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Ground Water Quality Parameters of Water Samples Drawn from Different Parts of Pollachi, Tamilnadu, India using Multivariate Statistical Analysis

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Abstract

In the present investigation, multivariate statistical analysis of various Physico-chemical parameters of groundwater samples drawn from different parts of Pollachi, Tamilnadu, India have been carried out. In this study, water samples of three kinds like Bore well water, Open well water and Municipal water (drinking water) samples are consider. For each Bore well, Open well and Municipal water samples, indeed there have been ten water quality parameters namely Electric conductivity, pH value, Calcium, Magnesium, Sodium, Potassium, Bicarbonate, Chloride, Total Dissolved Solids and Alkalinity have been taken for the study. Descriptive Statistical parameters namely measure of central tendency and dispersion for these water samples are calculated and compared. Cross correlation between two sets of data is a commonly used measure to identify the similarities between the data. So, the coefficient of cross correlation for each category of water samples is developed separately and discussed in detail. Finally, variation between and within the group of water samples was studied using Analysis of variance. It is found that other than pH value, all the remaining water quality parameters shown significant variation.

Keywords: Pollachi, Water Quality Parameters, Ground water, Cross Correlation and ANOVA

1 Introduction

Fresh water has become a scarce commodity due to over exploitation and pollution of water. Groundwater is the major source of drinking water in both urban and rural areas. Ground water is one of the Earth's widely distributed, renewable and most important energy source. While nearly 70% of the world is covered by water, only 2.5 % of it is fresh. The rest is saline and ocean-based. Even then, just 1% of our freshwater is easily accessible; the importance of groundwater for the existence of human society must be over emphasized. Ground water is particularly important as it accounts for about 88% safe drinking water.

In the recent years, investigation of water quality parameters of samples drawn from various water catchment areas using statistical tools provide scientific procedures for water management. The surfaces as well as the subsurface water sources are getting polluted due the activities like industrialization and urbanization in cities of Coimbatore [4]. Jothivenkatachalam *et al*. analyzed the effect of coefficient of correlations between water quality parameters of Noyyal River in and around Perur, Coimbatore, and Tamilnadu, India [6]. Assessment of water quality and its parameters of Yercaud taluk, Salem district, Tamilnadu, India using correlation matrix by Lillyflorence *et al*. [8]. Sarathprasad *et al.* analyzed the evolution of ground water quality and its suitability for drinking and agriculture use in the waste stretch of Alappuzha district, Kerala, India [9].

Shiva Prasad *et al*. from their contribution of study on water samples drawn from sugar town, Mandy city, Karnataka, India, concluded that certain degree of treatment has to be done before the consumption of ground water and it needs to be protected [13]. Rose Mary George *et al.* analyzed different type quantities of Bore wells as well as Open wells in Kerala to find a sustainable alternative [18]. Mohamed sheriff and Zahirhussain stated that due to the human activities like discharge of industrial and sewage waters and agricultural runoff the quality of water deteriorates which leads serious health hazards [20]. Nitin Kamboj and Vishal Kamboj carried out the analysis of ground water quality and all the parameters of river Ganga in Haridwar district [22]. Numerous contributions have been made to study the quality of water samples drawn from different parts using appropriate statistical tools [1-3, 5, 7, 10-12, 14-17, 19, 21, 23-24]. Hence, it is important to analysis the water quality parameters annually to avoid water contamination. In this article, it has been experimented that the various groundwater quality parameters where set up in Pollachi using multivariate statistical analysis. The linear relationship between the various water quality

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parameters drawn from Bore well, Open well and municipal water (distributed drinking water with the pipes) at different location has been established. The analysis of variance used to determine the sample data between and within the samples variation.

2 Materials and Methods

2.1 Study Area

Pollachi is bounded to the South of Coimbatore district, Tamil Nadu State, India. There are few villages in Pollachi Taluka are under Coimbatore district, and Pollachi is endorsed as the second largest town in the district after Coimbatore. Hence, Government of Tamilnadu initiated the proposal to bifurcate Pollachi as a new district. In addition to the point Pollachi was also stated as a 'Town of Export Excellence'.

