GROUND WATER QUALITY CHARACTERISTICS STUDY BY USING WATER QUALITY INDEX IN VILLUPURAM DISTRICT, TAMIL NADU, INDIA.

V. C. Ananthimalini1*, M. M. Senthamilsselvi2 and S. Manikandan3

1Department of Chemistry, Siga College of Management and Computerscience, Affiliated to Tiruvalluvar University, Villupuram, Tamil Nadu, India.

2Regional Joint Director, Directorate of Collegiafe Education Tiruchirappalli Region, Tiruchirappalli, Tamil Nadu, India.

3Department of Chemistry, Surya College of Engineering and Technology, Affiliated to Anna University, Villupuram, Tamil Nadu, India.

ABSTRACT

Water quality index (WQI) is a dimensionless number that combines multiple water quality factors into a single number by normalizing values to subjective rating curves. The present work is aimed at assessing the Water Quality Index (W.Q.I) of ground water of some towns of villupuram district. Physicochemical parameters were monitored for the calculation of W.Q.I for the sep 2016. The physicochemical parameters namely pH, Total hardness, TDS, Alkalinity, Chloride, Sulphate, Fluoride, Nitrate,, EC and Ammonia was determined and it is found that their values were exceeding the permissible limits as prescribed by WHO. The analysis reveals that the ground water of the area needs some treatment before consumption, and it also needs to be protected from the perils of contamination.

KEYWORDS: Physicochemical parameters, Water quality standards, Water Quality Index, villupuram district.

INTRODUCTON

In recent years, the competition for scarce water resources is intense both in India and in many places all over the world. Groundwater has long been considered as one of the purest
forms of water available in nature and meets the overall demand of rural and semi-urban people. Apart from this, the most important are non availability of potable surface water and a general belief that groundwater is purer and safer than surface water due to the protective qualities of the soil cover. On the other hand, the development of human societies and industry result in bioenvironmental problems; pollution puts the water, air and soil resources at risk. The general WQI was developed by Brown et al. (1970) and improved by Deininger for the Scottish Development Department (1975). Horton (1965) suggested that the various water quality data could be aggregated into an overall index. Water quality index is well-known method as well as one of the most effective tools to expressing water quality that offers a simple, stable, quality to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of surface water. WQI is defined as a Rating reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of ground water for human consumption. Moreover, it may be used for comparing the quality of different water sources and in monitoring the temporal changes in the quality of water. It reflects the aggregate influence of various physical, chemical, and biological parameters of water quality conditions water quality index provide a single number that expresses overall water quality at a certain location and time based on several water quality parameters. The Objective of water quality index is to turn complex water quality data into information that is understandable and usable by the public. A single number cannot tell the whole story of water quality there are many other water quality parameters that are not include in the index. however the water quality index based on some very important parameters can provide a simple indicator of water quality. In general water quality indices importance data from multiple water quality parameters into a mathematical equation that rates the health of a water body with number.

The objective of this research is to represent a water quality evaluation of some towns of villupuram district that receives industrial effluents, through the use of WQI.

The main objective of this work is to analyze various physico-chemical parameters of the ground water at Villupuram, Vikkravandi and Tindivanm and its surrounding areas of about 20 square kilometer in Villupuram district, Tamil Nadu.
2. Description of the study area

Study Area
The study area lies between Latitude N 11°56' and Longitude E 79°29' and is located in Northeast of TamilNadu in India, which is in the far southeast part of India, situated 160 km south of Chennai, 160 km north of Trichy, 177 km east of Salem, 40 km west of Pondicherry, it shares the seashore of the Bay of Bengal covering about 7217 Km² area (Fig.1). The area includes Villupuram, Vikravandi, Tindivanam.
Cinthamani, S8-Villupuram medical college, S9-Sugar factory, S10-Panayapuram.

**Rainfall**

Villupuram district receives rainfall from both southwest and northeast monsoons. The annual normal rainfall for the district is 1046.8 mm (41.2in). The driest month is March with 6 mm (0.24in) with an average of 222 mm (8.7in) per annum, the most precipitation falls in October.

**Climate**

The district enjoys a tropical climate. The highest temperatures are recorded during May and June. The mean daily minimum and maximum temperature are 24.6 to 32.0° C. The average annual temperature 28.4° C.

