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Evaluation of potable groundwater in Veppanthattai block Perambalur district using Water Quality Index

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ABSTRACT

Water Quality Index (WQI) is a statistical tool used to transform large quantities of water quality data into single number which represents water quality level. This research work is accomplished to evaluate the quality of groundwater in Veppanthattai block for the purpose of drinking and domestic usage by using Water Quality Index (WQI). WQI requires several parameters to satisfy the calculations. The groundwater samples were collected from 44 different locations of Veppanthattai block during Nov 2012 to Dec 2012. Physicochemical parameters namely pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness(TH), Total Alkalinity (TA), Calcium Hardness (CH), Magnesium Hardness (MH), Chloride, Sulphate, Nitrate, Iron, Dissolved Oxygen(DO), Chemical Oxygen Demand (COD) and Phosphate were assessed to calculate the WQI. The present study indicates that the quality of groundwater in most of the samples is poor in quality for drinking purpose.

Key words: Water Quality Index, Groundwater, Veppanthattai Block, physicochemical parameters.

INTRODUCTION

Water is a dynamic renewable natural resource. Its availability with good quality and adequate quantity is very important for human life and other purposes. In general, the quality of water is equally important as the quantity. Therefore, water quality is considered as an important factor to judge environment changes which are strongly associated with social and economic development [1]. In developing countries about 1.8 million people, mostly children, die every year as a result of water related diseases [2]. It is necessary to obtain accurate and timely information to observe water quality of any water resources [3]. Therefore analysis of water quality is very important and highly social relevance. Water quality must be in the standard range for drinking usage.

Water Quality Index (WQI) is regarded as the most effective ways to communicate water quality. The data of quantitative analysis and world health organization (WHO) standards are used for calculating water quality indices [4,5]. WQI is a dimensionless number that combines multiple water-quality factors into a single number by normalizing values to subjective rating curves [6]. Factors to be included in WQI model could vary depending upon the designated water uses and local preferences. Water quality indices (WQIs) have been developed to integrate water quality variables [7, 8, 9]. A WQI summarizes large amounts of water quality data into simple terms (e.g., excellent, good, poor, etc.) for reporting to managers and the public in a consistent manner [10].

Study Area

Veppanthattai is one of the prominent Taluk in Perambalur District of Tamil Nadu and located 13 km away from Perambalur on the way to Attur. It faces Krishnapuram in the North, Esanai in the South and Valikandapuram in the

East. The average rainfall of the District is 908 mm. The study area gets about 52% annual rainfall during Northeast monsoon, about 34% in the Southwest monsoon timing and approximately 14% in the winter and summer seasons.

MATERIALS AND METHODS

Groundwater samples were collected from forty-four different stations in sterilized 2L poly ethylene containers from different bore wells from the study area during Nov 2012. Maximum care was taken during the collection of samples to avoid any kind of pollution and air bubbles. Volumetric and instrumental techniques were adopted for systematic analysis of the water samples using Standard procedures [11-15]. The analysis was carried out immediately for pH, EC and DO and for all other parameters it was done within the stipulated time.

Calculation of Water Quality Index (WQI)

Water quality index is a tool to determine the conditions of water quality and, like any other tool it requires knowledge about principles and basic concepts of water and related issues [16]. It is a well-known method of expressing water quality that offers a stable and reproducible unit of measure which responds to changes in the principal characteristics of water [17]. WQI is a mechanism for presenting a cumulatively derived numerical expression defining a certain level of water quality [18].

Water Quality Index (WQI) is calculated by using the Weighted Arithmetic Index method. By this method, different water quality components are multiplied by a weighting factor and are then aggregated using simple arithmetic mean.

For assessing the quality of water in this study, the quality rating scale (Qi) for each parameter was calculated by using the following equation;

 $Qi = \{[(Va - Vi) / (Vs - Vi)] * 100\}$

Where,

Qi = Quality rating of ith parameter for a total of n water quality parametersVa = Actual value of the water quality parameter obtained from laboratory analysisVi = Ideal value of that water quality parameter obtained from the standard Tables.Vi for pH = 7 and for other parameters it is equivalent to zero, but for DO Vi = 14.6 mg/LVs = Recommended WHO standard of the water quality parameter.

Then, after calculating the quality rating scale (Qi), the Relative (unit) weight (Wi) is calculated by a value inversely proportional to the recommended standard (Si) for the corresponding parameter using the following expression;

Wi = K/Sn

Where,

K [constant] = $1/[(1/S1) + (1/S2) + (1/S3) + \dots + (1/Sn)]$

Here, Wi = Relative (unit) weight for n^{th} parameter Sn = Standard permissible value for n^{th} parameter

Finally, the overall WQI is calculated by aggregating the quality rating with the unit weight linearly by using the following equation:

$WQI = \sum_{i=1}^{n} (QiWi) / \sum_{i=1}^{n} Wi$

In general, WQI is defined for a specific and intended use of water. For human consumption or uses the WQI values is classified as five types. The value from 0 to 24 indicates quality of water is excellent, the value from 25 to 49 indicates quality of water is good, the value from 50 to 74 indicates quality of water is poor, the value from 75 to 100 indicates quality of water is very poor, the value greater than 100 indicates quality of water is unfit for drinking. These types are summarized in table 1

Table 1: Water quality scale with reference to WQI by using the Weighted Arithmetic Index method

WQI	Quality of water
0-24	EXCELLENT
25-49	GOOD
50-74	POOR
75-100	VERY POOR
>100	UNFIT FOR DRINKING

RESULTS AND DISCUSSION

The standard and ideal value of 14 parameters which is taken for the study is given in table 2. And the Water Quality Index (WQI) value is given in table 3. From the result of the WQI value the following points were observed.

