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Assessment of Ground Water Quality in NTPC Seepat Area of Chhattisgarh State

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Abstract: ***Quality of water is an important criterion for evaluating the suitability of water for drinking and irrigation purpose whereas the quality of ground water depends on various chemical constituents and their concentration. Ground water sample were collected from different sites in NTPC Seepat Area of Bilaspur district of Chhattisgarh State and analyzed for 14 water quality parameters viz. pH, Alkalinity, Free CO_2, dissolved oxygen, Biological oxygen demand, Chemical oxygen demand, Chloride, Total hardness, Calcium & Magnesium hardness, Nitrate, Iron, Phosphate and Sulfate, considering all three season (summer, rainy and winter) and observed values were compared with standard values recommended by Bureau of Indian Standards (BIS) and World Health Organization (WHO). Analysis of result showed that most of the physico- chemical parameters were within the permissible limits; however at a few sites water is not suitable for public health.***

Keywords: Water quality, Ground water, Drinking water, Physico-chemical analysis, NTPC Seepat.

1. Introduction

As the most essential commodity for human consumption water is one of the most important renewable resources, which must be prevented from deterioration in quality. Various physicochemical parameters like pH, alkalinity, total hardness, total dissolved solid, calcium, magnesium, nitrate, sulphate have a significant role in determining the portability of drinking water (Ahipathy and Puttaiah, 2006; Gawas et al., 2006; Gupta et al., 2004; Jeyraj et al., 2002; Jitendra et al., 2008; Patel and Ragothaman 2005; Sankar et al., 2002; Sirsath et al., 2006; Solanki, 2012; Tiseer et al., 2008; Udhayakumar et al., 2006; Venkatasubramani et al., 2007;). Quality of surface and ground water is inadequate even for costummering living and is getting deteriorated due to unwise utilization of water resources, dehumanizing manner of organization, industrialization and other developed activities. Today many rivers receive million litres of industrial effluents (Adekunle, 2009; Adhikari and Gupta, 2002; Jain et al., 2003; Mahanta et al., 2004; Sharma et al., 2002; Tyagi et al., 2000,), sewage domestic waste (Adnan et al., 2005; Prakash and Somshekhar, 2006; Tanwir et al., 2003), agricultural waste (Demir et al., 2003; Fatta et al., 1999; Ikem et al., 2002) and land drainage etc. that cause degradation of water quality the accelerated pace of development and population growth has led to the scarcity of potable water.

The major sources of drinking water supply in our country are groundwater, which is being tapped on a large scale by wells, tube wells and borings. However, the quality of drinking water is extremely poor and except 15-20% of Indian population, who get piped filtered clean drinking water the rest have to depend upon unfiltered natural water. So far as the state of Chhattisgarh is concerned, the situation regarding drinking water standard is deplorable like many other states in India and abroad. Keeping in view the aforesaid facts the present investigation is being proposed to assess the quality of groundwater and suitability of drinking water consumed by urban as well as rural people in NTPC of Bilaspur district by scientific study of physico-chemical properties in various samples of available drinking water.

2. Material and Methods

Geographically Bilaspur district of Chhattisgarh state is located in north-western part of Chhattisgarh and fall within latitude 21^0 43 N & 23^0 7' N and longitude 81^0 29' E to 82^0 29' E. The newly setup NTPC's 2980 MW Super Thermal Power Plant at Sipat that was rechristened as Rajiv Gandhi Super Thermal Power Station (RGSTPS) is located at 22 km towards east of the Bilaspur city. Ground water samples were collected from eight different sampling sites. The samples for the routine analysis of parameters were collected bimonthly considering the seasons of rainy, winter and summer throughout the ear.

Physico-chemical analysis of sample water was conducted in laboratory except two parameters i.e. temperature and pH, which were examined at collection spots using mercury filled glass thermometer and digital pH meter respectively (Buragohain et al; 2009). Titratable acidity and total acidity, total alkalinity and total hardness were determined using standard procedures as described by FAO (1997). For some of the chemical parameter, like dissolved oxygen (DO) and alkalinity, the samples were taken in brown glass bottles avoiding any kind of bubbling and were fixed at the site with preservatives. Standard methods were employed, as suggested by A.P.H.A. (1998); Trivedi and Goel, (1984) and Kumar and Ravindranath (1998).