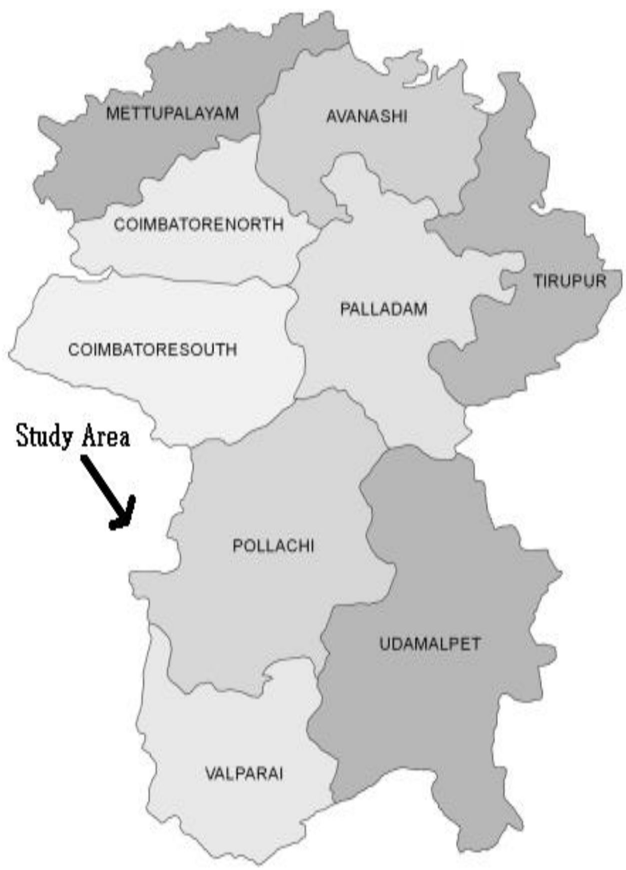

Figure 1: Pollachi Map

2.2 Analytical Methods

The water samples for the current investigation were collected from Jothi Nagar, Venkatesa colony, Mahalingapuram, Kandasamy Chettiar Park, and Sudharsan Nagar. The Physio-chemical parameters namely electric conductivity, pH value, calcium, magnesium, sodium, potassium, bicarbonate, chloride, total dissolved solids and alkalinity are considering in the study.

Electric conductivity: Water's conductivity is an indicator of its ability to regulate an electric current and it can be measured by using digital conductivity meter Alpha 06. Conductivity is a property that is of little interest to a water analyst in and of itself, but it is an invaluable measure of the range within which hardness and alkalinity values are likely to fall, and perhaps even the order in which the dissolved solids content of the water is likely to fall.

pH value: The definition of pH is the negative logarithm of a solution's hydrogen ion concentration, that would be used to ascertain whether the solvent is acidic or alkaline. The conduct of several other essential water quality parameters is regulated by pH values by analyzing ammonia toxicity, chlorine disinfection quality, and metal water content. pH of the water samples is measured by using pH meter Alpha 06.

Calcium: High levels can be highly beneficial and calcium-rich waters are very appetizing. There is some evidence that areas covered by a public water source with a high degree of hardness, the primary constituent of which is calcium, have a comparatively low incidence of heart disease, inferring that the presence of the element in a water supply is beneficial to health.

Magnesium: Like calcium, magnesium is abundant for humans, it is plentiful and a significant dietary necessity (0.3-0.5 g/day). It is the second most important component of hardness, contributing for 15-20% of total hardness expressed as $CaCO3$. As compared to sulphate, its concentration is very high. Both magnesium and calcium present in the water sample are measured by using EDTA complex metric titration methods.

Sodium: Natural waters always contain Sodium. It is also an important dietary requirement, and the usual intake that seems to be in the form of common salt (sodium chloride) in food; daily consumption can be as high as 5 grams and above. The major reason for using it is because of the mutual impact it has with sulphate, but too much of it (normally 2-3 times the dietary threshold) can cause hypertension.

