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Research Article

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Hydro-Chemical Spatial Distribution of Groundwater for Drinking Water Purpose in Dhanbad District, Jharkhand State

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ABSTRACT

Our date to date life groundwater is one of the important natural resource. In this paper, intends to evaluate the groundwater quality for drinking water purpose in Dhanbad district. In this study area, the important coal deposits occur in Jharia and Nirsha blocks. It is play a vital role for groundwater contamination in this district. The groundwater analysis data collected from Central Groundwater Board, Calcutta and Central Mine Environment, ISM Dhanbad. These data were used to evaluate spatial distribution of groundwater quality to fit for drinking purpose. In this study, IS: 10,500 drinking water standard was used and what are the parameters exceed permissible limit taken into account for analysis. Assessment of quality has been carried out with the help of various parameters and using overlay analysis in GIS. The study concealed that while the 4.33% area have excellent quality, 74.12% area identified as good quality and 21.08% and 0.47% area comes under moderate and poor categories respectively.

Keyword: Hydro geochemistry; Hydrogeology; Water quality; Overlay analysis and GIS

INTRODUCTION

The quality of water may be evaluated for different intended use considering various standards available for water quality parameters. The groundwater in Dhanbad district has been evaluated for drinking purposes considering only the significant parameters concerning to the intended use of water in order to prepare different land-modules that indicates the different classes of water quality with respect to the different parameters for multi-criteria analysis[6]. Water quality of Dhanbad district has been evaluated from the ground water quality monitoring network developed by Central Ground Water Board (CGWB) that contains 16 wells in and around Dhanbad district. Some studies were earlier made to evaluate groundwater quality in the area. Singh studied status of water quality in Jharia coalfield [3]. This study revealed that water in this field is grossly polluted. It is noted that the effluents from coal washeries, coke ovens and thermal power plants used to possess serious problems. Gupta studied pollution profile of Damodar River along Dugda – sindri industrial stretch [2]. The water quality study has been investigated by many researchers in different areas [1,5,7-11].

EXPERIMENTAL SECTION

Study area

Dhanbad district is bounded by Giridhi district in the west, Dumka district in the north, Bokaro in the southwest and Asonsal district in the east and southeast. It has eight blocks. The Dhamodar and Barakar rivers are flowing in south and northern border respectively. The district is situated in northern part of Jharkhand state. It is bounded between 23^{o} 38’ 58” N to 24^{o} 03’ 30” N latitudes and 86^{o} 06’ 11” E to 86^{o} 50’ 26” E longitude and covers an area of about 2057 km^{2} (Figure 1). In this study area, one third part of the area covered by gondwana sedimentary rock and remaining area spread out Archeaan rocks.

