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Research Article

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Interpretation of Groundwater Quality using Correlation and Linear Regression Analysis from Tiruchengode taluk, Namakkal district, Tamilnadu, India

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ABSTRACT

Water is the most important commodity and mainly most misused one. Groundwater is the main principal source for drinking water and other activities in Tiruchengode Taluk, Namakkal district, Tamilnadu, India. It is an indispensable source of our life. The problem of groundwater quality obtains high importance in this present-day, whether in the study area or any other countries in the world. The present study was carried out to analyse and evaluate the groundwater samples collected from residential areas of Tiruchengode Taluk, Namakkal district, Tamilnadu, India. The parameters studied were pH, Temperature, Total Alkalinity, Total Hardness, Calcium, Magnesium, Chloride, Total Dissolved Solid, Nitrate, Nitrite, Phosphate, Sulphate and Fluoride. Suitable correlation studies have been carried out among all possible pairs of 19 Physico-chemical groundwater quality parameters of various groundwater samples collected from Tiruchengode area of Namakkal district, (Tamilnadu), India. Correlation study indicates that different parameters are strongly interrelated. The correlation and regression provides an excellent tool for the prediction of parameter values within reasonable degree of accuracy.

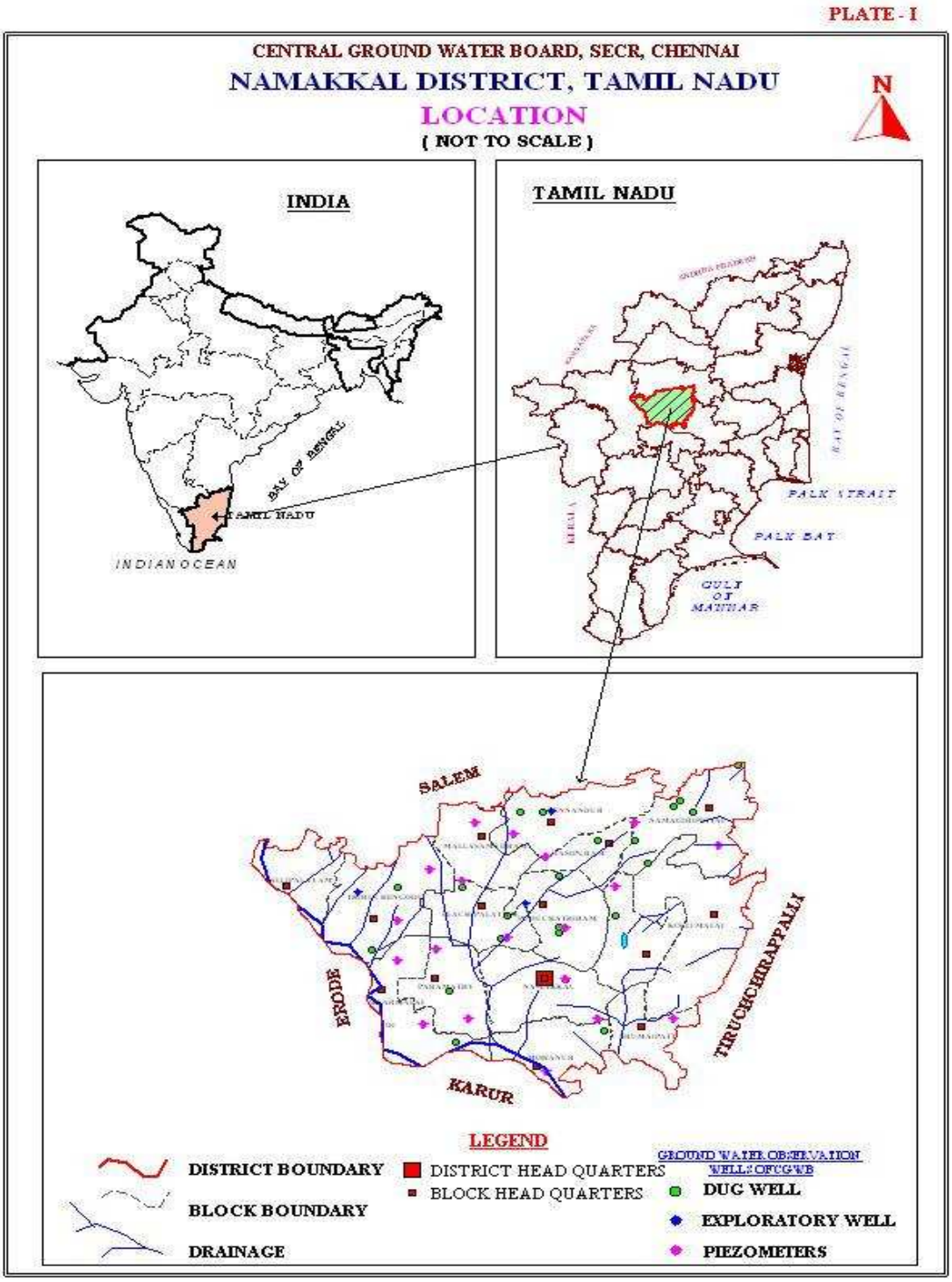
Key words: Groundwater, Tiruchengode, Physico-Chemical parameter, Correlation and Regression Analysis.