Potassium: Since potassium is an important component of many artificial fertilizer formulations, it is commonly measured in lake waters when nutrient supply is being examined. Both Sodium and Potassium ions present in the water samples are measured by using digital flame photometer CL 220.

Bicarbonate: All mineral waters contain it as a natural component. The bicarbonate content of mineral waters sourced from limestone-rich areas is considerably higher. Bicarbonate is vitally important for buffering acids and ensuring that the mineral water tastes clean and refreshing. EDTA titration method is used to measure the Bicarbonates present in the water sample.

Chloride: It is measured by using argento metric method. Chloride can be present in all natural waters, with concentrations ranging from very low to very high, with seawater having the highest concentration (up to 35,000 mg/l Cl). Soil and rock formations, sea spray, and sewage discharges are all causes of pollutants in freshwaters. Some industrial effluents, like sewage, contain a lot of chloride.

Total dissolved solids: Natural sources, sewage, urban run-off, industrial wastewater, chemicals used in the water treatment process, and the nature of the piping or hardware used to distribute the water are all sources of TDS in drinking water. The total dissolved solids test provides a qualitative measure of the amount of dissolved ions but does not tell us the nature or ion relationships. TDS presents in the water sample are measured by gravimetric method.

Alkalinity: The presence of Bicarbonates produced in reactions in the soils in which the water percolates is responsible for the Alkalinity of natural water. It is a measure of the water's ability to neutralize acids, and it represents the buffer capacity of the water. Alkalinity of the water sample has measured by using the double indicator method.

2.3 Statistical Methods

To compare the water quality parameters under consideration for the water samples drawn from the Bore well, Open well and Municipal water in different parts of Pollachi, multivariate statistical procedures is used. In particular, Descriptive Statistical parameters like Mean, Median, Mode, Variance, Standard deviation and Coefficient of variation have been calculated. To understand interrelationship between these samples, cross correlation between the samples for the Bore well, Open well and Municipal water are carried out. A cross-correlation coefficient is a metric that determines how two or more sets of data shift in relation to one another. It is used to objectively assess how well different series of data match up with one another and, in particular, at what point the closest match emerges by evaluating them. The correlation coefficient of data can be anywhere from -1.0 and +1.0. If the value of the cross-correlation is to 1, the more closely the sets are identical. The k^{th} cross correlation coefficient between the data 'X' and 'Y' is given by

$$\rho_K = \frac{\sum_{i=1}^{n-k}(X_I - \bar{X})(Y_{I+K} - \bar{Y})}{\sqrt{\sum_{I=1}^{n}(X_I - \bar{X})^2 \sum_{I=1}^{n}(Y_I - \bar{Y})^2}} \quad (1)$$

where

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} y_i$$

The important method in exploratory and confirmatory data analysis is termed as Analysis of Variance (ANOVA). It emphases mathematically on linear regression and general linear models that excellence the relationship between the dependent variable and the independent variables. Basically, ANOVA acts thrice at once for solving balanced data: (I). An ANOVA is a structure of additive data decomposition used in exploratory data analysis, and its sums of squares imply the variance of each aspect of the decomposition. (II). Comparisons of mean squares, along with F-tests (III). A linear model fit with coefficient estimates and standard errors is closely related to the ANOVA. As a consequence, in order to explain the variance within and between these samples, analysis of variation is taken at the end.

In this research work all the statistical parameters are calculated using the package namely 'Data Analysis' available in Microsoft Excel 2010.

3 Results and Discussion

Water quality parameters namely Electric conductivity (EC), pH value (pH), Calcium (CA), Magnesium (MG), Sodium (SO), Potassium (PO), Bicarbonate (BIC), Chloride (CH), Total dissolved solids (TDS) and Alkalinity (AL) for the water samples collected from the Bore well, Open well and Municipal water are considering in this study.

