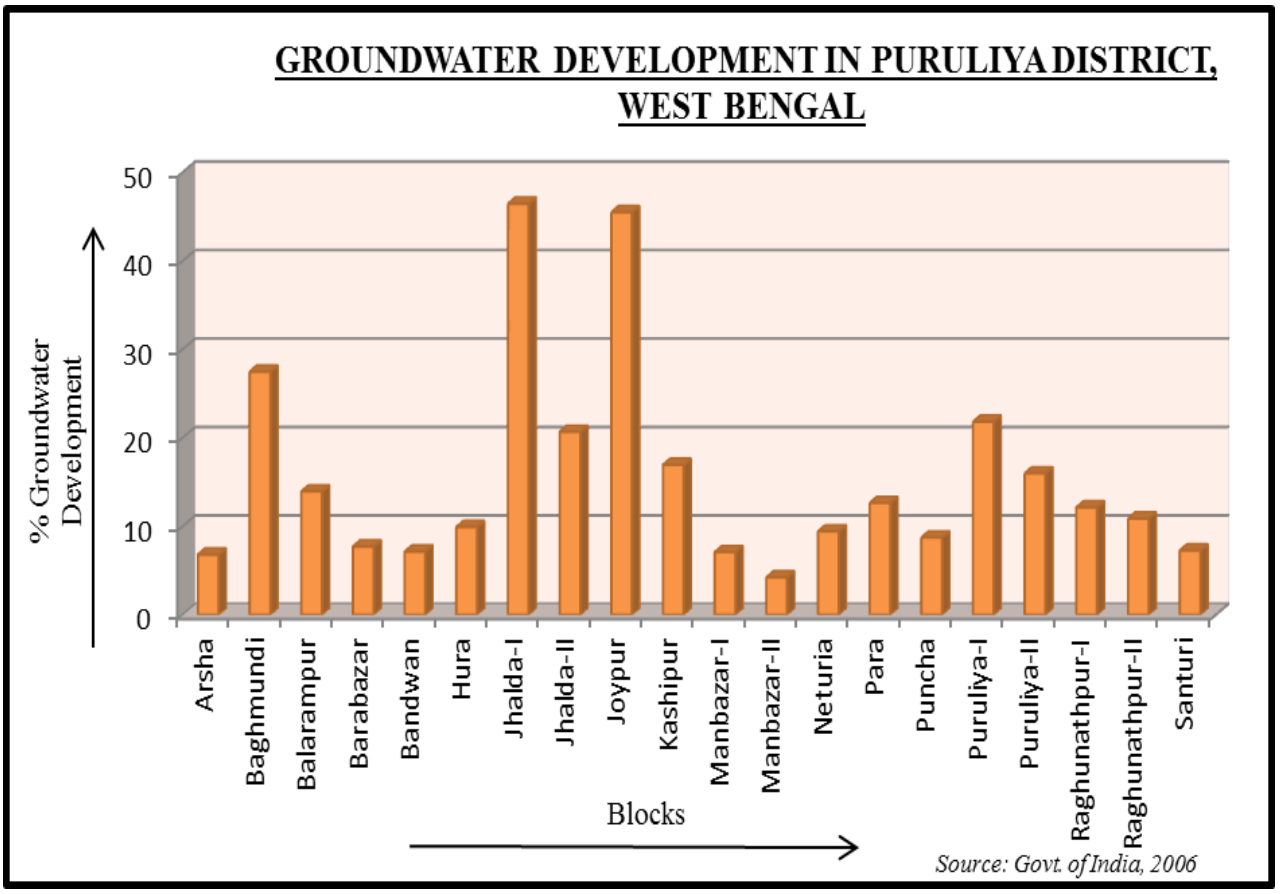
Several works have done after independence of India to mitigate the water problem of Puruliya district. Wells, tube wells being installed and ponds excavated in several blocks under supervision of Gram-Panchayet and Jilla-Parishad. Apart from the different small and medium irrigation projects including river water lifting, dug-wells and canals have been constructed. As a result of that net shown area has increased and migration of people from water scares regions in summer has stopped (Gangopadhaya, 2003). But yet, there are abundant examples like the village Dakakendu where the tube-wells become dry in summer (Adhikari, 2003).