**Topography**

The general geological formation of the district appears to be simple. The greater part of it is covered by the Metamorphic rocks belonging to Genesis family. There are also three great groups of sedimentary rocks belonging to different geological periods. The Kalrayan Hills in the north represents a continuous range of hills covered with some thorny forests and vegetation. Among the hills, the most beautiful part of the district lies, round about the Gingee Hills.[10]

3. **MATERIALS AND METHODS**

**Collection of water samples**

Groundwater samples were collected from 20 locations within the study area during month of Sep 2016. Sampling is done at each station in polythene bottles of two-litre capacity. The samples were analyzed for various water quality parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Alkalinity, Total Hardness (TH), Chloride, Sulphate, Nitrate, Fluoride and Ammonia were determined using standard methods.[11] The method used for estimation of various Physico-chemical parameters are shown in Table-1. Reagents used for the present investigation were A.R. Grade and double distilled water was used for preparing various solutions. Methods used for estimation of various Physico-chemical parameters are shown in Table-1.
Table: 1 Methods used for estimation of Physico - Chemical parameters

<table>
<thead>
<tr>
<th>S. No</th>
<th>Parameter</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>pH Meter</td>
</tr>
<tr>
<td>2</td>
<td>Electrical Conductivity</td>
<td>Conductivitymeter</td>
</tr>
<tr>
<td>3</td>
<td>Total Hardness</td>
<td>EDTA Titration</td>
</tr>
<tr>
<td>4</td>
<td>TDS</td>
<td>Filtration method</td>
</tr>
<tr>
<td>5</td>
<td>Alkalinity</td>
<td>Indicator method</td>
</tr>
<tr>
<td>6</td>
<td>Chloride</td>
<td>Argentometric method</td>
</tr>
<tr>
<td>7</td>
<td>Nitrate</td>
<td>Phenol disulphonic acid method</td>
</tr>
<tr>
<td>8</td>
<td>Sulphate</td>
<td>Nephelometry Method</td>
</tr>
<tr>
<td>9</td>
<td>Fluoride</td>
<td>SPADN spectrophotometric method</td>
</tr>
<tr>
<td>10</td>
<td>Ammonia</td>
<td>Calorimetric method</td>
</tr>
</tbody>
</table>

CALCULATION OF WATER QUALITY INDEX: (WQI)\(^4\)

The weighted arithmetic index method has been used for the calculation of W.Q.I. Further quality rating or sub index (qn) was calculated using the following express

\[
\text{Water Quality Index (WQI)} = \frac{\sum q_n W_n}{\sum W_n}
\]

(i) CALCULATION OF \( W_n \)

\[ W_n \text{ (unit weight)} = \frac{K}{S_n} \]

Where \( K \) (constant) = \[ \frac{1}{1/Vs1 + 1/Vs2 + 1/Vs3 + 1/Vs4 \ldots + 1/Vsn} \]

\( S_n = \text{‘n’ number of standard values.} \)

Table: 2 Drinking Water standards recommending agencies and unit weight (All values except pH is in mg/L)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>WHO Standards</th>
<th>Unit weight(Wn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH(Vs1)</td>
<td>7.0 - 8.5(Vs1)</td>
<td>0.04163</td>
</tr>
<tr>
<td>Electrical conductivity(Vs1)</td>
<td>1000(Vs2)</td>
<td>0.00035</td>
</tr>
<tr>
<td>Total dissolved solids(Vs2)</td>
<td>1000(Vs3)</td>
<td>0.00035</td>
</tr>
<tr>
<td>Total hardness(Vs3)</td>
<td>300(Vs4)</td>
<td>0.00118</td>
</tr>
<tr>
<td>Alkalinity(Vs4)</td>
<td>200(Vs5)</td>
<td>0.00177</td>
</tr>
<tr>
<td>Chloride(Vs5)</td>
<td>250(Vs6)</td>
<td>0.00141</td>
</tr>
<tr>
<td>Sulphate(Vs6)</td>
<td>200(Vs7)</td>
<td>0.00177</td>
</tr>
<tr>
<td>Nitrate</td>
<td>45(Vs8)</td>
<td>0.00786</td>
</tr>
<tr>
<td>Fluoride</td>
<td>1.5(Vs9)</td>
<td>0.23592</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.5(Vs10)</td>
<td>0.70776</td>
</tr>
</tbody>
</table>

