International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.12, pp 67-73, 2017

Water Quality Assessment of Ground Water samples using water Quality Index Method of North Karanpura Coalfield, Jharkhand

Babita Neogi[1, 2], Abhay Kumar Singh[1], D. D. Pathak [2]

[1]CSIR-Central Institute of Mining and Fuel Research, Barwa Road, Dhanbad, 826 015, India
[2]Departments of Applied Chemistry, Indian Institute of Technology (ISM), Dhanbad, 826004, India

Abstract : Groundwater is a natural resource for drinking water. Like other resources, it should be assessed regularly. The present study was intended to calculate Water Quality Index (WQI) of groundwater of North Karanpura Coalfield (Jharkhand) in order to ascertain the quality of water for public consumption and other purposes. This has been determined by collecting 19 ground water samples from bore and tube wells. For calculating WQI, the following parameters have been considered pH, TDS, TH, Fluoride, Chloride, Nitrate, Sulphate, Calcium, Magnesium, Sodium, and Potassium. The WQI for these samples ranged between 21.8- 231.2. The analysis reveals that the ground water of North Karanpura Coalfield needs some treatment before consumption. In the study area mining is one of the major activities causing water pollution and threatens the quality and quantity of ground water.
Keywords : Ground water, WaterQuality Index, North Karanpura Coalfield.

Introduction

Water is nature's most wonderful, abundant and useful compound of the many essential elements for the existence of human beings, animals and plants[1]. It is a prime natural resource and a basic human need. Without food, human can survive longer but without water they can't survive. An average man (of 53 kg – 63 kg body weight), requires about 3 litres of water in liquid and food daily to keep healthy[2]. This fact apparently accounts for why water is regarded as one of the most indispensable substances in life and like air it is most abundant[3]. Increase in human population has exerted an enormous pressure on the provision of safe drinking water especially in developing countries[4]. Water scarcity is increasing worldwide and pressure on the existing water resources is increasing due to growing demand of different sectors such as domestic, agriculture, industrial and hydropower etc. Most of the fresh water bodies all over the world are getting polluted, thus decreasing the portability of water[5].Anthropogenic activities such as mining, indiscriminate discharge of untreated sewage, industrial waste, population growth and urbanization are major causes of deterioration of ground and surface water quality[6, 7, 8].Mining have both quantitative and qualitative impacts on the water regime in and around mining complexes. Disruption of hydrological pathways, contamination of water resources and depression of water table around the dewatered zone are the major measurable impacts of mining activities on water environment[9, 10]. Therefore evaluation of water quality is important research topic in the recent years. Water quality monitoring and assessment is the foundation of water quality management; thus, there has been an increasing demand for monitoring water quality by regular measurements of various water quality variables. The Physico-chemical study could help in understanding the structure and function of particular water body.

Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from their sources. Groundwater chemistry has been utilized as a tool to outlook water quality for various purposes. WQI is an important technique for demarcating groundwater quality and its suitability for drinking purpose. Water quality index (WQI) provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. The objective of water quality index is to turn complex water quality data into information that is understandable and used by the public. In general, water quality indices incorporate data from multiple water quality parameters into a mathematical equation that that describes water quality status.