The rainfall statistics of Puruliya present a reverse scenario. Total rainfall for the consecutive years from 1999 to 2003 were 1,606 mm, 1,033 mm, 1,434 mm, 1,383 mm and 1,260 mm respectively (Govt. of W.B, 2004). Here, 1,398 m.m rainfall a year is considered as 'normal'. So from 1999 to 2003 the rainfall was far above the normal rate. Only in 2000 it was below normal (Govt. of India- 2003). Even flood is not alien word in this water deficit district of West Bengal. The years 1898, 1946, 1992 and 2005 bares the reminiscence of devastating floods in Puruliya. So here the input of water through rain is plenty. But there is neither capacity of soil to hold the moisture for long time, nor any initiative to collect and harvest the excess runoff and rain water through proper technology to use it in time of deficiency. Clearly there exists a gap between water demand and supply in the district and that has been expanded due to failure in utilizing the potential of ground water and runoff. In this paper, however, only the potential presented by the ground water resources in different blocs of Puruliya district is taken for consideration.

Present status of water resource utilization in Puruliya district: A precarious situation exists in present day water utilization scenario of Puruliya district. Plenty of rainfall in monsoonal months washing off the slopes making the soil cover too thin to support vegetation, yet the soil profile suffers from acute shortage of water that causes young saplings to wilt at the winter. Much of the ground water potential lie unutilized yet dearth of irrigation restricts extension and development of agriculture in the district. In a district where a large number of residents

have no access to safe and dependable source of potable water, much of the governmental effort and huge amount of money is drained in constructing large sized pumped storage hydroelectricity project.

There are disparities in ground water reserve and utilization among the blocks of Puruliya district. Utilization of ground water depends on the yielding capacity of the aquifer and the quality of the abstracted water from them. Central Ground Water Board (CGWB) and State Water and Irrigation Department (SWID) of West Bengal have jointly assessed the dynamic ground water resources of Puruliya district. They declared all of the blocks in Puruliya district are in 'safe category' i.e. no imbalance in ground water recharge and withdrawal (Govt. of India, 2007).



Hydrogeology: Geological set up of Puruliya district shows that the district is underlain by Pre-Cambrian metamorphic except in some parts of northeast where Gondwana sediments predominate. Unconsolidated sediments of recent or sub recent age are found in narrow stretches along the major river courses. Granite and granite gneisses are most common rocks with widespread occurrence in the district into which metabasics occur as

intrusive (CGWB, 2006). The rock types other than granite gneiss are amphibolites, mica schist, quartzite, quartz vein, calc-silicate rocks with inter banded crystalline limestone. The upper surface of the district is composed of thin soil cover followed by crystalline massive metamorphic rocks of very high resistivity. Metamorphic rocks are also exposed on the surface at several locations (Sharma, 2005).

The study conducted by the Central Ground Water Board in Puruliya district shows that ground water occurs in Puruliya within four distinct zones, i.e. (i) weathered mantle, (ii) saprolitic zone, (iii) fractured zone of hard rock and (iv) zone of unconsolidated sediments.

The weathered Mantle varies in depth in different parts of the district and its maximum thickness reaches up to 25 meters. Ground water occurs in water table conditions and predominantly developed by open dug wells. In some places these wells become dry in dry summer season. Water yielding capacities are low and restricts within 2.75 liters per second (lps).

The saprolitic zone is sandwiched between weathered mantle and un-weathered granitic rocks. Depth of this zone ranges between 10 – 30 mts. below ground level (mbgl). Average thickness of this zone is 4 mts. Ground water occurs in semi confined conditions that can yield water at a rate of 2.5 lps. Drawdown in the wells tapping this zone is much less and recovery is quite fast.

In the hard crystalline rocks ground water occurs in saturated fractures situated well beneath the ground. The occurrences of these fractures are generally restricted to 50 – 110 mbgl. Fractures, that are of shallower depths generally occur at 50 – 60 m depth and tapped mainly by borewells fitted with hand pumps, yield water at a rate below 1 to 2.77 lps. Deeper fractures are found at 100 to 110 m depth. Yielding capacity of this zone in Manbazar is 3 lps. In Gondwana sediment zones, fractures are encountered at 103 m depth. They are located within the depth of 24 to 36 mbgl and are capable of yield water at 3.3 – 5.5 lps.

Along the river valleys, stretches the zone of unconsolidated sediments in 5 to 13 mbgl level. This narrow zone varies in thickness and its areal extent is limited within 1 – 2 k.m. across the valley. Saturated thickness of alluvial tract varies from 1 m to 5.5 m. Water yielding capacity of this zone is medium. Open dug wells and shallow tube wells can yield 20 m3 of water per hour for a considerable period of time.

