Physico-Chemical Parameters and Quality Assessment of Groundwater Near Municipal Solid Waste Dumpsite, Mayiladuthurai, Tamilnadu - A Correlation Study

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ABSTRACT

Correlation Study of Ground Water from Municipal solid waste dumpsite area of Mayiladuthurai was carried out to study the correlation between different physico-chemical Parameters like pH, Electrical conductivity, Total dissolved solids, Total hardness, Calcium, Magnesium, Sodium, Potassium and Chloride were calculated by standard procedures and methods of sampling and estimation. The average values of pH come under both desirable limit and permissible limit of WHO standards. Calcium and Magnesium values comes under both desirable limit and permissible limit except few locations. Chloride recorded high values and the correlation and regression of Physico - chemical parameters of groundwater 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.

Keywords: Ground water Analysis, Correlation, Regression Analysis.

INTRODUCTION

Ground water act as a natural filter by the virtue of large pores in earth materials as conduct which can transport water over long distances and act as mechanical filter which improves water quality by removing suspended solid and bacterial contamination. It is a source of water for wells and springs that is the recommended source for rural domestic use. As a result of anthropogenic activities ground water is contaminated by the constant addition of industrial domestic and agricultural wastes to it. Ground water contaminated its original
quality cannot be restored back. Excessive mineralization of ground water degrades water quality producing objectionable taste, odor and excessive hardness\(^1\). Inorganic salts, Minerals, Acids, Metals and Metal compounds enter in natural water because of the industrial activities. This increase the acidity, salinity and toxicity\(^2\). Municipal solid waste reacts with ground water and rain water to form a liquid called leachate. It carries organic and inorganic compounds from the wastes and deposit at the bottom of the landfill. Leachate are toxic and defiant. Municipal and industries disposed their wastes born leachate\(^3\). Highly concentrated leachate leads to hazardous effect on adjacent soil, subsoil, waterbodies, and aquifer along the water table\(^4\).

Statistical correlation of groundwater parameter has been carried out to assess the water quality. Senthilkumar.G, Murugappan.A studied the physico–chemical parameters of dumpsite by using Pearson correlation\(^5\) Statistical study of water parameters has been given from various parts of India\(^6,7,8,9,10\). The aim of the present study is to assess the water quality by statistical analysis.

**STUDY AREA**

Mayiladuthurai is a rural area situated in Nagapattinam district in the state of Tamil Nadu. The town is located in the Cauvery delta basin. The area is covered by residential and commercial units and served by a population of more than a lakh. The Municipal solid dumpsite is located between 11º6'N latitude and 79º39'E longitude along the coast of Bay of Bengal. The dumping operations were started during the 1983 and till it is being operated. The landfill operations were started over an extent of 4.62 acres now extended to more than 20.0 acres. The open dumpsite is surrounded by domestic area including water bodies and cultivable lands. Nearly 33 to 60 tons (based on actual measurement) of Municipal Solid Waste is being dumped per day.

**FIELD SAMPLING AND EXPERIMENTAL ANALYSIS**

The Analysis was carried out in Anandathandavapuram village Mayiladuthurai, Nagapattinam District. The dumpsite was located in this area. The analysis was carried out during summer in 2017. The fifteen samples \(S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14}, S_{15}\) were taken from different points around the dumpsite. After their collection, pH meter (Systronics digital model 335) was used to determine the hydrogen ion concentration. The samples were analyzed for EC using conductivity meter. Total Dissolved Solids (TDS) were estimated using Systronics water analyzer. Total Hardness (TH) and Calcium Hardness (CH) as \(CaCO_3\) were determined titrimetrically using standard EDTA. The calculation of Magnesium Hardness (MH) was done by subtracting the CH from TH value. Chloride was calculated titrimetrically using standard silver nitrate. Sodium and Potassium were determined by flame photometry. The physico–chemical water quality parameter like \(pH\), EC, TDS, Total hardness, Calcium, Magnesium, Sodium, Potassium and Chloride were determined and the basic mathematical correlation coefficients for all these parameters were developed by SPSS. In our study all the parameters are taken a dependent variable the distance (sampling site) in kilometers is taken as independent variable.
CORRELATION AND REGRESSION ANALYSIS

Let \( x \) and \( y \) be any two variables \( X_i, Y_i \) be \( n \) pairs of observed values of these variables (\( I = 1,2,3, \ldots \ldots \ldots \ldots \ldots n \)). Then the correlation coefficient \( r \) between the variables \( x \) and \( y \) is given by the equation

\[
 r = \frac{n \sum x y - \sum x \sum y}{\sqrt{[n \sum x^2 - (\sum x)^2][n \sum y^2 - (\sum y)^2]}}
\]

Where, \( n \)= number of observation are taken over 1 to \( n \). The values of empirical parameters were calculated with the help of equations.

\[
a = \frac{n \sum x y - \sum x \sum y}{n \sum x^2 - (\sum x)^2}
\]

Based on the above equations, a linear relationship was determined. Regression is the measure of average relationship between two or more variables in terms of the original units of the data. The pair of parameters, which exhibited very good correlation subjected to regression analysis. The values are fitted in straight line a linear relationship is worked out by the method of least squares.

\[y = a x + b\]

To study the correlation between various water quality parameters, the regression analysis was carried out.

RESULT AND DISCUSSION

The following table Table-1 shows the average values like Total hardness, Calcium, Magnesium, Chloride, Sodium, Potassium, Total dissolved solid, Electrical conductivity and pH.

