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PHYSICOCHEMICAL ANALYSIS OF GROUND WATER OF SELECTED AREAS OF RAIPUR CITY

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ABSTRACT

Assessment and mapping of groundwater is an important quantity because the physical and chemical characteristics of groundwater determine its suitability for agricultural, industrial and domestic usages. Present work deals with the assessment of physico-chemical parameters of ground water samples Raipur city during 2015-2016. Ground water samples were tested for physico-chemical parameters following the standard methods and procedures. Statistical studies have been carried out by calculating correlation coefficients between different pairs of parameters and t- test applied for checking significance. The observed values of various physico-chemical parameters of water samples were compared with standard values recommended by WHO for drinking and the extent of deterioration. Sewage and industrial effluents are the probably sources for the variation of water quality in the study region.

KEYWORDS: Ground Water, Chemical Composition, Statistical Analysis, T- Test.

The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Ground water occurs in weathered portion, along the joints and fractures of the rocks (APHA 1992). In fact, industrial waste and the municipal solid waste have emerged as one of the leading causes of pollution of surface and ground water. 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 (Jena et al 2012, 2013). The quality of water may be described according to their physico-chemical and micro-biological characteristics. Therefore, the quality of ground water varies from place to place, with the depth of water table, and from season to season and is primarily governed by the extent and composition of dissolved solids present in it. However it is very difficult and laborious task for regular monitoring of all the parameters even if adequate manpower and laboratory facilities are available (Jena et al 2012, 2013, Mintz et al 2001, Wuta et al 2016). Therefore, in recent years an alternative approach based on statistical correlation, has been used to develop mathematical relationship for comparison of physico-chemical parameters. The present study deals with study of physico-chemical parameters of ground water in Raipur City India.

EXPERIMENTAL

Water samples (n =20) were collected from different sites located in Figure 1 of the Raipur City, Chhattisgarh during June 2015 -April 2016. All collected samples were collected in sterilized polypropylene bottles using standard procedure of grab or catch as per the methods of APHA. All the chemicals used were of AR grade. Details of the analysis methods are summarized in Table-1. KarlPearson correlation coefficient (r) was calculated and correlation for significance has also been tested by applying t-test. ArcGIS (version 9.0) software has been used for the present study to locate the Samplig Site Figure 1. The different locations of the sampling sites were importated into GIS software through point layer11. A software statistiXl is used for the performing t- test. The analysis of various parameter of sampled water with their applicable methods are summarized in Table-1.

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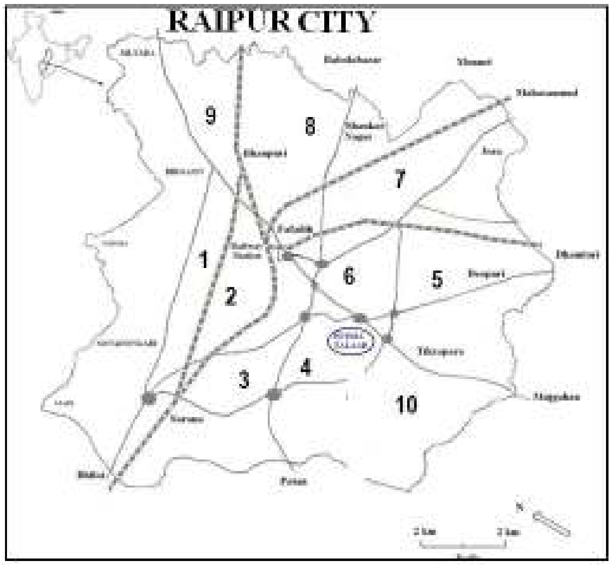

Figure 1: Sampling site of Raipur city

Table 1: Sample Water

S No	Parameters of water analysis	Method employed
1.	pH	Potentiometric
2.	EC(µs/cm)	Potentiometric
3.	TDS(mg/l)	Gravimetric
4.	TSS(mg/l)	Gravimetric
5.	COD(mg/l)	Titrimetric
6.	Na^+	Flame photometeric
7.	K^+	Flame photometric
8.	Cl^-	Titrimetric
9.	SO_4^{2-}	Spectrophotometric

