A Correlation Analysis on the Ground water at selected areas of Thoothukudi District, TamilNadu, India

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Abstract : The only vital source for sustenance and survival of every living organism is the groundwater. The present study is aimed at a correlation analysis of Groundwater at seven locations of Thoothukudi district, Tamil Nadu. A correlation study has been carried out amongst all possible pairs of seven physico-chemical parameters to assess the groundwater quality. The correlation analysis provides an excellent tool for the prediction of parameter values within reasonable degree of accuracy. The existence of strong correlation between Total Hardness and Total Alkalinity with sodium and calcium is ascertained.

Keywords : TDS, Chlorides, Total hardness, Physiochemical parameters, correlation coefficient etc.

Introduction

Water plays an essential role in human life**.**[1]. Water is our most valuable natural resource. This fact though recognized by man has not stopped him from polluting the rivers, lakes and oceans. The cause of water pollution could be municipal, agricultural and industrial. All these major causes have rampantly deteriorated the quality of water the world over. This has resulted in the decrease in the quality of drinking water available, and has also caused the decline of resources from our marine sources as the runoff water from the land is ultimately destined for the seas [2]. Ground water is the only alternative option for even the urban centre's having well planned, designed and executed water supply systems like Thoothukudi district, during the periods of water scarcity due to shortfall of rain or its non-occurrence [3].Ground water has been used as a source of drinking water for millions of rural and urban families in India. It was estimated that, only 0.9% of the total water resources on earth is supplied from groundwater, though it is the major and the preferred source of drinking water in rural as well as urban areas. It covers 80% of the total drinking water requirement and 50% of the agricultural requirement in rural India. The changes in quality of ground water response to the variation in physical, chemical and biological environments [4]. The environmental impact of human activity on the groundwater is considered as one of the major hazard in the modern days[5]. The main objectives are to develop a WQI of the study area and correlation model for assessment of groundwater parameter.

Experimental

In the present investigation 7 ground water samples were collected from different areas of Thoothukudi District namely Nazareth (Loc.no.1), Srivaikundam (Loc.no.2), Thenthiruperai (Loc.no.3), Neivilai (Loc.no.4), Kurumbur (Loc.no.5), Mukkani (Loc.no.6) and Ammanpuram (Loc.no.7).

Collection of samples

Polythene cans of 2 L capacity were made use for collection of water samples.These polythene cans were first washed with tap water, soaked in chromic acid solution for about 10-15 minutes to remove any impurities, again washed with tap water. Finally, they were rinsed with deionised distilled water. Then the polythene cans were taken for sample collection.

Physicochemical analysis

The samples collected were analyzed for important physical and chemical parameters such as pH, total dissolved solids (T.D.S.), total hardness (T.H.) and Cl⁻as per the procedures given in "Standard methods for the examination of water and waste water", American Public Health Association (APHA) [6]. The parameters seen in the samples of water were determined by following various methods [7-9].

Results and Discussion

The results of physicochemical analysis of different groundwater samples are presented in Table 1. These results were compared with values of prescribed standard quality parameters of WHO.

Table 1: Parameters measured for the water samples

Location	Appearance	Odour	pH	TDS (ppm)	Cl⁻ (ppm)	Total Alkaliniy	Total Hardness	Calcium (ppm)	Sodium (ppm)
L$_1$	Unclear	None	7.5	1100	322.9	321	460	64.7	61.5
L$_2$	Unclear	None	7.1	680	187	668	449	97	92
L$_3$	Unclear	None	7	260	460	642	190	30	28
L$_4$	Unclear	None	7.2	520	912	963	317	96	93
L$_5$	Clear	None	7.3	350	561	775	227	56	49
L$_6$	Unclear	None	6.7	1360	421	1230	497	158	122

L$_7$	Clear	None	7.8	1270	365	1043	455	128	108

Table 2: Correlation Matrix for different parameters of Ground water of selected areas of Thoothukudi District

	pH	TDS (ppm)	Cl (ppm)	TA (ppm)	TH (ppm)	Ca2+	Na+
pH	1						
TDS (ppm)	0.176536	1					
Cl (ppm)	-0.08466	-0.39748	1				
TA (ppm)	-0.26851	0.343473	0.319842	1			
TH (ppm)	0.106112	0.907246	-0.49503	0.20025	1		
Ca2+	-0.11659	0.790886	-0.08948	0.770221	0.776204	1	
Na+	-0.04815	0.746243	-0.04887	0.70937	0.794383	0.979938	1

Coefficient of Correlation (r):

The mathematical models used to estimate water quality require two parameters to describe the realistic groundwater situations. Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables. This analysis attempts to establish the nature of the relationship between the variables and thereby provides a mechanism for prediction of forecasting [10]. In this study, the relationship of water quality parameters on each other in the data of water analyzed was determined by calculating correlation coefficient, R, by using the formula as given [11-12].

$$R = n \frac{\sum(X_iY_i - \sum X_i \sum Y_i}{\sqrt{[n\sum x_{i2} - (\sum x_i)2][[n\sum y_{i2} - (\sum Y_i)2]]}}$$

Where, x (x=values of x-variable) and y (y=values of x-variable) represents two different water quality parameters. N=number of data points.

In statistics, correlation is a broad class of statistical relationship between two or more variables. The correlation study is useful to find a predictable relationship which can be exploited in practice. It is used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters [13].

The correlation between the various parameters is studied using Pearson's Correlation coefficient Matrix [14]. Correlation is the mutual relationship between two variables. Direct correlation exists when increase or decrease inthe value of one parameter is associated with a corresponding increase or decrease in the value of other parameter. The regression analysis explored the pattern of the relationship between the variables and the subsequentapplication of correlation analysis determined the extent to which the variables are related.

The value of regression coefficient, r more than 0.80 means there is more than 80% association in the data. This correlationcoefficient measures the degree of association or correlation that exists between two variables, one taken asdependent variable. The greater the value of regression coefficient, the better is the fit and more useful theregression variables. Considerably, significant positive correlation has been observed between Total Hardness i.e. TH andTDS (R=**0.90**), Na$^+$ and Ca^{2+} (R= **0.97**), TDS and Ca^{2+}(R=**0.79**) & Na$^+$ and TH (R= **0.79**). Similarly negative correlation has been observedbetween the parameters pH and Cl(R=**-0.08**), Ca^{2+} and Cl(R= **-0.08**), Na$^+$ and pH (R=**-0.04**) & Na$^+$ and Cl$^-$(R=**-0.04**). In our studythe correlation is said to be

perfect as the deviation in one variable is followed by a corresponding and proportionaldeviation in the other. The value of correlation coefficient lies between -1 and +1.

Conclusion

In the present study, the correlation study of groundwater revealed that all the parameters were more or less correlated with one another. In the light of correlation study, we can conclude that all the parameters are more or less correlated with each other, especially strong correlations observed between sodium ions and calcium ions(r=0.97). The values of correlation coefficients and their significance levels will help in selecting the proper treatments to minimize the contaminations of the river water of Thoothukudi. The correlation study is very useful to get fairly accurate idea of the quality of the groundwater by determining just a few examples experimentally and then predicting the remaining from correlation equation.

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