INTRODUCTION

Water is one of the most indispensable resources and is the elixir of life. Water constitutes about 70% of the body weight of almost all living organisms. About 97.2% of water on earth is salty and only 2.8% is present as fresh water from which about 20% constitutes groundwater [17]. Groundwater is highly valued because of certain properties not possessed by surface water[14]. Water quality is based on the physical and chemical constituents due to weathering of parent rocks and anthropogenic activities[1]. The statistical regression analysis has been found to be a highly useful tool for correlating different parameters. Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables. If the correlation coefficient is nearer to +1 or -1, it shows the probability of linear relationship between the variables x and y. This way analysis attempts to establish the nature of the relationship between the variables and there by provides a mechanism for prediction of forecasting[12],[3],[19],[8].

A considerable number of researches however are available regarding the analysis of groundwater quality data using regression techniques for prediction purposes in different parts of India, Bangladesh, Nigeria and Iraq [10],[18],[4],[5],[6],[16],[13],[2].

Figure 1



The correlation coefficient is a helpful tool for the promotion of research in water pollution problems. No attempt has yet been made to predict the groundwater quality of the study area with precision using the correlation coefficient of different water quality parameters. This paper is an eye opener on water quality parameters using the correlation coefficient and regression method in analyzing the groundwater of Tiruchengode area of Namakkal district.

Study area

The study area is situated at a distance of 45 km south-west of salem and at a distance of 8 km from sankaridurg, which is the nearest railway station. It lies between North Latitudes 11° 20' and 11° 30' and East Longitudes 70° 50' and 78° 0' with a total extent of 25.20 sq km. This area experiences a tropical climate, with an average rainfall varies from 640 mm to 880 mm.

EXPERIMENTAL SECTION

Water Sampling

In the present investigation, twenty one groundwater samples were collected from seven different locations (Three from each location) of Tiruchengode taluk of Namakkal district. The samples were collected in clean 2L, polythene bottles without any air bubbles. The bottles were rinsed before sampling and tightly sealed after collection and labeled in the field. The temperatures of the samples were measured in the field itself at the time of sample collection.

Analysis of water sample

Analysis was carried out for various water quality parameters such as pH, Temperature, 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 recommended by APHA(1995) method. The water quality parameter values are in mg/l except pH and EC in µs/cm.

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 [9]. 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 [15],[7].

$$R = \frac{n \Sigma (x_i y_i) - (\Sigma x_i).(\Sigma y_i)}{\sqrt{[\, n\Sigma x_i^2 - (\Sigma x_i)^2 \,][\, n \Sigma y_i^2 - (\Sigma y_i)^2 \,]}} \quad \text{----------(1)}$$

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.

To determine the straight linear regression, following equation of straight line can be used.

$$y = a x + b \quad \text{----------(2)}$$

where, y and x are the dependent and independent variable respectively. a is the slope for the line, b is intercept on y-axis.