Study area

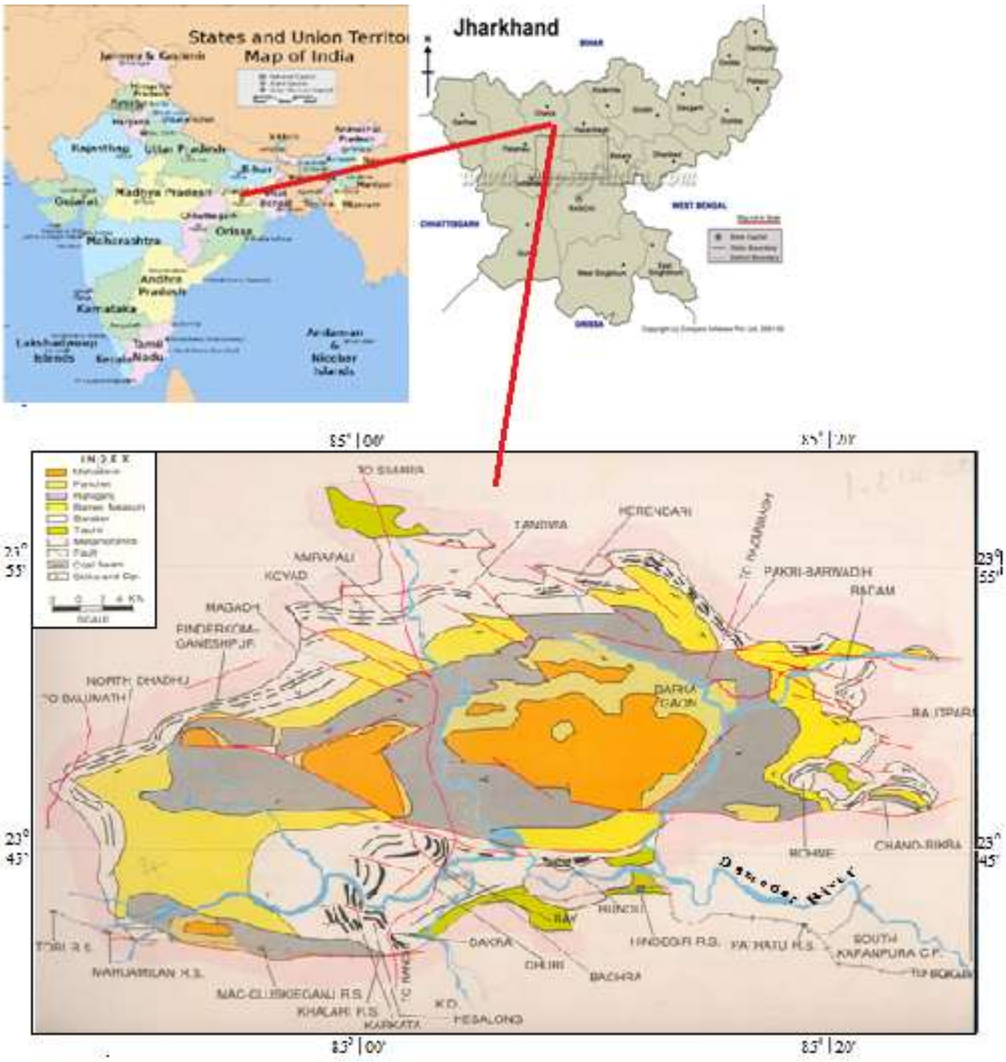

Figure1.Geological map of the North Karanpura Coalfield

The North Karanpura is a western most member of the Damodar Valley Coalfields, covering an area of 1230 km^2 and known for its very large reserves of the inferior non-coking power grade coal[11]. This coalfield comes under Central Coalfields Ltd. (CCL), a subsidiary of Coal India Limited and is located in Hazaribagh, Chatra, Palamu and Ranchi districts of the Jharkhand state. North Karanpura coalfield is elliptical in shape, having axes of 64 km in east-west direction and 32 km in north-south direction and bounded by North Latitudes $23^0$37'16" to $23^0$58'05" and East longitudes $84^0$45'00" to $85^0$28'44". The topography of the area is characterized by high hills in the central part which rises from low relief along the periphery with elevation ranging from 418 m to 462 m. The coalfield is surrounded by the Archaean shield of Hazaribagh plateau in the north and Ranchi plateau in the south. Damodar River originates near SW corner of the coalfield and flows towards east along the southern portion of the coalfield. Raniganj, Barakar and Karharbari are the major coal bearing horizons in this coalfield[12]**.** Rocks of Mahadeva Formation occur in the three isolated patches. Talchir Formation is thin and occurs mostly along the fringes of the coalfield. A few dolerite dykes are recorded in northern part while mica-peridotite intrusive occurred in the eastern part of the Coalfields. Geological Map of North Karanpura Coalfield shown in (Fig-1). The Karanpura area experiences tropical climate where the maximum temperature rises up to 42°C during May-June and dips to 4°C in December-January. The average annual rainfall of the area is 1300 mm and more than 85% of the annual rainfall occurs during the four monsoon months (June to September). Karanpura Coalfield was discovered by D. H. Williams in 1848, but the commercial scale production from this coalfield started in 1985 by opencast method. The mining activities are presently restricted to the south central part of the North Karanpura Coalfields where both opencast and underground mines are in operation. Ashok, Piparwar, Purnadih, KD Hesalong, Manki, Churi, Bachara, Ray and Dakara are the major operating mines in the North Karanpura Coalfields.

To meet the national energy demands, about thirty new opencast projects including Pakari-Barwadih and two mega thermal power plants are planned for the Karanpura valley in coming future.