Measures of Central tendency and Dispersion are calculated for the water samples drawn from Bore Well, Open Well and Municipal Water distributions and tabulated in Table 1, 2 and 3 respectively. On comparison of Table 1, 2 and 3, it is observed that the range value of the parameters of water samples drawn from the Bore well are high, which may show the notable variation in the data observed from it. Note that the standard deviation and coefficient of variation of the parameters observed from the Bore well water samples also be high compared to other water samples. This is due to over exploitation of ground water, improper waste disposal and fertilizers used. This is good agreement with the earlier findings by Dhanalakshmi and Shanmugapriya, 2015.

The nature of value of Skewness (S_k) indicates that whether the distribution of data is symmetry or not. The data are skewed right when $S_k > 0$, it is skewed left when $S_k < 0$. If $S_k = 0$ indicate that the data are symmetric and clearly, the skewness for a normal distribution is zero. Kurtosis is a measure of whether the data are heavy-tailed or light-tailed relative to a normal distribution. The data set is said to have heavy tails or outliers, if the kurtosis is high and it tend to have lack of outliers when the kurtosis is low. It is clear from the Table 1, 2 and 3 that the distribution of Sodium is symmetric in the case of water sample taken from the Bore well, the distribution of Total dissolved solids is normal in Open well and the distributions of Potassium, Bicarbonate, Alkalinity are symmetric in Municipal water samples.

For the better understanding of interrelationships between the three categories of water samples, the coefficient of cross correlation (ρ_{xy}) of parameters between Bore Well water and Open Well water (ρ_{BO}) , Open Well water and Municipal water (ρ_{OM}), Municipal water and Bore Well water (ρ_{MB}) are established and consolidated in Table 4, 5 and 6 respectively. When $\rho_{xy} > 0$, indicates that increase (or decrease) in 'x' results in increase (or decrease) in 'y'. When $\rho_{xy} < 0$, indicates that increase or decrease in 'x' results in decrease or increase in 'y'. It is noted that $-1 \leq \rho_{xy} \leq 1$. To establish a linear relationship between the three categories of water samples, linear Regression model is used. To reduce the error occurs in this prediction model, moderate and high values of cross correlation coefficient between the factors are consider. In this study, the parameters having cross correlation numerically greater than ± 0.677 is considered.

Table 7, 8 and 9 show the regression relationships between the samples collected from Bore well, Open well and municipal water as pairs in the form $y = \alpha x + \beta$ and their corresponding cross correlation coefficients. Unlike other research findings using correlation matrix, here Cross correlation between the parameters of two nature of water samples drawn from the same place is used. From this, one can find the approximate predicted value of an unknown water quality parameter in one nature of water with the help of other.

From Table 7, it is observed that the water quality parameters namely MG, SO, pH, BIC and AL of water samples from the Bore well have good positive or negative agreement with the parameters PO, EC, BIC, CH and AL of water samples from the Open well respectively. Note that due to the dynamic property of Bore well water, not all the parameters have agreement with the samples from Open well. From Table 8, it is generally seen that most of the parameter values observed between Open well and municipal water have an excellent agreement. This gives better linear relationships between the samples drawn from the Open well and the Municipal water. The same observations are made from Table 9. To understand the significant difference in statistical sense, between the samples, ANOVA can be used. Estimation of variation within and between three categories of water samples are presented in Table 10. Note that P values determine whether the hypothesis test (there is no significant difference between the samples) results are statistically significant. It is observed from Table 10 that except pH, the variation in all the parameters between Bore well, Open well and Municipal water are significant. This is due to external factors and factors of affecting the river water. Here, F-test shows the consistency of statistical model used in this work.