The slope, a and y-intercept, b can be determined using the following.

$$a = \frac{n \Sigma x y - \Sigma x \Sigma y}{n \Sigma x^2 - (\Sigma x)^2} \quad \text{----------(3)}$$

and

$$b = \frac{\Sigma y - a \Sigma x}{n} \quad \text{----------(4)}$$

Table1.Physico – chemical Characteristics of groundwater samples of Tiruchengode block in Namakkal district in the month of December 2011 and February 2012.

Sampling station	pH	EC	TDS	TH	TA	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	NO_3^-	DO	Temp	COD	BOD	F^-	PO_4^{3-}
C-S1	8.0	4366	1530	602	465	563.74	14.44	200.4	195.78	0.8	2.42	27.1	11.6	1.2	0.54	0.2
C-S2	8.0	6826	670	854	690	732.72	27.90	344.68	124.27	0.93	1.01	26.8	17.6	1.2	0.51	0.3
C-S3	8.1	6328	2090	610	840	692.96	24.54	274.14	81.94	1.11	2.02	27.0	12.0	1.0	1.1	0.3
D-S1	7.9	6810	1700	690	675	792.36	13.95	228.45	112.61	1.27	1.21	26.0	10.0	1.2	1.1	0.5
D-S2	8.1	5907	710	656	600	712.84	26.30	230.86	103.73	1.05	1.01	26.3	17.6	1.9	0.95	0.3
D-S3	7.9	5860	1710	612	615	711.42	17.92	216.43	96.51	1.02	1.41	25.9	9.2	4.8	0.94	0.2
E-S1	7.7	6415	5450	860	560	756.86	15.20	347.09	125.15	1.05	0.80	25.8	7.6	4.3	0.87	0.4
E-S2	8.1	5189	1000	732	480	624.80	29.36	283.76	109.37	1.08	0.60	25.6	7.2	4.9	0.96	0.0
E-S3	7.9	5855	3100	716	550	712.84	19.25	308.61	99.40	0.95	1.61	26.1	8.4	4.5	0.93	1.2
F-S1	8.2	2628	1974	620	835	450.14	27.91	114.62	123.31	1.08	3.4	31.1	46.8	0.9	1.9	0.3
F-S2	8.7	3126	2388	316	150	515.46	31.76	62.52	61.84	0.6	8.4	30.7	29.2	2.1	3.1	0.5
F-S3	8.1	3180	2418	484	1080	579.36	29.84	147.49	82.10	1.04	3.0	30.8	29.6	1.0	2.2	0.7
G-S1	8.2	1483	1146	218	595	191.70	24.54	47.29	41.65	1.27	4.4	31.1	28.8	1.2	0.25	0.9
G-S2	7.8	1061	848	390	555	130.64	16.84	105.81	69.34	0.95	3.2	31.0	29.6	1.3	0.52	0.5
G-S3	8.0	702	550	298	485	75.26	18.77	68.93	55.89	0.95	7.4	31.0	10.8	1.9	0.62	0.7
H-S1	8.0	708	557	254	415	100.82	14.44	62.52	46.72	0.62	10.9	31.1	6.4	1.4	0.31	0.9
H-S2	7.8	1349	1088	468	595	281.16	21.17	105	88.57	1.0	4.4	31.1	10.4	1.5	0.14	1.1
H-S3	7.9	1820	1439	338	705	285.42	18.29	69.73	65.45	0.90	3.6	31.1	12.8	1.2	0.51	0.7
I-S1	8.0	1841	1432	250	790	203.06	28.88	58.51	46.72	0.90	3.0	31.2	8.4	2.2	0.30	0.8
I-S2	7.9	1095	845	342	600	146.26	24.54	69.73	66.43	0.84	2.2	31.2	6.4	3.2	0.53	0.7
I-S3	7.8	743	588	310	475	97.98	13.95	70.54	58.42	0.84	9.6	31.2	7.2	2.7	0.36	0.8

All the values are expressed in mg/l except pH and EC

STATION - C → ANANGUR
STATION -D → DEVANANKURICHI
STATION -E → SRINIVASAMPALAYAM
STATION - F →PIRITHI
STATION -G →MOLASI
STATION -H →ERYAMANGALAM
STATION -I →PATLUR