RESULTS AND DISCUSSION

Due to increasing urbanization, surface water is getting over contaminated and more stringent treatments would be required to make surface water potable. Therefore, it is required to additional sources for fulfill the requirement of water. Because the ground water sources are safe and potable for drinking and other useful purposes of human being. Hence studies of physic-chemical characteristics of underground water to find out whether it is fit for drinking or some other beneficial uses.

pH

Comparing with the WHO standards, the pH levels of the water investigated are within the permissible range of 7.54 – 8.86. All the underground water samples are characterized by either a weakly acidic or slightly basic pH and are within the maximum permissible pH level (6.5-8.5) of WHO. The water sample No 7 with the lowest pH of 6.5 may be attributed to the discharge of acidic products into this source by the agricultural and domestic activities. This is supported by the fact that studies have shown that 98 % of all world ground water are dominated by calcium and bicarbonate ions due to lime stone weathering in the catchments and underground water beds. Extreme pH values can affect the palatability of water. Most biochemical reactions are sensitive to variation of pH. In the present study pH value of the water samples varied in a narrow range within the permissible limits in all sources. Hydrogen ion concentrations govern the behaviour of several other important parameters of water quality such as ammonia toxicity, chlorine disinfection efficiency and the solubility of metal ions that may be catalyzed by H^+ ions (WHO 193, 2000, 2004).

Electrical Conductance (EC)

The mobility of ions in solution can be seen to be closely related with the total alkalinity. This is not surprising as the flow of water would be proportional to the concentration of the hydroxide ion (alkalinity) in the water. The EC values were found higher at two points (Sample No1 and Sample No 6) with values of 721 and 728 µS/cm respectively. These water points are located within the densely populated areas. Hence the relatively higher values may be associated to concentrated dissolved salts as a result of human activities (Udhayakumar et al 2016). Very low electrical conductivity was found at all the other sampling points. In this study, the electrical conductance was generally lower than the MPL (1000 µs/cm) in all the water samples. The conductance is related to the ionic content of the water sample which is in turn a function of the dissolved solids. This property is related to the hardness of water because the more dissolved ions that are present in a water sample, the more would be its conductance and hence its hardness. Total dissolved solids and conductivity can be used to delineate each other. Conductivity is proportional to the dissolved solids. Both showed analogous trend in all the sites (Rajankar et al 2013, Tagi et al 2013).

TDS

The results of this analysis recorded TDS values below 500 mg/l for all water samples which are all below the WHO, MPL of 1000 mg/l. The highest TDS values were observed for the Sample No 11 and Sample No 82, which are about 460 mg/l while the lowest value, 86.7±0.58 mg/l was recorded for Sample No 4. No further studies were conducted to ascertain the variation of the values for the boreholes studied. It is known that where TDS are high, the water may be "saline" and the applicable parameter is "Salinity" (WHO, 2004, APHA 1992).

Chloride

Chloride exists in all natural waters; the concentrations varying very widely and reaching a maximum in sea water (up to 35,000 mg/l Cl^-). In fresh waters, the sources include soil and rock formations, sea spray and waste discharges. Sewage contains large amounts of chloride, as do some industrial effluents. Chloride does not pose a health hazard to humans and the principal consideration is in relation to palatability. In Table 2 the concentrations of the chloride in all the water samples were below the MPL (250 mg/l) (Manivasakam 1996). At levels above 250 mg/l Cl; water will begin to taste salty and will become increasingly objectionable as the concentration rises further, hence the objectionable taste recorded. High chloride levels may similarly render freshwater unsuitable for agricultural irrigation. In this work underground water samples Sample No1, Sample No 2, Sample No 5 & Sample No 9 showed high levels of chloride ions, in the range 161.2, 175.8, 167.4 & 189.4 mg/l, respectively. The chloride contents range from 141.2 – 189.4 mg/l and are far below the maximum permissible level of MPL. The presence of ions such as Cl^-, K^+ etc in human fluids are required as electrolytes(Vardhan et al 2015, WHO 1994)). So the low levels found in virtually all the water points studied means the chloride ions in the drinking water should be supplemented. The water sample points studied may be safe few samples because, it is a known fact that an increase of even 5 mg/l Cl- may give rise to suspicions of a sewage discharge.