Table 1: Descriptive Statistics for Bore Well water samples

	EC	***pH***	***CA***	***MG***	***SO***	***PO***	***BIC***	***CH***	***TDS***	***AL***
Minimum	1456.00	7.10	76.00	30.00	196.00	7.00	628.00	158.00	833.00	525.00
Maximum	1510.00	7.30	88.00	32.00	202.00	8.00	648.00	164.00	841.00	535.00
Range	54.00	0.20	12.00	2.00	6.00	1.00	20.00	6.00	8.00	10.00
AM	1480.25	7.18	80.75	31.50	199.00	7.75	636.75	161.25	836.25	528.25
Median	1477.50	7.15	79.50	32.00	199.00	8.00	635.50	161.50	835.50	526.50
GM	1480.11	7.17	80.62	31.49	198.98	7.74	636.71	161.24	836.24	528.24
HM	1479.96	7.17	80.50	31.48	198.97	7.72	636.66	161.22	836.24	528.22
STD	23.87	0.10	5.25	1.00	2.94	0.50	8.54	2.50	3.59	4.57
Skewness	0.50	0.85	1.16	−2.00	0.00	−2.00	0.75	−0.56	0.89	1.81
Kurtosis	−1.54	−1.29	1.09	4.00	−4.89	4.00	0.34	0.93	−0.58	3.38
CV	0.02	0.01	0.07	0.03	0.01	0.06	0.01	0.02	0.00	0.01
CV%	1.61	1.33	6.50	3.17	1.48	6.45	1.34	1.55	0.43	0.87
Conf.95%	81.25	0.33	17.88	3.40	10.02	1.70	29.07	8.51	12.24	15.57
SE	11.93	0.05	2.63	0.5	1.47	0.25	4.27	1.25	1.79	2.29

Table 2: Descriptive Statistics for Open Well water samples

	EC	***pH***	***CA***	***MG***	***SO***	***PO***	***BIC***	***CH***	***TDS***	***AL***
Minimum	1048.00	7.20	52.00	21.00	129.00	11.00	406.00	80.00	605.00	327.00
Maximum	1062.00	7.40	59.00	22.00	157.00	12.00	413.00	83.00	613.00	332.00
Range	14.00	0.20	7.00	1.00	28.00	1.00	7.00	3.00	8.00	5.00
AM	1054.50	7.33	55.00	21.75	136.50	11.25	409.00	81.75	609.00	330.50
Median	1054.00	7.35	54.50	22.00	130.00	11.00	408.50	82.00	609.00	331.50
GM	1054.48	7.32	54.94	21.75	136.02	11.24	408.99	81.74	608.99	330.49
HM	1054.46	7.32	54.88	21.74	135.57	11.23	408.98	81.74	608.99	330.49
STD	7.05	0.10	2.94	0.50	13.67	0.50	3.56	1.26	3.37	2.38
Skewness	0.14	−0.85	0.94	−2.00	1.99	2.00	0.27	−1.13	0.00	−1.78
Kurtosis	−5.02	−1.29	1.50	4.00	3.98	4.00	−4.48	2.23	−0.16	3.13
CV	0.01	0.01	0.05	0.02	0.10	0.04	0.01	0.02	0.01	0.01
CV%	0.67	1.31	5.35	2.30	10.02	4.44	0.87	1.54	0.55	0.72
Conf.95%	23.99	0.33	10.02	1.70	46.55	1.70	12.12	4.28	11.46	8.10
SE	3.52	0.048	1.47	0.25	6.84	0.25	1.78	0.63	1.68	1.19