\[ \sum W_n = 1.00000 \]
Results are presented in Table-2, compared with the permissible drinking water standards specified by WHO Standard Specification as per 2011,\textsuperscript{[12]}

\begin{table}
\begin{center}
\textbf{Table: 3 Water Quality Index (W.Q.I.) and status of water quality\textsuperscript{[13]}}
\begin{tabular}{|c|c|}
\hline
Water Quality Index & Water Quality Status \\
\hline
0 – 25 & Excellent Water Quality \\
26 – 50 & Good Water Quality \\
51 – 75 & Poor Water Quality \\
76 – 100 & Very Poor Water Quality \\
> 100 & Unfit for drinking \\
\hline
\end{tabular}
\end{center}
\end{table}

\textbf{RESULTS AND DISCUSSION}

\begin{table}
\begin{center}
\textbf{Table: 4 Physico-chemical parameter of ground water during month of sep 2016}
\begin{tabular}{|c|c|c|c|c|c|c|c|c|c|c|c|}
\hline
Sample No & pH & EC & TH & TDS & ALKALINITY & Cl & NO\textsubscript{3} & SO\textsubscript{4} & F & Ca & Mg & Fe & NH\textsubscript{3} \\
\hline
S1 & 7.1 & 2460 & 530 & 1710 & 430 & 390 & 24 & 213 & 0.2 & 115 & 60 & 0 & 0.74 \\
S2 & 7.0 & 2500 & 520 & 1740 & 460 & 382 & 32 & 215 & 0.3 & 124 & 64 & 0 & 0.76 \\
S3 & 7.1 & 2490 & 495 & 1724 & 456 & 376 & 31 & 211 & 0.2 & 126 & 66 & 0 & 0.80 \\
S4 & 7.2 & 2650 & 464 & 1676 & 443 & 378 & 25 & 225 & 0.6 & 118 & 58 & 0 & 0.66 \\
S5 & 7.0 & 2670 & 456 & 1679 & 432 & 386 & 25 & 226 & 0.7 & 122 & 62 & 0 & 0.68 \\
S6 & 7.0 & 2670 & 473 & 1680 & 412 & 373 & 17 & 217 & 0.5 & 114 & 78 & 0 & 0.55 \\
S7 & 7.2 & 1620 & 288 & 1090 & 303 & 19 & 38 & 124 & 0.6 & 72 & 57 & 0 & 0.36 \\
S8 & 7.1 & 1350 & 284 & 1160 & 321 & 210 & 39 & 127 & 0.4 & 74 & 45 & 0 & 0.45 \\
S9 & 6.6 & 1160 & 275 & 1232 & 405 & 230 & 33 & 115 & 0.2 & 71 & 44 & 0 & 0.51 \\
S10 & 6.5 & 1030 & 260 & 1279 & 389 & 228 & 34 & 117 & 0.1 & 73 & 48 & 0 & 0.42 \\
S11 & 6.7 & 4130 & 1070 & 2835 & 560 & 614 & 85 & 249 & 0.3 & 237 & 116 & 0.5 & 2 \\
S12 & 7.0 & 3900 & 950 & 2815 & 545 & 633 & 76 & 228 & 0.2 & 238 & 115 & 0.4 & 1.9 \\
S13 & 7.1 & 4100 & 979 & 2820 & 576 & 621 & 78 & 227 & 0.3 & 234 & 108 & 0.5 & 1.95 \\
S14 & 7.1 & 3820 & 967 & 2750 & 512 & 386 & 74 & 240 & 0.6 & 232 & 116 & 0 & 0 \\
S15 & 7.2 & 4030 & 980 & 2765 & 505 & 380 & 69 & 239 & 0.7 & 235 & 102 & 0 & 0 \\
S16 & 7.0 & 3850 & 946 & 2776 & 501 & 395 & 69 & 228 & 0.6 & 219 & 102 & 0 & 0 \\
S17 & 7.2 & 2724 & 725 & 1933 & 560 & 503 & 118 & 226 & 0.2 & 158 & 89 & 0.1 & 0.46 \\
S18 & 7.1 & 2770 & 695 & 1935 & 545 & 495 & 116 & 228 & 0.3 & 155 & 88 & 0 & 0.5 \\
S19 & 7.1 & 2800 & 835 & 1980 & 501 & 565 & 108 & 239 & 0.1 & 166 & 95 & 0.1 & 0.5 \\
\hline
\end{tabular}
\end{center}
\end{table}
Water Quality Index (WQI) = $\sum q_n W_n$