Table 1: Physico-chemical properties of ground water samples collected from different sites during different seasons

Study Sites	Season	PHYSICO-CHEMICAL PARAMETERS													
		pH	Alkalinity mg/l	Free CO_2 mg/l	DO mg/l	BOD mg/l	COD mg/l	Chloride mg/l	Total hardness mg/l	Ca hardness mg/l	Mg hardness mg/l	NO_3 mg/l	Fe ppm	PO_4 mg/l	SO_4 mg/l
Site - I	Summer	7.7 ±0.7	88.2 ±3.31	12.9 ±2.3	9.4 ±1.4	3.5 ±0.9	11.35 ±1.8	25.92 ±2.62	166.3 ±3.7	39.7 ±2.31	42.1 ±2.7	0.59 ±0.1	0.69 ±0.21	0.06 ±0.012	7.58 ±1.8
	Rainy	7.8 ±1.12	88.5 ±2.9	12.2 ±1.8	9.4 ±2.5	3.55 ±0.6	12.2 ±2.3	24.93 ±3.0	111.12 ±2.8	34.01 ±3.4	34.1 ±2.2	0.68 ±0.23	0.54 ±0.25	0.06 ±0.013	6.39 ±1.65
	Winter	7.6 ±1.5	91.5 ±2.7	13.7 ±2.1	9.8 ±2.6	3.55 ±0.2	11.3 ±2.1	16.93 ±2.8	123.2 ±3.4	34.31 ±2.6	28.3 ±2.8	0.72 ±0.21	0.62 ±0.23	0.08 ±0.01	6.86 ±1.55
Site - II	Summer	7.5 ±1.1	91.5 ±2.5	13.9 ±1.9	8.8 ±2.9	1.85 ±0.5	9.05 ±2.6	38.32 ±2.7	157.05 ±3.5	39.5 ±2.9	40.2 ±2.3	0.92 ±0.33	0.62 ±0.28	0.06 ±0.01	5.78 ±1.84
	Rainy	7.7 ±1.3	91.7 ±3.72	14.4 ±2.5	8.8 ±2.3	1.75 ±0.1	9.6 ±2.3	19.81 ±2.2	100.83 ±3.0	35.6 ±3.5	26.4 ±3.4	0.96 ±0.28	0.52 ±0.1	0.06 ±0.02	5.41 ±1.64
	Winter	7.5 ±1.4	94.5 ±3.3	14.2 ±2.9	9.5 ±1.8	1.85 ±0.2	10.1 ±2.0	19.38 ±2.6	117.72 ±2.55	36.37 ±2.64	34.7 ±3.0	0.85 ±0.23	0.55 ±0.28	0.08 ±0.012	5.73 ±1.51
Site - III	Summer	7.3 ±0.7	75.1 ±2.7	14.9 ±2.1	6.5 ±2.5	2.4 ±0.4	10.2 ±1.8	27.75 ±2.9	217.82 ±3.7	38.5 ±2.2	38.9 ±2.8	0.65 ±0.25	0.68 ±0.21	0.06 ±0.01	7.08 ±1.47
	Rainy	7.4 ±1.5	78.5 ±2.9	14.3 ±2.6	6.5 ±1.4	2.6 ±0.9	13.4 ±2.4	32.19 ±2.3	120.06 ±3.0	30.7 ±2.6	25.4 ±2.9	0.74 ±0.1	0.55 ±0.28	0.05 ±0.0	6.03 ±1.55
	Winter	7.4 ±1.2	73.5 ±2.7	14.1 ±2.3	6.6 ±1.9	2.35 ±0.8	9.95 ±2.1	22.68 ±2.9	142.38 ±3.5	19.19 ±2.8	30.8 ±2.2	0.66 ±0.24	0.6 ±0.23	0.08 ±0.032	6.56 ±1.49
Site - IV	Summer	7.7 ±1.3	98.5 ±3.81	19.6 ±1.8	9.6 ±2.9	3.5 ±0.6	11.85 ±2.6	25.84 ±2.7	187.3 ±3.85	41.6 ±2.3	38.1 ±2.6	0.56 ±0.27	0.66 ±0.33	0.07 ±0.03	8.4 ±1.58
	Rainy	7.6 ±1.4	116.2 ±3.7	18.7 ±1.4	9.6 ±1.9	3.55 ±0.3	12.8 ±1.9	23.9 ±2.6	118.67 ±3.7	35.5 ±2.9	31.6 ±2.7	0.59 ±0.21	0.63 ±0.1	0.08 ±0.031	7.2 ±1.84