Experimental

For the assessment of ground water quality of the North Karanpura Coalfield, 19 groundwater samples were collected from different places including rural, urban, and mining areas. The water samples were collected in one litre narrow-mouth pre-washed polyethylene bottles. Electrical conductivity (EC) and pH values were measured in the field using a portable conductivity and pH meter. Turbidity was measured by Turbidity meter (TN-100). In the laboratory, the water samples were filtered through 0.45 µm Millipore membrane filters to separate suspended particles. Acid titration method was used to determine the concentration of bicarbonate (HCO_3^-) in water (APHA 1998). Major anions (F^-, Cl^-, SO_4^{2-}, NO_3^-) were analysed in ion chromatograph (Dionex Dx-120) using anions AS12A/AG12 columns coupled to an anion self-regenerating suppressor (ASRS) in recycle mode. Major cations (Ca^{2+}, Mg^{2+}, Na^+, K^+) were measured by Double Beam Atomic Absorption Spectrophotometer (Varian 280-FS) after calibrating the instrument with known standards. The details of sampling location are given in Table 1.

Table 1.The details of sampling location

S.No.	Sample code	Location	Type of sample
1	GW1	Ashoka Proj	Dug Well
2	GW2	Macluskigang	Tube well
3	GW3	Khalari	Tube well
4	GW4	Dakra	Dug Well
5	GW5	Subash Nagar	Dug Well
6	GW6	Churi	Tube well
7	GW7	K.D.H	Tube well
8	GW8	Bachra	Tube well
9	GW9	Ray	Dug Well
10	GW10	Piparwar	Dug Well
11	GW11	Mandar	Dug Well
12	GW12	Kalyanpur	Tube well
13	GW13	Rautpara	Tube well
14	GW14	Barkagaon	Tube well
15	GW15	Bacharia	Tube well
16	GW16	Asnatari	Dug Well
17	GW17	Kerendari	Tube well
18	GW18	Laranga	Tube well
19	GW19	Jamuari	Dug Well

Water Quality Index

Water quality index (WQI) is defined as a technique of rating that provides the composite influence of individual water quality parameter on the overall quality of water. One of the major advantages of WQI is that, it incorporates data from multiple water quality parameters into a mathematical equation that rates the health of water quality with number[13]**.** The concept of indices to present gradation in water quality was first proposed by Horton (1965)[14]. In this method the weight age for various water quality parameters is assumed to be inversely proportional to the recommended standards for the corresponding parameters[15].

Calculation of Water Quality Index

The calculation of WQI was made using weighed Arithmetic method in following steps- Let there be water quality parameters and quality rating (qn) corresponding to nth term parameter is a number reflecting relative value of this parameter in the polluted water with respect to its standard

Permissible limits value. qn values are given by the relationship .

$qn = 100 (Vn – Vi) / (Vs – Vi)$

Where Vs- standard value, Vi- ideal value, in most cases Vi = 0 except in certain parameters like pH, dissolved oxygen etc., calculation of quality rating for pH and DO (Vi was not zero).

$q pH = 100 (V pH – 7.0) / (8.5-7.0)$ and $q DO = 100 (V DO – 14.6) / (5.0-14.6)$

Calculation of Unit Weight:

The unit weight (Wn) to various water quality parameters is inversely proportional to the recommended standards for the corresponding parameters.

$Wn = k / Sn$

Where Wn= unit weight for the nth parameter, Sn= standards permissible value for nth parameter, k=Proportionality constant

The unit weight (Wn) values in the present study are taken[16].

Calculation of WQI**:**

$WQI = \Sigma qn Wn / \Sigma Wn$ Where n= i-n

Result and discussion

The data were used to calculate the Water Quality Index (WQI) to get a better understanding of the overall water quality. The WQI ranged from 21.8 to 231.2 and average 71.9(Fig. 2) which indicate Very Good to Very Poor status of water quality. This may be attributed to the proximity of the location to the mining activities. Among all the of the water samples, the percentage (%) of WQI categories Very Good (10.5%), Good (36.9%), Poor (21.1%) and Very Poor (31.6 %) were observed (Fig. 3). More than half of the locations fall in the Poor to Very Poor category shows that the water is not suitable for direct consumption and requires treatment before its utilization. The Indian Standards as per ISI for the drinking water together with its corresponding status categories of WQI are given in Tables 2, Table 3 and Table 4, respectively.