Observation records from different ground water monitoring wells throughout the district reveals that, in the year 2006 the pre monsoon and post monsoon water levels in Puruliya district ranges from 4.32 – 11.68 mbgl and 2.07 – 5.60 mbgl respectively. The regional fluctuation is restricted within 2.00 mbgl only; hence no abnormal rise or fall in water level is observed here (Govt. of India, 2007). In a study conducted between 1997 and 2006, water table in Arsha, Baghmundi, Barabazar, Bandwan, Jhalda- I and II and Puncha block of Puruliya district showed a trend of rise during pre and post monsoon seasons. Maximum rise of 9.01 mgbl was recorded in Hura block. The other blocks of the district experienced rise as well as fall in ground water level during the study period (CGWB, 2007). Out of 50 ground water monitoring wells in Puruliya, 34 wells showed rise when the other16 of them recorded fall during pre and post monsoon decadal (1997 – 2006) trend of water level. During pre-monsoon season, 0.001 to 0.37 m/year rise and 0.006 to 0.44 m/year fall had been recorded when the same for the post monsoon season were 0.016 to 0.36 m/year and 0.014 to 0.37 m/year respectively (ibid).

Groundwater availability and potential: Total dynamic ground water reserve of Puruliya district is assessed as 70147 hector meters (ha m). Only 9666 ha m or 13.78% of the net ground water availability is currently abstracted for use in different sectors e.g. domestic, agriculture, industry etc. Among the utilized resource, irrigation comprises lion's share of 6000 ha m. Rest 3666 ha m is consumed jointly by domestic and industrial sectors. CGWB and SWID forecasted very small increase in future demand of ground water in Puruliya district for domestic and industrial use. According to them the present figure of 3666 ha m will reach to 4940 ha m in next 25 years. The available ground water for future irrigation development is thus measured as 59207 ha m (Govt. of India-2007).

Ground water reserve varies greatly among different blocks of Puruliya district, so as the utilization. Barabazar block ranks first in ground water availability within the district. Net ground water available in this block is estimated as 6275 ha m. On the other hand, Jaypur block stands at the end of the list with mere 2090 ha m of ground water reserves. According to their ground water availability, blocks of Puruliya is divided into four classes i.e. very low, low, medium and high as described in the table below.

Table 1: Groundwater availability in blocks of Puruliya district

Ground water availability class	Blocks
Very low *(below 3000 ha m)*	Baghmundi, Balarampur, Bandwan, Jhalda-I and II, Jaypur, Neturia, Raghunathpur- I and II
Low *(3000 – 3999 ha m)*	Arsha, Hura, Manbazar-II, Para, Puruliya – I and II, Santuri.
Medium *(4000 – 4999 ha m)*	Puncha
High *(5000 and above)*	Manbazar-I, Barabazar, Kashipur.

Source: *constructed by the author by the data available from Ministry of water resources, government of India*

It is evident from the above table that most of the blocks in Puruliya are poor in ground water reserve. Sixteen out of twenty blocks of the district lay below 4000 ha m reserve category. Distribution of ground water rich and poor blocks have no distinct pattern, rather the rich blocks stands amidst of their poorer counter parts.