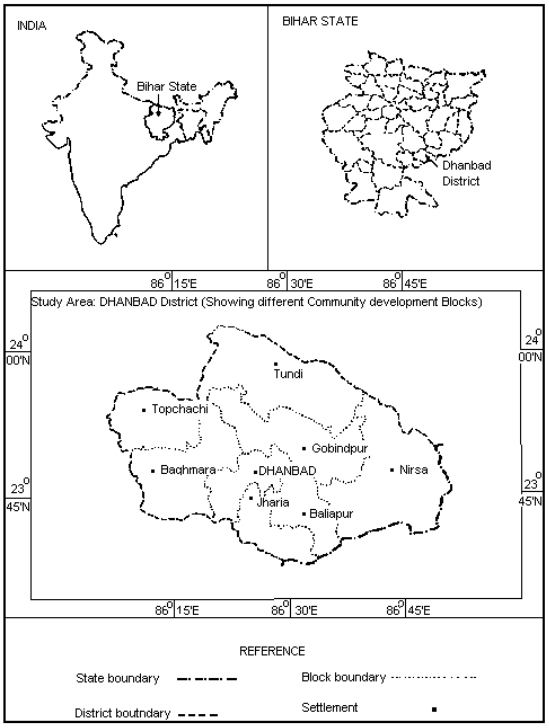

Figure 1: Location Map

MATERIALS AND METHODS

The district consists of 73I/1,2,5,6,9,10,13,14 and 72L/8 Survey of India toposheets of 1:50,000 scale were used. The water samples considered for the assessment of drinking water use are as same as the samples assessed for agricultural purpose, collected from 16 wells, which comes under the ground water monitoring network system of Central Ground Water Board (CGWB), Calcutta. In all, 14 samples were analyzed in Center of Mining Environment, Indian School of Mines, Dhanbad [11, 4]. Only fifteen significant parameters are considered to evaluate the water quality in terms of indices for drinking purpose according to IS:10500 [4]. The computed indices are interpolated for other areas to prepare the land-modules indicating the various classes of groundwater quality as contours drawn with respect to each parameter and its standard. The total area of various water quality classes has been estimated for each parameter. The total areas of different water quality classes have been presented in result and discussion, only for those parameters, which exceed the permissible limits. The secondary source of data has widely been used in the present study. Spatial distribution of chemical constitutes were arrived by applying GIS technique. The Overlay analysis (Multi criterion analysis) in ARC-GIS software was adopted. Inter class dependencies or inter map dependencies were determined by assigning different scores. The weights were assigned by the method suggested by Yager[6]. The average score is then defined by

$$\overline{S} = \frac{\sum_{i}^{n} S_{ij} W_i}{\sum_{i}^{n} W_i}$$

RESULT AND DISCUSSION

Total Hardness

Hardness of ground water may be classified into soft, slightly hard, moderately hard and very hard. According to the Bureau of Indian standard, the desirable and permissible limits for drinking purpose are 300mg/l (as $CaCO_3$) and 600 mg/l respectively. Total hardness of the district varies from 50mg/l to 1060 mg/l. The Soft water is found in Mahuda area whereas very hard water is found in Kusunda and East Kastras areas. About 44% area of Dhanbad district is found to occur below desirable limit whereas the 56% area has the total hardness above within permissible limit. The water quality with respect to the total hardness in Nirsa and northwestern

part of the district is found below the permissible limit. The quadtree map for total hardness has been shown in Figure 2.

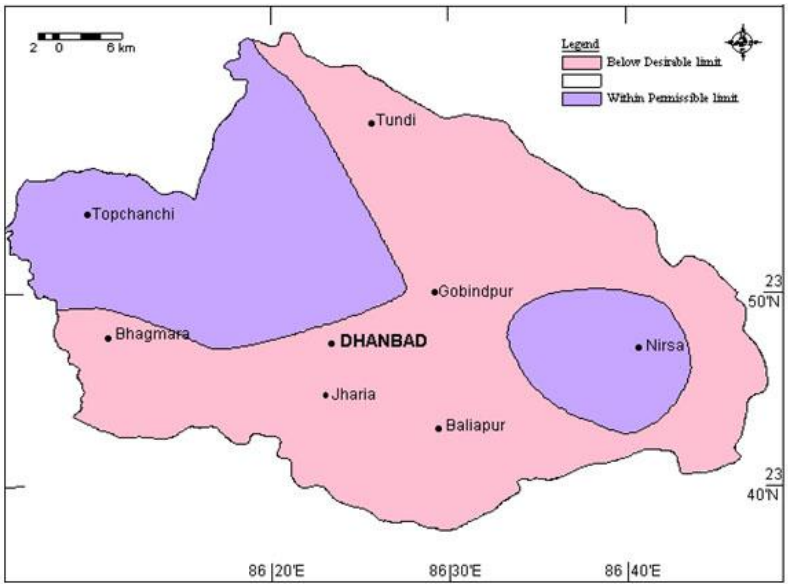

Figure 2 Total Hardness Map

Iron Concentration

The desirable and permissible limits of iron concentration for drinking purpose ranges are between 0.3mg/l and 1.0mg/l. The minimum concentration of iron found is 0.24 mg/l in Bhowrah area while 3.09 mg/l of Iron has the highest value as noted in Jharia area. About 46% area of Dhanbad district around Baghmara and Nirsa has iron concentrations above the permissible limit whereas the 54% area has the concentration of iron within the permissible limit. Very high concentration of Iron is found only around mining areas. The distribution of ground water of quality with respect to iron concentration over the district has been shown in Figure 3.

