# Water Quality Index of Ground Water Bodies of Kilvelur Taluk, Nagapattinam District, TamilNadu, India

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**Abstract - The present work is evaluating the water quality index (WQI) for the ground water of Kilvelur taluk, Nagapattinam District. WQI is calculated on the basis of weighted arithmetic index by analyzing 16 physico – chemical parameters. The physico – chemical parameters namely pH, Electrical conductivity, Total dissolved solids, Total hardness, Calcium, Magnesium, Carbonate, Bicarbonate, Chloride, Nitrate, Sulphate, Sodium, Potassium, Dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand. This study is to determine the suitability of water for drinking purpose based on water quality index (WQI) estimated. The analysis indicates that the water samples of the location needs some degree of treatment before consumption and it also essential to be protected from the perils of contamination.**

**Keywords: Ground water, Water quality index, Kilvelur taluk, Nagapattinam District.**

## I. INTRODUCTION

Ground water is the most useful water sources. Water is second to oxygen as being needed for life. People can survive days, weeks or even longer without food, however totally regarding four days while not water. Contamination of such water sources is a big problem creating health hazard[1].

Water is an essential component of the surroundings and it sustains life on the earth. Humans rely upon water for their survival. Water is also a raw material for photosynthesis and therefore, is crucial for crop production[2]. The cause of ground water gets polluted and creates health problems, due to the fact the water may be very crucial surroundings. Any imbalance in term of amount it may be harm to the entire environment. Therefore there is always needed for concern over the safety and management of ground water quality[3]. Good drinking water quality is important for the well being of all people[4].

Drinking water is a vital resource that has to be protected against pollution and biological contamination. Underground water is clean however it depends upon quality and amount of materials distributed and dissolved in it. Water picks up impurities in during its flow, which are harmful to human beings and vegetation. The reason for contamination and pollution of water in the natural surroundings and in the storage are pesticides, fertilizers, industrial wastes, inorganic and organic salts from top soil and geological layer. Excess mount of physico – chemical components, cause a certain ecological and physical problems to human[5].

Ground water is a treasured natural present and an essential renewable aid having several inherent advantages over surface water. It is a good supply of fresh water available in the world. The demand for water has increased over the years and this has led to water scarcity in several parts of the world. The scenario is irritated by using the problem of water pollutants or infection. India is heading towards fresh water crisis specifically due to incorrect management of water resource and environmental degradation. This leads to lack of access to safe potable water supply to millions of people. It becomes imperative to regularly monitor the quality of water and to device ways and means to protect it. Water quality index is one of the exceptional tools to communicate information on general water quality status of ground water to the concerned user community and policy makers. For that reason, it turns into a vital parameter for the evaluation and management of ground water[6].

The principle of water quality index is to show the water quality information that is understandable and usable via the public[7]. Water quality index provides a single number that shows total quality of water, primarily based totally on several water quality parameters[8]. A single number cannot

 DOI : 10.18231/2454-9150.2018.0773 

tell complete story of water quality; there are many different quality parameters that are not included in the index. However, a water quality index based totally on some very essential parameters can provide a simple indicator of water quality indices incorporate from multiple water quality parameters into mathematical equation that rates the health of a water body with number. The objective of the present work is to discuss the suitability of ground water for human consumption based on computed water quality index values[9].

## II. STUDY AREA

Kilvelur is a town Panchayat town in district of Nagapattinam, Tamil Nadu. It is located 17 km closer to west from district head quarters Nagapattinam. Kilvelur taluk is a 311 km from the capital Chennai towards north. Kilvelur taluk is located by Thiruvarur taluk in the direction of West, Keelaiyur taluk in the direction of South and Nagapattinam taluk in the direction of East. Thiruvarur city, Nagapattinam city, Thiruthuraipoondi city, Karaikal city are the neighbouring cities to Kilvelur.

