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Archives of Applied Science Research, 2013, 5 (3):21-26 (http://scholarsresearchlibrary.com/archive.html)



Water quality index of ground water around Ampikapuram area near Uyyakondan channel Tiruchirappalli District, Tamil Nadu, India

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ABSTRACT

The present work is aimed to water quality index (WQI) for the groundwater samples collected an Ampikapuram area near Uyyakondan channel Tiruchirappalli district. This has been determined by collecting ground water samples and subjecting the samples to a comprehensive physicochemical analysis. For calculating the WQI, the following 10 parameters have been considered: pH, EC, TDS, TH, DO, COD, BOD, Cl, NO₃ and Mg. The WQI for these samples ranged between is 244 to 383.8. The analysis reveals that the groundwater of the area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination.

Key words: Physicochemical parameters; Ampikapuram area; Water quality index

INTRODUCTION

Water is indispensable and one of the precious natural resource of our planet. Ground water is an important natural source of water supply all over the world. It is used in irrigation, industries and domestic purpose [1]. Ground water quality depends on the quality of recharged water, atmospheric precipitation, in- land surface water, and on subsurface geochemical processes. Temporal changes in the origin and constitution of the recharged water, hydrologic and human factors, may cause periodic changes in groundwater quality. According to WHO, about 80% of all the diseases in human beings are caused by water? Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from their sources. Groundwater chemistry has been utilized as a tool to outlook water quality for various purposes [2]. WOI is an important technique for demarcating groundwater quality and its suitability for drinking purpose [3].WOI is computed to reduce the large amount of water quality data to a mere numerical value that expresses the overall water quality at a certain location and time based on several water quality parameters [4]. The standards for drinking purposes as recommended by WHO (2003) have been considered for the calculation of WOI. There are three steps for computing WOI. In the first step, each of the ten parameters (pH, , EC, TDS, TH, DO, COD, BOD, Cl, No₃ and Mg has been assigned a weight (W_i) according to its relative importance in the overall quality of water for drinking purposes. Water quality index is one of the most effective tools to communicate information on the quality of any water body. WOI is a mathematical equation used to transform large number of water quality data into a single number. It is simple and easy to understandable for decision makers about quality and possible uses of any water body [5]. It serves as the understanding of water quality for the possible uses by integrating complex data and generating a score that describes water quality status.

J Sirajudeen et al

Study area

Tiruchirappalli is one of the most important industrial cities in Tamil Nadu. The Uyyakondan channel is a tributary of river Cauvery. The channel starts from Pettavathalai located about 35 km of Trichy city and flows via many villages and some parts of cities. Ampikapuram, which is located in 10 Km away from Tiruchirappalli. The population of the area is around 20,000. Many industries like distillery, small scale industries are located in and around this area. They are discharging the waste water, untreated effluent into the open lands them by polluting ground water through percolation. People of this area have population depending only on the ground water as the main source for drinking purpose and other purposes. Hence the present study has been undertaken to analyze the ground water quality in and around Ampikapuram area.

Map showing location area



MATERIALS AND METHODS

In present investigation ten ground water samples were collected from ten different stations during the year March - 2012 and June 2012 at Ampikapuram area Tiruchirappalli district. The water samples were collected in polythene bottles which were cleaned with acid water, followed by rinsing twice with distilled water. The water samples were chemically analyzed. [6] The analysis of water was done using procedure of standard methods. Ten parameters were analyzed for WQI such as pH, EC, TDS, TH, DO, COD, BOD, Cl⁻, NO₃ and Mg.

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J Sirajudeen et al

Water Quality Index:

Water quality index (WQI) is defined as a technique of rating that provides the composite influence of individual water quality parameter on the overall quality of water. It is calculated from the point of view of human consumption. Water quality and its suitability for drinking purpose can be examined by determining its quality index. The standards for drinking purpose have been considered for calculation of WQI. In this method the weightage for various water quality parameters is assumed to be inversely proportional to the recommended standards for the corresponding parameters [7, 8].

The Calculation Involves the Following Steps:

First, the calculation of weightage of ith parameter. Second, the calculation of the quality rating for each of the water quality parameters. Third, the summation of these sub-indices in the overall index

The Weightage of ith Parameter

$$W_{i} = k/S_{i} \tag{1}$$

Where W_i is the unit of weightage and S_i the recommended standard for ith parameter (I = 1-6), k is the constant of proportionality

Individual quality rating is given by the expression

$$Q_i = 100 V / S_i$$
⁽²⁾

Where Qi is the sub index of ith parameter, Vi is the monitored value of the ith parameter in mg/l and S_i the standard or permissible limit for the ith parameter.

