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A Correlation and Regression Study on the Ground Water of Vaiyampatti Village, Tiruchirappalli District

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ABSTRACT

Groundwater is the vital source of sustenance and survival of every living organism. The present study aimed at a statistical regression analysis of twenty two data points of Groundwater at eleven locations of Vaiyampatti village, Tiruchirappalli district, Tamilnadu. A correlation study has been carried out amongst all possible pairs of 14 physico-chemical parameters to assess 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 Magnesium is ascertained.

Key words: Groundwater, Physico-Chemical Parameters, Correlation and Regression Analysis.

INTRODUCTION

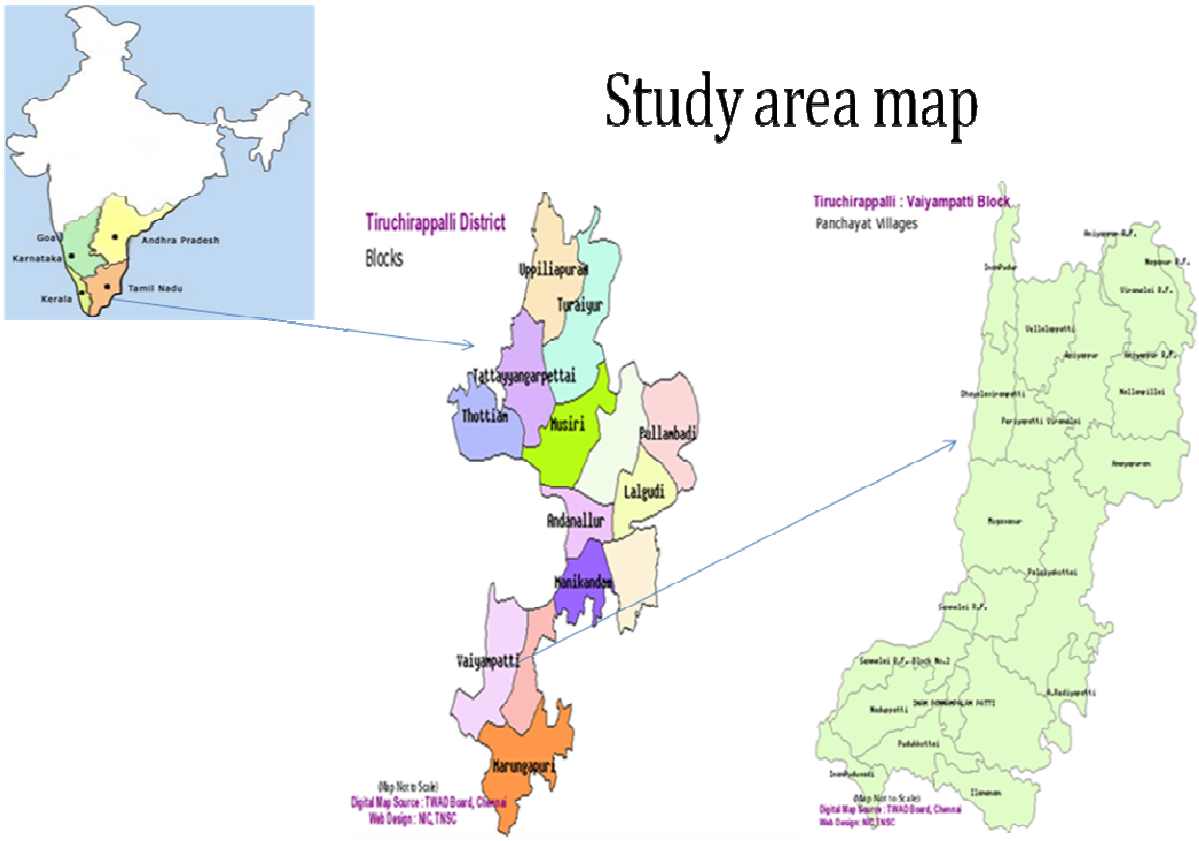
Ground water is one of the earth's most important, renewable and widely distributed resource. About 97.2% of water on earth is salty and only 2.8% is present as fresh water, from which about 20% constitutes groundwater [1]. It is generally considered least polluted compared to other inland water resources. However, studies indicate that ground water is not absolutely free from pollution though it is likely to be free from suspended solids. Due to rapid growth of population, industrialization and urbanization, there have been intense human activities and interference into nature leading to an over-exploitation and severe pollution stress on natural water bodies. Improper waste disposal and unscientific anthropogenic practices over the years have adversely affected the surface and ground water quality. The major problem with the ground water is that once contaminated, it is difficult to restore its quality. The solution is non-trivial because of complex dynamics involved in the ground water flow, which requires simultaneous solution of complicated geochemical and hydrological equations. Hence there is a need for and concern over the protection and management of ground water quality. Groundwater investigation consists of both quality and quantity determination [2].