Table 3: Descriptive Statistics for municipal water samples

	EC	***pH***	***CA***	***MG***	***SO***	***PO***	***BIC***	***CH***	***TDS***	***AL***
Minimum	*183.00*	*7.50*	*14.00*	*6.00*	*11.00*	*4.00*	*102.00*	*11.00*	*103.00*	*83.00*
Maximum	*188.00*	*7.60*	*15.00*	*7.00*	*12.00*	*5.00*	*104.00*	*12.00*	*108.00*	*85.00*
Range	*5.00*	*0.10*	*1.00*	*1.00*	*1.00*	*1.00*	*2.00*	*1.00*	*5.00*	*2.00*
AM	*186.50*	*7.58*	*14.75*	*6.25*	*11.75*	*4.50*	*103.00*	*11.75*	*104.75*	*84.00*
MEDIAN	*187.50*	*7.60*	*15.00*	*6.00*	*12.00*	*4.50*	*103.00*	*12.00*	*104.00*	*84.00*
GM	*186.49*	*7.57*	*14.74*	*6.24*	*11.74*	*4.47*	*103.00*	*11.74*	*104.73*	*84.00*
HM	*186.48*	*7.57*	*14.74*	*6.22*	*11.73*	*4.44*	*103.00*	*11.73*	*104.72*	*83.99*
STD	*2.38*	*0.05*	*0.50*	*0.50*	*0.50*	*0.58*	*0.82*	*0.50*	*2.22*	*0.82*
Skewness	*−1.78*	*−2.00*	*−2.00*	*2.00*	*−2.00*	*0.00*	*0.00*	*−2.00*	*1.72*	*0.00*
Kurtosis	*3.13*	*4.00*	*4.00*	*4.00*	*4.00*	*−6.00*	*1.50*	*4.00*	*3.26*	*1.50*
CV	*0.01*	*0.01*	*0.03*	*0.08*	*0.04*	*0.13*	*0.01*	*0.04*	*0.02*	*0.01*
CV%	*1.28*	*0.66*	*3.39*	*8.00*	*4.26*	*12.83*	*0.79*	*4.26*	*2.12*	*0.97*
Conf.-95%	*8.10*	*0.17*	*1.70*	*1.70*	*1.70*	*1.97*	*2.78*	*1.70*	*7.55*	*2.78*
SE	*1.19*	*0.03*	*0.25*	*0.25*	*0.25*	*0.29*	*0.41*	*0.25*	*1.11*	*0.41*

Table 4: Cross Correlation Coeffienct matrix between the water quality parameters of Bore well and Open well water samples

	EC2	*pH2*	*CA2*	*MG2*	*SO2*	*PO2*	*BIC2*	*CH2*	*TDS2*	*AL2*
EC1	0.312	-0.675	0.569	0.677	0.812	-0.370	-0.840	0.380	-0.411	-0.150
pH1	-0.420	0.091	-0.118	-0.174	-0.496	0.870	0.978	-0.899	-0.103	0.366
CA1	-0.374	0.149	-0.345	0.603	-0.002	-0.349	-0.767	0.643	0.490	-0.893
MG1	0.615	0.174	0.000	-0.333	0.317	-1.000	-0.749	0.927	0.198	-0.140
SO1	0.980	-0.473	0.731	-0.453	0.696	-0.453	-0.127	0.090	-0.673	-0.809
PO1	0.520	-0.522	0.679	-0.333	0.366	0.333	0.562	-0.662	-0.792	-0.420
BIC1	-0.180	-0.561	0.466	0.293	0.121	0.878	0.658	-0.969	-0.638	0.533
CH1	-0.709	0.522	-0.589	-0.200	-0.853	0.733	0.862	-0.609	0.396	-0.084
TDS1	0.941	-0.702	0.882	-0.139	0.892	-0.417	-0.313	0.092	-0.799	0.721
AL1	-0.543	0.666	-0.792	0.182	-0.504	-0.328	-0.451	0.652	0.888	-0.964

Table 5: Cross Correlation Coeffienct matrix between the water quality parameters of Open well and municipal water samples

	EC3	**pH3**	*CA3*	*MG3*	*SO3*	*PO3*	*BIC3*	*CH3*	*TDS3*	*AL3*
EC2	-0.616	0.520	0.615	0.709	-0.426	0.983	-0.637	0.615	-0.565	-0.811
pH2	0.951	-0.522	0.174	-0.870	-0.522	-0.302	-0.426	0.174	0.353	0.426
CA2	-0.957	0.679	0.000	0.906	0.226	0.588	0.139	0.000	-0.562	-0.555
MG2	-0.420	-0.333	-0.333	0.333	1.000	-0.577	0.817	-0.333	0.526	0.000
SO2	-0.983	0.366	0.317	0.999	0.317	0.591	0.000	0.317	-0.258	-0.806
PO2	0.140	0.333	-1.000	-0.333	0.333	-0.577	0.817	-1.000	-0.225	0.817
BIC2	0.433	0.562	-0.749	-0.562	-0.375	-0.162	0.229	-0.749	-0.591	0.803
CH2	0.056	-0.662	0.927	0.132	0.132	0.229	-0.649	0.927	0.567	-0.649
TDS2	0.873	-0.792	0.198	-0.792	-0.198	-0.515	-0.243	0.198	0.670	0.364
AL2	-0.471	0.980	-0.140	0.420	-0.420	0.728	-0.172	-0.140	-0.979	-0.172