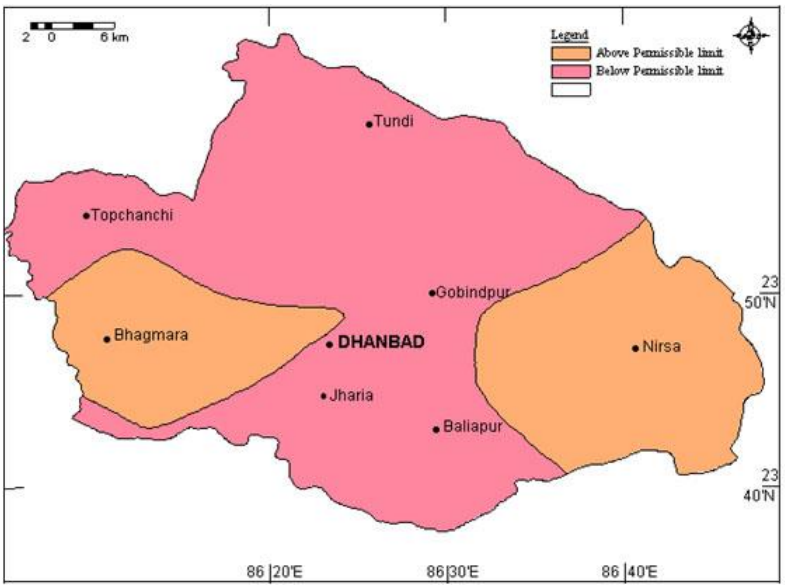

Figure 3: Concentration of Iron

Calcium Concentration

According to drinking water quality standards, the desirable and permissible limit of calcium concentration ranges between 75mg/l and 200mg/l. Regarding concentration of calcium in water Topchanchi area has the highest value of 132 mg/l whereas Mahuda has 12mg/l the lowest value. About 54% of the Dhanbad district (around Baliapur and Bhagmara) has calcium concentration below the desirable limit and the remaining 45%

area (around Topchanchi and Nirsa) has the concentration within permissible limit. The aerial extent of drinking water quality with respect to the calcium concentration has been presented in Figure 4.