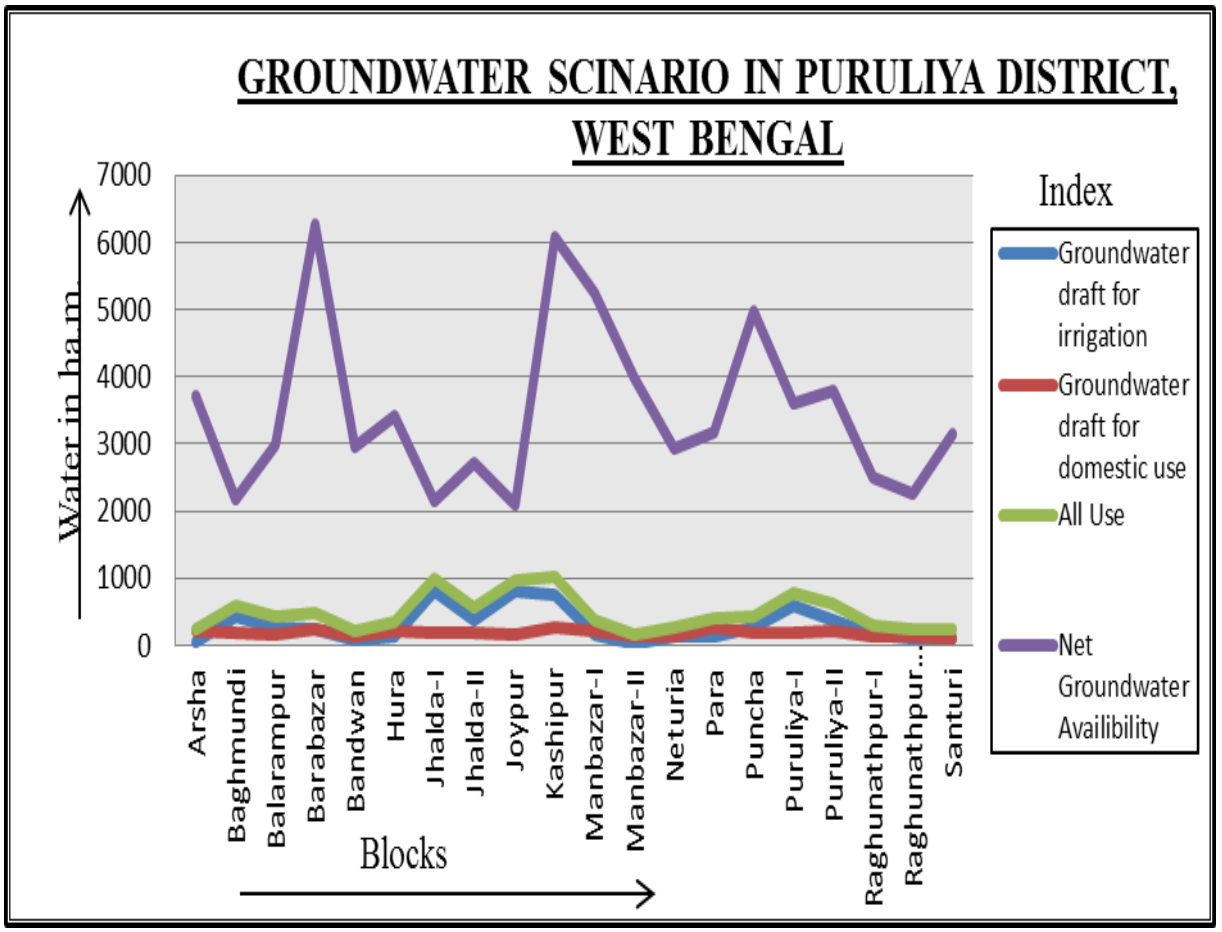
Groundwater utilization: Utilization status of ground water is even poorer in Puruliya district. No block has succeeded in abstracting 50% of its available ground water. Manbazar-II block utilize only 4.2% of its groundwater resources. Amount of groundwater withdrawal varies between 168 ha m in Manbazar-II to 1028 ha m in Kashipur. Thus the blocks of Puruliya district are divided into various classes of groundwater utilization in the following table.

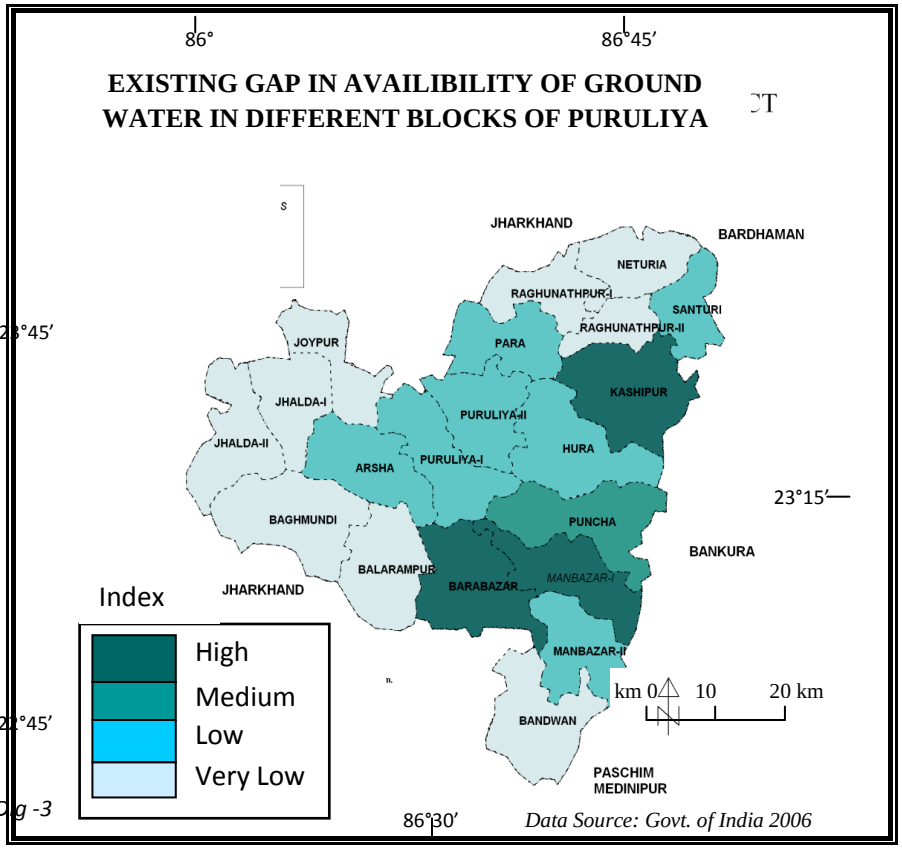
Table 2: Groundwater utilization in blocks of Puruliya district

