WATER RESOURCE AND HYDOLOGICAL CHARACTERISTICS: A STUDY IN PASCHIM BARDHAMAN DISTRICT, WEST BENGAL

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Abstract

Paschim Barddhaman District consists of pre-Cambrian-era metasedimentary rock, Gondwana sedimentary rock, Rajmahal basalt and high tertiary silt. Broadly speaking, this region forms the main part of the Ajay-Damodar intersection, with the exception of the western part of which lies at the bottom of the Ajay and Barakar divisions. The Ajay and Damodar intersections are a convex plateau, actually an extension of the Chhotanagpur Plateau, with an average elevation of 150 m. The surface gradient of this part is west to west, north to Ajay and south to Damodar. The description of hydroelectric properties is usually defined for a specific position along the course of a current or river. Hydrology is a very influential factor in determining the amount and movement of surface water in this area. The main objective of the present study is to find out the hydrological characteristics and water resources of paschim Barddhaman district. The study recommends proper treatment of contaminated water for use and measures to protect water from intrusion into wastewater.

Keywords: Hydrology, Ground water condition, River Characteristics, Water table, Quality of water

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Introduction

Paschim Barddhaman district is formed of Archaean (Precambrian) rocks containing a multitude of variations of granitoid and schistose which had crystallized at least 900 million years ago (Gaz, Burd. 1994: 29). The area consists of barren, vacant and rolling land with occasional laterite cover.The study area is situated on the interfluves between Damodar and Ajoy rivers. Therefore it also has gradual slopes towards south and north (Gaz, Burd. 1910:1-3). The Ajay-Damodar intersection is a convex plateau, actually an extension of the Chhotanagpur Plateau, with an average elevation of 150 m.The surface gradient of this part is westerly towards the west, northerly towards the Ajoy and southerly towards the Damodar. The Ajoy-Damodar interfluves, the major part of the area under study, is composed of several stows, consisting of small and shallow valleys and low convex spurs running almost in all directions thereby forming a radial drainage pattern. The area under study lies in the humid tropical monsoon regime. It is characterized by (i) hot and dry summer from March to May

(ii) Monsoon or rainy season from June to September (iii) a brief autumn involving October and November and (iv) a cool pleasant winter from December to February. This region receives, on an average, 1332m of annual rainfall with 41 percent of the various rivers, ponds and wells. (CDP Annual Report, May 2019, ADDA Asansol: 19) The major rivers are Damodar, Ajay and Barakar which supply water to the area for the greater part of the year (Gaz, Burd, 1910:3-9) Mode of occurrence of water in surface and subsurface regime is the major component of hydrology. Sub-surface water is mainly the ground water potential areas within the weathered, joined and fractured residuum beneath the depth of 20 mbgl(meter below ground level). Huge amount of ground water is discharged into the mines from the zone of the weaHuge amount of ground water is discharged into the mines from the zone of weathering, the sections of alternating jointed fissured sandstones and thinly laminated shale intercepted in 100 mbgl are harnessed through dug wells and bore wells both. Where surface water is not readily available the inhabitants resort to extraction of groundwater through dug wells.

Objectives

The prime objectives of the present paper are:

- to identify the hydrological characteristics of paschim Barddhaman District, West Bengal;
- to identify the water table of paschim Barddhaman District;
- to investigate the General characteristics of river and use of water in this industrial belt;

