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CORRELATION ANALYSIS OF DRINKING WATER QUALITY IN AND AROUND PERUR BLOCK OF COIMBATORE DISTRICT, TAMIL NADU, INDIA

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ABSTRACT

Water is an elixir of life. It is an important component to human survival. Water should be purified for a better life style. It is the basic duty of every individual to conserve water resources. The present study attempts to bring an acute awareness among the people about the quality of ground water by taking water samples from specific locations for analysis. The experiment analyses its various Physico-chemical and biological parameters such as pH, Electrical Conductivity, TDS, TH, Ca^{2+}, Mg^{2+}, Cl^{-}, SO_4^{2-}, Total Acidity, Total Alkalinity and DO etc., The results are compared with standards of WHO, USPH and ICMR. A systematic correlation and regression study showed significant linear relationship among different pairs of water quality parameters.

Keywords: Water quality, Physico-chemical parameters, Correlation, Regression, Coimbatore.

INTRODUCTION

Water quality performs important role for all living beings. The quality of surface water within a region is governed by both natural processes such as precipitation rate, weathering processes and soil erosion and anthropogenic effects such as urban, industrial and agricultural activities and the human exploitation of water resources[1-5]. Ground water quality has become an important water resources issue due to rapid increase of population, rapid industrialization, unplanned urbanization, flow of pollution from upland to lowland, and too much use of fertilizers, pesticides in agriculture[6].

Ground water is one of the earth's widely distributed, renewable and most important resources. It is generally considered least polluted compared to other inland water resources, but studies indicate that ground water is not absolutely free from pollution though it is likely to be free from suspended solids. The major problem with the ground water is that once contaminated, it is difficult to restore its quality. Hence there is a need and concern for the protection and management of ground water quality. It is well known that no straight forward reasons can be advanced for the deterioration of water quality, as it is dependent on several water quality parameters[7,8]. There exists strong correlations among different parameters and a combined effect of their inter-relatedness indicates the water quality. Ground water quality in the industrial areas is determined by measuring the concentration of some physico-chemical parameters and comparing them with drinking water standards[9].

The developed regression equations for the parameters having significant correlation coefficients can be successfully used to estimate the concentration of other constituents. A systematic study of correlation and regression coefficients of the water quality parameters not only helps to assess the overall water quality but also to quantify relative concentration of various pollutants in water and provide necessary cue for implementation of rapid water quality management programmes[10-12]. In this present study, an attempt has been made to evaluate and improve the quality of ground water in the study area and thereby to analyse correlation and regression study of various physico-chemical parameters

EXPERIMENTAL

In the present investigation seven ground water (Bore well) samples were collected from different locations of perur block of Coimbatore district. The samples were collected in cleaned and well-dried brown glass bottles (2.5 L) with necessary precautions[13, 14]**.** These bottles were labelled with respect to collecting points, date and time in order to avoid any error between collection and analysis. The collected samples were stored in an icebox and brought to laboratory for determining both physical and chemical parameters. All the chemicals used were AR grade of pure quality. Double distilled water was used for the preparation of all the reagents and solutions. Glasswares were cleaned with commercial HCl followed by distilled water.

The pH and Electrical Conductivity were measured by using Systronics digital pH meter (model 335) with an accuracy of ± 0.01 and Systronics digital Conductivity meter (model 304) with an accuracy of ± 0.01 respectively. TDS was determined by using evaporating methods at 185^{o} C. Total Hardness, Calcium, Magnesium were measured by EDTA titration method [15]. Total Alkalinity was measured by titration method. Chloride was measured volumetrically by silver nitrate titrametric method using potassium chromate as indicator and was calculated in terms of mg/L [16]. Sulphate was measured by Gravimetric method using Barium chloride as precipitating agent. DO was measured by Winkler's titration method. The physico-chemical analysis was carried out according to standard methods [13,14,16,17]. The various parameters analyzed are pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Ca^{2+}, $Mg^{2+,}$ Cl^{-}, SO_4^{2-}, Total Hardness (TH), Total Alkalinity (TA), Total Acidity (TAC), Dissolved oxygen (DO), etc.,