It is well known that no straightforward reasons can be ascribed for deterioration of water quality, as it is dependent on several water quality parameters. There exist strong correlations among different parameters and a combined effect of their inter - relationship indicated the water quality. Correlation analysis is a useful statistical tool to determine the extent to which changes in the value of an attribute are associated with the changes in another attribute [3]. Therefore, a systematic statistical study of correlation and regression coefficients of the quality parameters not only helps to assess the overall water quality but also quantify relative concentration of various pollutants in water and provide necessary clue for implementation of rapid water quality management programmes. Many workers [4]

have undertaken statistical analysis and assessed the ground water quality in different parts of the country. Present authors while assessing fluoride pollution of ground waters on the study area, have showed statistically that fluoride is significantly correlated with number of other parameters. However, to the best of our knowledge, there has been no systematic correlation and regression study involving a large number of water quality parameters in ground water sources in the study area. This paper is an attempt to address the issue taking into account as many as 20 water quality parameters in the analysis.

Study area

Vaiyampatti village is located in Trichy district of Tamilnadu, India. It lies between 1031'59.880'' N latitude and 7817'60.000'' E longitude. Its total area is about 3.2 square miles. Vaiyampatti village is 60 km distance from Trichy city and located on Trichy to Dindigul National Highway (NH-47). The summer in Vaiyampatti is unbearably hot with temperatures rising above 38 ◌C mark. In the winters, the temperatures come down near 18 ◌C. The major portion of the village is occupied by Fertile farms, Forests, Ponds and Mountains.



MATERIALS AND METHODS

Preparation of water samples:

The water samples were collected in clean polythene bottles, in the month of May and July 2011, which were thoroughly rinsed with sample water and tightly sealed and labeled after collection. The method applied by R. Shyamala et.al has been used for sampling. All the chemicals used were of A R Grade. The temperature and Dissolved Oxygen of the sample was measured in situ.

Analysis of water sample:

Analysis was carried out for various water quality parameters such as Temperature, pH, Electrical conductivity, Total dissolved solid, Total Hardness, Total Alkalinity, Calcium, Magnesium, Chloride, Bio Chemical Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, Nitrite and Fluoride as per standard procedures using APHA method. The water quality parameter values are in mg/l except pH and EC in µs/cm.

Statistical Analysis:
The statistical analysis has been performed using standard methods, by calculating correlation coefficients between different pairs of parameters.

Coefficient of Correlation (r):
Let x and y be any two variables (water quality parameters in the present case) and (Xi, Yi) be n pairs of observed values of these variables (I =1,2,3……n). Then the correlation coefficient r between the variables x and y is given by the well known relation

$$r = \frac{n \Sigma x y - \Sigma x \Sigma y}{\sqrt{[n \Sigma x^2 - (\Sigma x)^2][n \Sigma y^2 - (\Sigma y)^2]}} \quad \text{----------(1)}$$

Where, the summations are taken over 1 to n (n=number of observations). The values of empirical parameters a and b were calculated with the help of equations 2 and 3.

$$a = \frac{n \Sigma x y - \Sigma x \Sigma y}{n \Sigma x^2 - (\Sigma x)^2} \quad \text{----------(2)}$$

Keeping the above observations in mind a linear relationship (regression line) is proposed.

$$y = a x + b \quad \text{----------(3)}$$

To study the correlation between various water quality parameters, the regression analysis was carried out using computer software R, Version. 2.15.0.

Table 1 .Physico – chemical Characteristics of groundwater samples of Vaiyampatti village in May and July 2011

