Statistical Analysis of Groundwater Quality on the Bank of Noyyal River at Tiruppur, Tamilnadu, India

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Abstract. The present study is accomplished to evaluate the quality of groundwater on the bank of Noyyal river for the purpose of drinking and domestic usage by using correlation analysis. The study was carried out for three successive years in both summer and rainy seasons (2013-2015). The results were evaluated and compared with WHO water quality standards. The statistical data predict that the groundwater quality is unsuitable for drinking purposes in the study area.

KeyWords: Water quality, correlation, variables and groundwater.

1 Introduction

Tiruppur is an industrial hub for the textile sector and is one of the most important export centers of India. It is located on the bank of Noyyal River. Tiruppur is also known as the textile city of India. Unplanned urbanization and rapid growth of industrialization increased the ground water pollution crisis in water ecosystem. The problem of water quality deterioration is mainly due to human activities such as discharge of industrial and sewage wastes and agricultural runoff which cause ecological damage and pose serious health hazards. Most of the ground water in India is getting increasingly polluted due to onslaught of human activities of diverse nature. The demand for water has increased over the years and this has led to water scarcity in many parts of the world. Thus, the present study has been attempted to study the statistical analysis of ground water quality on the bank of Noyyal river at Tiruppur. Statistical package for social sciences (SPSS) has been used to perform symmetrical correlation matrix between major ion species. The results regarding correlation analysis of various parameters are given in table 1 & 2.

2 Materials and Methods

The correlation matrix is one of the most common and useful statistical technique. The coefficient of correlation (r) is a measure of the strength of the linear relationship between two variables. The numerical value of the correlation coefficient (r) for 19 water quality parameters is tabulated (Table 1 & 2). The correlation coefficient takes on values ranging between +1 and -1. The Karl Pearson correlation coefficient is used as a measure to establish the relationship between two variables X and Y. The correlation studies are 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 (Arul Antony et al., 2008).

$$r = \frac{n\sum XY\sum X\sum Y}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2] - (\sum Y)^2]}}$$

Here,
n = number of data points;x = values of x–variable
y = values of y–variable

3 Results and Discussion.

The correlation coefficient has ranged from -0.223 (temperature and bicarbonate), 0.930 (TH and magnesium) in summer and -0.290 (BOD and COD), 0.935 (TH and magnesium) in rainy seasons respectively. High positive correlation is observed for total hardness and magnesium (0.935) in rainy season.

EC shows positive correlation with all the parameters except fluoride (-0.041) in summer and EC shows positive correlation with all the parameters except fluoride and DO (-0.150 and -0.018) in rainy season. The correlation study shows that EC is strongly influenced by all the charged ions (ZahirHussain., 2004).

TDS shows positive correlation with all the parameters except fluoride (-0.141). The high positive correlation is observed for TDS and TH (0.620). This shows that most of the ions are involved in various physico-chemical reaction such oxidation-reduction and ion exchange in the groundwater aquifer system (Udayalaxmi et al., 2010).

TH shows positive correlation with all the parameters except fluoride (-0.113 and -0.250) in summer and rainy seasons. It shows that the major source of magnesium and sodium ion in the groundwater may be ion exchange of minerals between rocks and water.

Fluoride shows a negative correlation with most the parameters except temperature (0.037), pH (0.067), TDS (0.086), HCO_3 (0.234), Cl (0.095), SO_4 (0.050) and PO_4 (0.358) in summer season and temperature (0.187), pH (0.085), Cl (0.082) and PO_4 (0.038) in rainy seasons. Negative correlation between a pair of parameters is due to the increase of one parameter while other decreases (Arul Antony et al., 2008).

Calcium shows positive correlation with EC (0.805), TDS (0.577), TH (0.872), HCO_3 (0.493), Cl (0.408), Na (0.441), K (0.442) in summer and calcium shows positive correlation with EC (0.815), TDS (0.752), TH (0.894), HCO_3 (0.367), Cl (0.394), Na (0.432) and K (0.411) in rainy seasons.

Chloride shows positive correlation with temperature (0.280), pH (0.058), EC (0.774), TDS (0.703), TH (0.383) and bicarbonate (0.300) in summer and temperature (0.584), pH (0.008), EC (0.747), TDS (0.722), TH (0.384), bicarbonate (0.267) in rainy seasons. It indicates the chloride ions in the form of salts.

Sulphate shows positive correlation with all the parameters except temperature (-0.018) in summer and pH (-0.056) in rainy season. High positive correlation is observed with Mg (0.806) which indicates that the water samples are hard due to sulphate ions.

BOD shows positive correlation with pH (0.083), EC (0.150), TDS (0.028), TH (0.176), HCO_3 (0.263), Cl (0.091), Na (0.007), K (0.029), Ca (0.114), Mg (0.288), NO_3 (0.234), SO_4 (0.270), PO_4 (0.203), F (0.113) except temperature (-0.165) in summer and Na (-0.108) and F (-0.026) in rainy seasons.

COD shows positive correlation with most of the parameters except temperature (-0.013), Mg (-0.012), F (-0.102) and BOD (-0.131) in summer and COD shows positive correlation with most of the parameters except Mg (-0.010), SO_4 (-0.153) and BOD(-0.290) in rainy seasons. This trend suggests that the pairs of concerned ions originated from common natural and anthropogenic sources.

DO shows positive correlation with all the parameters in summer and negative correlation with temperature (-0.121), pH (-0.202), EC (-0.018), Cl (-0.070), Na (-0.157), Mg (-0.062) and COD (-0.062) in rainy seasons.