	Winter	7.6 ±0.7	91.1 ±3.3	18.4 ±2.9	10.5 ±2.3	3.45 ±0.9	13.5 ±2.0	21.06 ±2.55	127.34 ±3.5	36.92 ±2.6	33.2 ±3.0	0.55 ±0.28	0.54 ±0.21	0.08 ±0.014	7.5 ±2.0
Site - V	Summer	7.5 ±1.3	119.1 ±3.5	27.1 ±1.9	8.6 ±2.6	2.8 ±0.4	9.05 ±2.12	25.51 ±3.0	209.21 ±3.45	39.6 ±2.55	36.4 ±2.3	0.85 ±0.23	0.59 ±0.27	0.07 ±0.016	6.3 ±1.9
	Rainy	7.5 ±1.5	104.4 ±3.71	26.3 ±2.5	8.6 ±1.8	2.55 ±0.3	9.6 ±2.3	24.89 ±2.9	117.01 ±3.8	27.2 ±2.7	25.3 ±2.6	0.84 ±0.33	0.54 ±0.25	0.06 ±0.01	6.2 ±1.7
	Winter	7.6 ±1.2	94.3 ±2.9	26.2 ±2.1	9.2 ±1.4	2.35 ±0.8	10.1 ±1.9	22.01 ±2.2	141.4 ±3.4	33.34 ±3.5	33.2 ±2.2	0.86 ±0.1	0.57 ±0.24	0.06 ±0.0	6.9 ±1.75
Site - VI	Summer	7.5 ±1.4	91.4 ±3.7	16.3 ±2.6	9.7 ±2.9	1.75 ±0.1	14.15 ±2.6	31.79 ±2.8	148.72 ±3.55	39.7 ±2.3	31.5 ±2.7	0.74 ±0.27	0.68 ±0.23	0.07 ±0.02	8.8 ±1.55
	Rainy	7.6 ±1.1	77.9 ±3.71	15.2 ±2.3	9.7 ±2.5	1.7 ±0.1	15.3 ±2.5	32.14 ±2.3	108.78 ±3.32	28.7 ±2.8	18.7 ±3.4	0.86 ±0.33	0.56 ±0.27	0.07 ±0.01	8.2 ±1.35
	Winter	7.5 ±0.7	82.8 ±2.9	15.5 ±1.4	9.6 ±1.9	1.6 ±0.2	13.9 ±1.8	33.88 ±2.7	118.06 ±3.8	30.56 ±2.6	32.3 ±2.8	0.82 ±0.25	0.66 ±0.1	0.07 ±0.03	8.4 ±1.23
Site -VII	Summer	7.6 ±1.3	94.3 ±3.3	12.9 ±2.1	8.7 ±2.3	3.5 ±0.7	15.6 ±1.9	24.96 ±3.4	167.17 ±3.65	37.5 ±2.55	40.7 ±2.3	0.71 ±0.23	0.68 ±0.33	0.07 ±0.012	5.9 ±1.53
	Rainy	7.7 ±1.2	93.5 ±3.7	12.2 ±1.8	8.7 ±2.1	3.55 ±0.9	14.4 ±2.3	23.34 ±3.0	122.12 ±3.5	25.8 ±2.6	31.3 ±2.9	0.7 ±0.21	0.61 ±0.24	0.06 ±0.011	5.4 ±1.91
	Winter	7.7 ±1.5	95.5 ±3.3	13.7 ±2.5	9.7 ±2.56	3.55 ±0.6	13.6 ±2.0	18.1 ±2.6	139.78 ±3.4	31.81 ±2.9	31.7 ±2.7	0.85 ±0.24	0.58 ±0.25	0.08 ±0.03	5.7 ±1.67
Site -VIII	Summer	7.4 ±1.2	65.1 ±2.96	15.2 ±1.4	8.6 ±2.9	2.1 ±0.9	11.85 ±2.4	28.98 ±2.8	157.45 ±2.95	38.1 ±3.0	33.5 ±3.4	0.65 ±0.23	0.64 ±0.1	0.06 ±0.01	7.1 ±1.55
	Rainy	7.4 ±1.1	73.6 ±3.1	15.1 ±2.5	8.6 ±2.3	1.75 ±0.1	12.8 ±2.6	20.76 ±2.7	110.22 ±2.3	22.6 ±2.2	24.6 ±2.6	0.69 ±0.33	0.58 ±0.28	0.05 ±0.012	6.7 ±1.35
	Winter	7.3 ±1.4	77.5 ±3.3	16.6 ±2.3	8.7 ±1.8	1.7 ±0.4	13.5 ±2.3	20.33 ±2.3	118.61 ±3.4	36.84 ±2.6	28.7 ±2.3	0.65 ±0.1	0.65 ±0.25	0.09 ±0.02	6.9 ±1.7

