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# EVALUATION OF TRENDS IN CHEMICAL AND PHYSICAL PROPERTIES OF GROUND WATER AND ITS MODELING: A CORRELATION REGRESSION STUDY

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**ABSTRACT**

The present study was carried out to analyze and evaluate the ground water samples collected from residential areas of Jalgaon city. The level of TDS, alkalinity, Ca, Mg, Hardness, Electrical Conductivity, pH, and selected heavy metals (Fe, Cr, Cd & Zn) were determined. The results showed that all water samples have alkaline pH. All these water samples have very low concentration of Fe and Zn. The concentration of Cr and Cd was observed higher than the prescribed limit of WHO and ISI. In the light of this analysis we can conclude that all these water samples require some treatment before their use for drinking purpose. Also, the result establish that ground water sample no. 2, is useful for irrigation and household purpose, but is unsuitable for drinking. A correlation study has been carried out amongst all possible pairs of 11 physical and chemical parameters to assess ground water quality. 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.

**Keywords**: Evaluation of trends, ground water, physical and chemical parameters, correlation regression.

## INTRODUCTION

Water is the most vital source for all kinds of life on the earth. Water is essential component of the environment and it sustains life on the earth. Water is raw material for photosynthesis, and therefore, is important for crop production.[1] Even though water is a renewable resource, the growing human population is further increasing the demand of this renewable resource. Ground water exhaustion is faster than its percolation back into ground[2].Out of the total water available on earth, only 0.16% is suitable for human use and the remaining is polluted because of different environmental reasons. In India, 96% of water resources are used for agriculture, 3% for domestic and 1% for industrial applications[3]. However water for domestic use must be in pure form otherwise it will affect the human health and cause diseases such as kidney stone, typhoid, cholera and other seasonal diseases.

Almost 70% of water in India has become polluted due to the discharge of domestic sewage and industrial effluents into natural water sources such as river stream as well as lakes[4]. The Government of India showed its commitment for the protection of our environment long ago by passing the Water Act in 1974. The quality of ground water in general and potable water in particular may be analyzed by its physical, chemical and microbiological characteristics known as water quality parameters. However the number of such characteristics which are necessary to completely specify the quality of water is quite large.[5] But we can find some correlation among these numerous parameters. Environmental science and Statics offer extremely attractive studies. In the present study, a systematic study of the correlations among water quality parameter of ground water sources of dug well & bore well in Jalgaon city (M.S.) India has been undertaken.

## EXPERIMENTAL

### Study Area

Jalgaon city lies between 20 $^0$ and 21$^0$ North Latitude land , and 74 $^0$ 55' and 76 $^0$ 28' east longitude land on the northern border of the state of Maharashtra.[6] The study was undertaken at three different areas of Jalgaon city considering the surroundings and distance. The sampling stations selected for the present study are

S1: Iqra's Thim College Campus, Jalgaon.
S2: Salar Nagar, Jalgaon.
S3: Mehrun, Jalgaon.

### Water samples and Chemicals

The water samples were collected in clean polythene bottles which were thoroughly rinsed with sample water and tightly sealed and labeled after collection. The method applied by R. Shyamala et. al.[7] has been used for sampling. All the chemicals used were of A R grade.

### Methodology

Temperature, pH ,Total Dissolved Solid and Electrical Conductance were measured by using calibrated thermometer 1/10, Equiptronics digital pH meter model EQ-610, digital TDS meter model 514, and digital conductivity meter model EQ 664, respectively. Alkalinity, Hardness, Ca and Mg were measured volumetrically by standard procedures. Heavy metals such as chromium, cadmium, zinc and iron were determined by Atomic Absorption Spectrophotometer (Unicom, U.K. model-52). Determination of Fe in water samples was done by Flame Emission Atomic Absorption Spectrophotometer, as suggested by Stasys and Laura.[8]

### Correlation and Regression:

Let X & Y be any two variables (water quantity 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 & Y is given by the well known relation-

$$r = [\ \sum XY - X \sum Y\ ] / [(\ \sum X^2 - X \sum X)(\sum Y^2 - Y \sum Y)\ ] \quad (1)$$

Where the summations are taken over 1 to n (n = no. of observations) the value of empirical parameters a and b were calculated with the help of equation (2) and (3).