**In this study, Water Quality Index was obtained for parameters such as Electrical conductivity, Total Dissolved Solids, Nitrate, Chloride, Alkalinity, Sulphate, Fluorine, pH and Total Hardness and ammonia so that the suitability of water quality can be understood well. The computed WQI values ranges from 12.11 to 291.86 and therefore, can be categorized into five types “good water” to “unfit for drinking”.[13]**

Comparing the values obtained with the water quality standards WHO, the water quality rating clearly shows that three stations have the value of Water Quality Index within the range 0-25. From this it is observed that three of the stations could be rated for excellent quality of water which is fit for drinking purpose.

The analysis revealed that the Water Quality Index of none of the stations lie under the range of 26-50.
Water Quality Index within the range 51-75. From this it is observed that six of the stations
could be rated for poor quality of water. This investigation shows that there is a slight decline
in the amount of Electrical conductivity, Total Dissolved Solids, Nitrate, Chloride, Sulphates,
Alkalinity and Total Hardness in water this session as compared with the previous
observations of V.C. Ananthimalini&M.M. Senthamilselvi[14], which records the increase in
these salts. This shows that water is moderately polluted in these stations. About 30% of the
stations fall under this category. the arithmetic mean method by Brown WQI ranges from 51-
75 has been classified as poor.

It is observed that the Water Quality Index of around 3 stations lie between the range of 76-
100. This shows that water in these stations is very poor. Steps should be taken to treat the
water for useful purposes and prevent further pollution. [15]

It is observed that the Water Quality Index of around 8 stations lie between the range of
>100. This shows that water in these stations unfit for drinking purpose. The main pollutant
present in those areas is ammonia.

![WQI](image)

**Fig-I**

**Table 6: Number of stations and percentage of stations that fall under different water
quality**

<table>
<thead>
<tr>
<th>Standard WQI</th>
<th>No.of stations</th>
<th>% of stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>
Fig: 2 WQI-For sampling stations
The high values of Water Quality Index are found to be mainly from the higher values of Nitrates, Fluorides and Ammonia in ground water. The present study also reveals that pollution in ground water has increased considerably when compared to the previous years and proper measures have to be taken.

<table>
<thead>
<tr>
<th>WQI Range</th>
<th>Stations</th>
<th>% of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>51-75</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>76-100</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>&gt;100</td>
<td>8</td>
<td>40</td>
</tr>
</tbody>
</table>

CONCLUSION
Water Quality index (WQI) of the present study for villupuram district was calculated from important various physiochemical parameters in order to evaluate the suitability of water for various purposes. The calculated WQI provides an easy way of understanding the overall water quality and water management. The water quality rating at more of the sampling sites clearly showed that the status of the water body in villupuram district was degraded and unsuitable for the human uses during the period of sep 2016 study because it was not within the WHO standards and guidelines for drinking. It was also observed that the pollution load was relatively high during rainy season when compared to the winter seasons. It has been concluded that discharging of domestric and industrial waste water and also other anthropogenic activities were the main factors for contaminating villupuram district. However, there isa need for regular monitoring of water quality in order to detect changes in
physiochemical. WQI can play a big role in mitigating the parameters concentration and convey it to the public through WQI.

Application of Water Quality Index (WQI) in this study has been found useful in assessing the overall quality of water and to get rid off judgment on quality of the water. This method appears to be more systematic and gives comparative evaluation of the water quality of sampling stations

REFERENCE

1. Water parameter were considered for calculation of water quality index (Harkins, 1974; Tiwari et al., 1986; Tiwari and Manzor, 1988; Mohanta and Patra, 2000, Kesharwani et al., 2004; Padmanabha and Belagalli, 2005.
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