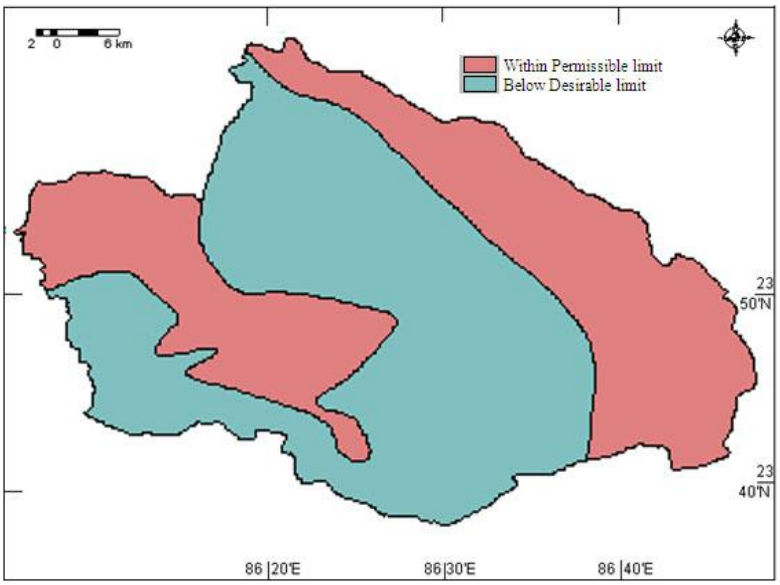

Figure 4: Calcium concentration Map

Magnesium Concentration

For drinking purpose, desirable limit of Mg in water is 50mg/l and permissible limit is 150 mg/l. The magnesium concentration in East Katras area is found to be 180 mg/l in the higher than permissible limit whereas in Lodna area the concentration is found to be 0.40 mg/l. About 21% area of the district has the concentration within the permissible limit, whereas the area about 78% has below desirable limit and remaining about 0.23% area has above permissible limit. The aerial extent of the different water quality zones with respect to the magnesium content is shown in Figure 5.

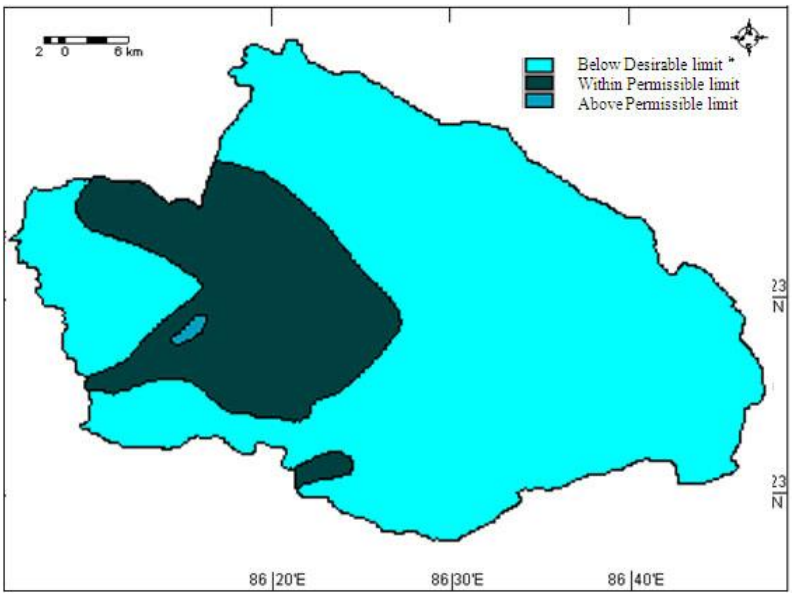

Figure 5: Magnesium concentration Map

Fluoride Concentration

According to drinking water standard desirable limit is 1.0 mg/l and permissible limit is 1.5 mg/l. about 0.81% area of Dhanbad district around Gobindpur town area, the concentration of fluoride has been found 1.20 mg/l, which is shown in **Fig 6**. Most of the area in the district i.e. about 99.19% has fluoride concentration below the desirable limit.