PERAMETERS	PH	TA	TH	DO	Fe	SO_4	Ca	Mg	PO ₄	EC	TDS	NO ₃	Cl	COD
Standard Value (Vs)	8.5	120	300	5	0.3	200	75	30	1	250	500	45	250	10
Unit Weight (Wi)	0.558	0.04	0.0158	0.9493	15.822	0.0237	0.0633	0.1582	4.7465	0.019	0.0095	0.1055	0.019	0.4747
Ideal value (Vi)	7	0	0	14.6	0	0	0	0	0	0	0	0	0	0

The WQI value between 0 and 24 indicates the water quality is excellent for drinking and domestic purpose. In our study there are two stations under this type namely 25 and 44. The WQI value between 25 and 49 indicates the water quality is good. There are twelve stations under this type, also 2, 4, 8, 16, 20, 24, 31, 32, 34, 38, 41 and 43. The WQI value between 50 and 74 indicates the water quality is poor. In which nineteen stations are under this type, they are station 3, 6, 7, 11, 12, 14, 19, 21, 22, 26, 27, 28, 29, 30, 33, 35, 36, 37 and 42.



The WQI value between 75 and 100 indicates the water quality is very poor and six stations are under this type, namely stations 5, 9, 13, 17, 18 and 39. And The WQI value greater than 100 indicates that the water quality is unfit for drinking purpose. There are five stations are under this type, they are station 1, 10, 15, 23 and 40.



The statistics of the above discussed is graphically representing in fig no 1. From the analysis most of the data is lying in poor area and represented in fig no 2. The percentage result of the analysis is mentioned in fig no 3. Through this graph we can conclude that 5% of water belongs to excellent quality, 27% of water belongs to good, 43% of water belongs to poor, 14% of water belongs to very poor and 11% of water belongs to unfit for drinking.

Table 3: WQI value of the sampling stations

Station Num	Name of the Sampling Place	WQI
1	AGARAM	154.84
2	ANUKKUR	31.93
3	ARASALUR	54.42
4	ERAIYUR	41.12
5	K PURAM	98.72
6	KADAMBUR	58.31
7	KOTTARAKUNRU	64.88
8	KUDIKADU	29.39
9	MALAYALAPATTI	77.70
10	MANGALAMEDU	138.23
11	METTUPALAYAM 1	56.84
12	METTUPALAYAM 2	50.45
13	METTUPALAYAM 3	86.97
14	NEIKUPPAI	65.46
15	NERKUNAM	106.84
16	NOOTHAPUR	46.69
17	P DESAM	83.43
18	P PALAYAM	76.68
19	P VADAGARAI	71.84
20	PANDAGAPADI	48.94
21	PASUMBALUR	57.36
22	PIMBALUR	51.00
23	PUTHUR	211.87
24	RAYAPPA NAGAR	36.91
25	T THURAI	20.28
26	THALUTHALAI 1	68.11
27	THALUTHALAI 2	74.21
28	THALUTHALAI 3	74.56
29	THAMBAI	57.25
30	THIRUVALANDURAI	60.88
31	THONDAPADI	27.14
32	UDUMBIAM	44.99
33	V MATHAVI	68.24
34	V R S PURAM	35.12
35	V.KALATHUR	52.76
36	VALIKANDAPURAM	51.59
37	VALLAPURAM	73.88
38	VALLIYUR	29.58
39	VANNARAMPOONDI	76.82
40	VENBAVUR	108.93
41	VENGALAM	43.37
42	VEPANTHATTAI	73.51
43	VGR PURAM 1	39.97
44	VGR PURAM 2	24.78
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Figure 3: graphical data of WQI percentage

CONCLUSION

The above observations of the present study concluded that The WQI value in station 25 and 44 is excellent, and in station 2, 4, 8, 16, 20, 24, 31, 32, 34, 38, 41 and 43 are good. So the usage of groundwater in this area for drinking and domestic purpose is advisable. But in the case of stations 3, 6, 7, 11, 12, 14, 19, 21, 22, 26, 27, 28, 29, 30, 33, 35, 36, 37 and 42 are under very poor category, And station 5, 9, 13, 17, 18 and 39 are unfit for drinking because they are having highest WQI value. When WQI is greater than 100, it implies that the pollutants are above the standard limits. It shows the nature of unsuitability of water for drinking and domestic purpose.

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