Correlation coefficient and Linear Regression

Let X and Y are the two variables, and then the correlation coefficient [PEARSON] (r) between the variable X and Y is given by,

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \sum(y-\bar{y})^2}}$$

If the values of correlation coefficient 'r' between two variables X and Y are fairly large, it implies that these two variables are highly correlated. In such cases it is fissile to try linear relation in the form-

$$Y = a+bX$$

The value of empirical parameters '*a*' and '*b*' are calculated with the help of the following equation-

$$b = \frac{\sum XY - \bar{X}\sum Y}{\sum X^2 - \bar{X}\sum X}$$

$$a = \bar{Y}-b\bar{X}$$

RESULTS AND DISCUSSION

In the studied area, water used for drinking purposes should be colourless, odourless and free from slight turbidity and excess salts. The taste of the water is slightly brackish at some of the locations. The temperature of the water is in the range 30-35° C. The important physico-chemical characteristics of analyzed water samples viz., Mean, Standard Deviation (SD), Standard Error (SE) and Coefficient of Variation (CV) have been presented in Table-1 and the values are compared with standard parameters in Table-2.

The Coefficient of Variation observed for Mg, Cl, and TAC values found to be 55.63%, 70.13% and 73.27%. Also the observed Coefficient of Variation in Mg, Cl and TAC are of very high. The Coefficient of Variation for pH, EC, TDS, TH, TA, SO4, DO found to be 6.00%, 0.04%, 30.98%, 38.23%, 30.05%, 25.02%, 35.92% and 16.10%. It shows that variation in these parameters among its measured values at different locations is not high and variation range is very narrow.

The pH value of drinking water is an important index of acidity or alkalinity. A number of minerals and organic matter interact with one another to give the resultant pH value of the sample. In the present study, pH ranges from 6.6-7.9, which lies in the range prescribed by WHO[13].

The EC values for most samples range between 1020-2910(μ mho/cm). The EC value is directly proportional to the Total dissolved matter. All the samples show higher EC values than the permissible limit. When EC value exists at 3000 μ mho/cm, the generation of almost all the crops would be affected and it may result in much reduced yield[18].

The level of TDS is one of the characteristics, which decides the quality of drinking water. In the present study, TDS ranged from 968-2010mg/L. According to WHO and USPH, total dissolved solid values for drinking water less then 500mg/L minimum is the desirable limit and 1500 mg/L is the maximum permissible limit (ICMR). The analyzed data show that 57% samples had more than the maximum permissible limit. Water with high residue is normally less palatable and may induce an unfavourable physiological reaction in the transient consumer and even may cause gastrointestinal irritation[19]. Water containing high solid concentration may cause constipation effects[20]. High level of TDS may aesthetically be unsatisfactory for bathing and washing[21].

The Total Hardness is an important parameter of water quality whether it is to be used for domestic, industrial or agricultural purposes. The total hardness ranges between 855-2432ppm, while WHO and Indian standards permit any value less than 500mg/L. In all samples total hardness exceeds beyond the maximum acceptable limit. The hardness is due to dissolution of alkaline earth metal salts from geological matter. Calcium salts are non-toxic except at very high doses (100mg for 20 day). Maximum permissible limit of calcium and magnesium in drinking water is100mg/L and 50mg/L as suggested by USPH and WHO[22]; 75mg/L and 50mg/L as suggested by ICMR. In the studied area, the content of calcium and magnesium in portable water range from 413-1048mg/L and 325-1384mg/L respectively. All sample exceed beyond the maximum acceptable limit. In human body Hypocalcaemia causes coma and death if serum calcium level rises to 160 mg/L. Too high magnesium causes nausea, muscular weakness and paralysis in human body when it reaches a level of about 400mg/L[19].

