Assessment of Water Quality Index for the Groundwater in Part of Thiruvallur District, Tamil Nadu, INDIA

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Abstract : The present study is the aptness and eminence of groundwater for drinking and domestic purposes based on the Water Quality Index (WQI). Groundwater samples were collected in Fifty Nine locations in the year 2016. In this study area over exploitation of groundwater, direct discharge of effluents and agricultural impact. The water quality parameters have been considered for the calculation of water quality index viz. pH, electrical conductivity (EC), total hardness (TH), total dissolved solid (TDS), sodium (Na+), potassium (K+), calcium (Ca2+), magnesium (Mg2+), bicarbonate (HCO3–), chlorides (Cl–), sulphates (SO4–).The values of WQI of the samples were found in the range of 27.11 to 72.88. The majority of groundwater samples fall in good category (72.88%) others fall in excellent category (27.11%). The present study is helpful in proper planning and groundwater management of available water resource for drinking and agricultural purpose.

IndexTerms - **water quality index, groundwater, physicochemical analysis and parameters.** .

I. Introduction

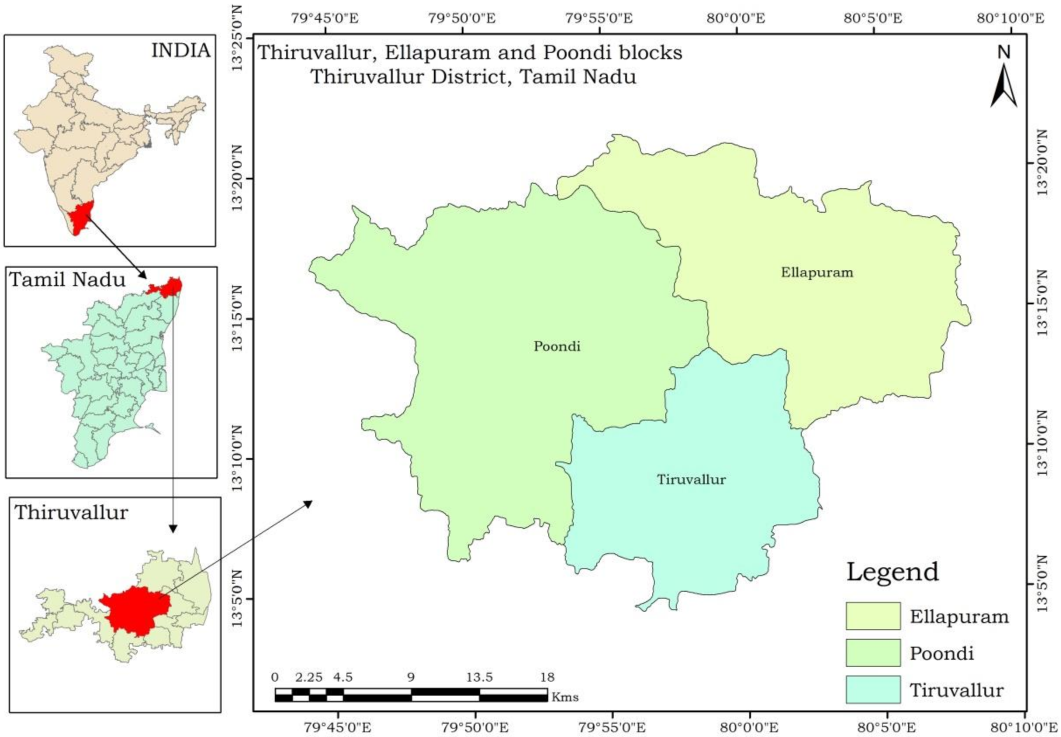
Groundwater occurs almost everywhere beneath the earth surface not in a single widespread aquifer but in thousands of local aquifer systems and compartments that have similar characters. Knowledge of the occurrence, replenishment, and recovery of groundwater has special significance in arid and semi-arid regions due to discrepancy in monsoonal rainfall, insufficient surface waters and over drafting of groundwater resources. Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water, and on sub-surface geochemical processes. Temporal changes in the origin and constitution of the recharged water, hydrologic and human factors, may cause periodic changes in groundwater quality (Vasanthavigar et al 2010). Water quality index (WQI) is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of groundwater. The increase in population, industrialization and the pressure for development in agriculture has led to the over exploitation and pollution of groundwater in most of the places. It has its importance is also high and intensive agriculture is also carried out in this district. These amounts to high demand for quality water in this district. So an attempt has been made to assess the quality of groundwater in this district. Quality of groundwater cannot be assessed by a single parameter. So it is usually assessed by Water Quality Index (WQI). Water quality index relates a group of water quality parameters to a common scale and combines them into a single number in accordance with a chosen method of computation (Chaturvedi et al. 2008). WQI implies that the water under consideration is fit for human consumption if its WQI is greater than 300 and is unfit for drinking without treatment if its WQI is lesser than or equal to 100 is useful for drinking and agriculture (Ramakrishnaiah et al., 2009). Water quality index is a very useful tool for communicating the information on overall quality of water (Pradhan et al. 2001). WQI is defined as a rating reflecting the composite influence of different water quality parameters. The concept of WQI to represent gradation in water quality was first proposed by Horten, 1965. It is calculated from the point of view of the suitability of groundwater for human consumption. The objective of the present work is to discuss the suitability of groundwater for human consumption based on computed water quality index values. I.A. Kwami et al .,(2018). So in the present study WQI was used to assess the quality of groundwater in the part of Thiruvallur district.