Table 2 Correlation Matrix for different parameters of groundwater ofTiruchengode block, Namakkal District in the month of December 2011

	pH	EC	TDS	TH	TA	Cl	SO4	Ca	Mg	NO3	DO	Temp	COD	BOD	F	PO4
pH	1.000	0.002	-0.055	-0.204	-0.226	0.102	0.676	-0.222	-0.132	-0.211	0.245	0.124	0.540	-0.235	0.720	-0.202
EC		1.000	0.461	0.887	0.153	**0.969**	0.074	**0.920**	0.628	0.393	-0.702	**-0.943**	-0.142	0.298	0.241	-0.538
TDS			1.000	0.461	0.107	0.530	-0.040	0.470	0.303	0.156	-0.327	-0.398	0.037	0.351	0.391	-0.045
TH				1.000	0.187	0.876	0.014	**0.950**	0.776	0.388	-0.722	-0.869	-0.075	0.324	0.145	-0.532
TA					1.000	0.191	0.243	0.143	0.058	0.546	-0.464	0.021	0.241	-0.308	0.007	-0.021
Cl						1.000	0.157	0.866	0.660	0.369	-0.680	**-0.890**	-0.009	0.262	0.409	-0.519
SO4							1.000	-0.012	-0.134	0.051	-0.202	0.060	0.450	-0.063	0.500	-0.179
Ca								1.000	0.658	0.354	-0.695	**-0.923**	-0.235	0.393	0.055	-0.464
Mg									1.000	0.158	-0.562	-0.640	0.010	0.076	0.096	-0.565
NO3										1.000	-0.610	-0.331	0.164	-0.015	-0.102	-0.169
DO										1.000	0.665	0.034	-0.262	0.026	0.448	
Temp												1.000	0.323	-0.512	-0.090	0.561
COD													1.000	-0.486	0.568	-0.150
BOD														1.000	-0.035	-0.107
F															1.000	-0.286
PO4					1.000											

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 [11].

RESULTS AND DISCUSSION

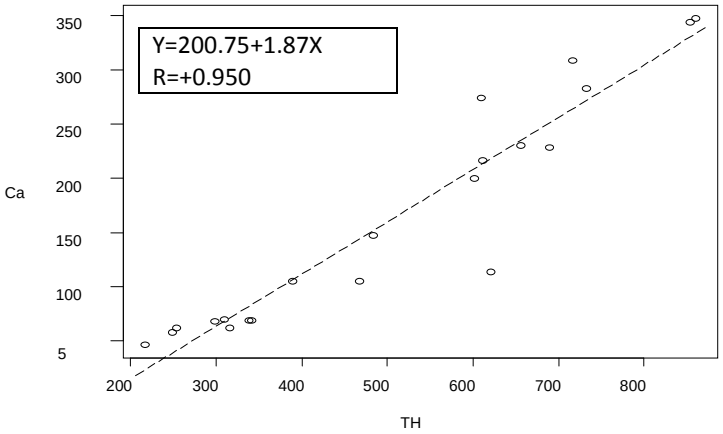
Correlation is the mutual relationship between two variables. Direct correlation exists when increase or decrease in the value of one parameter is associated with a corresponding increase or decrease in the value of other parameter [16]. The regression analysis explored the pattern of the relationship between the variables and the subsequent application of correlation analysis determined the extent to which the variables are related.

The value of regression coefficient, r more than 0.90 i.e.there is more than 90% association in data. This correlation coefficient measures the degree of association or correlation that exists between two variables, one taken as dependent variable. The greater the value of regression coefficient, the better is the fit and more useful the regression variables. Considerably, significant positive correlation has been observed between EC and Chloride(R=**0.969**), EC and Ca(R= **0.920**)&Ca and TH(R= **0.950**). Similarly negative correlation has been observed between the parameters Temp and EC(R=**-0.943**), Temp and Ca(R= **-0.923**)& Temp and Cl(R=**-0.890**). In our study the correlation is said to be perfect as the deviation in one variable is followed by a corresponding and proportional deviation in the other. The value of correlation coefficient lies between -1 and +1.