Conclusion

The correlation analysis of various physico-chemical parameters of groundwater samples revealed that most of the parameters have more or less correlated with other parameters. This proves to be a rapid method of water quality monitoring. The significance of the analysis is that in addition to finding correlation among the parameters, it provides a fairly accurate idea about the quality of the groundwater. The statistical data indicates that the groundwater quality in the study area is poor as it is polluted with high amount of TDS, TH, chloride, nitrate, etc. Most of the parameters are either more than the permissible limit or excessive limit. Therefore, the groundwater samples are not potable. To maintain quality of groundwater, the continuous monitoring of physico- chemical parameters should be done. On the basis of the present study, it is recommended that the groundwater should be suitably treated before which is used for drinking and other domestic purposes.

Table 1. The mean correlation matrix of groundwater quality during Summer season. (2013, 2014 and 2015)

	Temp	pH	EC	TDS	TH	HCO_3	Cl	Na	K	Ca	Mg	NO_3	SO_4	PO_4	F	BOD	COD	DO
Temp	1																	
pH	0.003	1																
EC	0.148	0.320*	1															
TDS	0.194	0.201	0.825**	1														
TH	0.006	0.361*	0.831**	0.620**	1													
HCO_3	-0.223	0.246	0.609**	0.492**	0.521**	1												
Cl	0.280	0.058	0.774**	0.703**	0.383*	0.300	1											
Na	-0.149	0.298	0.553**	0.400*	0.429**	0.455**	0.326*	1										
K	0.063	0.406**	0.527**	0.512**	0.320*	0.379*	0.320*	0.764**	1									
Ca	0.202	0.435**	0.805**	0.577**	0.872**	0.493**	0.408**	0.441**	0.442**	1								
Mg	-0.083	0.254	0.765**	0.554**	0.930**	0.542**	0.364*	0.380*	0.208	0.767**	1							
NO_3	0.195	0.257	0.309	0.136	0.389*	0.270*	0.029	0.228	0.232	0.471	0.249	1						
SO_4	-0.018	0.246	0.594**	0.431**	0.740**	0.540**	0.161	0.297	0.225	0.652**	0.806**	0.341*	1					
PO_4	-0.031	0.298	0.511**	0.472**	0.488**	0.677**	0.356*	0.396*	0.268	0.451**	0.549**	0.152	0.575**	1				
F	0.037	0.067	-0.041	0.086	-0.113	0.234	0.095	-0.020	-0.147	-0.067	-0.032	-0.012	0.050	0.358*	1			
BOD	-0.165	0.083	0.150	0.028	0.176	0.263	0.091	0.007	0.029	0.114	0.288	0.234	0.270	0.203	0.113	1		
COD	-0.013	0.298	0.300	0.366*	0.041	0.206	0.242	0.246	0.440**	0.198	-0.042	0.113	0.012	0.004	-0.102	-0.131	1	
DO	0.103	0.196	0.218	0.160	0.208	0.267	0.074	0.173	0.305	0.207	0.263	0.188	0.305	0.301	0.037	0.618**	0.028	1

Table 2. The mean correlation matrices of groundwater quality during Rainy season. (2013, 2014 and 2015)

	Temp	pH	EC	TDS	TH	HCO_3	Cl	Na	K	Ca	Mg	NO_3	SO_4	PO_4	F	BOD	COD	DO
Temp	1																	
pH	-0.126	1																
EC	0.495**	0.074	1															
TDS	0.436**	0.045	0.940**	1														
TH	0.282	0.123	0.865**	0.810**	1													
HCO_3	0.353*	-0.064	0.574**	0.581**	0.457**	1												
Cl	0.584**	0.008	0.747**	0.722**	0.384*	0.267	1											
Na	0.119	0.118	0.510**	0.531**	0.414**	0.332*	0.287	1										
K	0.055	0.167	0.480**	0.508**	0.300	0.349*	0.329*	0.749**	1									
Ca	0.341*	0.275	0.815**	0.752**	0.894**	0.367*	0.394*	0.432**	0.411**	1								
Mg	0.216	0.017	0.766**	0.700**	0.935**	0.439**	0.313*	0.321*	0.153	0.688**	1							
NO_3	0.005	0.099	0.230	0.241	0.274	0.169	-0.004	0.122	0.169	0.364*	0.133	1						
SO_4	0.033	-0.056	0.469**	0.508**	0.626**	0.330*	0.090	0.161	0.047	0.432**	0.655**	0.121	1					
PO_4	0.425**	-0.043	0.557**	0.563**	0.447**	0.595**	0.394*	0.290	0.194	0.459**	0.367*	-0.047	0.376*	1				
F	0.187	0.085	-0.150	-0.141	-0.250	-0.020	0.082	-0.05	-0.053	-0.163	-0.253	-0.151	-0.245	0.038	1			
BOD	0.045	0.013	0.113	0.075	0.187	0.122	-0.027	-0.115	-0.108	0.215	0.111	0.283	0.119	0.104	-0.026	1		
COD	0.084	0.193	0.237	0.161	0.084	0.215	0.241	0.282	0.477**	0.230	-0.010	0.173	-0.153	0.167	0.060	-0.290	1	
DO	-0.121	-0.202	-0.018	0.041	0.001	0.209	-0.070	-0.157	0.122	0.046	-0.062	0.093	0.095	0.176	0.031	0.533	-0.062	1

** Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

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