Sulphate

The sources of sulphate in underground waters may be rocks, geological formation, and so on. Excess sulphate has a laxative effect, especially in combination with magnesium and/or sodium. Sulphates exist in nearly all natural waters, the concentrations varying according to the nature of the terrain through which they flow. They are often derived from the sulphides of heavy metals such as iron, nickel, copper and lead. Iron sulphides are present in sedimentary rocks from which they can be oxidised to sulphate in humid climates; the latter may then leach into watercourses so that ground waters are often excessively high in sulphates. As magnesium and sodium are present in many waters, their combination with sulphate will have an enhanced laxative effect of greater or lesser magnitude depending on concentration. The utility of water for domestic purposes will therefore be severely limited by high sulphate concentrations, hence the limit of 200 mg/l SO_4^{2-} (WHO, 2000, Tag et al 2013, Jena et al 2012). The sulphate contents in the range 14.56 – 26.14 mg/l of all the samples fall below the MPL Table 2.

Chemical Oxygen Demand (COD)

COD is a measure of the oxygen required for the chemical oxidation of organic matter with the help of strong chemical oxidant. High COD may cause oxygen depletion on account of decomposition of microbes to a level detrimental to aquatic life (WHO 2000). In this study COD found in the range of 9.6 to 11.4 in various samples collected.

Table 2: Physiochemical parameters of water samples

	WHO Standards		Experimental values
Parameters	HDL	MPL	
pH	7.0 - 8.5	6.5 – 9.5	7.54 – 8.86
EC(µs/cm)	-	-	512 - 814
TDS(mg/l)	500	1000	213 - 546
TSS(mg/l)	-	-	1.7 – 3.4
COD(mg/l)	-	-	9.6 – 11.4
Na^+	-	200	122.5 – 227.6
K^+	-	-	0.24 – 1.6
Cl^-	200	600	141.2 – 189.4
SO_4^{2-}	200	400	14.56 – 26.14

The standard and observed values of physico-chemical parameters of experimental ground water samples for different areas are presented Table 2. The observed pH values ranging from 7.54- to 8.86 which shows that the present water samples are slightly alkaline. These values are slightly more than maximum permissible limit prescribed by WHO8. Chloride ion at site 1 bears significant positive correlation with pH (r= 0.89, t = 7.4), TDS (r = 0.85, t = 8.1), and TSS (r = 0.47, t = 11.4). Cl- (r= 0.87, t= 9.6), SO_4^{2-} (r= -0.7, t= 8.1) , TDS values of water samples is within the highest desirable or maximum permissible limit set by WHO. EC has significant negative correlation with TSS (r= -0.6, t= 12.6). This shows that with increase or decrease in the EC values it also exhibit increase or decrease TSS at almost all site . The sulphate ion is one of the important anion present in natural water produce cathartic effect upon human beings when it is present in excess. Positive correlation was found of $SO4^{2-}$ with pH and TSS at both site of sampling. High values of COD at some location indicate that water was highly contaminated with chemically oxidisable inorganic and organic substances.

CONCLUSION

All the physicochemical variables of ground water at Raipur city within the highest desirable limit or maximum permissible limit set by WHO8. An appreciable significant positive correlation has been recorded for chloride with pH, TDS and TSS and SO_4^{2-} with pH and TSS. The study has demonstrated the utility of GIS technology combined with laboratory analysis in evaluation and mapping of groundwater quality in urban region. It must be noted that a regular chemical analysis must be done to insure that the quality of water in this area is not contaminated, in addition to research for new walls in the area in order to get additional water for the resident people. A water quality intervention, in terms of household (point-of-use) treatment is known to reduce diarrhoeal illness levels. This suggests that water quality intervention may be more important than previously thought, as previous studies have suggested that such interventions are only effective where good sanitary conditions at point-of-use already exist.

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