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### Comparative study of ground water by physicochemical parameters and water quality index

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#### ABSTRACT

A systematic study has been carried out to explore the Physicochemical characteristics and Water Quality Index (WQI) of groundwater in three big cities (Bhilai, Durg & Raipur) of Chhattisgarh India. Water sample from open wells in various sites of were collected during Jan.–Dec 2011 and analyzed for pH, EC, TDS, TSS, total hardness, total alkalinity, COD, chloride, sulphate, sodium and potassium. Comparative studies of samples in different area in the NH-6 highway were conducted, it shows Bhilai water have low hardness comparatively than Raipur area water. W.Q.I values in the present investigation were reported to be 57.35, 75.37 and 61.1. On the basis of all parameters of water we concluded the Bhilai City ground water is not suitable for drinking purpose as compared to other two nearby cities.

**Key words:** water quality, Ground Water, Physicochemical characteristics, WQI

#### INTRODUCTION

In recent years, an increasing threat to ground water quality due to human activities has become of great importance. The adverse effects on ground water quality are the results of man's activity at ground surface, unintentionally by agriculture, domestic and industrial effluents, unexpectedly by sub-surface or surface disposal of sewage and industrial wastes. Groundwater is the major source of drinking water in both urban and rural areas[1-2] Groundwater is the most important source of water supply for drinking, irrigation and industrial purposes. Increasing population and its necessities have lead to the deterioration of surface and sub surface water[3-5]. The modern civilization and urbanization frequently discharging industrial effluent, domestic sewage and solid waste dump. The cause of ground water gets pollute and create health problems [6]. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source it therefore becomes imperative to regularly monitor the quality of groundwater and to device ways and means to protect it [7-9]. The objective of this study is to investigate qualitative analysis of some physicochemical parameters of groundwater in study area. This may be considered as reference for the society to get cautious about the impending deterioration of their environment and health. In this study W.Q.I has been calculated by using the standards of drinking water quality recommended by the WHO10, BIS 11 and ICMR12. Further quality rating or sub index (qn) was calculated using the following expression [3]:

$$Q_n = 100 \times [V_n - V_o] / [S_n - V_o]$$

Where,  $q_n$  = Quality rating for the  $n$ th water quality parameter.  
 $V_n$  = Estimated value of the  $n$ th parameter at a given sampling station.  
 $S_n$  = Standard permissible value of the  $n$ th parameter.  
 $V_o$  = Ideal value of  $n$ th parameter in a pure water.

Unit weight was calculated by a value inversely proportional to the recommended standard values  $S_n$  of the corresponding parameters.

$$W_n = K / S_n$$

Where,  $W_n$  = Unit weight for the  $n$ th parameter.  
 $S_n$  = Standard value for  $n$ th parameter.  
 $K$  = Constant for proportionality

The overall Water Quality Index (W.Q.I) was calculated by aggregating the quality rating with the unit weight linearly.

$$WQI = \sum q_n W_n / \sum W_n$$

### MATERIALS AND METHODS

Water samples were collected in polyethylene bottles of one liter from different locations of Raipur, Bhilai and Durg during Jan.–Dec. 2011. The samples were collected deep well and hand pump. Borosilicate glassware, distilled water and E-Merck reagents were used throughout the testing. Samples were collected in sterilized screw-capped laboratory for their physicochemical parameters. Total alkalinities of the water samples were determined by titrating with N/50  $H_2SO_4$  using phenolphthalein and methyl orange as indicators. The chloride ions were generally determined by titrating the water samples against a standard solution of  $AgNO_3$  using potassium chromate as an indicator. The total hardness of the water samples was determined by complexometric titration with EDTA using Eriochrome black-T as an indicator. TDS of water sample were measured using gravimetric method [13-16].

Table 1 Drinking Water standards recommending agencies and unit weight. (All values except pH is in mg/L)			
Parameters	Standards	Recommended Agency	Unit weight( $W_n$ )
pH	6.5-8.5	ICMR / BIS	0.2188
Total alkalinity	120	ICMR	0.0155
Total hardness	300	ICMR / BIS	0.0062
TDS	500	ICMR / BIS	0.0037
Cl	250	ICMR	0.0074
SO <sub>4</sub>	150	ICMR / BIS	0.0124
DO	5.0	ICMR / BIS	0.3723
Nitrate	45	ICMR / BIS	0.0413
			$\sum W_n = 0.7636$

### RESULTS AND DISCUSSION

The physicochemical parameters of the ground water samples of Bhilai, Durg and Raipur with their standard values prescribed by BIS & WHO are given in Table 2.