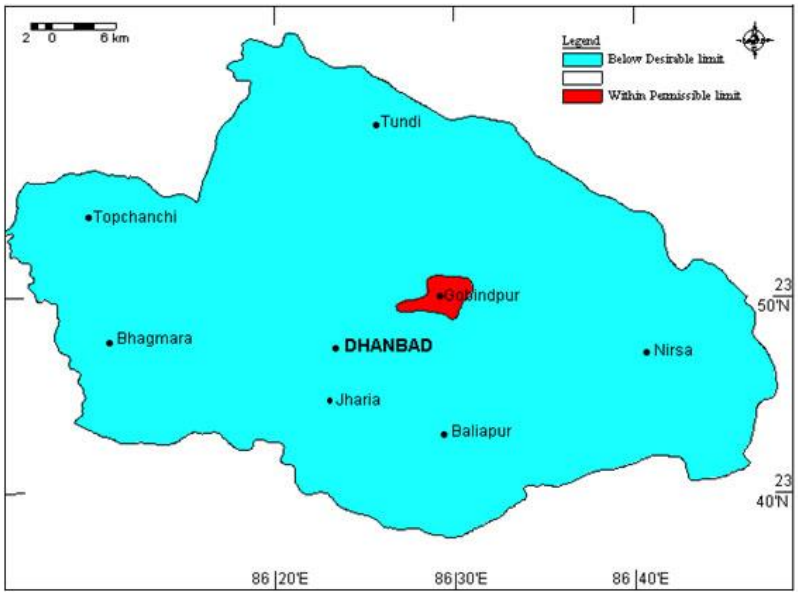

Figure 6: Fluorine concentration Map

NO_3 Concentration

As per IS: 10500 for drinking water quality, the desirable limit of NO_3 is 45mg/l and permissible limit is 100mg/l. The concentration of NO_3 in and around Topchanchi town area has been found above the permissible limit (105mg/l). About 46% of Dhanbad district around Tundi, Gobindpur, Topchanchi and Baghmara areas has the concentration of NO_3 within the permissible limit whereas the remaining 53% of the district has below desirable limit. The aerial distribution of various water quality classes in Figure 7.

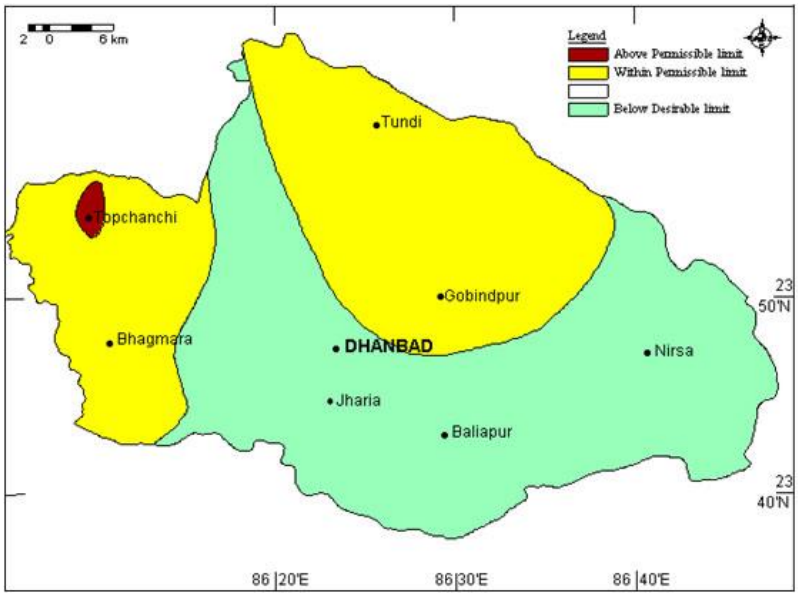

Figure 7: NO_3 concentration Map

Total Alkalinity

For drinking water purpose, desirable limit of total alkalinity in water in 200 mg/l and permissible limit is 600 mg/l. The total alkalinity concentration in Muralidih, Madhuband and Sudamdih areas are found to be 510 mg/l, 276 mg/l and 329 mg/l respectively i.e. higher than desirable limit whereas in Lodna, Katrasgarh and Kusunda area the concentration were found to be 2.70 mg/l, 90.84 mg/l and 8.50 mg/l respectively. About 12% area of the district has the concentration within the permissible limit and remaining 88% has below desirable limit. The aerial extension of the different water quality zones with respect to the total alkalinity content is shown in Figure 8.

