



GROUND WATER QUALITY MODELLING FOR POLLACHI TALUK OF COIMBATORE DISTRICT

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ABSTRACT

A detailed study on water quality was conducted by collecting samples from 20 bore wells of Pollachi taluk, Coimbatore district. A correlation analysis has been carried out among the various parameters. The usefulness of this approach has been demonstrated to predict the quality of ground water. Significant linear relationships among some water quality parameters have been obtained which can be used for rapid monitoring of water quality parameters.

INTRODUCTION

The very nature of any investigation is that it results in a barrage of information both in terms of number of variables and the number of values of each variable. The technique used in the analysis deserves appreciation only when the volume is condensed to a reasonable level. This process demands the application of statistical techniques, a pack of tools which makes the data tell its story.

In the process of reducing the volume of data, a careful analysis is needed, mainly because of the fact that any variable is affected by multiplicity of causes. A perfect understanding of the environment, which contributed the data is necessary to pool the information in an effective manner. This perfect understanding leads to a process of including all relevant information and excluding all irrelevant information. This mind boggling exercise provides information for model formation. Framing a model is the main theme of many statistical studies. A model is a simplified representation of the reality. In the statistical jargon, this representation is in terms of mathematical notations. The regression model is a ready made model which readily explains the nature of relationship between variables. This model can be conveniently used in the process of estimation of unknown value of the variable using the known information.

MATERIALS AND METHODS

For the analysis and interpretation of data, statistical modelling has been done. The statistical modelling was carried out by collecting the past data pertaining to the same location from Ground Water Division, Salem, for the period 1995 to 2003. ANOVA and regression factor analysis are some of the statistical tools used for modelling.

Statistics such as mean, coefficient of variation, minimum and maximum values etc., have been summarized. They are used in the analysis of physical and chemical nature of ground water at each Taluk during the period of study.

The comparison of various parameters especially includes mean and variance need F-statistics. Analysis of variance has also been made for 1% and 5% level of significance. Stepwise linear multiple regression model has been fitted and a correlation analysis among various parameters has

also been made. The strong correlation always exists among the water quality parameters, a systematic calculation and interpretation of correlation coefficient gives an idea of rapid water quality monitoring methods. The correlation coefficient (r), coefficient of determination (r^2) and regression coefficients (A and B) are very important variables to evaluate the quality of water (Kaza Somasekhara Rao 1993).

For all Taluks in the Coimbatore district, the summary statistics of parameters and intercorrelation matrix among parameters are discussed in detail. The correlation coefficient greater than 0.7 is taken for discussion.

The minimum, maximum, mean and coefficient of variation of Coimbatore south Taluk are given in Table 1. The intercorrelation matrix among parameters is presented in Table 2.

In Pollachi Taluk, a high correlation exists between chloride and total hardness (0.877) indicating that the hardness is mainly due to chloride (Karunakaran et al. 2005). A moderate correlation exists between electrical conductivity and total dissolved solids (0.769), chloride and total dissolved solids (0.706), nitrate and potassium (0.788).

Stepwise multiple regression model: Stepwise multiple regression model for parameters namely pH, TDS, TH, Al, SO_4 , EC, Cl, Ca, K, Mg, Na, and NO_3 was fitted with explanatory variable for all Taluks of Coimbatore District. The following models were fitted to study the relation among the parameters and to establish a functional relation to study the combined influence of the explanatory variables on the dependent variable and the results were presented.

$$Y = b_0 + b_1 \text{pH} + b_2 \text{TDS} + b_3 \text{TH} + b_4 \text{Al} + b_5 \text{EC} + b_6 \text{SO}_4 + b_7 \text{Cl} \\ + b_8 \text{Ca} + b_9 \text{K} + b_{10} \text{Mg} + b_{11} \text{Na} + b_{12} \text{NO}_3$$

Table 1: Summary statistics of parameters.

	Min.value	Max.value	Mean	C.V(%)
pH	7.66	8.36	7.95	2.69
TDS	767.2	1251.4	1010.91	16.34
TH	349.0	525.0	424.90	14.44
Al	221.8	313.2	262.23	11.56
SO_4	89.1	229.6	161.57	31.81
EC	653.0	987.0	867.58	10.80
Cl	127.2	326.0	238.55	27.79
Ca	60.3	132.0	79.46	26.20
K	15.1	65.9	41.91	37.01
Mg	33.9	148.3	62.00	54.00
Na	40.0	241.0	137.84	45.48
NO_3	10.5	59.11	23.14	60.98

The values are in mg/L except pH and EC.