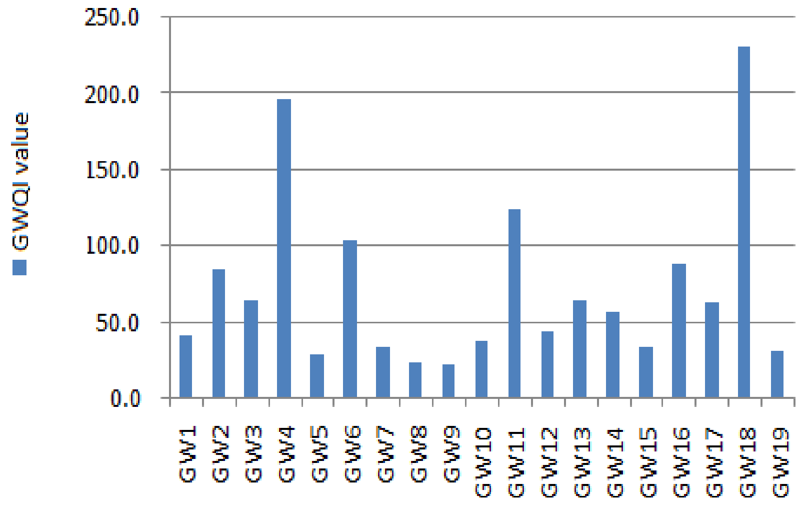

Figure 2.Graphs showing location wise GQWI in North Karanpura Coalfield

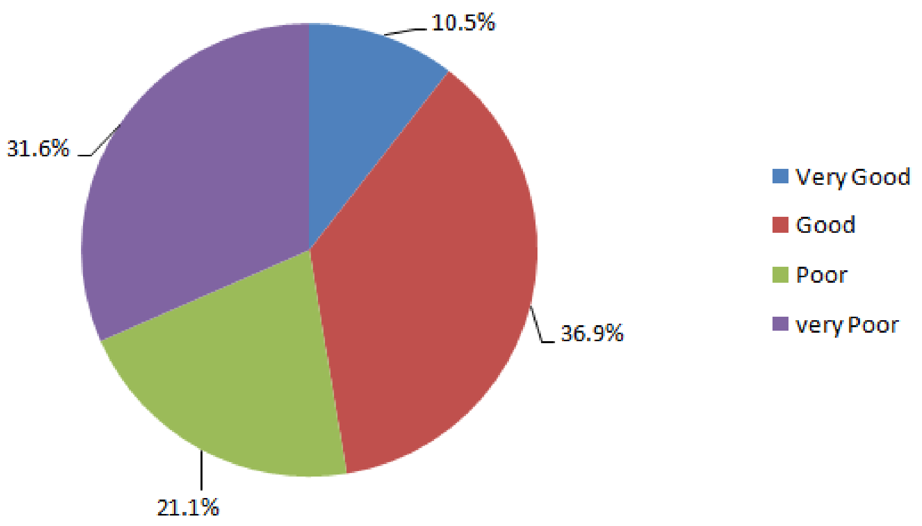

Figure 3 WQI categories of samples (%)

Table 2.Chemical parameters corresponding the IS: 10500

Chemical parameters	Standard	Wi=KSi
pH	7.5	0.107826667
TDS	500	0.0016174
TH	300	0.002695667
F	1	0.8087
Cl	250	0.0032348
NO_3^-	45	0.017971111
SO_4^{2-}	200	0.0040435

HCO_3^-	200	0.0040435
Ca^{2+}	75	0.010782667
Mg^{2+}	30	0.026956667
Na^+	200	0.0040435
K^+	100	0.008087

∑ Wi=1.000002478
Units: Concentration in mg L^{-1}, except pH.

Table 3.Classification of WQI range and category of water

WQI Range	Category of water
<50	Very Good water
50-100	Good water
100-200	Poor water
200-300	Very Poor water
>300	Unfit for drinking purpose

Table4. Water Quality Index of Ground water of North Karanpura Coalfield

S.No.	Sample code	GWQI value	Status
1	GW1	41.0	Good
2	GW2	83.5	Very poor
3	GW3	64.0	Poor
4	GW4	197.0	Very poor
5	GW5	28.4	Good
6	GW6	102.8	Very poor
7	GW7	33.4	Good
8	GW8	23.2	Very good
9	GW9	21.8	Very good
10	GW10	37.5	Good
11	GW11	124.0	Very poor
12	GW12	44.0	Good
13	GW13	63.7	Poor
14	GW14	56.2	Poor
15	GW15	33.5	Good
16	GW16	88.4	Very poor
17	GW17	62.1	Poor
18	GW18	231.2	Very poor
19	GW19	30.2	Good