The values of various physicochemical parameters for calculation of water quality index are presented in Table 3.

The values of pH was maximum permissible limit in all samples of ground water taken from different areas of Bhilai city and it ranges from 7.61 to 7.91 which are comparable higher than other two studied city. The electrical conductivity for all the sample studies in all the areas has been ranging from 442 to 961  $\mu S/cm$ . The values of EC in different areas of Raipur city was ranging from Siltara-911, Maruti Enclave-713, Vandna Industry-1645, Navin Nagar-1086, Daganania -678 and Raipur University 614 961  $\mu S/cm$ . The hardness of Bhilai city ground water (176 mg/l) was more than other Durg and Raipur city. The order of EC & TDS in all sample follows: Raipur>Durg>Bhilai. The concentration of chloride ion in also in higher range in the different areas of Raipur city. Total hardness of ground water in different area of Bhilai city (Light Industrial Area- 186 mg/L, Steel Plant Area- 210 mg/L, Sector Residential area -154 mg/L, Priyadarshini Nagar-163 mg/l) are in higher range than Raipur &

Durg. WQI values of three cities are in the order of: Bhilai (WQI= 75.37) >Durg (WQI= 61.1) > Raipur (WQI=57.35). The WQI values indicate that the ground water is of Poor Water Quality and consumption is not totally safe for peoples living in these regions.

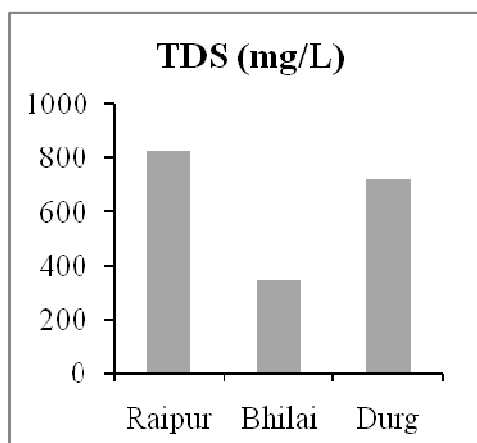
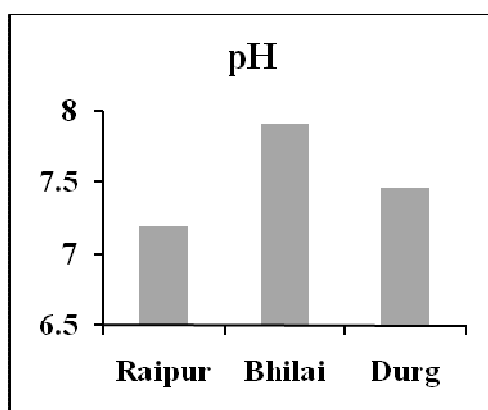
**Table 2 The values of physicochemical parameters of ground water samples**  
(All values except PH is in mg/L)