Table 2: Comparison of observed data (Physico-chemical properties of ground water from different sites) with standard recommended by BSI and WHO

Parameters	Site - I	Site - II	Site - III	Site - IV	Site - V	Site - VI	Site -VII	Site -VIII	Recommended by BSI		by WHO
									Desirable	Permissible	
pH	7.6 - 7.8	7.5 - 7.7	7.3 - 7.4	7.6 - 7.7	7.5 - 7.6	7.5 - 7.6	7.6 - 7.7	7.3 - 7.4	6.5 to 8.5	Up to 9.2	6.5 to 8.5
Alkalinity (mg/l)	88.2 - 91.5	91.5 - 94.5	73.5 - 78.5	98.5 - 116.2	94.3 - 119.1	77.9 - 91.4	93.5 -95.5	65.1 - 75.5	200 mg/l	„ 600 mg/l	---------
Free CO_2 (mg/l)	12.2 - 13.7	13.9 - 14.4	14.1 - 14.9	18.4 - 19.6	26.2 - 27.1	15.2 - 16.3	12.2 - 13.7	15.1 - 16.6	----------	----------	----------
DO (mg/l)	9.4 - 9.8	8.8 - 9.5	6.5 - 6.6	9.6 - 10.5	8.6 - 9.2	9.6 - 9.7	8.7 - 9.7	8.6 - 8.7	----------	----------	4.0 mg/l
BOD (mg/l)	3.5 - 3.55	1.75 - 1.85	2.35 - 2.6	3.45 - 3.55	2.35 - 3.55	1.6 - 1.75	3.5 - 3.55	1.7 - 2.1	3.0 mg/l	„ 10 mg/l	2.0 mg/l
COD (mg/l)	11.3 - 12.2	9.05 - 10.1	9.95 - 13.4	11.85 - 16.5	9.05 - 10.1	13.9 - 15.3	13.6 - 15.6	11.85 - 13.5	250 mg/l	„ 250 mg/l	10 mg/l
Chloride (mg/l)	16.93 - 25.92	19.38 - 38.32	22.68 - 32.19	21.06 - 25.84	22.01 - 25.51	31.79 - 33.88	18.1 - 24.96	20.33 - 28.9	250 mg/l	„ 1000 mg/l	250 mg/l
Total hardness (mg/l)	111.12 - 166.3	100.83 - 157.05	120.06 - 217.8	118.67 -187.3	117.01 - 2.09.21	108.78 -148.72	122.12 -167.17	110.22 - 157.45	300 mg/l	„ 600 mg/l	500 mg/l
Ca hardness (mg/l)	34.01 - 39.7	35.6 - 39.5	19.19 - 38.5	35.5 - 41.6	27.2 - 39.6	28.7 - 39.7	25.8 - 37.5	22.6 - 38.1	75 mg/l	„ 200 mg/l	200 mg/l
Mg hardness (mg/l)	28.3 - 42.1	26.4 - 40.2	25.4 - 38.9	31.6 - 38.1	25.3 - 36.4	18.7 - 32.3	31.3 - 40.7	24.6 - 33.5	30 mg/l	„ 100 mg/l	50 mg/l
NO_3 (mg/l)	0.59 - 0.72	0.85 - 0.96	0.65 - 0.74	0.55 - 0.59	0.84 - 0.86	0.74 - 0.86	0.7 - 0.85	0.65 - 0.69	45 mg/l	„ 100 mg/l	45 mg/l
Fe (ppm)	0.54 - 0.69	0.52 - 0.62	0.55 - 0.68	0.54 - 0.66	0.54 - 0.59	0.56 - 0.68	0.58 - 0.68	0.58 - 0.65	0.3 ppm	„ 01.0 ppm	0.1ppm
PO_4 (mg/l)	0.06 - 0.08	0.06 - 0.08	0.05 - 0.08	0.07 - 0.08	0.06 - 0.07	0.07 - 0.07	0.06 - 0.08	0.05 - 0.09	----------	----------	----------
SO_4 (mg/l)	6.39 - 7.58	5.41 - 5.78	6.03 - 7.08	7.2 - 8.4	6.2 - 6.9	8.2 - 8.8	5.4 - 5.9	6.7 - 7.1	200 mg/l	„ 400 mg/l	205 mg/l