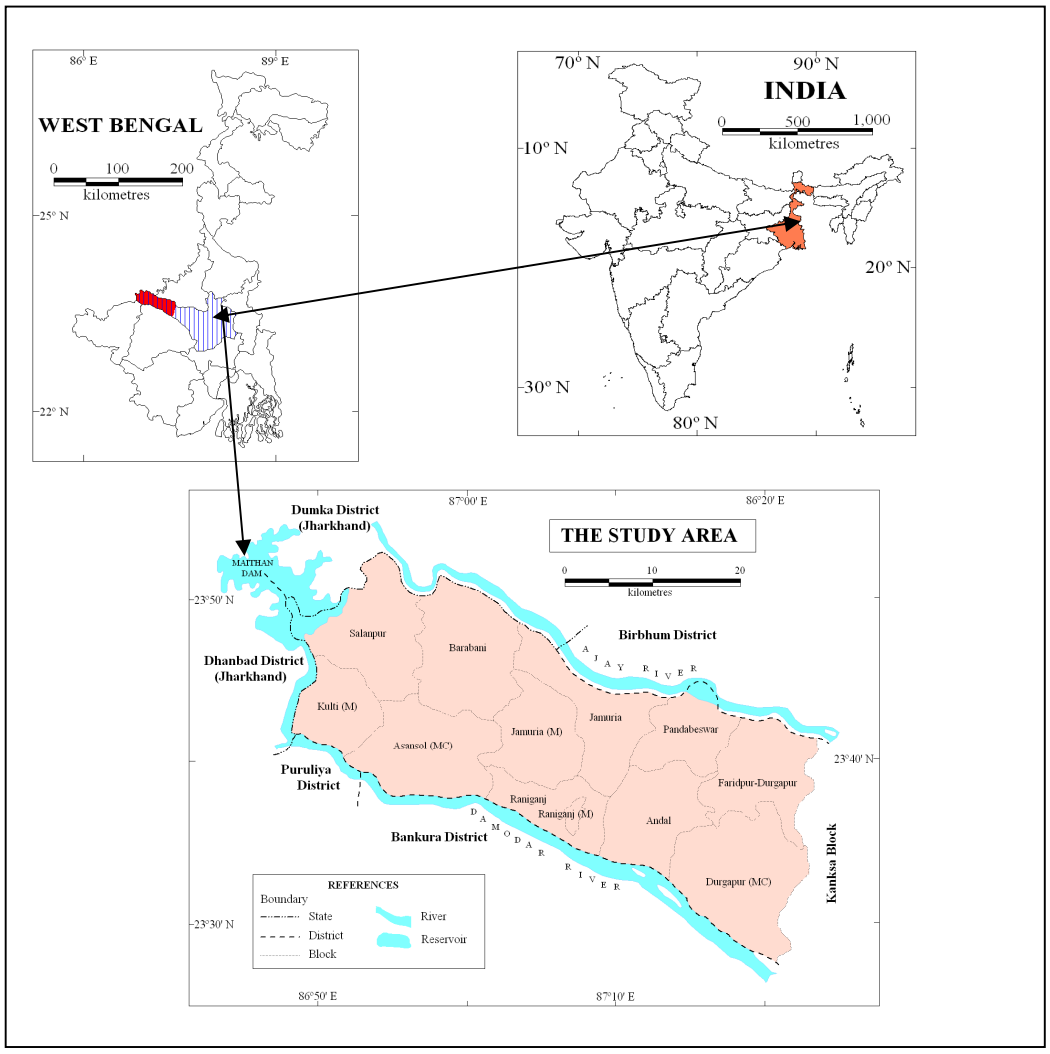
Methodology

The data for the study has been gathered from different books, articles, Journals and different offices .Tables and charts have been prepared in some cases, with the help of computers. Conclusions have been drawn with authentic information to fulfill the objectives.

Study Area

Paschim Barddhaman District, West Bengal, has been considered as the area of study for the present investigation. The area includes two important Sub-Divisions of Paschim Barddhaman District, namely, Asansol and Durgapur. It is bounded on the north by the Ajoy River and Birbhum District; on the east by Kanksa Police station of Durgapur Sub-Division; on the south by the Damodar River and Bankura and Puruliya Districts; and on the west by the Barakar River and Dhanbad Police Station .The area under investigation is located

between 23° 24' 30" and 23° 53' 00" North latitude and between 86° 48' 00" and 87° 32' 30" East longitude.(73 I/13,73 M/2, 73 M/7,73 I/14,73 M/6) .



Source:73 I/13,73 M/2, 73 M/7,73 I/14,73 M/6, 2019

Hydrological Characteristics

- Weathered residuum down to about 20 MBGL under unconfined condition being harnessed by dug.
- Fractures generally down to 100 MBGL under confined condition being exploited through dug-cum borewell (CGWB, 2019)