II. STUDY AREA

The study area has been sub divided in to three blocks Thiruvallur ,Ellapuram and Poondi of Thiruvallur district, and is located in northern part of Tamil Nadu with an aerial extent of 792 Sq.kms. The entire study area falls in toposheet no. 66C/3, 66C/4, 57O/16 and 57O/15 .The geographical location of North Latitude between 12°10’00” and 13°15’00”East Longitude between 17°15’00” and 80°20’00”. The region is mainly occupied by sedimentary formation and rocks belonging to Archean and Proterozoic. The area under investigation is a part of the east flowing Araniar–Korattaiyar and Cooum sub-basins. The Monsoon Rivers like Araniyar and Korattalayar, are the important rivers and the drainage pattern is generally dendritic. (Figure: 1). Ground water occurs under phreatic conditions in the weathered mantle and under semi-confined conditions in the fissured and fractured zones at deeper levels. The depth to water level in the district varied between 2.38 and 7.36 m bgl (CGWB 2007). The study area is mainly influenced by agriculture activities chiefly donated for Groundnut, Rice, Sugarcane, Ragi, Cumbu. Hydrogeomorphological units such as patterns are Agricultural Land ii) Build-up Land iii) Waste Land iv) Forest and Water Bodies. The aim of the study is to assess the water quality for irrigation and drinking water purposes in part of Tiruvallur District, Tamil Nadu, India.

III. METHODOLOGY

Fifty-nine ground water samples were collected from open wells and bore wells in the study area (Figure: 1). Sampling and analysis was carried out using standard procedures (APHA 2012; Ramesh and Anbu 1996;). Five hundred milliliters of 2water samples was collected in polyethylene bottle. Bore water was collected by pumping out the stagnant water for 20 min with hand pump, to get representative samples. Then, it was sealed and brought to the laboratory for analysis, stored properly and filtered with 0.45lm filter paper before analysis. The Temperature, Electrical conductivity (EC), and pH were measured using a Digital Water and Soil Analysis Kit Model-161 Aristocrat at the sample collection site itself. SO4 of the samples were determined by ELICO SL 27 Spectrophotometer. Na and K of the samples were determined by ELICO CL 354 Flamephotometer. The carbonate and bicarbonate were determined by titration with 0.2 N sulphuric acid using phenolphthalein and methyl orange indicators. The analytical precision of the measurements of ions was determined by calculating the ionic balance error, which was observed to be within the standard limit of ±10 %.



IV. Water Quality Index (WQI)

Water quality index is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water (Tiwari and Manzoor, 1988). The WQI was calculated to evaluate the suit ability of groundwater quality for drinking purposes. Water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public. In this study, for the calculation of WQI, 11 important parameters were chosen. The WQI was computed in four steps as follows: In the first step, each parameter has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes. The maximum weight of 5 is assigned to parameters like total dissolved solids, chloride, sulphate and due to their major importance in water quality assessment (Srinivasamoorthy et al., 2008). Bicarbonate is given the minimum weight of 1 as it plays an insignificant role in the water quality assessment. Other parameters like calcium, magnesium, sodium and potassium are assigned a weight between 1 and 5 depending on their importance in the overall quality of water for drinking purposes. In the second step, the relative weight (Wi) is computed using a weighted arithmetic index method given below (Tiwari and Manzoor, 1988) in the following steps:

$W_i = W_i / \sum^{n}_{i=1} w_i$

(1)

Where, Wi is the relative weight, wi is the weight of each parameter and n is the number of parameters. In the third step, a quality rating scale (Qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines of WHO (2011) and then multiplied by 100:

$Q_i = (C_i / S_i) \times 100$ (2)

Where Qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/l, and Si is the WHO drinking water standard for each chemical parameter in mg/l according to the guidelines of WHO (2011). In the fourth step, the SI is determined first for each chemical parameter, which will then be used to determine the WQI as per the following equation: $SI_i = W_i \times Q_i$ (3)

SIi is the sub index of ith parameter and Qi is the rating based on concentration of ith parameter. The overall water quality index (WQI) is calculated by adding together each sub index values of each groundwater samples as follows: $WQI = \Sigma SI_i$ (4)

Computed WQI values are usually classified into five categories: excellent, good, poor, very poor and unfit water for drinking purposes (Ramakrishnaiah, et al., 2009). This classification is presented in Table 1. Spatial distribution map of the water quality index was plotted using Arc GIS 10.3.