Table 6: Cross Correlation Coeffienct matrix between the water quality parameters of Municipal and Bore well water samples

	EC1	*pH1*	*CA1*	*MG1*	*SO1*	*PO1*	*BIC1*	*CH1*	*TDS1*	*AL1*
EC3	-0.795	0.366	0.040	-0.140	-0.618	-0.420	-0.287	0.756	-0.838	0.566
pH3	-0.216	0.522	-0.920	-0.333	0.679	1.000	0.683	0.067	0.603	-0.984
CA3	0.370	-0.870	0.349	1.000	0.453	-0.333	-0.878	-0.733	0.417	0.328
MG3	0.831	-0.522	0.032	0.333	0.679	0.333	0.098	-0.867	0.881	-0.474
SO3	0.677	-0.174	0.603	-0.333	-0.453	-0.333	0.293	-0.200	-0.139	0.182
PO3	0.133	-0.302	-0.495	0.577	0.981	0.577	-0.169	-0.577	0.884	-0.568
BIC3	0.188	0.426	0.155	-0.817	-0.555	0.000	0.717	0.327	-0.341	-0.089
CH3	0.370	-0.870	0.349	1.000	0.453	-0.333	-0.878	-0.733	0.417	0.328
TDS3	0.348	-0.510	0.966	0.225	-0.715	-0.977	-0.550	-0.105	-0.575	0.929
AL3	-0.736	0.853	-0.233	-0.817	-0.693	0.000	0.478	0.980	-0.795	0.089

Table 7**:** Regression Equations between Bore well and open well water samples

Pair of Parameters	**Correlation Coefficient**	**Regression Coefficient**		**Regression Equation** $(y = \alpha x + \beta)$
		α	β	
MG1 and PO2	−1.00000	−0.5000	27.00	***PO2*** = −0.5000 ***MG1*** + 27.00
SO1 and EC2	0.98005	2.3462	587.62	***EC2*** = 2.3462 ***SO1*** + 587.62
pH1 and BIC2	0.97823	36.0000	148.09	***BIC2*** = 36.0000 ***pH1*** + 148.09
BIC1 and CH2	0.96946	−0.1429	172.71	***CH2*** = −0.1429 ***BIC1*** +172.71
AL1 and AL2	0.96441	−0.5020	595.68	***AL2*** = −0.5020 ***AL1*** + 595.68
TDS1 and SO2	0.89188	3.3935	−2701.35	***SO2*** = 3.3935 ***TDS1*** −2701.35
AL1 and TDS2	0.88764	0.6534	263.85	***TDS2*** = 0.6534 ***AL1*** + 263.85
TDS1 and CA2	0.88214	0.7226	−549.26	***CA2*** = 0.7226 ***TDS1*** – 549.26
TDS1 and pH2	−0.70232	−0.0187	22.97	***pH2*** = −0.0187 ***TDS1*** + 22.97
EC1 and MG2	0.67739	0.0142	0.74	***MG2*** = 0.0142 ***EC1*** + 0.74