Groundwater condition

The geology and geomorphology of the area control the occurrence and movement of groundwater. The area suffers from chronic water shortage. In the shallow zone groundwater occurs in an unconfined condition and is generally abstracted by dugwell. The depth to water table generally varies between 6 m to 10 m below the ground surface in the pre-monsoon period and 3 m to 6 m in the post-monsoon period. The water level usually deepens from the

depths near the coalfield area and decreases significantly during the pre-monsoon period. Dugwell has even dried up completely. The depth of water level varies from 15 m to 40 m below ground level in and around the coal mining area. Wetlands are less likely to fall below this depth limit due to the presence of huge rocks without fractures. The regional ground water flow is from west to east. Percolation of water in mine faces down to a depth of 200 m from surface leads to filling up of the abandoned mine pits. Hydrological tests carried out in these pits have established that they constitute a potential source of water supply in the study area (CGWB, 2019). In addition to the shallow uncontrolled wetlands consisting of climatic zones of solid aggregate or semi-aggregated rocks, there are many deep reservoirs in the region where groundwater is limited. Deep aquifers consist of weakly sitting flat planes such as joints, faults, fissures, bedding planes, etc.

Groundwater Potential Zoning

The choice among a set of zones for future development of groundwater is based on multiple criteria such as drainage texture, geomorphology, lithology, present land use, and steepness of slope and frequency of lineaments. This process is commonly known as Multi-Criteria Evaluation (Voogd, H. 1983:24-29).

Table No:1 Average depth of ground water level in the western part of Barddhaman District (in metres) 1981-2019

Year	Premonsoon	Postmonsoon
1981	9.42	5.52
1993	9.91	4.44
2001	8.76	4.17
2002	9.02	3.85
2003	8.7	4.61
2004	7.2	5.72
2005	7.99	4.66
2006	6.63	3.31
2007	7.93	3.99
2008	8.3	3.38
2019	8.53	2.88

Source: Office of the CMPDIL, 2019 and office of the CGWB 2019

Water Table:

Pre-monsoon Water Table

i.In the Paschim Barddhaman district pre-monsoon water table ranges from 6m-10m generally.

ii. Only in some pockets it sometimes goes beyond 10m depth in the block of Jamuria, Andal and Raniganj.

ii.In general, areas along three rivers, Ajoy, Barakar and Damodar experiencec relatively shallow depth of water table than those away from the rivers.It is however, not true for Raniganj, Andal, and Barabani and sometimes in Jamuria.

iii.During 2001 and 2019 almost entire the study area shows more than 7m depths of dugwell water level.Entire Raniganj and parts of Asansol,Andal Faridpur blocks show more than 9 m depth.

Spatial variation of water table is also makes.It is less than 1m in Durgapur, but more than 9m in Raniganj, Andal high water table in Durgapur and Chittaranjan are a may be due to greater secpage from reservoirs of Durgapur barrage and Maithon dam.In Kulti and Salanpur high water table may be due to less number of coal mines and the reserve in true for low water table of Raniganj and Andal (CGWB, 2019).

Post Monsoon WaterTable

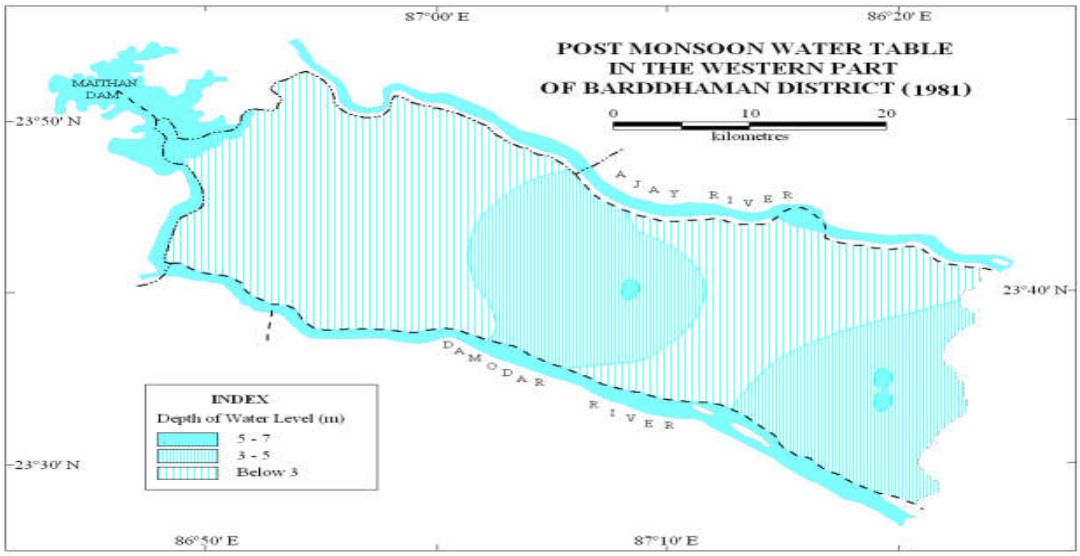
i. In the Paschim Barddhaman district post-monsoon water table ranges from 3m-6m generally.