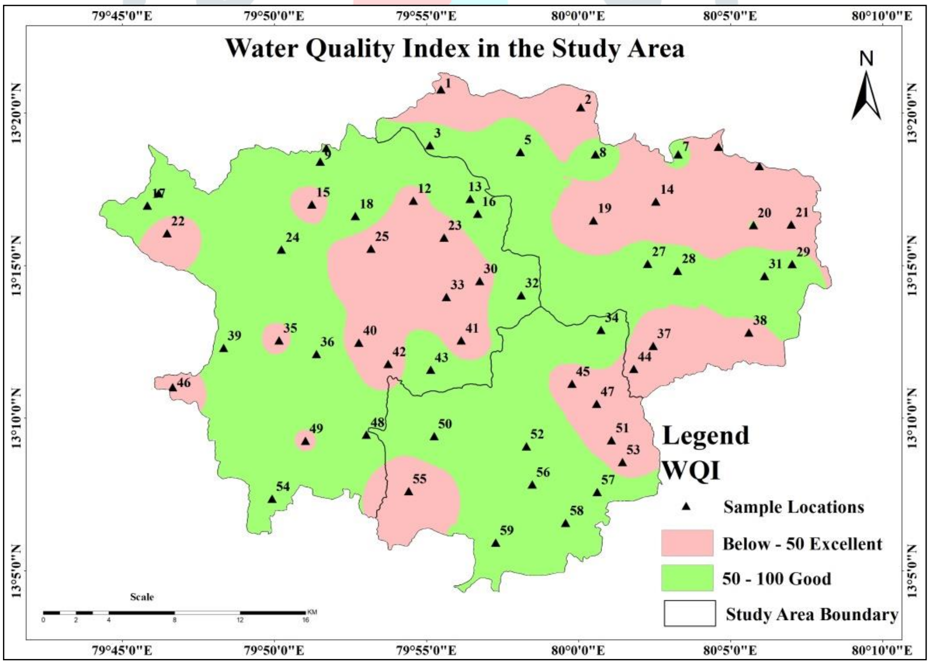


Fig. 2: Spatial distribution of WQI in the Study Area

Table : 1 Minimum and Maximum Values of anion and cations in mg/l for the present study

	Minimum	Maximum	Average	WHO(2011)
Ec	425.32	2230.59	1324.28	1500

TDS	301.98	1583.72	940.24	500
Ph	6.50	8.42	7.46	6.5-9.2
Ca^{+}	15.38	230.625	140.6602	75
Mg^{+}	19.3325	121.0825	47.93926	50
Na^{+}	16.504	216.615	90.80582	200
K^{+}	2.03	29.435	9.617541	12
Cl^{-}	46.2375	365.79	170.9861	250
So_4^{-}	34.5814	175.9583	92.15593	250
HCO_3^{-}	66.1888	422.9878	325.0948	500
TH	204.4002	1035.243	548.9825	300

V. RESULTS AND DISCUSSION

Table 1, indicating the statistical summary of the analysed parameters in reveals that the minimum and maximum value of total dissolved solids was 301.98 and 1583.72 mg/l, electrical conductivity was 425.32 to 2230.59 µmhos/cm, pH was 6.50 to 8.42, chloride was 46.23 to 365.79 mg/l, total hardness was 204.40 to 1035.24 mg/l, sulphate was 34.58 to 175 mg/l, calcium was 15.38 to 230.62 mg/l, magnesium was 19.33 to 121.08 mg/l, sodium was 16.50 to 216.61 mg/l, potassium was 2.03 to 29.43 mg/l. Spatial distribution of groundwater quality for drinking in the entire study area was represented using GIS software Arc Gis 10.3.

Table: 2 Relative Weight of Chemical Parameters

Parameters	Weight (w_i)	Relative Weight (W_i)
Ca^{+}	4	0.085
Mg^{+}	3	0.064
Na^{+}	4	0.085
K^{+}	3	0.064
Cl^{-}	5	0.106
$Hco3^{-}$	1	0.021
$So4^{-}$	3	0.064
pH	5	0.106
EC	5	0.106
TDS	5	0.106

TH	5	0.106

Table: 3 Water quality classification based on WQI value (Ramakrishnaiahet al., 2009).

WQI Value	**Rating of Water Quality**	**Nos.**	**%**
<50	Excellent	16	27.11864
50-100	Good	43	72.88136
100-200	Poor	0	0
200-300	Very Poor	0	0

VI. CONCLUSION

Gradually the population of the city is swiftly increasing, so for drinking and other consistent activities the people are liable on ground water and extracted much ground water domestic and irrigation. The fallouts of water quality index for drinking purposes revealed values ranging from 27.11% to 72.88% indicating excellent to good quality water. This shows that groundwater in the study area is fit for drinking purpose. But, the groundwater quality needs further investigations to see if there exists violence in its quality as far as irrigation practice is undertaking.

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