Groundwater utilization classes	Blocks
Very low *(below 300 ha m)*	Arsha, Bandwan, Manbazar-II, Neturia, Raghunathpur-II, Santuri.
Low *(300 – 599 ha m)*	Baghmundi, Balarampur, Barabazar, Hura, Jhalda-II, Manbazar-I, Para, Puncha, Raghunathpur-I
Medium *(600 – 899 ha m)*	Puruliya-I and II
High *(900 ha m and above)*	Jhalda-I, Jaypur, Kashipur.

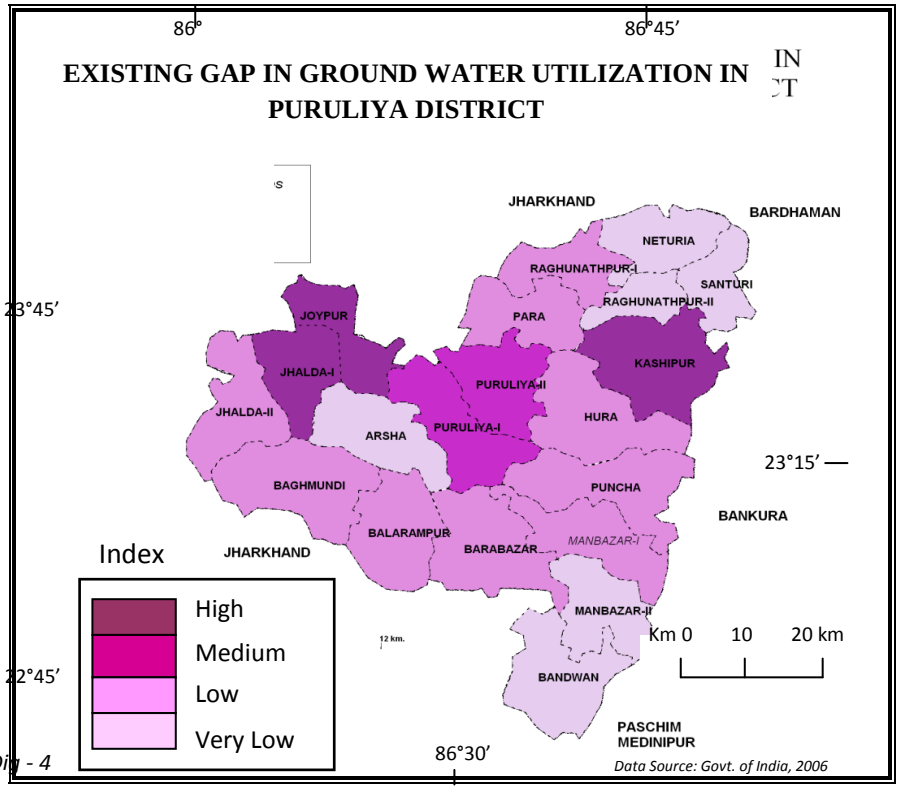
Source: *constructed by the author using the data available from Ministry of water resources, government of India*

A huge groundwater potential is left unutilized in Puruliya district. Sometimes it is intentional, as in Manbazar-I and II, where other sources like canals and reservoirs supplement the water demand. But in most of the cases, hydro-geological conditions play a negative role in groundwater abstraction. Low yielding capacities of the aquifers in some blocks possess serious constraint to groundwater development. The plea enhances with poor abstraction structures installed for ground water exploitation. The following table explains relation between hydrogeology and water utilization in Puruliya.