3. Result and Discussion

Variation in the Value of different Physico-chemical parameters of 72 ground water samples, as observed during present investigation has been computed in Table – 1. Whereas the entire value as mention in the Table - 1 are the mean (±SD) value of three samples of all three sites collected in triplicate, from different points during summer, rainy and winter season. The range value of each parameters considering the sites wise have been compare with standard value as recommended by BSI and WHO, as mentioned in Table – 2.

The pH values were found slightly alkaline at all sites of ground water that ranges from 7.3 to 7.8. Total alkalinity was observed minimum at site-viii while maximum at sites-iv & v. Variation in the value of DO was found from 6.5 mg/l to 9.8 mg/l that is more than standard value. High DO level in community water supply is good because it max drinking water taste better, however high DO level speed up corrosion in water pipe. The B. O. D. of the samples was found ranges from 1.6 mg/l to 3.55 mg/l, whereas the maximum value was observed at sites- i, iv and vi (3.5 – 3.55 mg/l). The maximum value of COD was observed at sites -vi & vii while minimum at sites –ii & v, varied from 9. 05 mg/l to 15.6 mg/l. Total hardness of ground water was found maximum at site –iii and variation from 108.78 mg/l to 209.21 mg/l was observed. The variation in the value of Nitrate, Phosphate and Sulphate was also observed, which are lesser than standard value, as recommended by WHO. Similarly value of Chloride and Iron were also found with variable range whereas Chloride is lesser than standard value while Iron in higher than standard value.

Alkalinity of water is a measure of its capacity to neutralize strong acid and is due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium ions. The observed values of alkalinity ranged between 65.1 to 119.1 mg/l in ground water. The cations analyzed in the present study include calcium, magnesium, sodium and potassium. For the present study the concentration of calcium has varied from 19.19 to 39.7 mg/l whereas the concentration of magnesium varies from 18.7 to 40.7 mg/l in the study area. Water is in the range of soft and moderately soft category which is due to the low concentration of calcium and magnesium ions present in the water. Dissolved oxygen (DO) is an important parameter of water quality which reflects physical and biological processes taking place in water. High level of DO speed up corrosion in water pipes. The value of DO for the water samples may be due to wave action, pollution load, organic matter and photosynthetic activity. Biochemical oxygen demand (BOD) is a measure of organic material contamination in water. BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials. It reduces oxygen content in water10. BOD depicts the oxygen uptake of organisms present in water. BOD of all the drinking water samples was in the range 1.6 to 3.55 mg/l. Almost all the samples had BOD within BIS permissible limit. Chemical oxygen demand (COD) is a measure of organic material contamination in water. COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. High COD may cause oxygen depletion on account of decomposition by microbes to a level, detrimental to aquatic life.

4. Conclusion

In spite of variation, the observed value of Physico-chemical parameters, findings show generally under the range of standard/ recommended value accept four parameters that are DO, COD, BOD and Iron. The values of these parameters in the most of the samples have found more than permissible limit. Similarly the value of Iron was found more than standard value, whereas the Chloride, Nitrate and Sulphate shows there very less presents than that of standard value.

Through the present investigation, we have confer the Physico-chemical properties of ground water used as drinking water by the public of NTPC Seepat area of Bilaspur district and findings reveal the fact that the ground water of this area, especially in few patches of semi urban area is not absolute suitable for public health. This study is alarming the management system of this industrial area. In order to meet the quality of ground water it is recommended that continuous monitoring with proper action is essential to ensure the supply of suitable drinking water.

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