**Table 1: Name of the locations of Kilvelur taluk**

| Samples | Locations | |
|---|---|---|
| S1 | Kovil Paththu | Profile – A |
| S2 | Vettaikkaraniruppu | |
| S3 | Pudhupalli | |
| S4 | Vizhunthamavadi | |
| S5 | Kameswaram South | |
| S6 | Kameswaram North | |
| S7 | Ramar Madam | |
| S8 | Prathabaramapuram | |
| S9 | Seruthur | |
| S10 | Cholavidyapuram | |
| S11 | Venmani | Profile – B |
| S12 | Venmanacheri | |
| S13 | Vappanchery | |
| S14 | Needur | |
| S15 | Palakurichi | |
| S16 | Vandalur | |
| S17 | Thevur | |
| S18 | Velankanni | |
| S19 | Thiruppoondi | |
| S20 | Killukudi | |

## III. METHODOLOGY

Ground water samples were collected from twenty locations during Pre monsoon, Monsoon, Post Monsoon period (May 2014 to Nov 2016). Each of the ground water samples became analysed for sixteen parameters such as pH, Electrical conductivity, Total dissolved solids, Total hardness, Calcium, Magnesium, Carbonate, Bicarbonate, Chloride, Nitrate, Sulphate, Sodium, Potassium, Dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand using standard procedures recommended by World Health Organization[10]. Water Quality Index is evaluated from the point of view of suitability of ground water for human consumption.

## IV. RESULT AND DISCUSSION

### WQI Calculation

The Weighted Arithmetic Index method became used for the calculation of Water Quality Index of the water body[7]. The Water Quality Index is calculated by using the following expression.

$$WQI = \sum q_n W_n / \sum W_n \quad \text{---------- (1)}$$

Where, qn = Quality rating of $n^{th}$ water quality parameter.

$W_n$ = Unit weight of $n^{th}$ water quality parameter.

### 1. Quality rating ($q_n$)

The quality rating ($q_n$) is calculated using the following expression.

$$q_n = ( (V_n - V_{id} ) / (S_n - V_{id} )) \times 100 \quad \text{---------- (2)}$$

Where,

Vn = Estimated value of $n^{th}$ water quality parameter at a given sample location.

($V_{id}$ = 0, except for pH & DO. $V_{id}$ = 7 for pH and $V_{id}$ = 14.6 mg /l for DO)

$S_n$ = Standard permissible value of $n^{th}$ water quality parameter.

### 2. Unit Weight

The unit weight ($W_n$) is calculated using the following equation.

$$Wn = k / S_n \quad \text{---- (3)}$$

Where,

$S_n$ = Standard permissible value of $n^{th}$ water quality parameter.

K = Constant of proportionality and it is calculated by using the following equation.

$$K = (1 / (\sum 1/ S_n = 1, 2 \ldots n)) \quad \text{--- (4)}$$

### 3. WQI and Status of Water Quality

The ranges of Water Quality Index and corresponding water quality status and their possible use are summarized in table (2).

**Table (2)**

| S.No | Water Quality Index | Water Quality Status | Possible Usages |
|---|---|---|---|
| 1 | 0 - 25 | Excellent water quality | Drinking, irrigation and industrial |
| 2 | 26 – 50 | Good water quality | Domestic, irrigation and industrial |
| 3 | 51 – 75 | Poor water quality | Irrigation and industrial |
| 4 | 76 – 100 | Very poor water quality | Irrigation |
| 5 | > 100 | Unfit for drinking | Proper treatment required before use |

### 4. Standard values and Unit weights of water quality parameters of the Study area

The water quality parameters are choose on primarily based on its direct involvement in deteriorating water quality for

 DOI : 10.18231/2454-9150.2018.0773 

human consumption. The standards for the drinking water, recommended by the World Health Organization are considered for the computation of Quality rating and Unit weights. The values of those physico – chemical parameters are observed high which is above the permissible limits in some of the samples of the study area. The higher values of those parameters would increase WQI value. The standard values of ground water quality parameters and their corresponding ideal values and unit weights are given in table (3).

