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Research paper

Groundwater Quality Assessment in Ambattur Industrial Estate

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Abstract

Groundwater is generally used for various purposes, particularly domestic and industrial purposes in all over the world. Fresh water from groundwater sources is high in the recent years and the groundwater is polluted high because of rapid population and industrial growth. It is very difficult to restore the contaminated groundwater by various pollutants. Hence, it is important to analyse physico-chemical parameters of groundwater for its need for various sectors. Therefore, the present study was under taken to define the quality of groundwater with the help of WQI. The ground water samples were collected from 20 different places around Ambattur Industrial Estate in Chennai city. The groundwater quality assessment showed that the water quality of bore wells around Ambattur Industrial Estate is poor for drinking purpose as per WQI for BIS acceptable limit. WQI observed from those selected 20 groundwater bore wells are ranging from 63.30 to 219.63. The analysis reveals that the groundwater from the Ambattur Industrial Estate needs pre-treatment before it is being used for various purposes.

Keywords*: Ambattur industrial estate; Physico-chemical parameters; Water quality index; BIS;*

1. Introduction

Water is one of the basic needs for any living being survival that shapes other land and air environment. The water quality is important and influencing the health aspect of human being. The water sources are coming from both surface and below surface sources. The groundwater sources are particular for supplying water for domestic and industrial purposes. In conjunction with surface water, groundwater is supplied for irrigation purpose. The groundwater is polluted because of over population and industrial growth.

The most potent threats to the quality of groundwater that have emerged from India are pollution. Quality of groundwater is affecting due to presence of poor drainage system. The physico-chemical characteristics of ground water are varying depends on the types of pollutants from water and wastewater sources.

Of all purposes, ground water should be more quality, hence, it is necessary to analyses the ground water quality before being used for domestic purposes. This can be done through Water Quality Index (WQI) assessment.

The GIS based assessment of groundwater quality with the help of WQI at Tirupathi, India was studied by Ambiga [1]. The groundwater quality of Dhrol taluka of Jamnagar district (India) was analyzed by Patel [2]. Furthermore, groundwater quality was assessed using index in Tumkur Taluk, Karnataka state, India by Ramakrishnaiah [3] and the WQI assessment of groundwater in Koilwar Block was determined by Neerja [4]. In addition the groundwater quality around Ampikapuram area of Tiruchirappalli District, Tamil Nadu, India was studied by Sirajudeen [5]. Groundwater quality around Pallavaram, Chennai, Tamil Nadu was determined for its suitability of drinking purpose by Sivakumar [6], and in and around Tannery industrial belt was assessed by Sivakumar [7], and checked the suitability of groundwater for irrigation in Pulicat Sivakumar [8], around Perungalathur [9] was studied. The correlation was done between the quality parameters around Perungalathur, also done by Sivakumar [10].

The purposes of the study are to find the physico-chemical characteristics and appropriateness of groundwater for domestic usage of Ambattur industrial estate. The objectives defined for this project are to identify the ground water pollution around Ambattur industrial estate, to study the appropriateness of groundwater for drinking with references to BIS standards and to verify the suitability of ground water using Water Quality Indices (WQI).

2. Methods and Materials

2.1 Study Area

Ambattur Industrial Estate is an industrial area located in Chennai. The total area in Ambattur Industrial Estate is 1300 acres with 1500 small and medium enterprises. Groundwater is mostly used for domestic and industrial purposes. Groundwater is polluted by discharge of large volume of wastewater from small and medium enterprises and dumping of solid wastes from those sectors. The map of selected area for the assessment of groundwater is shown in Fig.1.

2.2 Collection of Groundwater Samples

The parameters pH, TDS, TH, Calcium, Magnesium, Sulphate, Nitrate, Total alkalinity, Chloride, Fluoride, Sodium, Bicarbonate and Potassium were analysed in the groundwater of bore well around Ambattur Industrial Estate. Groundwater samples were collected from 20 different bore wells. One litre capacity sterilized plastic bottles with proper washed have been used for collecting groundwater samples. The sterilized bottles were used to collect the groundwater. Latitude and Longitude of the sample collecting

spots were recorded with the help of GPS reading. Each groundwater sample was analyzed against 13 parameters. The groundwater quality parameters of Ambattur Industrial Estate were compared with BIS. The calculation of WQI was done to discover the appropriateness of groundwater for drinking.