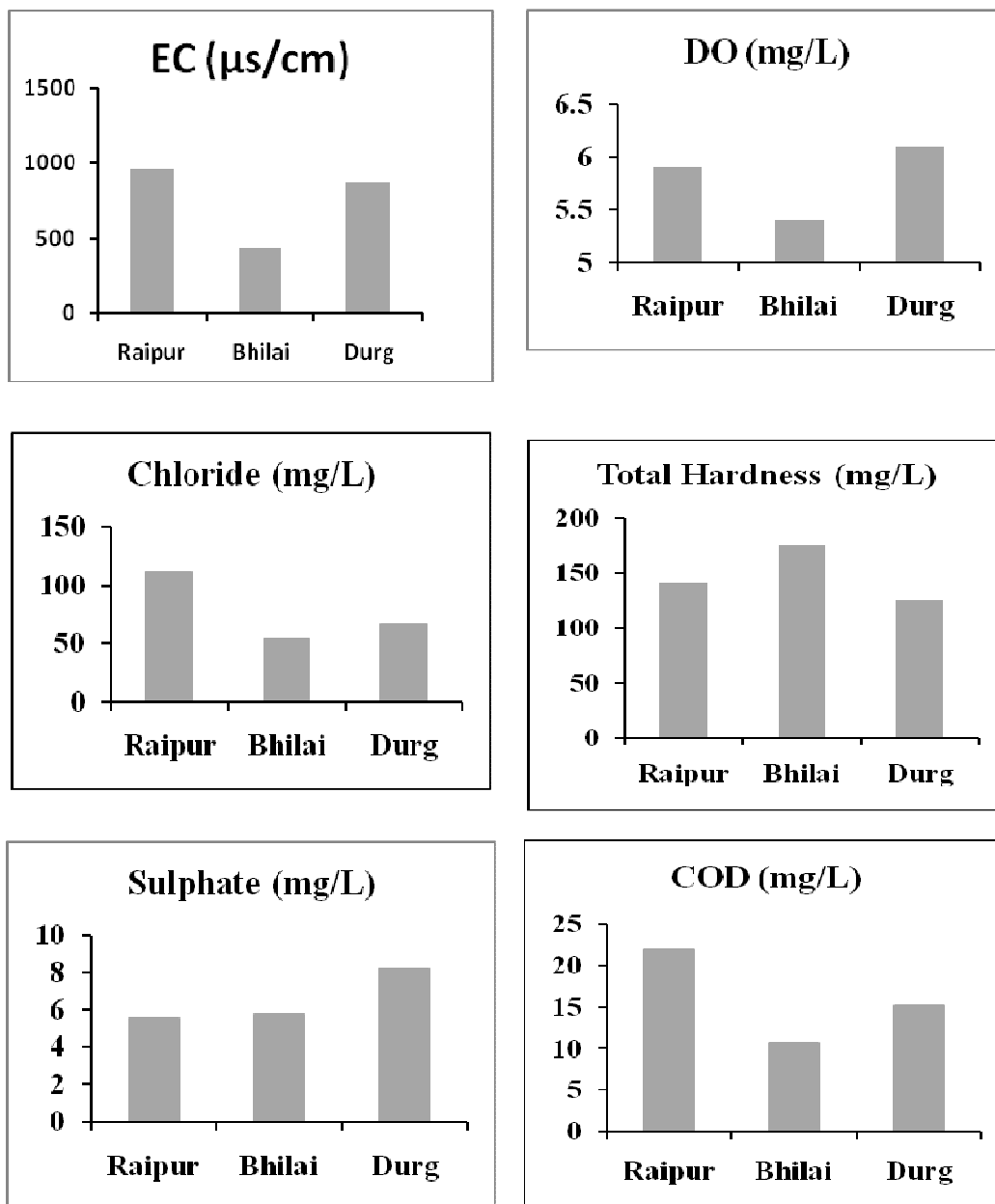
S. No	Parameters	WHO standard	BIS standard	Raipur (GW)	Bhilai (GW)	Durg (GW)
1.	pH	7-8.5	6.5-8.5	7.19	7.91	7.46
2.	Total alkalinity (mg/L)	120	120	83	97	49
3.	Total Hardness (mg/L)	300	300	141	176	125
4.	TDS (mg/L)	500	500	825	345	720
5.	Chloride (mg/L)	200	250	112	54	67
6.	Sulphate (mg/L)	200	200	5.61	5.78	8.23
7.	DO (mg/L)	8.0	8.0	5.9	5.4	6.1
8.	Nitrate (mg/L)	45	45	0.19	0.37	0.34

**Table 3 Calculation of Water Quality Index**

Parameters	Raipur GW		Bhilai GW		Durg GW	
	Quality Rating (Qn)	Wn Qn	Quality Rating (Qn)	Wn Qn	Quality Rating (Qn)	Wn Qn
pH	12.6	2.76	60.67	13.27	30.67	6.71
Total Alkalinity	69.17	1.07	80.83	1.25	40.83	0.63
Total Hardness	47	0.29	58.67	0.36	41.67	0.26
TDS	165	0.61	69	0.26	144	0.53
Chloride	44.8	0.33	21.6	0.16	26.8	0.20
Sulphate	3.74	0.05	3.85	0.05	5.49	0.07
DO	90.62	33.74	95.83	35.68	88.54	32.96
Nitrate	0.42	0.02	0.82	0.03	0.76	0.03
	$\sum WnQn$ =38.86		$\sum WnQn$ =51.07		$\sum WnQn$ =41.40	
	WQI =57.35		WQI =75.37		WQI =61.1	

The flow chart of the range of various parameters of groundwater samples





### CONCLUSION

The study has been conducted in the three big city of Chhattisgarh for measuring quality of ground water. The samples conform that the pH of the ground water is been with in limit of the Bhilai and Raipur but it is more in Durg city as prescribed by BIS and the water sample having almost same conducting property of electrical values which are within limits of maximum permissible. But the all the industrial sites of Raipur ground water have greater E.C.

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