The Water Quality Index (WQI) is then calculated as follows

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

Where, Q_i is the sub index of i^{th} parameter. W_i is the unit weightage for i^{th} parameter, n is the number of parameters considered. Generally, the critical pollution index values is 100

RESULTS AND DISCUSSION

Table 1: Physico-chemical parameters of ground water samples collected Ampikapuram area in the month of March 2012

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Ph	8.5	8.6	8.5	8.9	8.6	7.6	8.7	6.8	7.6	7.5
EC	8300	5700	6600	2900	1330	1490	1870	2430	1250	1440
TDS	3156	2168	2337	1083	4743	5373	6855	8915	6686	5367
TH	2440	2960	3160	2680	3200	3200	6720	6440	3200	3600
DO	5	3	3	3	3	2	3	4	4	3
BOD	19.8	18.6	12.6	17.4	17.4	10.8	19.8	18.0	18.6	12.6
COD	91.0	40.0	62.8	77.1	45.7	91.4	114.2	108.5	74.2	51.4
Cl	720.8	522.4	559.1	240.0	1708	1671	2386	3360	1383	1750
NO ₃	27.3	9.5	9.5	88.7	11.9	8.9	44.2	43.9	458.0	56.4
Mg	204.6	48.7	126.6	53.0	182.7	365.4	626.1	765.0	487.2	225.3

All the values are expressed in ppm expect pH and EC (micro mho cm⁻¹)

pН

pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. Most of the water samples are slightly alkaline due to presence of carbonates and bicarbonates. The pH values of water samples varied between 6.8 to 8.4 and were found below the limit prescribed by WHO (6.5-8.5). The higher range of pH indicates higher productivity of water, [9].

(3)

Parameters	S1	S2	S3	S4	S5	S6	S7	S 8	S9	S10
pН	8.0	8.3	6.8	6.8	7.2	7.4	6.9	6.7	7.1	7.8
EC	6000	4100	6100	8000	3000	6000	8700	1200	6000	6600
TDS	2307	3478	5133	3000	2438	500	7331	9916	8872	5571
TH	2320	2480	2720	2340	3660	3200	4800	7400	3900	3880
DO	10	6	10	10	6	8	16	24	16	16
BOD	40.8	48.0	38.0	34.0	34.0	40.0	30.0	42.0	38.0	42.0
COD	95.0	99.0	97.1	78.0	92.0	103.0	120.0	123.4	100.0	107.0
Cl	649.5	1171	1666	2400	6071	564.8	1598	2230	564.4	1623
NO ₃	23.1	12.2	12.2	66.1	9.6	7.9	52.3	59.7	396.2	44.3
Mg	90.1	934	411.7	601.8	52.3	179.8	231.4	825.9	36.5	177.7

 Table 2: Physico-chemical parameters of ground water samples collected Ampikapuram area in the month of June 2011

Electrical conductivity (EC)

Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts [10]. EC values wherein the range of 4900 micro-ohms/cm to 10500 microohms/cm. High EC values were observed for all sampling points indicating the presence of high amount of dissolved inorganic substance. When EC values exists 600microohms/cm, the generation of almost all the crops would be affected and it may result in much reduced yield [11].

Total Dissolved Solids (TDS)

Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/L is also allowed [12]. TDS values varied from 2041 mg/L to 9415 mg/L. In the present investigation TDS values are showed higher than the prescribed limit given by WHO. The TDS concentration was found to be above the permissible limit may be due to the leaching of various pollutants into the ground water which can decrease the pot ability and may cause gastrointestinal irritation in human and may also have laxative effect particularly upon transits. High level of TDS may aesthetically be unsatisfactory for bathing and washing [13].

Total Hardness (TH)

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water [13] .Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values shown range from 2380 mg/L to 6920 mg/L. The TH values for all water sample were found higher than the prescribed limit WHO (500 mg/L).This may be mainly due to the contamination by the large quantities of Sewage and detergents and the high total hardness would lead to heart disease and kidney stone formation.

Magnesium

Magnesium is directly related to hardness. Magnesium content in the investigated water samples was ranging from 269 mg/L to 715 mg/L which were found above the WHO limit(150mg/L). This may be due to the logging of the sewage and dissolution and rock weathering of soil. This may be due to a gusting in intestinal irritation of human system [14].

Chloride

The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects [15]. In the present analysis, chloride concentration was found in the range of 342 mg/L to 1312 mg/L. The values are observed higher than the limit WHO(250mg/L). Higher chloride concentration in samples from sites may be due to big discharge of sewage near the sampling sites. It cause impart a salty taste to water and accelerate corrosion of metals.

Dissolved Oxygen

Dissolved Oxygen is one of the important parameter in water quality assessment. Its presence is essential to maintain variety of forms of life in the water and the effect of waste discharge in a water body are largely determined by the oxygen balance of the system. It can be rapidly removed from the wastewaters by discharge of the oxygen demanding waste. DO values are obtained in the study were recorded above the permissible limit of WHO(6mg/L), that the ground water samples are showed free from organic contamination. The higher value of DO can impart good aesthetic taste to drinking water [16, 17].