Alkalinity of water is defined as the ionic concentration, which can neutralize the hydrogen ions. The phenolphthalein alkalinity value is zero indicating absence of any carbonate and hydroxyl ions. The bicarbonate alkalinity is expressed as a total alkalinity, which ranges between 218-460mg/L. The alkalinity value of all the samples are within the permissible limit of 600ppm. However, little abnormal value of alkalinity is not harmful to human beings[23].

In the present study, the amount of sulphate ion is estimated to vary from 39-169mg/L. The maximum tolerance range for sulphate is 200-400 mg/L. The excess amount of sulphate causes diarrhoea. All samples are free from sulphate problems. Sulphate produces an objectionable taste at 300-400 mg/L and bitter taste at 500 mg/L[24].

The chloride content in the samples lies between 120-891mg/L. chloride is normally the most dominant anion in water. According to ICMR the maximum permissible limit for chloride in drinking water is 250-mg/L [25]. In the present study; the value of chloride content in four samples has been found to be high, which can cause corrosion and pitting of iron plates or pipes.

The Dissolved oxygen in the water samples ranges from 3.2-5.6 mg/L, which is lower than the permissible limit of 8 mg/L for good quality drinking water. The aquatic life is held responsible for lowering the value of Dissolved oxygen. The ISI suggest that dissolved oxygen should be between 4-6 mg/L. The higher value of dissolved oxygen can impart good aesthetic taste to drinking water [26].

The systematic calculation of correlation coefficient between water quality variables and regression analysis provide indirect means for rapid monitoring of water quality. The correlation matrix for different ground water quality variables is depicted in Table-3. It is evident that distribution of Total Dissolved Solids, Total Hardness, Calcium, Magnesium and Chloride were significantly correlated ($r > 0.5$) with Electrical conductivity in most of the study areas. Positive correlation is obtained between 45 unions (i.e, 68.18% of the total number) and rest of the 21 unions (i.e, 31.82% of total number) demonstrates negative correlation. Highly positive correlation is observed between EC and TDS (0.9780) while highly negative correlation coefficient is seen among pH and TA (-0.0796), TAC and TH (-0.0289). The linear regression

analyses have been carried out for the water quality parameters which are found to have better and higher level of significance in their correlation coefficient. The regression equations obtained from the analysis are given in the Table 4. The different dependent characteristics of water quality were calculated using the regression equation and by substituting the values for the independent parameters in the equations. The experimentally estimated and calculated values using the regression equations are given in Table-5. Hence it can be concluded that the correlation studies of the water quality parameters have a great significance in the study of water resources.

CONCLUSION

The quality of ground water sample collected from seven different locations of Coimbatore district, centred on perur block is analysed and studied. On the basis of these analytical findings, the following conclusions can be drawn. The pH of the entire water sample is well within permissible limits. The TDS and Total hardness values of all the water samples are not within permissible limits. Total alkalinity values for all the samples are within permissible limit. Calcium and Magnesium content for all samples has high value above permissible limits. Chlorides content of four samples are in higher range than permissible limits. Sulphate content for all samples is within permissible limits. The general observation is that the samples of water from Sundakkamuthur, Pacchapalayam and Thithipalayam are inferior to other samples from perur block. The reason for dwindling quality of water in this region may be due to high density of population and location of big and ancillary industrial units in this area. The diseases mentioned in this paper may occur due to the lack of water quality in this area. Hence, rapid and reliable monitoring measures are essential for keeping a close watch on water quality and health environment. In the correlation regression study, we can conclude that all the parameters are more or less correlated with each other. The linear correlation is very useful to get fairly accurate idea of quality of the ground water by determining a few parameters experimentally.