ii. Only in some pockets it sometimes goes beyond 7m depth in the block of Jamuria and Durgapur.

iii. Postmonsoon water table occurs within 3m depth below the ground level in more than 75% area in 1981 and over 90% area in 2019except Raniganj, Andal, Barabani, and parts of Jamuria.In the rest of the area depth is below 3m in 1981.

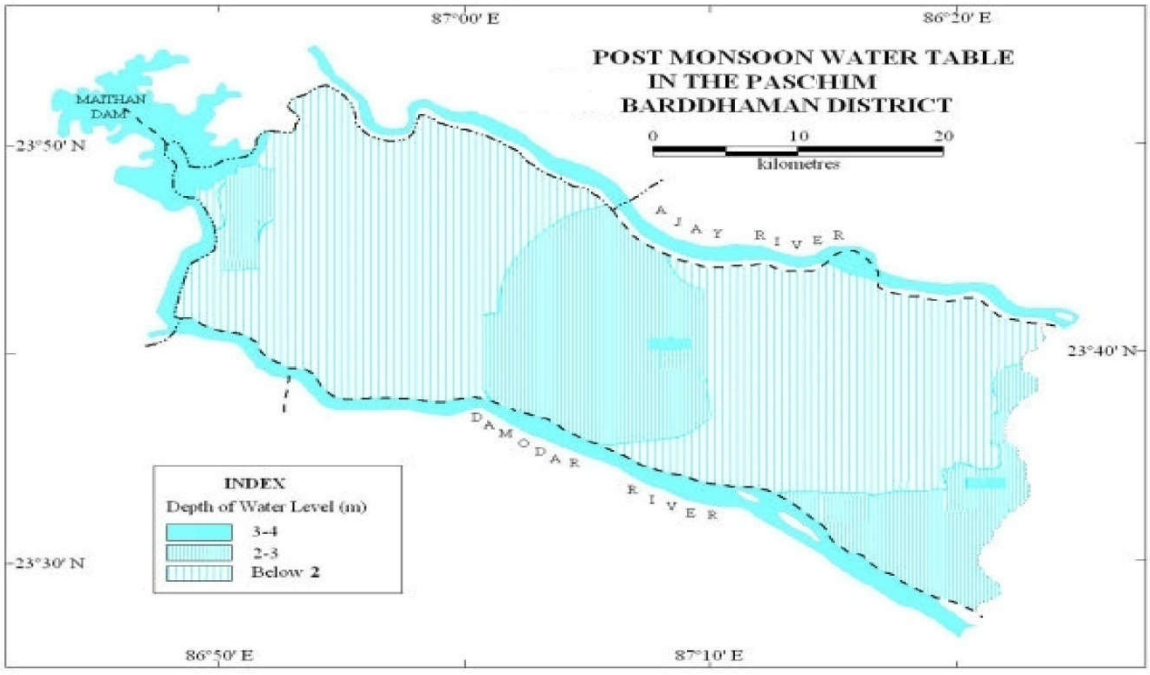
ii.During 2001 and 2019 this extensive area of 3m-4m deep water table zone is fragmented into patches from West to east due to intrusion of 3m to 6m water table zone in Barabani, Asansol, Hirapur, Raniganj and parts of Andal Block (CDP Annual Report, May 2019, ADDA, Asansol: 19-31 and CGWB, 2019).

Map No:1 Post Monsoon Water table in the Paschim Barddhaman District(1981)



Source: Office of the CMPDIL, 2019 and office of the CGWB 2019

Map No:2 Post Monsoon Water table in the Paschim Barddhaman District(2019)



Source: Office of the CMPDIL, 2019 and office of the CGWB 2019

Quality of water

The quality of water of river Damodar is found contaminated with presence of chemicals and heavy metals mixed with the river water from different sources.The heavy metals such as chromium, lead and cadmium have been found consistently higher than USEPA Aquatic

Standerd by about 5 to 40 times.It is reported that BOD level of the river water is 2 to 3 times higher than the Indian conventional water treatment facilities (CDP Annual Report, May 2019, ADDA, Asansol: 56-57).