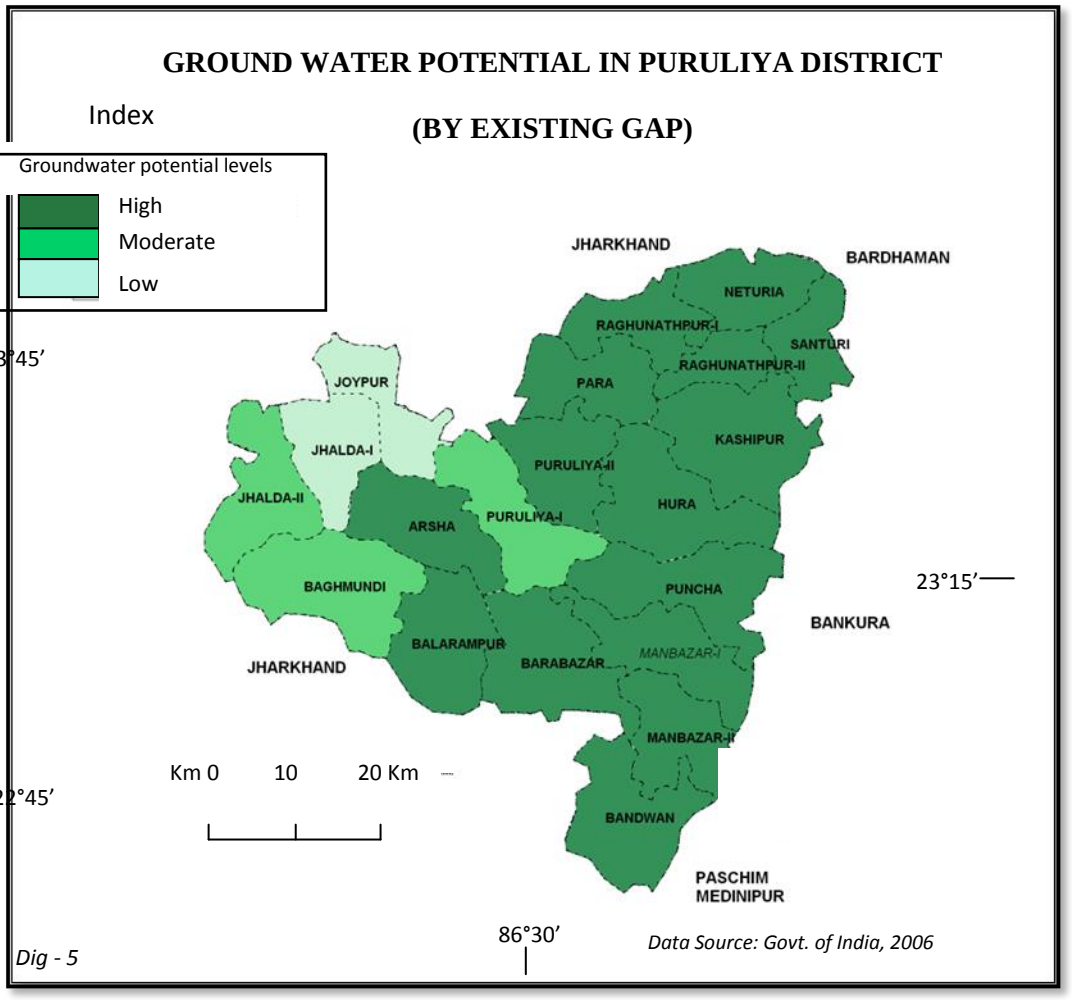


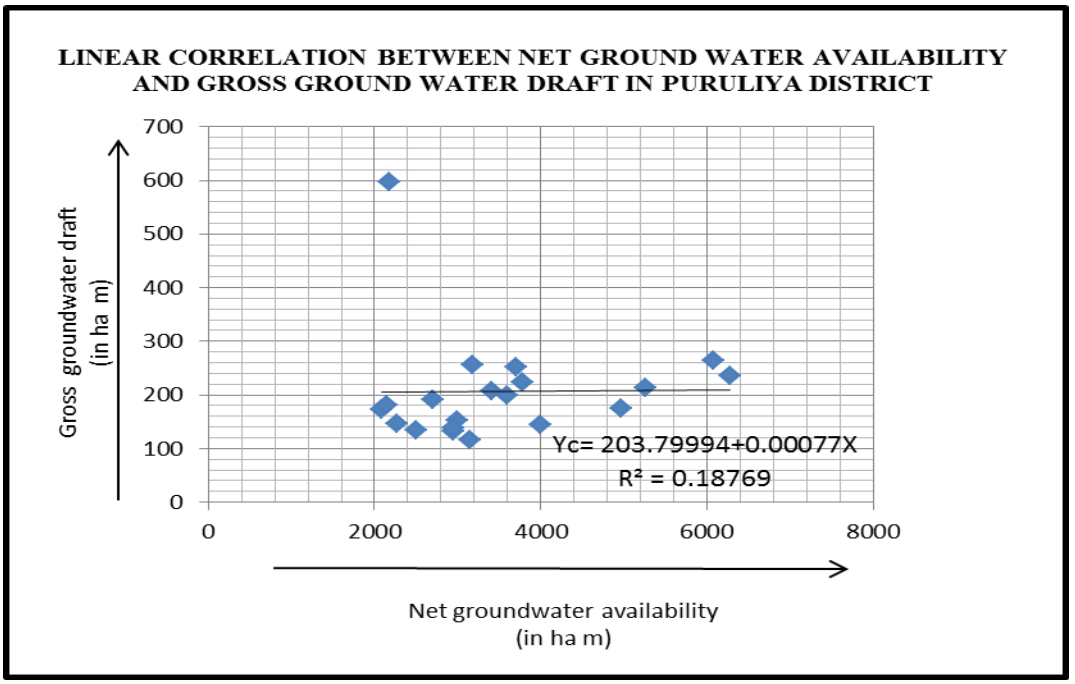

86°
86°45′
EXISTING GAP IN AVAILIBILITY OF GROUND WATER IN DIFFERENT BLOCKS OF PURULIYA
23°45′
22°45′
23°15′
86°30′
JHARKHAND
BARDHAMAN
NETURIA
RAGHUNATHPUR-I
SANTURI
RAGHUNATHPUR-II
JOYPUR
PARA
KASHIPUR
JHALDA-I
PURULIYA-II
JHALDA-II
HURA
ARSHA
PURULIYA-I
BAGHMUNDI
PUNCHA
BANKURA
BALARAMPUR
BARABAZAR
MANBAZAR-I
MANBAZAR-II
BANDWAN
PASCHIM MEDINIPUR
Index
High
Medium
Low
Very Low
km 0 10 20 km
Data Source: Govt. of India 2006

Dig -3


86°
86°45′
EXISTING GAP IN GROUND WATER UTILIZATION IN PURULIYA DISTRICT
23°45′
22°45′
23°15′
86°30′
JHARKHAND
BARDHAMAN
NETURIA
RAGHUNATHPUR-I
SANTURI
RAGHUNATHPUR-II
JOYPUR
PARA
KASHIPUR
JHALDA-I
PURULIYA-II
JHALDA-II
HURA
ARSHA
PURULIYA-I
BAGHMUNDI
PUNCHA
BANKURA
BALARAMPUR
BARABAZAR
MANBAZAR-I
MANBAZAR-II
BANDWAN
PASCHIM MEDINIPUR
Index
High
Medium
Low
Very Low
Km 0 10 20 km
Data Source: Govt. of India, 2006

Dig - 4





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Data Source: Govt. of India, 2006

Table 3: Factors that influence ground water abstraction

Ground water utilization class	**Name of the blocks**	**Hydrogeology**	**Existing structures of water abstraction (in no.)**	**Water level**	
				Pre monsoon (mbgl)	**Post monsoon (mbgl)**
Very low *(below 300 ha m)*	Arsha, Bandwan, Manbazar-II, Neturia, Raghunathpur-II, Santuri.	Within 20mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well-719	4.96 – 12.11	3.58 – 5.09
Low *(300 – 599 ha m)*	Baghmundi, Balarampur, Barabazar, Hura, Jhalda-II, Manbazar-I, Para, Puncha, Raghunathpur-I	Within 20mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well-3172	4.72 – 11.66	2.12 – 5.41
Medium *(600 – 899 ha m)*	Puruliya-I and II	Within 20mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl,	Dug well-2066	3.12 – 7.71	2.32 – 3.32

		yielding 2.5-2.75 lps.			
High *(900ha m and above)*	Jhalda-I, Joypur, Kashiupur.	Within 20mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps. In Gondwana rocks the existence of fractures within the depth of 24-26mgbl has been encountered, which yields 3.3- 5.5 lps.	Dug well-2169	6.51 – 9.28	3.63 – 7.19