**Table (3) Standard values of Water quality parameters and their corresponding ideal values and unit weights.**

| S.No | Parameters | Sn | Recommending agency for Sn | Ideal value (Vid) | K value | Unit weight |
|---|---|---|---|---|---|---|
| 1 | pH | 8.5 | WHO | 7 | 0.092 | 0.0108235 |
| 2 | EC | 1400 | WHO | 0 | 0.092 | 0.0000657 |
| 3 | TDS | 500 | WHO | 0 | 0.092 | 0.000184 |
| 4 | TH | 500 | WHO | 0 | 0.092 | 0.000184 |
| 5 | Ca | 75 | WHO | 0 | 0.092 | 0.0012267 |
| 6 | Mg | 30 | WHO | 0 | 0.092 | 0.0030667 |
| 7 | CO32- | 75 | WHO | 0 | 0.092 | 0.0012267 |
| 8 | HCO3- | 30 | WHO | 0 | 0.092 | 0.0030667 |
| 9 | Cl | 250 | WHO | 0 | 0.092 | 0.000368 |
| 10 | NO3 | 50 | WHO | 0 | 0.092 | 0.00184 |
| 11 | SO4 | 500 | WHO | 0 | 0.092 | 0.000184 |
| 12 | Na | 200 | WHO | 0 | 0.092 | 0.00046 |
| 13 | K | 12 | WHO | 0 | 0.092 | 0.0076667 |
| 14 | DO | 5 | WHO | 14.6 | 0.092 | 0.0184 |
| 15 | BOD | 5 | WHO | 0 | 0.092 | 0.0184 |
| 16 | COD | 10 | WHO | 0 | 0.092 | 0.0092 |

### 5. Water quality index values for different season of ground water samples

The WQI values of the different season samples are summarized in table 4 to 9 samples of the study area are very poor to not worthy for drinking and the ground water from these locations require proper water treatment before use.

**Table 4**

**Calculation of WQI of water samples in Pre monsoon season of Profile - A**

| S.No | Parameters | Observed Value ( $V_n$) | Standard Values ($S_n$) | Ideal Value ($V_{id}$) | Unit Weight ($W_n$) | Quality Rating ($q_n$) | $W_nQ_n$ |
|---|---|---|---|---|---|---|---|
| 1 | pH | 7.2 | 8.5 | 7 | 0.010824 | 13.33 | 0.144 |
| 2 | EC | 577 | 1400 | 0 | 0.000066 | 41.21 | 0.003 |
| 3 | TDS | 794 | 500 | 0 | 0.000184 | 158.8 | 0.029 |
| 4 | TH | 518 | 500 | 0 | 0.000184 | 103.6 | 0.019 |
| 5 | Ca | 309 | 75 | 0 | 0.001227 | 412 | 0.505 |
| 6 | Mg | 122 | 30 | 0 | 0.003067 | 406.67 | 1.247 |
| 7 | $CO_3^{2-}$ | 269 | 75 | 0 | 0.001227 | 358.67 | 0.439 |
| 8 | $HCO_3^-$ | 329 | 30 | 0 | 0.003067 | 1096.67 | 3.363 |
| 9 | Cl | 115 | 250 | 0 | 0.000368 | 46 | 0.017 |
| 10 | $NO_3$ | 19 | 50 | 0 | 0.001840 | 38 | 0.070 |
| 11 | $SO_4$ | 72 | 500 | 0 | 0.000184 | 14.4 | 0.003 |
| 12 | Na | 155 | 200 | 0 | 0.000460 | 77.5 | 0.036 |
| 13 | K | 64 | 12 | 0 | 0.007667 | 533.33 | 4.089 |
| 14 | DO | 14.4 | 5 | 14.6 | 0.018400 | 2.08 | 0.038 |
| 15 | BOD | 8.3 | 5 | 0 | 0.018400 | 166 | 3.054 |
| 16 | COD | 16.6 | 10 | 0 | 0.009200 | 166 | 1.527 |
| | | | | | $\sum W_n$ =0.07636 | $\sum q_n$ =3634.26 | $\sum W_n q_n$=14.585 |
| WQI = 190.99 | | | | | | | |

