

PHYSICO-CHEMICAL PARAMETERS ASSESSMENT OF GROUND WATER IN DIFFERENT SITES OF BHILAI CITY, CHHATTISGARH

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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 at Industrial, Residential and Near MSW site of Bhilai city during 2010-2011. Ground water samples are 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. Agricultural runoff, sewage and industrial effluents are the probable sources for the variation of water quality in the study region. The results revealed that the Groundwater was not suitable for drinking purpose in some area due to the influence of sewage, saltwater intrusion, industrial and high urban concentration.

Keywords: Ground water, Chemical composition, Statistical analysis, t- test.

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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 wastes¹⁻². In India, where groundwater is used intensively for irrigation and industrial purposes, a variety of land and water-based human activities are causing pollution of this precious resource. Its over-exploitation is causing aquifer contamination in certain instances, while in certain others its unscientific development with insufficient knowledge of groundwater flow dynamic and geo-hydrochemical processes has led to its mineralization³⁻⁴. The quality of ground water is of great importance in determining the suitability of particular ground water for a certain use (public water supply, irrigation, industrial applications, power generation etc)⁵. 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 it⁶⁻⁷. For effective maintenance of water quality through appropriate control measures, continuous monitoring of large number of quality parameters is essential. However it is very difficult and laborious task for regular monitoring of all the parameters even if adequate manpower and laboratory facilities are available. Therefore, in recent years an alternative approach based on statistical correlation, has been used to develop mathematical relationship for comparison of physico-chemical parameters⁸⁻⁹.

The present study deals with study of physico-chemical parameters of ground water in Bhilai. The analyzed data were compared with standard values recommended by WHO⁸. Systematic calculation of correlation coefficient between water quality parameters has been done with the objective of

minimizing the complexity and dimensionality of large set of data. The significant correlation has been further verified by using t-test.

EXPERIMENTAL

Water samples were collected from different sites (Residential, Industrial and MSW) of the Bhilai city, Chhattisgarh during June 2010 -April 2011. The city is located 22 km west of the capital Raipur on the Howrah–Mumbai rail line and National Highway 6. Bhilai is famous for its Integrated Steel Plant, which is one of the largest steel plants in India. All collected samples were collected in sterilized polypropylene bottles using standard procedure of grab or catch as per the methods of APHA¹⁰. All the chemicals used were of AR grade. Details of the analysis methods are summarized in Table-1. Karl-Pearson correlation coefficient (r) was calculated and correlation for significance has also been tested by applying t-test.