Source: *Constructed by the author*

Ground water quality: CGWB conducted a chemical analysis test of the water samples collected from ground water monitoring wells from different blocks of Puruliya district in the pre monsoon season of the year 2006. The study revealed that the ground water in Puruliya is neutral to slightly alkaline in nature, with pH ranging between 7.6 and 8.2. An electrical conductivity value varies from 141 to 2830 micromohs/cm at 25ºc. Chloride value ranges between 11 and 355 mg/l. Iron concentration varies from 0.01 to 1.9 mg/l. Fluoride concentration varies from 0.43 to 1.9 mg/l (Govt. of India-2007).

The bore well drinking water sources that taps water from fractured granitic rocks within the depth of 50 m contains high fluoride concentration. Seventeen out of

twenty blocks of Puruliya have sporadic occurrence of fluoride in ground water above permissible level i.e. below1.5 mg/l. The maximum range of contamination found in Jaypur where it ranges between 1.74 and 7.70 mg/l. Table - 4 shows the maximum value of fluoride in ground water of Puruliya district

Table 4: Analyzed results from rapid assessment report of fluoride task force

SL.NO.	Block	Maximum Concentration(mg/l)
1.	Arsha	2.92
2.	Baghmundi	2.38
3.	Balarampur	2.12
4.	Barabazar	2.08
5.	Hura	2.10
6.	Jhalda-I	4.93
7.	Jaypur	7.7
8.	Kashipur	2.78
9.	Manbazar-I	2.73
10.	Neturia	1.77
11.	Para	2.34
12.	Puncha	2.41
13.	Puruliya-I	3.53
14.	Puruliya-II	2.54
15.	Raghunathpur-I	4.30
16.	Raghunathpur-II	1.74
17.	Santuri	2.38

Source: *Government of India*, 2007

Findings: Major findings that emerged from the present study are enlisted below.

1. Puruliya district is a drought prone district of West Bengal with a perpetual shortage of water availability, particularly in winter months.
2. Input of water through rain is plenty but most of the water available from rain are drained out of the district as surface runoff and channel flow.
3. Lack of moisture holding capacity of the soil, in most part of the

district, leads to acute shortage of water in the soil profile.

4. Underlain granitic-gneissic hard crystalline rocks forms constraints in water percolation, thus restricts the water table formation.
5. Seasonal fluctuation of water level in the aquifers is common in Puruliya, general trend being the post monsoon rise.
6. Yielding capacity of the aquifers in most blocs of Puruliya district is poor.
7. Only the aquifers in Gondwana sediments, in the northern blocks possess considerable water yielding capacity.
8. Groundwater utilization is very poor. Only 13.78% of the net groundwater reserve is being utilized at present. Thus a huge potential is left out untouched.
9. Groundwater abstraction techniques are primitive, mostly they are dug wells.
10. Groundwater in Puruliya is neutral to slightly alkaline in reaction. Most of the blocs suffer from fluoride contamination. Some blocs have the problem of higher iron concentration in groundwater.

Conclusion: It is clear from the above discussion that the problem of water scarcity in Puruliya district is a combined effect of hydro geological constraints and lack of proper groundwater abstraction policy. If the potentiality offered by the groundwater reserve is used in prudent way, the problem of water shortage can be sustainably mitigated. Here are some humble suggestions for groundwater abstraction planning in Puruliya district-

i. Scientific explorations, using remote sensing techniques, are needed to prepare a detailed groundwater map of Puruliya district that can be used in planning bloc level water abstraction policies.
ii. Primitive dug wells should immediately be replaced by pump fitted bore wells.
iii. Different abstraction limits should be fixed for different hydro geological units, e.g. higher limits in Gondwana sediment and fractured zones and lower limits for hard crystalline rock zones.
iv. Sectoral priorities in groundwater distribution should be prefixed. Priority should be given to ensure yearlong supply of potable water to every resident of the district.
v. Economic use of groundwater should be encouraged to restrict

overutilization, in order to maintain its sustainability.

vi. Micro watershed planning and rainwater harvesting should be emphasized to release pressure on ground water. Demand of water in agriculture and industry should be mitigated in this way.

Filtration facility should be established at village level where there is problem of contamination in ground water

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