 DOI : 10.18231/2454-9150.2018.0773 

**Table 5**

| Calculation of WQI of water samples in Monsoon season of Profile - A | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No** | **Parameters** | **Observed Value ( $V_n$)** | **Standard Values ($S_n$)** | **Ideal Value ($V_{id}$)** | **Unit Weight ($W_n$)** | **Quality Rating ($q_n$)** | **$W_nQ_n$** |
| 1 | pH | 7.1 | 8.5 | 7 | 0.010824 | 6.67 | 0.072 |
| 2 | EC | 547 | 1400 | 0 | 0.000066 | 39.07 | 0.003 |
| 3 | TDS | 763 | 500 | 0 | 0.000184 | 152.60 | 0.028 |
| 4 | TH | 602 | 500 | 0 | 0.000184 | 120.40 | 0.022 |
| 5 | Ca | 364 | 75 | 0 | 0.001227 | 485.33 | 0.595 |
| 6 | Mg | 139 | 30 | 0 | 0.003067 | 463.33 | 1.421 |
| 7 | $CO_3^{2-}$ | 345 | 75 | 0 | 0.001227 | 460.00 | 0.564 |
| 8 | $HCO_3^-$ | 388 | 30 | 0 | 0.003067 | 1293.33 | 3.966 |
| 9 | Cl | 147 | 250 | 0 | 0.000368 | 58.80 | 0.022 |
| 10 | $NO_3$ | 20 | 50 | 0 | 0.001840 | 40.00 | 0.074 |
| 11 | $SO_4$ | 73 | 500 | 0 | 0.000184 | 14.60 | 0.003 |
| 12 | Na | 136 | 200 | 0 | 0.000460 | 68.00 | 0.031 |
| 13 | K | 58 | 12 | 0 | 0.007667 | 483.33 | 3.706 |
| 14 | DO | 13.5 | 5 | 14.6 | 0.018400 | 11.46 | 0.211 |
| 15 | BOD | 8.4 | 5 | 0 | 0.018400 | 168.00 | 3.091 |
| 16 | COD | 16.9 | 10 | 0 | 0.009200 | 169.00 | 1.555 |
| | | | | | $\sum W_n$ = 0.076363 | $\sum q_n$ =4033.93 | $\sum W_n q_n$ = 15.363 |
| WQI = 201.19 | | | | | | | |

**Table 6**

| Calculation of WQI of water samples in Post monsoon season of Profile - A | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No** | **Parameters** | **Observed Value ( $V_n$)** | **Standard Values ($S_n$)** | **Ideal Value ($V_{id}$)** | **Unit Weight ($W_n$)** | **Quality Rating ($q_n$)** | **$W_nQ_n$** |
| 1 | pH | 7.4 | 8.5 | 7 | 0.010824 | 26.67 | 0.289 |
| 2 | EC | 540 | 1400 | 0 | 0.000066 | 38.57 | 0.003 |
| 3 | TDS | 826 | 500 | 0 | 0.000184 | 165.20 | 0.030 |
| 4 | TH | 700 | 500 | 0 | 0.000184 | 140.00 | 0.026 |
| 5 | Ca | 403 | 75 | 0 | 0.001227 | 537.33 | 0.659 |
| 6 | Mg | 158 | 30 | 0 | 0.003067 | 526.67 | 1.615 |
| 7 | $CO_3^{2-}$ | 364 | 75 | 0 | 0.001227 | 485.33 | 0.595 |
| 8 | $HCO_3^-$ | 356 | 30 | 0 | 0.003067 | 1186.67 | 3.639 |
| 9 | Cl | 159 | 250 | 0 | 0.000368 | 63.60 | 0.023 |
| 10 | $NO_3$ | 20 | 50 | 0 | 0.001840 | 40.00 | 0.074 |
| 11 | $SO_4$ | 73 | 500 | 0 | 0.000184 | 14.60 | 0.003 |
| 12 | Na | 119 | 200 | 0 | 0.000460 | 59.50 | 0.027 |
| 13 | K | 50 | 12 | 0 | 0.007667 | 416.67 | 3.194 |
| 14 | DO | 12.5 | 5 | 14.6 | 0.018400 | 21.88 | 0.403 |
| 15 | BOD | 8.4 | 5 | 0 | 0.018400 | 168.00 | 3.091 |
| 16 | COD | 18.1 | 10 | 0 | 0.009200 | 181.00 | 1.665 |
| | | | | | $\sum W_n$ =0.07636 | $\sum q_n$ = 4071.68 | $\sum W_n q_n$ =15.336 |
| WQI = 200.84 | | | | | | | |