Table 4 Statistical evaluation for the ground water of Tiruchengode block, Namakkal District

Parameters	Min	1st Quad	Median	Mean	3rd Quad	Max
Temp	25.00	26.00	30.00	28.71	31.00	31.00
pH	7.7	7.9	8.0	8.0	8.1	8.7
EC	702	1349	3126	3490	5860	6826
TDS	550	845	1432	1583	1974	5450
TH	218	316	484	505	656	860
TA	150	485	595	607	690	1080
Ca	47	69	114	162	230	347
SO_4	13	16	21	21	27	31
Cl	75	191	515	445	711	792
COD	6	8	10	15	17	46
BOD	0.9	1.2	1.5	2.1	2.7	4.9
DO	0.6	1.4	3.0	3.6	4.4	10.9
F	0.14	0.51	0.62	0.88	0.96	3.1
PO_4	0.0	0.3	0.5	0.5	0.8	1.2

Fig 1. Positive Correlations between the parameters



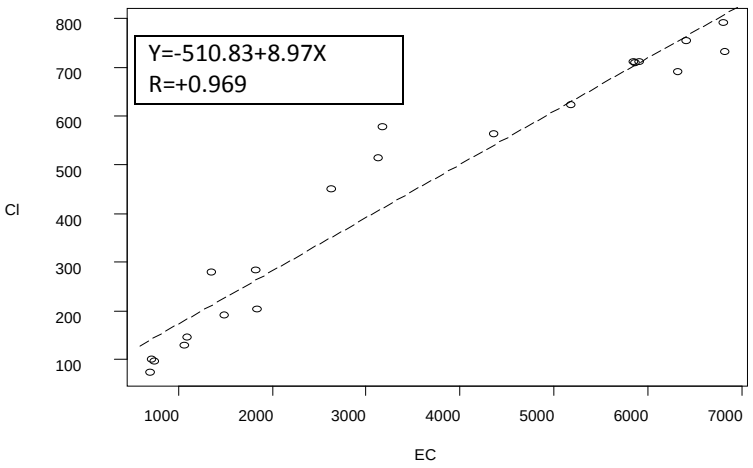
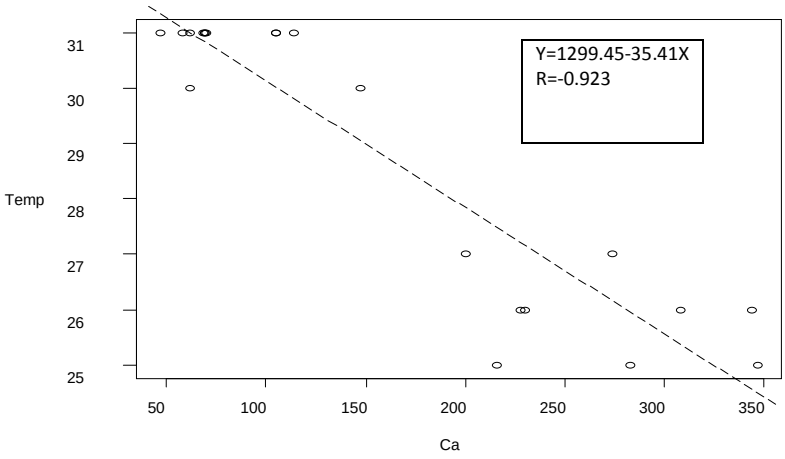
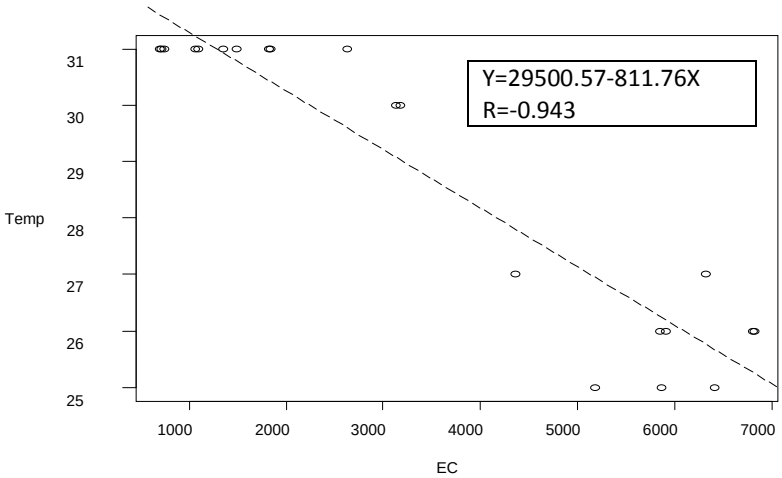
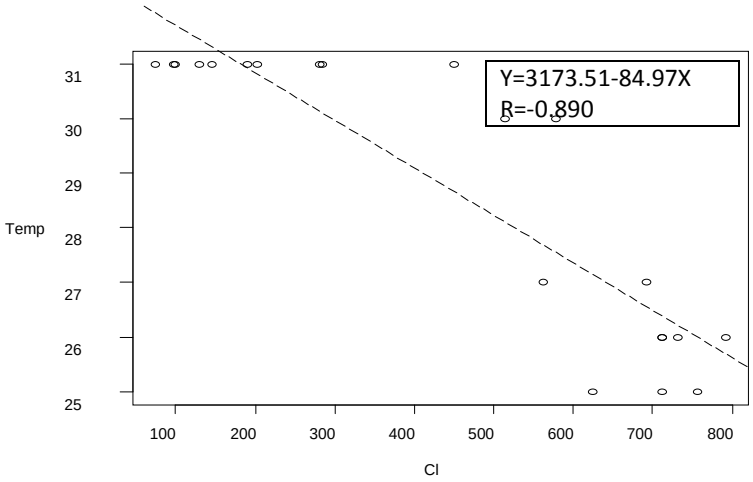