**Table-1: Average values of physico-chemical parameters of municipal solid waste dumpsite.**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Desirable limit (WHO)</th>
<th>Permissible limit (WHO)</th>
<th>Experimental value (Range) mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH</td>
<td></td>
<td></td>
<td>278-632</td>
</tr>
<tr>
<td>Ca</td>
<td>75</td>
<td>200</td>
<td>46-204</td>
</tr>
<tr>
<td>Mg</td>
<td>30</td>
<td>150</td>
<td>34-175</td>
</tr>
<tr>
<td>Cl</td>
<td>200</td>
<td>600</td>
<td>312-1235</td>
</tr>
<tr>
<td>Na</td>
<td>-</td>
<td>200</td>
<td>123-1022</td>
</tr>
<tr>
<td>K</td>
<td>-</td>
<td>-</td>
<td>32-104</td>
</tr>
<tr>
<td>TDS</td>
<td>500</td>
<td>1000</td>
<td>576-1531</td>
</tr>
<tr>
<td>EC</td>
<td>-</td>
<td>-</td>
<td>576-1456</td>
</tr>
<tr>
<td>pH</td>
<td>7-8.5</td>
<td>6.5-9.5</td>
<td>7.2-8.9</td>
</tr>
</tbody>
</table>
The Correlation matrix for the above parameters were given in table Table-2.

Table-2: Correlation matrix for the parameters of Municipal solid waste dumpsite.

<table>
<thead>
<tr>
<th></th>
<th>TH</th>
<th>Ca</th>
<th>Mg</th>
<th>CI</th>
<th>Na</th>
<th>K</th>
<th>TDS</th>
<th>EC</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH</td>
<td>1</td>
<td>0.988</td>
<td>0.983</td>
<td>0.703</td>
<td>-0.534</td>
<td>-0.476</td>
<td>0.543</td>
<td>0.485</td>
<td>0.726</td>
</tr>
<tr>
<td>Ca</td>
<td>1</td>
<td>0.780</td>
<td>-0.608</td>
<td>-0.378</td>
<td>0.406</td>
<td>0.664</td>
<td>0.687</td>
<td>0.839</td>
<td></td>
</tr>
<tr>
<td>Mg</td>
<td>1</td>
<td>0.707</td>
<td>0.465</td>
<td>0.375</td>
<td>0.660</td>
<td>0.617</td>
<td>0.538</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td></td>
<td>1</td>
<td>0.842</td>
<td>-0.567</td>
<td>-0.607</td>
<td>0.868</td>
<td>0.633</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na</td>
<td></td>
<td></td>
<td>1</td>
<td>0.546</td>
<td>-0.532</td>
<td>0.646</td>
<td>-0.459</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.745</td>
<td>0.759</td>
<td>0.474</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.523</td>
<td>0.679</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.546</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Hardness has strong positive correlation with Calcium (r=0.988) and magnesium (r=0.983) and poorly correlated with chloride (r=0.303). TH reveals that the total hardness is mainly due to presence of calcium and magnesium. The TH also positive correlation with PH (r=0.726), EC (r=0.480) and TDS (r=0.543). TH has negative correlation with sodium (r=0.534) and potassium (r=0.476). Calcium has high positive correlation with pH (r=0.839), indicates that alkalinity of water sample is due to calcium compounds. It also has positive correlation with magnesium (r=0.780), potassium (r=0.406), TDS (r=0.664), and EC(r=0.687). It has strong negative correlation with chloride (r=0.608) shows that calcium did not exist as calcium chloride in water sample. calcium has low negative correlation with sodium (r=0.378).

Figure 1: Linear Regression Model depicting the existence of strong correlation between Total Hardness and Calcium

Magnesium shows high positive correlation with Chloride (r=0.707) and low positive correlation with Sodium (R=0.465, Potassium (r=0.375). High positive correlation indicates magnesium exist as Magnesium chloride. It has positive correlation with TDS(r=0.660), EC.

(\(r=0.617\)) and \(\text{pH} (r=0.538)\). Chloride shows high positive correlation with Sodium \((r=0.842)\) and negative correlation with potassium \((r=0.567)\). High positive correlation indicates that Chloride present in the water sample as Sodium Chloride but not Potassium Chloride. It also has high positive correlation with EC \((r=0.868)\) shows that conductivity is mainly due to Chloride Iron. It has negative correlation with TDS \((r=0.607)\) and positive correlation with \(\text{pH} (r=0.633)\). Sodium has strong positive correlation with EC \((r=0.646)\) and Potassium \((r=0.546)\) and negative correlation with TDS \((r=0.532)\) and \(\text{pH} (r=0.459)\). Electrical conductivity is due to Sodium also. Potassium has strong positive correlation with TDS \((r=0.745)\), EC \((r=0.759)\) and \(\text{pH} (r=0.474)\). The Total suspended solid has major component of potassium Ions. TDS has positive correlation with EC \((r=0.523)\) and \(\text{pH} (r=0.679)\). EC has positive correlation with \(\text{pH} (r=0.456)\). The Linear Regression Model shows the existence of strong correlation between Total Hardness and Calcium is given in figure 1.

CONCLUSION

In the present study, the correlation and regression of nine Physico - chemical parameters of groundwater revealed that all the parameters were more or less correlated with one another. A linear regression method was very useful technique for monitoring groundwater and has a good accuracy. In correlation regression study, we can conclude that all the parameters are more or less correlated with each other, especially strong correlations observed between \(\text{TH} \) and \(\text{Ca} (R=0.988)\). The linear correlation is very useful to get sharp idea of the quality of the groundwater by determining experimentally and then calculating the balance from correlation equation.

REFERENCES