**Table 7**

| Calculation of WQI of water samples in Pre monsoon season of Profile - B | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No** | **Parameters** | **Observed Value ( $V_n$)** | **Standard Values ($S_n$)** | **Ideal Value ($V_{id}$)** | **Unit Weight ($W_n$)** | **Quality Rating ($q_n$)** | **$W_nQ_n$** |

 DOI : 10.18231/2454-9150.2018.0773 

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | pH | 7.3 | 8.5 | 7 | 0.010824 | 20 | 0.216 |
| 2 | EC | 1458 | 1400 | 0 | 0.000066 | 104.14 | 0.007 |
| 3 | TDS | 980 | 500 | 0 | 0.000184 | 196.00 | 0.036 |
| 4 | TH | 724 | 500 | 0 | 0.000184 | 144.80 | 0.027 |
| 5 | Ca | 430 | 75 | 0 | 0.001227 | 573.33 | 0.703 |
| 6 | Mg | 198 | 30 | 0 | 0.003067 | 660.00 | 2.024 |
| 7 | $CO_3^{2-}$ | 333 | 75 | 0 | 0.001227 | 444.00 | 0.545 |
| 8 | $HCO_3^-$ | 384 | 30 | 0 | 0.003067 | 1280.00 | 3.925 |
| 9 | Cl | 353 | 250 | 0 | 0.000368 | 141.20 | 0.052 |
| 10 | $NO_3$ | 20 | 50 | 0 | 0.001840 | 40.00 | 0.074 |
| 11 | $SO_4$ | 68 | 500 | 0 | 0.000184 | 13.60 | 0.003 |
| 12 | Na | 147 | 200 | 0 | 0.000460 | 73.50 | 0.034 |
| 13 | K | 70 | 12 | 0 | 0.007667 | 583.33 | 4.472 |
| 14 | DO | 12.5 | 5 | 14.6 | 0.018400 | 21.88 | 0.403 |
| 15 | BOD | 7.8 | 5 | 0 | 0.018400 | 156.00 | 2.870 |
| 16 | COD | 17 | 10 | 0 | 0.009200 | 170.00 | 1.564 |
| | | | | | $\sum W_n$ =0.07636 | $\sum q_n$ = 4621.78 | $\sum W_n q_n$ =16.954 |
| WQI = 222.02 | | | | | | | |

**Table 8**

| Calculation of WQI of water samples in Monsoon season of Profile - B | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No** | **Parameters** | **Observed Value ( $V_n$)** | **Standard Values ($S_n$)** | **Ideal Value ($V_{id}$)** | **Unit Weight ($W_n$)** | **Quality Rating ($q_n$)** | **$W_nQ_n$** |
| 1 | pH | 7.1 | 8.5 | 7 | 0.010824 | 6.67 | 0.072 |
| 2 | EC | 1420 | 1400 | 0 | 0.000066 | 101.43 | 0.007 |
| 3 | TDS | 969 | 500 | 0 | 0.000184 | 193.80 | 0.036 |
| 4 | TH | 758 | 500 | 0 | 0.000184 | 151.60 | 0.028 |
| 5 | Ca | 440 | 75 | 0 | 0.001227 | 586.67 | 0.720 |
| 6 | Mg | 219 | 30 | 0 | 0.003067 | 730.00 | 2.239 |
| 7 | $CO_3^{2-}$ | 399 | 75 | 0 | 0.001227 | 532.00 | 0.653 |
| 8 | $HCO_3^-$ | 377 | 30 | 0 | 0.003067 | 1256.67 | 3.854 |
| 9 | Cl | 395 | 250 | 0 | 0.000368 | 158.00 | 0.058 |
| 10 | $NO_3$ | 20 | 50 | 0 | 0.001840 | 40.00 | 0.074 |
| 11 | $SO_4$ | 65 | 500 | 0 | 0.000184 | 13.00 | 0.002 |
| 12 | Na | 135 | 200 | 0 | 0.000460 | 67.50 | 0.031 |
| 13 | K | 60 | 12 | 0 | 0.007667 | 500.00 | 3.833 |
| 14 | DO | 12 | 5 | 14.6 | 0.018400 | 27.08 | 0.498 |
| 15 | BOD | 8.3 | 5 | 0 | 0.018400 | 166.00 | 3.054 |
| 16 | COD | 17.9 | 10 | 0 | 0.009200 | 179.00 | 1.647 |
| | | | | | $\sum W_n$ =0.07636 | $\sum q_n$ = 4709.41 | $\sum W_n q_n$ =16.805 |
| WQI = 220.07 | | | | | | | |