Conclusion

On the basis of the above discussion, it may be concluded that the half of the ground water has polluted as indicated by WQI. The calculation of Water Quality Index (WQI) shows that out of 19 samples two samples are very good and seven samples are good category and can be use for direct consumption while rest of the water samples are the poor and very poor category. The analysis reveals that the ground water of North Karanpura Coalfield needs some treatment before consumption. Hence, application of Water Quality Index technique for the overall assessment of the water quality of a water body is a useful tool.

References

1. Gummadi, Sudhakar., G, Swarnalatha., V, Venkataratnamma.,and Z,Vishnuvardhan., Water quality index for groundwater of Bapatla Mandal, coastal Andhra Pradesh, India**,** International Journal of Environmental Science, 2014, v.5, pp.22-33.
2. Onweluzo, J. C., and Akuagbazie, C. A., Assessment of the quality of bottled and sachet water Sold in nsukka town. Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension,2010, v. 9, pp. 104 -110.
3. Okonko, I. O., Ogunjobi, A. A., Adejoye, A. D., Ogunnusi, T. A. and Olasogba, M. C.,Comparative studies and microbial risk assessment of different water samples used for processing frozen sea foods in Ijora-olopa,Lagos State,Nigeria, African Journal of Biotechnology, 2008, v. 7 (16), pp.2902-2907.
4. Umeh, C. N., Okorie, O. I.,Emesiani, G. A.,Towards the provision of safe drinking water: The bacteriological quality and safety of sachet water in Awka, Anambra State. In: the Book of Abstract of the 29th Annual Conference & General Meeting on Microbes As Agents of Sustainable Development, organized by Nigerian Society for Microbiology (NSM), University of Agriculture, Abeokuta,2005, pp.22.
5. Chandra, S., Singh, A.,Tomar, P. K., (2012). Assessment of Water Quality Values in Porur Lake Chennai, Hussain Sagar Hyderabad and Vihar Lake Mumbai, India, Chem Sci Trans.,2012,v..1(3), pp.508-515.
6. K., Impact assessment of chromite mining on groundwater through simulation modelling study in Sukinda chromite mining area, Orissa, India. J Hazard Mater, 2008, v. 160, pp.535–47.
7. Das, S., Ram, SS., Sahu, HK., et al., A study on soil physico-chemical, microbial and metal content in Sukinda chromite mine of Odisha, India, Environ Earth Sci,2013, v. 69:2487–97.
8. Giri, S. and Singh, A.K., Human health risk assessment via drinking water pathway due to metal contamination in the groundwater of Subarnarekha River Basin, India, Environ Monit Assess, 2015, pp. 187-63.
9. Pulles, W., Howie, D., Otto, D., Easton, J., A manual on mine water treatment and management in South Africa. Water Research Commission Rep. No. TT 80/96, Pretoria, South Africa, 1995.
10. Younger, PL., Banwart, SA.,Hedin, RS., Mine water – hydrology, pollution, remediation. Kluwer Acad Pub, Dordrecht, The Netherlands,2002
11. Coal Atlas of India. Central Mine Planning and Design Institute Ltd., Publication, Ranchi, 1993.
12. Sharma, NL.,Ram, KSV., Introduction to the geology of coal and Indian coalfields. Orient Publication, Jaipur, 1966.
13. Yogedra, K. and Puttaiah, E.T., Determination of Water Quality Index and Suitability of an Urban Waterbody in Shimga town, Karnatka.Sengupta,M and Dalwani,R (Eds.).Proceedings of Taal2007,The World Lake Conference 2008, 342-346.
14. Horton, R.K., An Index number system for rating water quality, Water Pollution Control Federation Journal, 1965, v.37, pp 300- 305.
15. Rao, N.S., Rao, J.P., Devadas, D.J. and Rao, K.V.S., Hydrogeochemistry and Groundwater Quality in a Developing Urban Environment of a Semi-Arid Region, Guntur, Andhra Pradesh, Journal Geological Society India, 2002, v. 59, pp. 159-166.
16. Krishnan, J. S.R., Rambabu, K., and Rambabu C., Studies on Water quality parameters of bore waters of Reddigudum Mondal, International Journal of Environmental Protection, 1995, v.18 (4), pp 91-98.

*****