All the values are expressed in ppm expect pH and EC (micro mho cm^{-1})

J Sirajudeen et al

Chemical oxygen demand (COD) and Biochemical oxygen demand (BOD):

COD is a measure of pollution in aquatic ecosystems. It estimates carbonaceous factor of organic matter. In present study obtained in the range of 69.5mg/L to93.0 mg/Land above the permissible limit set by WHO (10mg/L).BOD is the amount of oxygen required by the living organisms engaged in the utilization and ultimate destruction or stabilization of organic water. It is a very important indicator of the pollution status of a water body. The BOD value shown range from24.9 mg/L to 30.3 mg/L. The BOD values for all water sample were found higher than the prescribed limit WHO(10mg/L).Both BOD and COD may be due to discharge of domestic sewage and industrial waste water to soil and water bodies and may be due to the logging of the industry wastes[18]. Large quantities of domestic sewage, agricultural wastes and other wastes may contribute to the high values of chemical oxygen demand. High COD and BOD may causes to affect the aquatic life.

Nitrate

Groundwater contains nitrate due to leaching of nitrate with the percolating water. Groundwater can also be contaminated by sewage and other wastes rich in nitrates. The nitrate content in the study area varied in the range of84.0 mg/L to 77.4 mg/L and found above the prescribed limit set by WHO (50 mg/L). The high concentration of nitrate may be due to the various agriculture and anthropogenic activities. The excess amount of nitrate causes shortness breath and blue baby syndrome in infants [19, 20].

The calculation of water quality index is taken in the table 1&2. In this study, the computed WQI values ranges from 244 to 383.8 and therefore, can be categorized into four types "excellent water" to "water unsuitable for drinking". Table 5 shows the percentage of water samples that falls under different quality. The high value of WQI at these stations has been found to be mainly from the higher values of EC. Total hardness, total dissolved solids, chloride, magnesium, nitrate, COD and BOD in the groundwater.

Table 3: Calculation of WQI values for the physico- chemical parameters of ground water around Ampikapuram area in the month of March 2012.

Parameters	Mean value in ppm (Vi)	Highest permitted value(WHO)(Si)	Unit of weightage	Wi × Qi
pН	8.1	8.5	0.1	9.52
EC	3331	600	0.001	0.555
TDS	4668.3	500	0.002	1.867
TH	3760	500	0.002	1.504
DO	3.3	6	0.16	8.8
BOD	16.5	10	0.1	16.5
COD	75.6	10	0.1	75.6
Cl	1430	250	0.004	2.288
NO ₃	75.8	50	0.02	3.032
Mg	308.4	150	0.006	1.233

$WQI = \sum_{i=1}^{n} (Qi Wi) / \sum_{i=1}^{n} WiWQI = 244.0$

Table 4 : Calculation of WQI values for the physico- chemical parameters of ground water around Ampikapuram area in the month of June 2012

Parameters	Mean value in ppm (Vi)	Highest permitted value(WHO)(Si)	Unit of weightage	Wi × Qi
pH	7.3	8.5	0.1	8.58
EC	5570	600	0.001	0.928
TDS	3668.7	500	0.002	1.467
TH	3670	500	0.002	1.468
DO	12.2	6	0.16	32.52
BOD	38.6	10	0.1	38.6
COD	101.4	10	0.1	101.4
Cl	1853	250	0.004	2.964
NO ₃	68.3	50	0.02	2.732
Mg	354	150	0.006	1.416

WQI = $\sum_{i=1}^{n} (Qi Wi) / \sum_{i=1}^{n} WiWQI$ = 383.8

Table 5: Status categories of WQI

WQI	STATUS
0-25	Very good
26-50	Good
51-75	Poor
< 75	Very poor

CONCLUSION

The ground water samples were collected from 10 different places at Ampikapuram in Triuchirappalli district. The samples were subject to physico-chemical analysis. The results were showed most of the physico-chemical parameters like pH, TH,TDS, COD,BOD,EC and Cl are well above the permissible limit set by WHO(2003). In this study, the application of water quality index technique is used for the determination of ground water quality in around ampikapuram area. Assembling different parameters in to one single number leads an easy interpretation of water quality. However the water quality index values in the present investigation were reported to be greater than 75 (244 to 383.8) for all the samples indicating that the water is and unfit for drinking and domestic purpose. So people should be made aware of the water quality importance on sanitation and economical water treatment methods like filtration and boiling would prove beneficial to avoid waterborn disease. The remedial measure must be taken immediately to safeguard and conserve the precious water resources from pollution for future generation.

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