**Table 9**

| Calculation of WQI of water samples in Post monsoon season of Profile - B | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No** | **Parameters** | **Observed Value ( $V_n$)** | **Standard Values ($S_n$)** | **Ideal Value ($V_{id}$)** | **Unit Weight ($W_n$)** | **Quality Rating ($q_n$)** | **$W_nQ_n$** |
| 1 | pH | 7.4 | 8.5 | 7 | 0.010824 | 26.67 | 0.289 |
| 2 | EC | 1384 | 1400 | 0 | 0.000066 | 98.86 | 0.006 |
| 3 | TDS | 993 | 500 | 0 | 0.000184 | 198.60 | 0.037 |
| 4 | TH | 855 | 500 | 0 | 0.000184 | 171.00 | 0.031 |
| 5 | Ca | 477 | 75 | 0 | 0.001227 | 636.00 | 0.780 |
| 6 | Mg | 229 | 30 | 0 | 0.003067 | 763.33 | 2.341 |
| 7 | $CO_3^{2-}$ | 431 | 75 | 0 | 0.001227 | 574.67 | 0.705 |

 DOI : 10.18231/2454-9150.2018.0773 

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | $HCO_3^-$ | 385 | 30 | 0 | 0.003067 | 1283.33 | 3.936 |
| 9 | Cl | 430 | 250 | 0 | 0.000368 | 172.00 | 0.063 |
| 10 | $NO_3$ | 20 | 50 | 0 | 0.001840 | 40.00 | 0.074 |
| 11 | $SO_4$ | 68 | 500 | 0 | 0.000184 | 13.60 | 0.003 |
| 12 | Na | 129 | 200 | 0 | 0.000460 | 64.50 | 0.030 |
| 13 | K | 60 | 12 | 0 | 0.007667 | 500.00 | 3.833 |
| 14 | DO | 10.4 | 5 | 14.6 | 0.018400 | 43.75 | 0.805 |
| 15 | BOD | 8.9 | 5 | 0 | 0.018400 | 178.00 | 3.275 |
| 16 | COD | 19.7 | 10 | 0 | 0.009200 | 197.00 | 1.812 |
| | | | | | $\sum W_n$ =0.07636 | $\sum q_n$ = 4961.31 | $\sum W_n q_n$ =18.020 |
| WQI = 235.98 | | | | | | | |

In this study, the WQI values ranges from 190.99, 201.19 and 200.84 for Pre monsoon, Monsoon, Post monsoon respectively for Profile – A. The WQI values of ground water samples ranged from 222.02, 220.07 and 235.98 for Pre monsoon, Monsoon, Post monsoon respectively for Profile – B.

## V. CONCLUSION

The current investigation, the WQI values are ranged from 190.99 to 235.98 and therefore, can be categorized into five types "excellent water" to "water unsuitable for drinking". All the samples exceeded 100, the upper limit for drinking water. Table -2 shows the percentage of water samples that falls under different quality. The high value of WQI at these locations has been found to be mainly from Total dissolved solids, Total hardness, Calcium, Magnesium, Carbonate, Bicarbonate, Potassium, Dissolved oxygen, Biochemical oxygen demand and Chemical oxygen demand in the ground water. All the water samples are poor in quality. In this part, the ground water quality may improve because of inflow of fresh water of good quality during rainy season. Magnesium and Chloride are extensively interrelated and shows that the hardness of the water is permanent in nature. The analysis indicates that the ground water of the location needs few degree of treatment before utilization, and it additionally needs to be protected from the perils of contamination.

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