Ground water Resource potential

Net GW availability: 18739 HAM

>Existing gross GW draft for all uses: 2132 HAM

>Additional GW draft due to mining activities: 5622HAM

>Stage of GW development: 41 %(CDP Annual Report, May 20019, ADDA, Asansol: 66-69).

Impact of Coal Mining on GW regime

Hydro geological aspects:

>DTW varies from 7-18 MBGL around active Mine establishments

>Due to seepage of GH into Mines DTW declines considerably in wells and even wells get dry during summer in the vicinity of Coal Mines.

>Ground water flow pattern is fluenced by mining activity, mainly during premoonsoon period.

>Huge amount of ground water (about 108.33 MCM annually) discharges into the mines from the zone of weathering, the sections of alternating joined,

>The gradient of water table varies from 4M/ km to 10-20 M/Km (CDP Annual Report, May 2006, ADDA, and Asansol: 29-31).

Hydrochemical Aspects

In the open well in this region the amount of Silica, Calcium, Sodium, Magnesium, Potassium and Bicarbonate is 6.8-8.4 ppm, <1- 44 ppm, 1.2-100 pmm, 4-302 ppm, <1-144 ppm and 24-549 ppm respecter.The amount of BOD and COD is highest in in case of Mine Water,Choloride is more in Surface Water, Alkanility is also very high in Surface water, the pH value of Mine water and Surface is equal .

Table No:2 Quality of open well in the Paschim Barddhaman District

Chemical constituents	Range in ppm
Silica	6.8-8.4

Calcium	< 1-44
Sodium	1.2-100
Magnesium	4-302
Potassium	<1—144
Bicarbonate	24-549

Source: Office of the CMPDIL, 2019 and office of the CGWB 2019

Table No:3 Comparision of quality of water in the Paschim Barddhaman District

Parameters in ppm)	Open wells	Mine water	Surface water
pH	6.5-8.2	7.1-8.7	7.1-8.7
Total solids	260-656	436-4218	484-886
Suspended	0-8	0-746	0-24
Alkanility	26-300	-	174-252
Total Hardness	28-470	30-535	38-184
BOD	14-18	10-619.20	10-32
COD	28-56	18-940.20	32-78
Phenolic compound	Nil	Nil-0.125	Nil-0.3
Total cyanides	Nil	Nil	Nil-0.78
Oil and greases	Nil	Nil	Nil-4.0
Chloride	36-58	36-62	56-114
Amonical	Nil-0.20	Nil-1.64	Nil-8.65
Nitrogen	-	-	-
Sulphate	Trace	Trace	Trace
Nitrate	Nil-Trace	Nil-Trace	Trace
Copper	Nil	Nil-0.12	Nil
Hexavalent	Nil	Nil	Nil
Nickel	Nil	Nil-0.13	Nil

Source: Office of the CMPDIL, 2019 and office of the CGWB 2019

Recommendation

>Borewells after delineating water bearing fractures and its extension by photogeological and geophysical survey.

>Left in abandoned mines may help averting hazarda like under ground fire *etc*.

>Withdrawn water can be usd after proper treatment in domestic and industrial scope for conjuctive use of surface and ground water

>Large scope for GW development provided, mine seepage component is minimized adopting suitable measures.

Drainage

Drainage features of the Paschim Burdwan district include the Ajay and its tributaries to the north and Damodar and its tributaries to the southwest. Also, there are numerous old rivers throughout the region.

