INVESTIGATION OF WATER QUALITY IN AMBUR CITY BY WATER QUALITY INDEXING

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ABSTRACT

Present study is carried out for the assessment of ground water quality and comparing its suitability for drinking purpose in Ambur city in Tirupattur District, Tamil Nadu, India. Water quality index is calculated on the basis of pH, conductivity, total dissolved solids, total hardness, Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, alkalinity, and SO_4^{2-} content of the water samples. Water quality index study show that the ground water quality of the study area is deteriorated due to high value of total dissolved solids, conductivity, total hardness, calcium, magnesium, chloride, and sulphate in water samples.

Keywords: *Ambur city, water quality index, total dissolved solids, total hardness, ground water quality*

INTRODUCTION

Groundwater is ultimate, most suitable fresh water resource for millions of people for both drinking and irrigation. Ground water was considered to be very clean and safe in past but nowadays it is getting contaminated due to rapid industrialization and increasing human population. The groundwater quality in any area is determined by its physical and chemical parameters which depend on geological formations, climatic conditions and anthropogenic activities. Both the natural (such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere) and anthropogenic activities (such as mining, processing and the use of metal-based materials, agricultural practices) have resulted in contamination of ground water [1]. Faecal pollution of drinking water causes water born disease which has led to the death of millions of people [2, 3]. Wastes from manufacturing, power-generating, mining, construction, and food processing industries are the major sources for water pollution [4]. It is found that 70 - 80 % of water pollution is due to the untreated domestic sewage [5, 6]. Nowadays, the use of synthetic fertilizers, pesticides and herbicides in farming and gardening has become common around the world. When these chemicals enter into water bodies, they can cause disease in humans and

animals. These chemicals had an adverse effect on ground water quality [7]. Hepatitis, typhoid, diarrhoea, and dysentery are the common diseases which are caused by contaminated water [4]. It is very essential and important to check the water before it is used for drinking, domestic, agricultural or industrial purpose. Water must be tested with different physico-chemical parameters. Water quality index provides 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. In general, water quality indices incorporate data from multiple water quality parameters into a mathematical equation that rates the health of a water body with number. In this study, for the calculation of water quality index, eleven important parameters were chosen. The objective of this study is to analyse the ground water quality in the town of Ambur. This study highlights the contamination of water in Ambur.

Study Area

Ambur is a town in Tirupattur District, Tamil Nadu, India. It is an industrial area comprising many tannery industries. Due to excessive industrial effluents over the year, it has made the ground water and surface water in the region unfit for any use, be it for drinking or irrigational purpose. Figure 1 shows the geographic location of Ambur city.

EXPERIMENTAL

To analyse the contamination of water, 16 ground water samples were collected from different locations in the area chosen in January 2019. In this study, 12 physico-chemical parameters (pH, total dissolved solids (TDS), conductivity, turbidity, alkalinity, hardness, calcium, magnesium, sulphate, chloride, sodium, and potassium) were analysed.
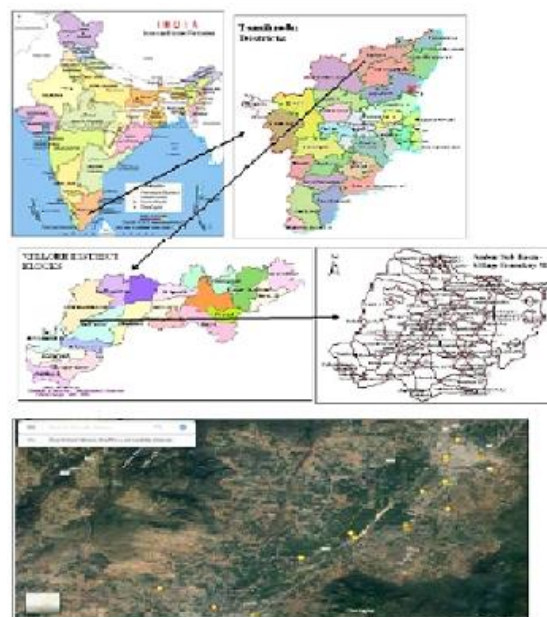

Figure 1. Map of study area (Ambur city)

Physiochemical parameters

Testing of pH was carried out with the use of aquasol pH meter (Model AM-PH-01) at the time of collection of samples. Turbidity measurement is based on a comparison of the intensity of light scattered by a sample and a standard reference under the same conditions. Turbidity is measured by Deluxe turbidity meter (Digital Turbidity meter ME 988, by Max Electronics India). TDS is calculated by the evaporation method. Testing of conductivity was carried out with the use of digital conductivity meter (model No: 611 by Electronics India). The determination of chloride is made by $AgNO_3$ titration (Mohr's titration). Total hardness (TH), calcium and magnesium determination is carried out by complexometric titration using sodium salt of ethylene-diamine tetra acetic acid (EDTA). The concentration of sodium and potassium in the water samples were determined by flame photometer (systronic, model No: 128). Alkalinity was measured by titrating the water samples with standard acid using phenolphthalein and methyl orange as indicator. Sulphate content of water samples was measured with the turbidity method.