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Table-1: Statistical analysis of ground water samples

	Max	Min	Range	Mean	SD	SE	CV%
pH	7.9	6.6	1.3	7.1057	0.426548	0.16122	6.00
EC, µ mho/cm	2910	1020	1890	1852.86	0.724611	0.273877	0.04
TDS	2010	968	1042	1461.43	452.7099	171.1083	30.98
TH	2432	855	1577	1351	516.5476	195.2366	38.23
CALCIUM	1048	413	635	649.429	195.1284	73.75161	30.05
MAGNESIUM	1384	325	1059	650.286	361.7851	136.7419	55.64
CHLORIDE	891	120	771	368.7	258.5524	97.72362	70.13
TOTAL ACIDITY	37	4	33	14.29	10.47057	3.957504	73.27
TOTAL ALKALINITY	460	218	242	314.7	78.72868	29.75664	25.02
SULPHATE	169	39	130	119.7	42.99407	16.25023	35.92
DO	5.6	3.2	2.4	4.84	0.77984	0.29475	16.11

Table-2: Comparison of ground water quality with drinking water standards

Parameter	USPH	WHO	European standard	ICMR	Present study report
PH	6.0-8.5	6.5-9.2	6.5-8.5	6.5-8.5	6.6-7.9
EC, µ mho/cm	300	300	400	-	1020-2910
TDS	500	500	500	500-1500	968-2010
Total Hardness	500	-	-	300	855-2432
Calcium	100	75	100	75	413-1048
Magnesium	30	50	-	50	325-1384
Chloride	250	200	250	250	120-891
Total Acidity	-	-	-	-	4-37
Total Alkalinity	-	-	-	-	218-460
Sulphate	250	200	-	200	39-169

USPH - United States Public Drinking water Standard
WHO - World Health Organisation
ICMR – Indian Council of Medical Research

Table-3: Correlation coefficients among various water quality parameters

	pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Cl^-	TAC	TA	SO_4^{2-}	DO
pH	1										
EC	-0.7765	1									
TDS	-0.7912	0.978	1								
TH	-0.6999	0.852	0.8027	1							
Ca^{2+}	-0.7838	0.835	0.8009	0.9533	1						
Mg^{2+}	-0.4492	0.68	0.5652	0.9154	0.8017	1					
Cl^-	-0.4942	0.8459	0.817	0.4866	0.4259	0.379	1				
TAC	0.0508	-0.2421	-0.3403	-0.0289	-0.1705	0.1879	-0.2224	1			
TA	-0.0796	-0.1651	-0.1294	-0.3336	-0.372	-0.391	0.0553	0.604	1		
SO_4^{2-}	-0.3511	0.009	0.1026	0.2837	0.2308	0.1453	-0.3197	0.3727	0.3263	1	
DO	0.0053	0.4685	0.4976	0.2437	0.0369	0.2114	0.6958	-0.0593	0.1905	-0.0205	1

Table-4: Linear correlation coefficient and regression equation for some pairs of parameters which have significant value of correlation

Pair of parameters	R	Regression coefficient		Regression equation
		a	*b*	
EC and TDS	0.978	-463.367	1.5849	EC= 1.5849(TDS)-463.367
EC and TH	0.852	218.1525	1.21	EC= 1.21(TH)+218.1525
EC and Ca^{2+}	0.835	-185.985	3.1394	EC= 3.1394(Ca^{2+})-185.985
EC and Mg^{2+}	0.68	956.1218	1.37899	EC= 1.37899(Mg^{2+})+956.1218
EC and Cl^-	0.8459	967.8824	2.40016	EC= 2.40016(Cl^-)+967.8824

Table-5: The observed and predicted (using regression equation developed using better correlated parameters) values of water samples.

Sample	Name of village	EC observed value	EC Predicted values				
			(TDS)	(TH)	(Ca^{2+})	(Mg^{2+})	(Cl^-)
1	Kovai Pudur	1020	1071	1253	1111	1566	1306
2	Perur	1280	1239	1369	1745	1420	1256
3	Kulathupalayam	1060	1118	1323	1356	1526	1304
4	Sundakkamuthur	2710	2624	3161	3104	2865	1810
5	Pacchapalayam	2910	2722	2230	2197	2201	3106
6	Thithipalayam	1660	1548	1777	1503	1989	1935
7	Selvapuram	2330	2648	1858	1955	1404	2252

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