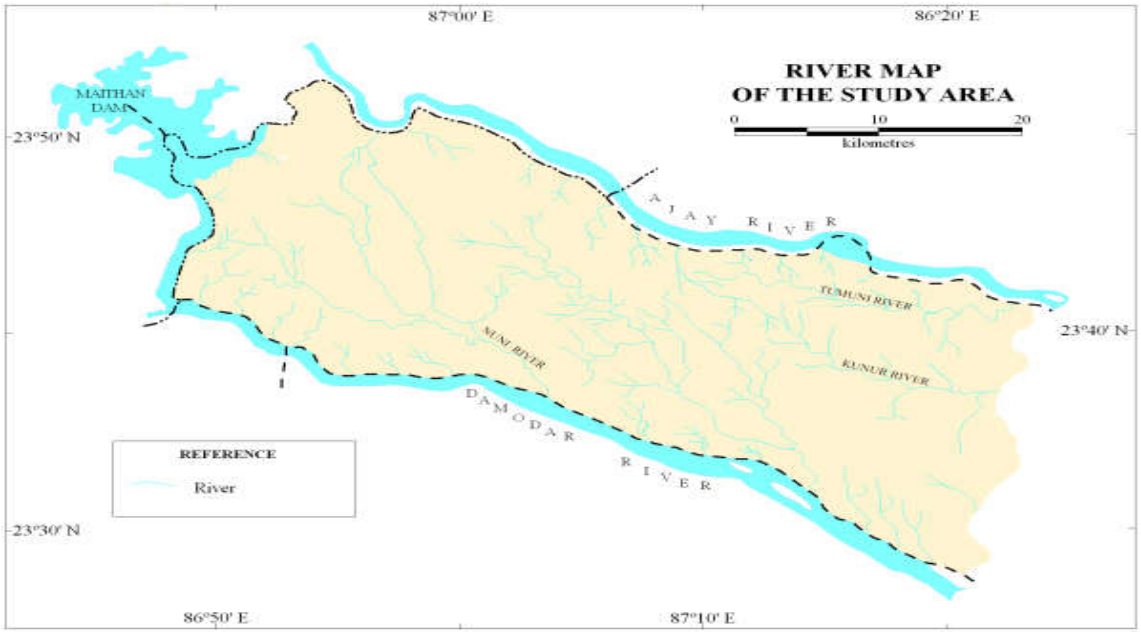
The *Damodar,* the sacred river of the Santhals, rises in the Chota Nagpur watershed and, after a southeasterly course of about 350 miles, falls into the Hooghly just above the ill famed *James and Mary Sands* a shoal and it has helped to deposit at its mouth. With its tributaries and it forms a large line of country drainage extending north-west from Calcutta to the edge of the Central Indian Plateau. The river first touches Burdwan district at the junction of Barakar a few miles south of Barakar police station. It then flows in a south-easterly direction, crossing Raniganj and Andal, forming a boundary between Burdwan and Bankura for about 45 miles, and entering the district near Khandaghosh. River Barakar, though not properly speaking a river of Burdwan its flows for some 5 miles along its north-western boundary before its junction with the Damodar and it separates the district from Manbhum. In Barakar it is bounded by the Grand Trunk Road carrying bridge and the railway bridge built for the Grand Cord line of the Eastern Railway.

River Nunia,which is enters the district from the north west and then it flowing like a hill stream in a deep ravine and after passing to the northern portion of Sitarampur and Asansol eventually enters the River Damodar at Raniganj. The Singaran, a tributary of the Damodar, rises a little north of the Ikda junction on the Ondal loop line of the Eastern Railway, and after about 20 miles to the south-east, falls into the Damodar below the Andal. In the village of Srirampur.River Ajay takes its rise in the Santal Parganas hills and its drains a large portion of their western and southern slopes. The larger tributaries such as the Tumni and the Kunur in the paschim Barddhaman district which are join the Ajay in its rights bank.

River Kunur which is a tributary of the Ajay and its rises in the undulating country north of Kanksa police station and receives the drainage of the eastern slopes of the Raniganj water shed.