Fig 2. Negative correlations between the parameters







CONCLUSION

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.Both the correlated variables might have influenced by one or more other variables. This study proved beyond doubt that all the physicochemical parameters of drinking water in Tiruchengode area are more or less correlated with each other. In our present study, correlation analysis helped in determining the degree of relationship between two or more variables. It does not tell us anything about cause and effect relationship.

REFERENCES

[1]. CO Akinbile; MS Yusoff. *International Journal of Environmental Science and Development*., **2011**, 2(1), 81-89.
[2]. Al-Tamir;A Mus'ab. *Al Rafidain Journal*., **2008**, 16(2), 24-30.
[3]. NRDraper et al., Applied Regression analysis Wiley, New-York., **1966**.
[4]. CK Jain; MKSharma. *Pollution Research*.,**1997**, 16 (4), 241-246.
[5]. CK Jain; MKSharma. *Indian Journal of Environmental Health*.,**2000**, 42(4), 159-168.
[6]. MAJoarder, et al., *International journal of Environmental Research*., **2008**, 2(3), 291-296.
[7]. K Jothivenkatachalam et al.,. *Rasayan Journal of Chemistry*.,**2010**. 3(4), 649-654.
[8]. J Kumar et al., *Indian Journal of Environmental Protection*.,**2005**. 25(5), 405.
[9]. N Kumar; DK Sinha. *International Journal of Environmental Sciences*.,**2010**, 1(2), 253-259.
[10]. Kumar et al., *Indian Journal of Environmental Protection*.,**1994**. 14(7), 595-603.
[11]. KV Meta. *Journal of Chemical pharmaceutical Research*.,**2010**. 2(4),663-670.
[12]. JG Mulla et al., *International Journal of Chemical Science*.,**2007**.5(2), 943.
[13]. GI Obiefuna; DM Orazulike. *Journal of Applied Sciences Environmental Management*., **2010**. 14(1), 5-11.
[14]. PK Goel. Water Pollution-Cause, Effects and Control, New Age Inter (P) Ltd., New Delhi.,**2000**.
[15]. VT Patil; PR Patil. *Electronic Journal of Chemistry*.,**2010**. 7(1),111-116.
[16]. VT Patil; PR Patil. *Electronic Journal of Chemistry*., **2011**.8(1), 53-78.
[17]. Rajesh kumar; SS Yadav. *Int. J Chem. Sci*.,**2011**. 9(1), 440-447.
[18]. KS Rao; BSRao. *Indian Journal of Environmental Protection*.,**1994**.14(7), 528-532.
[19]. GW Snedecor et al., Statistical method, The Lowa State University Press, Ames, 6 th Ed., **1967**.