Water quality index

Water quality index (WQI) is calculated on the basis of eleven important water quality parameters (pH, conductivity, TDS, TH, Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, alkalinity and SO_4^{2-}). The WQI has been calculated by using the standards of drinking water quality recommended by the Bureau of Indian Standards (BIS) [8] and Indian Council for Medical Research (ICMR) [9]. The weighted arithmetic index method [10] has been used for the calculation of WQI of the drinking water samples collected from various locations in Ambur.

Further, quality rating or sub index (q_n) was calculated using the following expression:

$$q_n = 100[V_n - V_{io}] / [S_n - V_{io}] \qquad (1)$$

where is: q_n - quality rating for the n-th water quality parameter, V_n - estimated value of the n-th parameter at a given sampling station, S_n - standard permissible value of the n-th parameter, V_{io} - ideal value of n-th parameter in pure water (i.e., 0 for all other parameters except the parameter pH and dissolved oxygen (7.0 and 14.6 mg/l respectively)

Unit weight was calculated by a value inversely proportional to the recommended standard value S_n of the corresponding parameter:

$$W_n = \frac{K}{S_n} \qquad (2)$$

where is: W_n - unit weight for the n-th parameters, S_n - standard value for n-th parameters, K - constant for proportionality.

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly:

$$WQI = \frac{\sum q_n W_n}{\sum W_n} \qquad (3)$$

RESULTS AND DISCUSSION

Physiochemical parameters

Details of physicochemical parameters at various locations of the study area have been tabulated and shown in Table 1. Range of the pH lies between 7.1 to 8.4, which follows the standards (Table 2) given by Council of Medical Research (ICMR 1975) and Bureau of Indian Standards (BIS 2012). The value of electrical conductivity (EC) ranges from 620 - 4984 µS/cm in study area. TDS found to be in the range of 395.5 - 3250 mg/l. About 63 % of the water samples had TDS above the limit (500 mg/l) set by BIS. High level of TDS indicating poor water quality in the study area. Turbidity falls in the range of 11.6 - 55 NTU. All samples had turbidity value greater than the ICMR and BIS recommended limit. The hardness values are within the range of 50 - 1587.5 mg/l. Calcium and magnesium ions from sedimentary rocks, seepage and runoff from soils are the sources of hardness in water. Based on ICMR limit, 94 % of the collected water samples had alkalinity above the maximum permissible limit of 120 mg/l. The concentration of sodium and potassium in the study area varies from 0.5 - 97.1 mg/l and from 0 - 22.5 mg/l respectively. 100 % of the water samples had chloride content above the ICMR limit. High value of chloride may be due to contamination from a tannery industry.

Water quality index

The WQI values of the samples are summarized in Table 3. WQI values in the study area range from 73.6 to 491.5. The WQI classification [11] shows that 19 % of water samples have very poor water status, 6 % of water samples have poor water status, and 75 % of water samples have been found unsuitable for drinking. This may be due to the location of the study area which is dominated by tannery industries and construction activities. Excellent water quality has not been observed in any location in the study area.