No	Temp	pH	EC	TDS	TH	TA	Ca	Mg	Cl	COD	BOD	DO	Ni	F
1	27	7.4	1530	968.2	110	610	59.31	50.69	150.52	16.00	4	1.57	0.22	1.60
2	28	7.0	2742	956.0	160	490	125.82	34.15	400.44	14.85	4	2.02	0.14	0.69
3	26	7.2	2348	975.0	156	505	116.23	39.77	330.86	18.28	8	2.47	0.22	1.00
4	31	7.2	2364	980.0	184	690	137.87	46.13	523.98	40.57	2	4.26	0.14	1.50
5	30	7.8	1340	933.6	116	455	89.77	26.28	160.46	25.71	6	6.85	0.20	1.30
6	29	6.8	1815	938.0	120	630	62.52	57.48	149.01	33.71	6	2.80	0.14	1.20
7	30	7.4	1536	941.0	110	410	84.96	15.01	252.76	33.14	6	4.83	0.18	2.00
8	29	7.2	3786	948.4	168	665	100.02	67.08	400.44	37.14	2	3.14	0.30	0.95
9	28	7.3	740	972.0	156	600	71.34	84.66	430.26	27.02	2	3.14	0.10	1.50
10	29	7.8	740	945.0	68	255	45.69	22.31	68.16	35.42	4	5.28	0.14	0.92
11	27	7.8	740	921.0	70	360	62.52	7.84	45.44	31.42	8	3.93	0.10	0.95
12	28	7.8	1426	970.4	204	825	99.39	104.61	194.54	21.14	4	8.76	0.10	1.50
13	26	7.2	2608	1002.7	194	785	128.25	65.75	391.92	19.42	8	1.46	0.16	0.69
14	27	7.5	2250	986.7	168	685	108.21	59.79	205.09	20.57	2	12.35	0.30	1.20
15	32	7.4	2287	980.1	180	835	97.79	82.21	494.16	20.00	2	7.56	0.16	1.20
16	30	8.2	1239	799.9	198	535	97.79	100.21	171.82	19.42	2	13.08	0.10	1.10
17	28	7.0	1701	966.5	244	890	83.36	160.64	193.12	20.57	6	10.11	0.18	0.99
18	32	7.8	1489	969.9	164	555	107.41	56.59	239.98	29.71	2	9.06	0.14	1.60
19	26	7.5	3657	996.0	224	530	101.80	122.02	231.46	32.00	0	2.47	0.16	0.74
20	28	7.5	2981	978.0	230	710	111.42	118.58	567.52	37.71	2	1.57	0.16	1.60
21	28	8.1	576	994.6	136	865	76.15	59.85	58.22	31.42	6	1.91	0.10	0.86
22	26	8.2	691	999.1	128	460	90.58	37.42	42.06	32.57	8	1.79	0.16	1.00

RESULTS AND DISCUSSION

Correlation is the mutual relationship between two variables. Direct correlation exists when increase or decrease in the value of one parameter is associated with a corresponding increase or decrease in the value of other parameter [5].

In this study, the numerical values of correlation coefficient, R for the fourteen water quality parameters are tabulated in table 3. It shows a range from 0.003 to 0.870 for all water quality parameters. The correlation co efficient, shows r more than 0.90, i.e. there is more than 90% association in the data. As we can see the calculated values depict some strong correlations between Total Hardness and Magnesium, (r= 0.870). However some weak correlations were observed between pH and Chloride (r= -0.533) pair having very high positive correlation between them shows the dependence of one parameter on the other while the pair having very high negative correlation shows inverse relation between them. BOD shows negative correlation with most of the parameters.

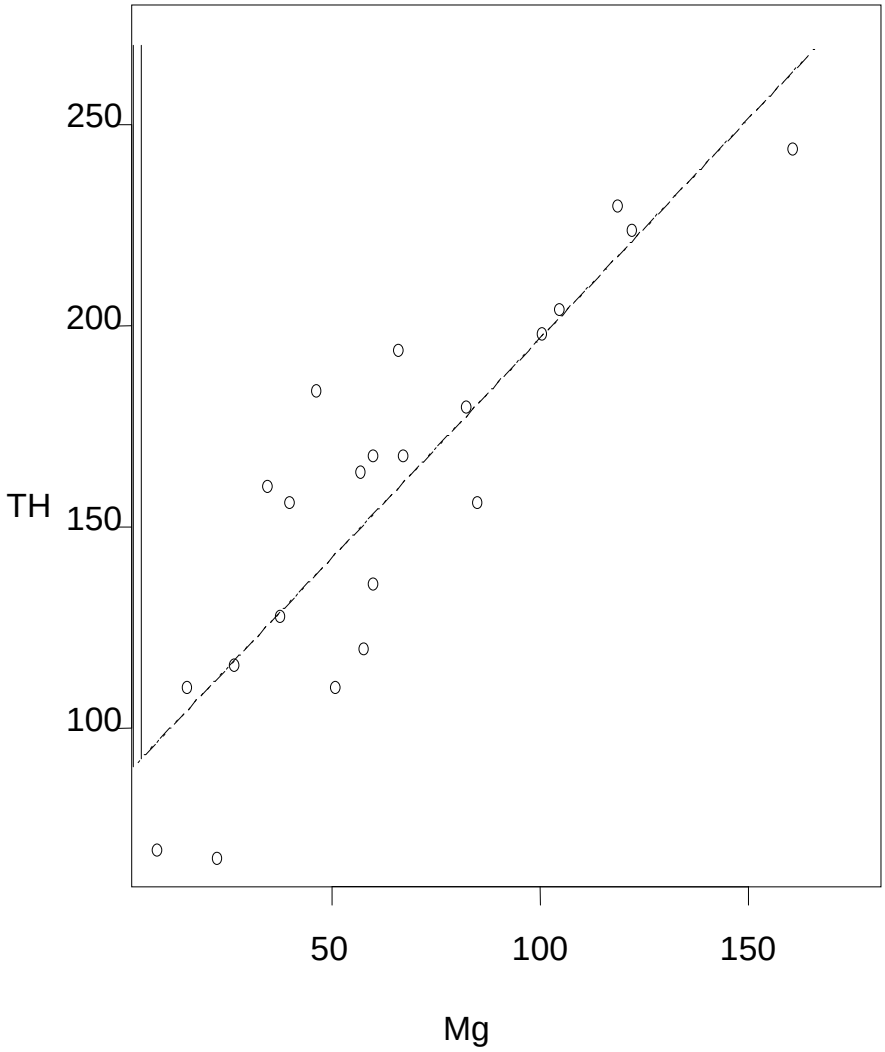
Table 2. Statistical evaluation for the ground water of Vaiyampatti village, Tiruchirappalli District