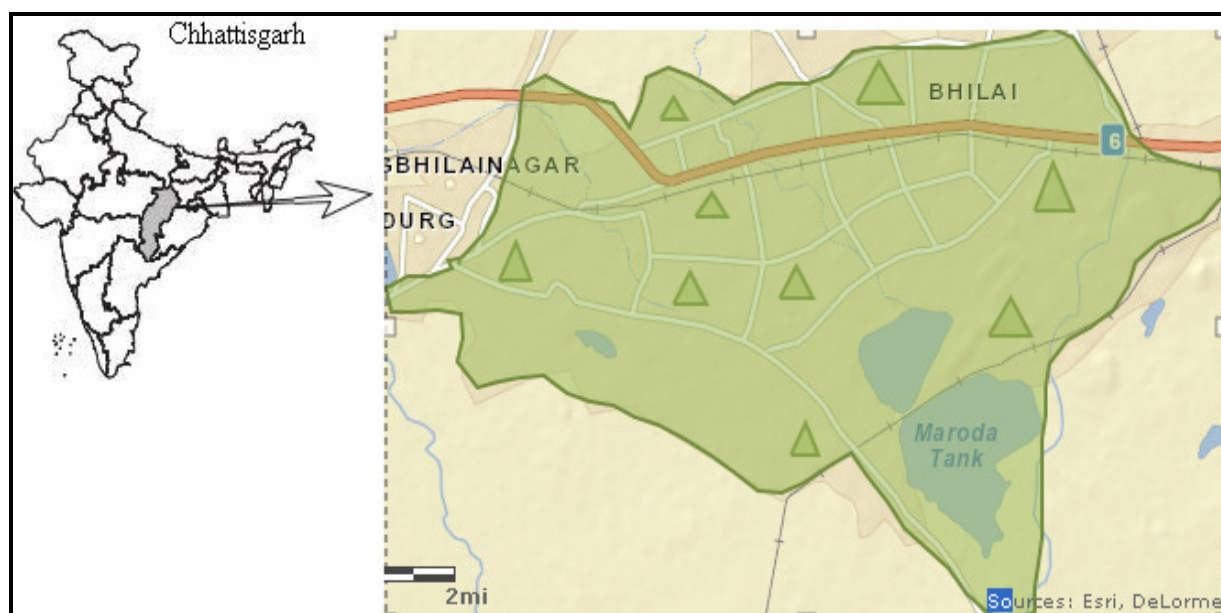


Fig.-1: Samplig Site

EXPERIMENTAL

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 imported into GIS software through point layer¹¹. A software statistiXI is used for the performing t- test. The analysis of various parameter of sampled water with their applicable methods are summarized in Table-1.

Table-1: Parameters and methods employed in the physicochemical examination of water samples

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

RESULTS AND DISCUSSION

The standard and observed values of physico-chemical parameters of experimental ground water samples for both Residential and Industrial area are presented in Tables 2-3. The observed pH values ranging from 7.64- to 8.86 in residential site and 7.26 to 7.89 in industrial site 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 industrial site bears significant positive correlation with pH ($r = 0.82$, $t = 7.5$), TDS ($r = 0.82$, $t = 8.3$), and TSS ($r = 0.37$, $t = 18.4$). Cl^- , SO_4^{2-} , TDS values of water samples is within the highest desirable or maximum permissible limit set by WHO. In the present study for the years 2010 and 2011. EC has significant negative correlation with TSS ($r = -0.66$, $t = 12.4$) at residential site whereas at industrial site EC has positive correlation TSS ($r = 0.52$, $t = 11.2$). This shows that with increase or decrease in the EC values it also exhibit increase or decrease TSS at industrial 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 SO_4^{2-} with pH and TSS at both site of sampling. High values of COD at some location indicate that river water was highly contaminated with chemically oxidisable inorganic and organic substances.

Table-2: The average values of physico-chemical parameters

Parameters	WHO Standards		Experimental Values (Range)mg/L	
	HDL	MPL	Residential Site	Industrial Site
pH	7-8.5	6.5-9.5	7.64-8.86	7.26-7.89
EC($\mu\text{s}/\text{cm}$)	-	-	498-618	556-987
TDS	500	1000	187-345	226-321
COD	-	-	10.5-12.4	2.5-8.1
TSS	-	-	2-7	1-6
Na^+	-	200	21.2-28.1	14.2-17.1
K^+	-	-	0.24-1.4	0.78-1.45
Cl^-	200	600	35.4-74.2	25.2-68.2
SO_4^{2-}	200	400	3.18-6.14	16.4-42.1

HDL: Highest desirable Limit, MPL: Maximum permissible limit, EC in $\mu\text{s}/\text{cm}$, Turbidity in NTU

Table-3: Different pairs of correlations

Parameters	Parameters	Residential Area		Industrial Area	
		r	t	r	t
EC	TSS	0.17	31.2	0.06	17.8
	TDS	-0.66	12.4	0.52	11.2
TDS	TSS	-0.62	16.2	-0.2	22.8
SO_4^{2-}	pH	0.16	-7.7	0.35	5.7
	TSS	0.46	0.25	-0.054	7.1
Cl^-	pH	-0.08	10.2	0.82	7.5
	TDS	-0.006	10.8	0.82	8.3
	TSS	-0.50	19.9	0.37	18.4

Note: Significant if $t > 2.132$

CONCLUSION

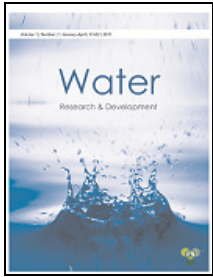
All the physicochemical variables of ground water at both residential and industrial site of Bhillai city are within the highest desirable limit or maximum permissible limit set by WHO⁸. An appreciable significant positive correlation has been recorded for chloride with pH, TDS and TSS and SO_4^{2-} 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 wells in the area in order to get additional water for the resident people.

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