Table 8: Regression Equations between Open well and municipal water samples

Pair of Parameters	Correlation Coefficient	Regression Coefficient		Regression Equation ($y = \alpha x + \beta$)
		α	β	
PO2 and CA3	−1.00000	−1.0000	26.00	***CA3*** = −1.0000 ***PO2*** + 26.00
PO2 and CH3	−1.00000	−1.0000	23.00	***CH3*** = −1.00000 ***PO2*** + 23.00
MG2 and SO3	1.00000	1.0000	−10.00	***SO3*** = 1.00000 ***MG2*** − 10.00
SO2 and MG3	0.99941	0.0365	1.26	***MG3*** = 0.0365 ***SO2*** + 1.26
EC2 and PO3	0.98308	0.0805	−80.43	***PO3*** = 0.0805 ***EC2*** − 80.43
SO2 and EC3	0.98303	−0.1711	209.86	***EC3*** = −0.1711 ***SO2*** + 209.86
AL2 and pH3	0.98020	0.0206	0.77	***pH3*** = 0.0206 ***AL2*** + 0.77
AL2 and TDS3	−0.97884	−0.9118	406.09	***TDS3*** = −0.9118 ***AL2*** + 406.09
MG2 and BIC3	0.81650	1.3333	74.00	***BIC3*** = 1.3333 ***MG2*** + 74.00
PO2 and AL3	0.81650	1.3333	69.00	***AL3*** = 1.3333 ***PO2*** + 69.00

Table 9: Regression Equations between Municipal and Bore well water samples

Pair of Parameters	Correlation Coefficient	Regression Coefficient		Regression Equation ($y = \alpha x + \beta$)
		α	β	
pH3 and PO1	1.00000	10.0000	−68.00	***PO1*** = 10.0000 ***pH3***−68.00
CA3 and MG1	1.00000	2.0000	2.00	***MG1*** = 2.0000 ***CA3***+2.00
pH3 and AL1	0.98393	−90.0000	1210.00	***AL1*** = −90.0000 ***pH3***+1210.00
PO3 and SO1	0.98058	5.0000	176.50	***SO1*** = 5.0000 ***PO3***+176.50
AL3 and CH1	0.97980	3.0000	−90.75	***CH1*** = 3.0000 ***AL3***−90.75
TDS3 and CA1	0.96604	2.2881	−158.93	***CA1*** = 2.2881 ***TDS3***−158.93
PO3 and TDS1	0.88354	5.5000	811.5	***TDS1*** = 5.5000 ***PO3***+811.5
CA3 and BIC1	0.87831	−15.0000	858.00	***BIC1*** =−15.0000 ***CA3***+858.00
CA3 and pH1	0.87039	−0.1667	9.63	***pH1*** = −0.1667 ***CA3***+9.63
MG3 and EC1	0.83103	39.6667	1232.33	***EC1*** = 39.6667 ***MG3***+1232.33

Table 10: Analysis of Variance

WQP	Source of Variation	Sum of	*df*	Mean Square	F Values	P-value	F Critical
	Between Groups	3477968	2	1738984	8348.237	1.96E-15	4.256495
EC	Within Groups	1874.75	9	208.3056			
	Total	3479843	11				
	Between Groups	0.326667	2	0.163333	23.52	0.000267	4.256495
PH	Within Groups	0.0625	9	0.006944			
	Total	3479843	11				
	Between Groups	8852.167	2	4426.083	363.7877	2.46E-09	4.256495
CA	Within Groups	109.5	9	12.16667			
	Total	8961.667	11				
	Between Groups	1297.167	2	648.5833	1297.167	8.4E-12	4.256495
MG	Within Groups	4.5	9	0.5			
	Total	1301.667	11				
	Between Groups	72708.5	2	36354.25	556.6793	3.7E-10	4.256495
SO	Within Groups	587.75	9	65.30556			
	Total	73296.25	11				
	Between Groups	91.16667	2	45.58333	164.1	8.29E-08	4.256495
PO	Within Groups	2.5	9	0.277778			
	Total	93.66667	11				

4 Conclusion

The characteristics of water quality parameters for three categories of water samples drawn from different parts of Pollachi have been analyzed. Linear Regression analyses have used to establish relationships between the parameters of water samples. It is observed that the parameters between Open well and the municipal water are in good agreement. Analyses of variations showed that except pH value, the variation within and between other parameters are significant. This is due to the external factors. Regression analysis using cross correlation coefficient may be the better tool to extract data of one quality of water from the other known one.

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