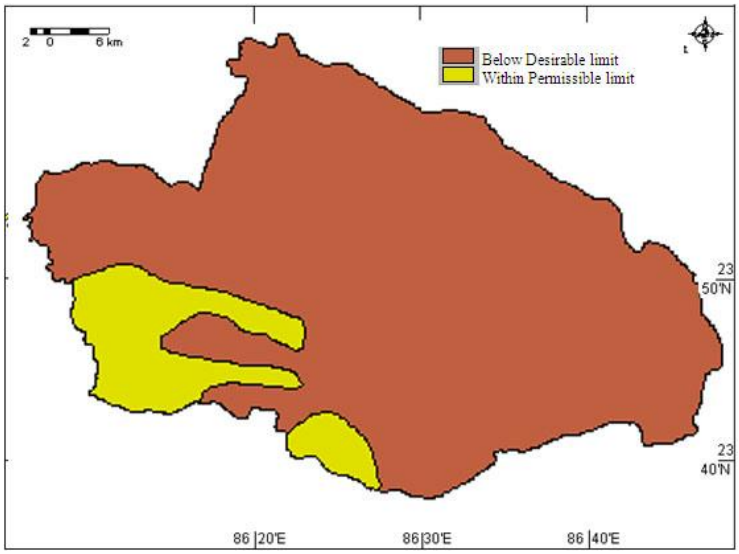

Figure 8: Total Alkalinity concentration Map

Evaluation of Water Pollutants

Groundwater is one of the important resources given by the nature. Generally, groundwater is being used for drinking and agricultural purposes. The quality of water should be at least satisfactory for the intended use. There are several standards constituted by many organizations and they vary as per the desired use of water. The water quality is evaluated with respect to the given standards for the drinking water use.

CONCLUSION

Drinking water quality standards and distribution of various classes of water quality over the district have been described above. Based on these standards, the significant parameters have been taken into account while creating an integrated module for drinking water quality using multi-criteria decision making analysis. There are only 4 different drinking water qualities classes fall in the district. The aerial distribution of the various integrated water quality classes has been shown in Figure 9. Poor class of water quality is found about 0.47% area of the district around east Katras area. The southern part of the district and very little area, which is located towards northern side from Nirsa and western side of Tundi fall under the excellent class of water quality and the total area under this category is about 3% of the district. The area about 74% comes under good class of quality whereas about 21% area in the western side of the district and around Nirsa town and is found under the class of moderate quality. The Table 1 shows the detailed statistics of various classes of water quality and its aerial extension.

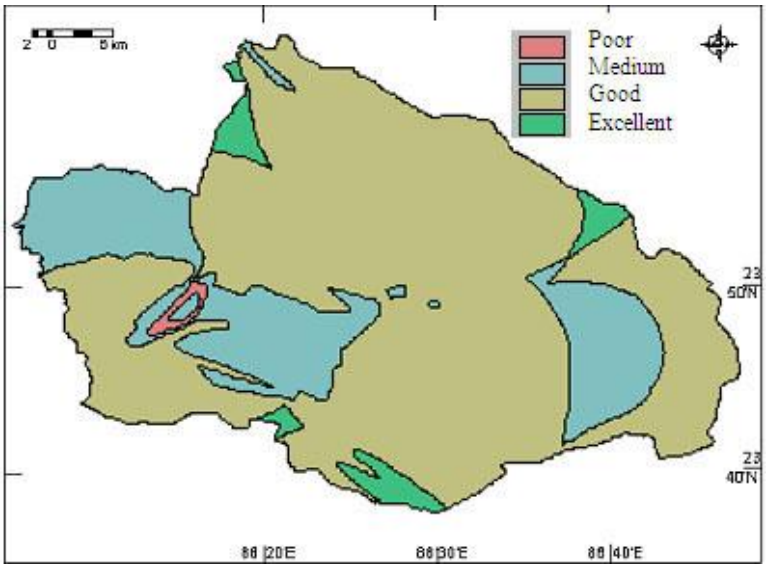

Figure 9: Drinking Water Quality Map

Table 1: Distribution of Various Classes of Integrated Drinking Water Quality over the Dhanbad District

S. No	Category	Area (sq.km.)	Area (%)
1	Excellent	89.09	4.33
2	Good	1524.99	74.12
3	Moderate	433.71	21.08
4	Poor	9.67	0.47
Total		2057.26	100

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