Parameters	Min	1st Quad	Median	Mean	3rd Quad	Max
Temp	26.00	27.00	28.00	28.40	29.70	32.00
pH	6.80	7.20	7.40	7.50	7.80	8.20
EC	576.00	1264.00	1618.00	1845.00	2360.00	3786.00
TDS	799.90	945.90	970.10	960.10	980.10	1002.70
TH	68.00	122.00	162.00	158.50	191.50	244.00
TA	255.00	493.80	605.00	606.60	705.00	890.00
Ca	45.69	77.95	97.79	93.55	108.01	137.87
Mg	7.84	38.01	58.63	64.50	84.05	160.64
Cl	42.06	153.00	218.28	259.19	398.31	567.52
COD	14.85	20.14	28.36	27.17	33.00	40.57
BOD	0.00	2.00	4.00	4.27	6.00	8.00
DO	1.46	2.13	3.53	5.01	7.38	13.08
Ni	0.10	0.14	0.16	0.16	0.18	0.30
F	0.69	0.95	1.15	1.18	1.50	2.00

Table 3. Correlation Matrix for different parameters of groundwater around Vaiyampatti Village, Tiruchirappalli district

	Temp	Ni	DO	TA	TDS	Cl	Mg	EC	TH	COD	Ca	F	pH	BOD
Temp	1.00	-0.15	0.43	0.04	-0.33	0.25	-0.07	-0.08	-0.02	0.21	0.04	0.46	0.03	-0.39
Ni		1.00	0.06	0.03	0.21	0.13	-0.06	0.51	0.04	-0.09	0.17	0.003	-0.321	-0.08
DO			1.00	0.14	-0.46	-0.17	0.29	-0.18	0.25	0.29	0.04	0.17	0.26	-0.29
TA				1.00	0.35	0.34	0.65	0.24	0.67	-0.21	0.31	-0.00	-0.24	-0.15
TDS					1.00	0.22	0.05	0.23	0.14	0.10	0.22	-0.05	-0.26	0.07
Cl						1.00	0.26	0.64	0.53	0.03	0.65	0.19	-0.53	-0.44
Mg							1.00	0.32	**0.87**	-0.15	0.16	-0.05	-0.13	-0.43
EC								1.00	0.56	0.02	0.61	-0.19	-0.55	-0.41
TH									1.00	0.14	0.14	0.19	0.11	-0.14
COD										1.00	0.16	-0.13	0.37	0.26
Ca											1.00	-0.08	-0.21	-0.19
F												1.00	0.01	-0.22
pH													1.00	0.02
BOD														1.00

Figure 1. Linear Regression Model depicting the existence of strong correlation between Total Hardness and Magnesium



Y= mx+c, TH = 1.088(Mg) + 88.334

CONCLUSION

In the present study, the correlation and regression of 14 Physico - chemical parameters of groundwater revealed that all the parameters were more or less correlated with one another. A linear regression analysis technique has been proven to be a very useful tool for monitoring groundwater and has a good accuracy. In the light of correlation regression study, we can conclude that all the parameters are more or less correlated with each other, especially strong correlations observed between Total Hardness and Magnesium (r=0.870). The linear correlation 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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