$$b = [\ \sum XY - X \sum Y\ ] / [\ \sum X^2 - X \sum X\ ] \quad (2)$$

$$a = Y - bX \quad (3)$$

$$\text{Where, } X = (\sum X)n \text{ and } Y = (\ \sum Y)/n \quad (4)$$

Keeping the above observations in mind, a linear relationship is obtained-

$$Y = a + b\,X \quad (5)$$

## RESULTS AND DISCUSSION

The results of physical and chemical analysis of ground water samples S1 to S3, collected from 3 different stations of Jalgaon city are compared with standard values and presented in Table 1. The observed pH value ranges from 8.08 to 8.66 showing that the present water samples are slightly alkaline. It was observed that sample no. 3 crosses the maximum permissible limit of TDS and the value observed is 783 mg/l. High TDS in ground water may be due to ground water pollution when waste waters from both residential and dyeing units are discharged into pits, ponds and lagoons enabling the waste to migrate down to the water table. Similarly hardness of sample no. 1 and 3 is 400 and 360 mg/l, respectively, which is well within the prescribed limit of W.H.O. However, the value of hardness of sample no. 2 was 590 mg/l., which is well above the maximum permissible limit prescribed by W. H .O (500 mg/l).

The concentrations of Fe and Zn are within the prescribed limit while Cd and Cr are present beyond the limit of WHO and ISI. It was observed that sample no. 2 shows maximum average values for all the parameters which are studied. This shows that a correlation exists between different parameters.
The correlation and regression calculations are done by the help of above equations. The numerical values of correlation coefficient are depicted in table 2. It shows a range from 0.9999 to 0.3800 for all water quality parameters. A total of 55 distinct correlation coefficients are possible in all. As we can see the calculated values depict some strong correlations between TDS & EC (r = 0.9999) Chromium & alkalinity (r = 0.9986) and Ca & Mg (r = 0.9962). However some weak correlations were observed between pH & Hardness(r = -o.9995), Pair having very high positive correlation between them shows the dependency of one parameter on the other while pair having very negative correlation between them shows inverse relation between them.

## CONCLUSION

From the average value of ground water sample, we can conclude that all these samples need some treatment to reduce the TDS, Cd & Cr if the water is to be used for drinking purpose. While the water sample no. 2 can be safely used for irrigation and other household purposes, it is not suitable for drinking purpose. In the light of correlation regression study, we can conclude that all the parameters are more or less correlated with each other. The linear correlation is very useful to get fairly accurate idea of quality of the ground water by determining just a few parameters experimentally.

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Table-1: Average values of physical and chemical parameters of ground water sample collected at different locations of Jalgaon city.

| Sr. No. | Parameter/ Sample | Temp $^0$K | pH | Conductivity micro/cm | Total alkalinity mg/lit | TDS mg/lit | Ca mg/lit | Mg mg/lit | Hardness | Fe mg/lit | Cd mg/lit | Cr mg/lit | Zn mg/lit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S1 | 296.5 | 8.56 | 739 | 325 | 403 | 0.50 | 0.50 | 400 | 0.0183 | 0.0758 | 1.2283 | 0.0810 |
| 2 | S2 | 296.5 | 8.08 | 1453 | 360 | 783 | 0.5 | 0.60 | 590 | 0.0745 | 0.0745 | 1.2724 | 0.6941 |
| 3 | S3 | 295.5 | 8.66 | 393 | 290 | 216 | 0.25 | 0.20 | 360 | 0.0122 | 0.0677 | 1.7754 | 0.0694 |

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Table-2: Average values of linear coefficient of ground water sample for different parameters.

| | Temp | pH | EC | Alkalinity | Hardness | TDS | Ca | Mg | Fe | Cd | Cr | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp | | | | | | | | | | | | |
| pH | | 1 | | | | | | | | | | |
| EC | | -0.9813 | 1 | | | | | | | | | |
| Alkal-inity | | -0.9106 | 0.9858 | 1 | | | | | | | | |
| Hard-ness | | -0.9995 | 0.9868 | 0.9358 | 1 | | | | | | | |
| TDS | | -0.9808 | 0.9999 | 0.9812 | 0.9862 | 1 | | | | | | |
| Ca | | -0.7258 | 0.8444 | 0.9332 | 0.7468 | 0.8464 | 1 | | | | | |
| Mg | | -0.7824 | 0.8875 | 0.8528 | 0.8014 | 0.8464 | 0.9962 | 1 | | | | |
| Fe | | -0.9990 | 0.9720 | 0.9175 | 0.9975 | 0.9711 | 0.6779 | 0.7546 | 1 | | | |
| Cd | | -0.4847 | 0.6437 | 0.7815 | 0.5116 | 0.6466 | 0.9534 | 0.9239 | 0.4539 | 1 | | |
| Cr | | -0.9032 | 0.9688 | 0.9986 | 0.9161 | 0.9698 | 0.9507 | 0.9739 | 0.8837 | 0.8131 | 1 | |
| Zn | | -0.9932 | 0.9524 | 0.8740 | 0.9891 | 0.9513 | 0.6411 | 0.7049 | 0.9973 | 0.3800 | 0.8474 | 1 |

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