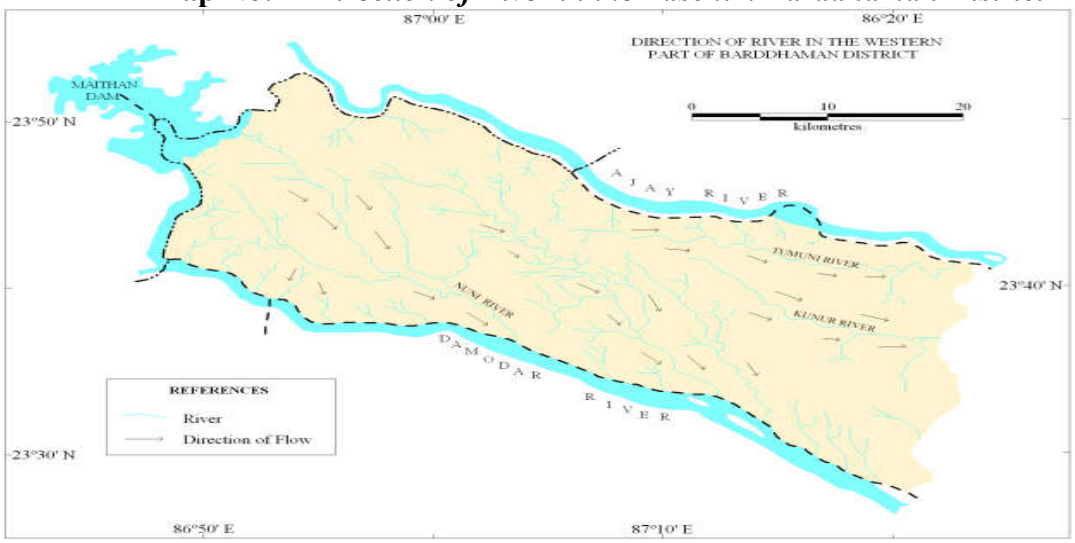
The river Tumuni rises from a place near Haripur and flows eastwards parallel to Ajay which takes a few small tributaries from the south. Tumuni is perennial and the lower parts are prone to floods. (Peterson J.C.K 1910:35-46)

Map No:3 River map of the Paschim Barddhaman District



Source: Toposheet No *73 I/13, 73 M/2, 73 M/7, 73 I/14, 73 M/6* Surveys, 2019-2020

Map No:4 ***Direction of River in the Paschim Barddhaman District***



Source: Toposheet No *73 I/13, 73 M/2, 73 M/7, 73 I/14,73 M/6* Surveys, 2019-2020

General characteristics of the rivers and use of water of Paschim Barddhaman District

Rivers are highly meandering due to almost flat topography and huze sediment load.

(a) The flow from west and east.

(b) They are parallel to each other.

(c) Rivers are non-perennial. Only three trunk rivers Bhagirathi, Ajay and Damodar are perennial.

(d) Rivers often shift their courses. These shifting courses are presumed to from lithology to alternate sand and clay at small scale.

(e) They often show a number of perpendicular bends (Saxena, N.C. 1998. 36-39).

Use of water

The Western part of Barddhaman district is bounded by three perennial rivers, the Damodar, the Barakar and the Ajay. There are no other tributaries rivers except nalas (Nunia,Tamla,Tumni,Singaran) and Jores (Amrasota,Tanti), ponds are less in number compared to the eastern Barddhaman.Due to lack of surface water sources people have to depend on dugwells and tubewells. Again tubes well are expensive to drill through hard rock and dugwell are not adequate to meet the domestic water demand of this mining and industrial belt of the study area. The PHE supplies drinking and domestic water from river and river bed tubewells to the municipal towns and non-municipal urban and rural areas. Entire mining and industrial area is however not covered by PHE water supply.

Type of utilization of mine water

i. Drinking and Domestic: Kunustoria
ii. Official uses within colliery
iii. Agriculture
iv. Pisiculture
v. Tourism
vi. Travel and Transport (Saxena, N.C, 1998:35-37)

Conclusion

In general the ground water potential for future development in the study area is medium. There is a major northwest-southeast trending zone of low ground water potential apart from small pockets scattered throughout the area. High ground water potential is observed along the Damodar River, Ajoy River and in small pockets in northern part of the study area .The groundwater abstraction structures feasible in high potential areas are dug wells fitted with low power pumps and tubewell fitted with hand pump and submersible pump, in the medium potential areas are dug well, dug-cumbored well and tube well fitted with hand pump and in the low potential areas are dugwell, dug–cum-bored well. In the very low potential areas generally ground water abstractions structures will not be successful. Dugwell, dug-cum-bored well may be constructed. Surface water should be harnessed and rooftop rainwater

harvesting schemes may be adopted. The areas affected by mining have medium groundwater potential. Therefore, the pumped out water from active mining areas should be utilized for domestic and other purposes to tide over the water crisis in the pre-monsoon period.

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