Table 2: Inter-correlation matrix among parameters.

	pH	TDS	TH	Al	SO_4	EC	Cl	Ca	K	Mg	Na	NO_3
pH	1											
TDS	0.312	1										
TH	0.111	0.657	1									
Al	0.417	0.475	0.296	1								
SO_4	0.182	0.360	0.412	0.332	1							
EC	0.420	0.769	0.459	0.092	0.484	1						
Cl	0.367	0.706	0.877	0.466	0.648	0.607	1					
Ca	-0.077	0.617	0.469	0.552	0.331	0.492	0.497	1				
K	0.277	0.243	-0.007	0.154	0.008	0.211	0.070	0.003	1			
Mg	-0.141	0.151	0.492	-0.139	-0.077	0.052	0.188	0.010	0.011	1		
Na	0.094	0.032	0.165	-0.049	0.078	0.374	0.183	0.416	0.389	0.276	1	
NO_3	0.635	0.482	0.005	0.448	-0.030	0.437	0.219	0.227	0.788	-0.107	0.287	1

Table 3: Estimated regression model for various parameters.

Explanatory variable	Regression Coefficients	Standard error	t- value (d.f = 8)	R ²	F- value
Estimated Regression Model For pH					
Constant	7.728	0.111	69.635	0.403	6.397
NO ₃	0.009	0.004	2.323		
Estimated Regression Model For TDS					
Constant	-166.300	347.353	-.479	0.592	11.606
EC	1.357	.398	3.407		
Estimated Regression Model For TH					
Constant	206.799	31.334	6.60	0.880	25.786
Ca	0.753	0.123	6.115		
Na	0.621	0.244	2.55		
Estimated Regression Model For SO₄					
Constant	41.714	51.505	0.810	0.420	5.792
Cl	0.502	0.209	2.407		
Estimated Regression Model For EC					
Constant	426.550	131.002	3.256	0.592	11.606
TDS	0.436	0.128	3.407		
Estimated Regression Model For Cl					
Constant	-164.256	78.674	-2.088	0.769	26.706
TH	0.948	0.183	5.168		
Estimated Regression Model For K					
Constant	21.865	6.396	3.418	0.621	13.108
NO ₃	0.866	0.239	3.620		
Estimated Regression Model For NO₃					
Constant	-238.157	88.517	-.785	0.809	14.790
K	0.603	0.157	3.853		
pH	29.684	11.33	2.620		

Where,

$$Y = \text{pH/TDS/TH/Al/SO}_4\text{/EC/Cl/Ca/K/Mg/Na/NO}_3 \text{ (dependent variable)}$$

The regression models for various parameters are presented in Table 3. Compared to other water quality parameters, EC and TDS are easily determinable. Hence, by knowing the EC or TDS values, one can determine other significant parameters, like Na, Mg and Cl without spending more time in the experimental analysis of these parameters. The presented correlations are, therefore, of predictive nature and will go a long way in assessing the quality of ground waters.

Based on the above analysis, the correctness of the hypothesis is checked and corresponding equations are tabulated in Tables 4 and 5.

CONCLUSION

Based on the developed statistical models, it can be concluded that one of the parameters (say EC or

Table 4: t-Test values obtained for various parameters of Pollachi Taluk.

S.No.	Dependent Variable	Independent Variable	Hypothesis H_0	t_{cal}	t_{tab}	Acceptance /Rejection status	Inference
1	pH	NO ₃	$\rho = 0$	2.323	2.896	Accept H_0	$\rho = 0$
2	TDS	EC	$\rho = 0$	3.407	2.896	Reject H_0	$\rho \neq 0$
3	TH	Ca	$\rho = 0$	6.115	2.998	Reject H_0	$\rho \neq 0$
4	TH	Na	$\rho = 0$	2.550	2.998	Accept H_0	$\rho = 0$
5	SO ₄	Cl	$\rho = 0$	2.407	2.896	Accept H_0	$\rho = 0$
6	EC	TDS	$\rho = 0$	3.407	2.896	Reject H_0	$\rho \neq 0$
7	Cl	TH	$\rho = 0$	5.168	2.896	Reject H_0	$\rho \neq 0$
8	K	NO ₃	$\rho = 0$	3.620	2.896	Reject H_0	$\rho \neq 0$
9	NO ₃	K	$\rho = 0$	3.853	2.896	Reject H_0	$\rho \neq 0$
10	NO ₃	pH	$\rho = 0$	2.620	2.896	Accept H_0	$\rho = 0$

Table 5: Regression model for various parameters of Pollachi Taluk.

S.No. Variable	Dependent Variable	Independent	R ² Model	Regression
1	pH	NO ₃	0.403	$pH = 7.728 + 0.009NO_3$
2	TDS	EC	0.592	$TDS = -166.300 + 1.357EC$
3	TH	Ca, Na	0.880	$TH = 206.799 + 0.753Ca + 0.621Na$
4	SO ₄	Cl	0.420	$SO_4 = 41.714 + 0.502Cl$
5	EC	TDS	0.592	$EC = 426.550 + 0.436TDS$
6	Cl	TH	0.769	$Cl = -164.256 + 0.948TH$
7	K	NO ₃	0.621	$K = 21.865 + 0.866NO_3$
8	NO ₃	K	0.809	$NO_3 = -238.157 + 0.603K + 29.684pH$

TH or others) can be predicted in terms of the other parameters. The consistency of mathematical model has been supported by the well known t-Test and F-Test. Further correlation among the parameters have been identified and analysed for the support of the curve fit.

REFERENCES

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