Table 1. Water quality data of Ambur city

Sample ID	Place	Coordinates	pH	Conductivity (µS/cm)	TDS (mg/l)	Turbidity (NTU)	TH (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Alkalinity (mg/l as $CaCO_3$)	Sodium (mg/l)	Potassium (mg/l)	Sulphate (mg/l)	Chloride (mg/l)
WD1	Udayendram	12°41'34.0"N 78°37'05.3"E	8.4	685.8	470.32	18.9	52.5	12	5.4	135	7.01	0	7.19	799.68
WD2	Pallipattu	12°27'28.5"N 78°34'05.6"E	8.3	630.2	410.65	16	50	22	0	125	7.61	0	6.09	599.8
WD3	Veliagaram	13°19'30.1"N 79°26'23.2"E	7.7	619.8	395.55	26.5	197.5	118	0	355	12.65	10	100.81	749.6
WD4	Chinnapallikuppam	12°43'24.0"N 78°39'13.5"E	8.3	689.7	425.76	13.1	55	16	3.6	145	3.29	13	49.83	599.8
WD5	Melkrishnapuram	12°47'02.8"N 78°42'40.1"E	7.6	708.5	487.21	26.7	195	98	0	290	12.3	21.2	101.57	699.6
WD6	Kethandapatty	12°55'45.1"N 78°21'01.2"E	8	658.5	425.23	12.5	175	58	7.2	320	0.54	18.2	47.55	649.6
WD7	Dharmapuri	12°12'33.3"N 78°06'05.1"E	7.5	810.52	524.22	25.6	275	106	2.4	455	54.35	12.1	97.38	999.6
WD8	Vaatimanai	12°47'49.3"N 78°42'53.8"E	7.8	907.6	615.82	28.1	212.5	94	0	315	9.81	13.1	106.89	599.8
WD9	Maniyarakuppam	12°44'23.5"N 78°40'13.1"E	8.2	925.4	632.23	11.6	62.5	22	1.8	100	7.58	22.5	11.60	599.8
WD10	Sanankuppam	12°46'31.3"N 78°42'09.4"E	7.7	845.9	576.25	14.5	150	42	10.8	320	21.49	11.79	14.50	649.6
WDI1	Periyankuppam	12°45'09.5"N 78°42'02.8"E	7.2	2885	1850	48.7	1100	701	0	330	82.96	10.14	370.51	2149.2
WDI2	Vinnamangalam	12°44'42.2"N 78°41'30.0"E	7.2	3558	2425	38.4	1542.5	822	0	340	29.76	0	292.15	3448.8
WDI3	Minnur	12°44'03.1"N 78°40'17.9"E	7.4	2774	1520	12.8	1587.5	982	0	280	37.05	12.5	486.91	4098.6
WDI4	Gandhi nagar	12°46'26.7"N 78°43'40.8"E	7.5	4568	3080	55	725	561	0	330	97.11	0	418.44	2149.2
WDI5	Sanan Kuppa	12°46'27.5"N 78°42'34.8"E	7.9	4984	3250	14.2	212.5	60	15	325	7.86	11.03	108.03	699.6
WDI6	Ambur Plantation	12°45'57.0"N 78°43'00.9"E	7.1	3048	2042	45	775	481	0	370	20.39	11.76	258.67	2049.2

Table 2. Drinking water standards and recommending agencies

S No.	Parameters	Standards	Recommended agency
1.	pH	6.5 - 8.5	ICMR/BIS
2.	Electrical conductivity (µS/cm)	300	ICMR
3.	Total dissolved solids (mg/l)	500	ICMR/BIS
4.	Turbidity (NTU)	5	ICMR/BIS
5.	Hardness (mg/l)	300	ICMR
6.	Calcium (mg/l)	75	ICMR/BIS
7.	Magnesium (mg/l)	30	ICMR/BIS
8.	Alkalinity (mg/l)	120	ICMR
9.	Sodium (mg/l)	50	BIS/WHO
10.	Potassium (mg/l)	12	BIS/WHO
11.	Sulphate (mg/l)	150	ICMR/BIS
12.	Chlorides (mg/l)	250	ICMR

Table 3. WQI values of samples

Sample ID	WQI	Water quality status
WD1	86.9	Very poor
WD2	73.6	Poor
WD3	117.2	Unsuitable for drinking
WD4	89	Very poor
WD5	120.8	Unsuitable for drinking
WD6	133.4	Unsuitable for drinking
WD7	161.4	Unsuitable for drinking
WD8	158.4	Unsuitable for drinking
WD9	97.6	Very poor
WD10	121.7	Unsuitable for drinking
WD11	386.2	Unsuitable for drinking
WD12	473.45	Unsuitable for drinking
WD13	491.5	Unsuitable for drinking
WD14	445.1	Unsuitable for drinking
WD15	316.2	Unsuitable for drinking
WD16	345.7	Unsuitable for drinking

CONCLUSION

Study of physicochemical parameters of the ground water of Ambur city indicates excess amount of TDS, EC, total hardness, calcium, magnesium, chloride and sulphate in water samples. The majority of water samples were found to be beyond desirable limits as prescribed by ICMR and BIS. Natural weathering, anthropogenic sources, excess groundwater extraction, and different polluting agents from tannery industry are contaminating the groundwater in the study area. The overall view of higher WQI of the present study indicates the deteriorated water quality and therefore it is unsuitable for human consumption. Hence, regular investigation of groundwater quality is required to observe the rate and type of contamination.

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