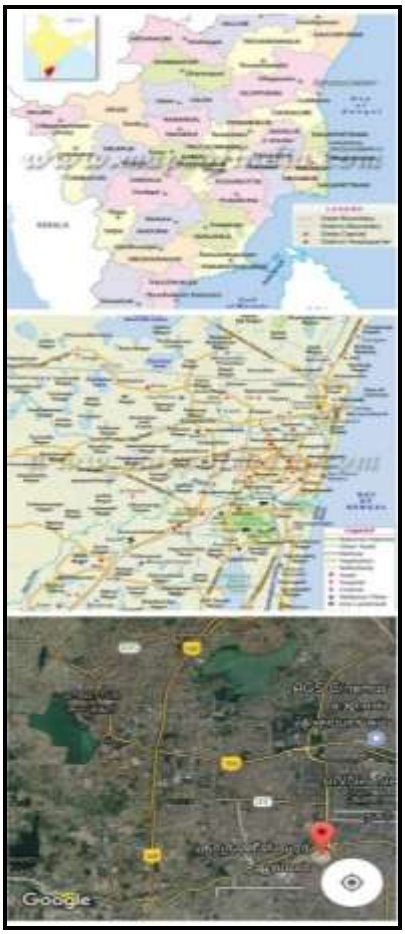

Fig. 1: Map of the Study Area

2.2 Location of Wells

The Table 1 represents the location of 20 groundwater sample station and the corresponding latitude and longitude of the selected bore wells is presented.

Table 1: Location of Wells

Wells	Latitude	Longitude
1	13.118	80.204
2	13.118	80.196
3	13.096	80.174
4	13.100	80.161
5	13.111	80.170
6	13.114	80.165
7	13.106	80.164
8	13.116	80.170
9	13.105	80.170
10	13.102	80.167
11	13.102	80.171
12	13.109	80.174
13	13.114	80.177
14	13.102	80.177
15	13.105	80.180
16	13.110	80.182
17	13.113	80.184
18	13.116	80.189
19	13.108	80.187
20	13.100	80.182

2.3 BIS Drinking Standard

The standard was adopted by the Bureau of Indian Standard with the objectives for assessing and checking effectiveness of water treatment. Table 2 shows standard for drinking against accepted and permissible limit recommended by BIS.

Table 2: BIS standards

Parameters	Acceptable Limit	Permissible Limit
pH	7	7.2
Ca	75	200
Mg	30	100
Na	200	200
K	10	10
HCO_3	200	200
SO_4	200	400
Cl	250	1000
NO_3	45	100
F	1	1.5
TDS	500	2000
TH	300	600
TA	200	600

2.4 Water Quality Index (WQI)

Water quality is assessed with the help of WQI and it is determined as per below various steps.
First step: Based on the relative importance, assign the weight to each parameter (wi). The maximum weight factor is 5 and minimum is 1. The one 5 is assigned to most important parameters and 1 is assigned to least important parameters, which influencing the strength of the contaminant in the groundwater.
Second step: Relative weight (Wi) is computed

$$Wi=wi/\sum wi \quad (1)$$

Third step: A quality rating scale (qi) for each parameter is assigned:

$$qi= (Ci/ si) x100 \quad (2)$$

where, qi = quality rating, Ci = concentration of each parameter in mg/l, and si = water standard of each parameter in mg/l.
Fourth step: the product of Wi and qi is calculated (Si).

$$Si= Wi x qi \quad (3)$$

Fifth step: WQI is calculated as below.

$$WQI = \Sigma Si \quad (4)$$

The WQI standard ranges are presented in Table 3.

Table 3: WQI standard ranges

WQI Value	Water Quality
<50	Excellent
50-100	Good
100-200	Poor
200-300	Very Poor
>300	Not fit for drinking

3 Results and Discussion

The parameters pH, TDS, TH, Calcium, Magnesium, Sulphate, Nitrate, Total alkalinity, Chloride, Fluoride, Sodium, Bicarbonate and Potassium were analysed in the 20 groundwater of bore well around Ambattur Industrial Estate. The Table 4 represents the physico-chemical parameters of the collected groundwater samples from 20 sites.

Table 4: Physico-chemical parameters of 20 bore well samples

Wells	pH	Ca	Mg	Na	K	HCO_3	SO_4	Chloride	Nitrate	Fluoride	TDS	TH ($CaCO_3$)	Total Alkalinity
1	7.1	88	182	433	3	580	10	922	9	0.61	2032	970	475
2	7.2	38	22	110	0	275	40	121	4	0.52	473	185	225
3	7.1	64	134	353	3	305	231	659	21	0.62	1618	710	250
4	7.2	36	75	366	0	531	314	248	9	1.58	1315	400	435
5	6.4	148	126	478	28	366	148	1046	38	0.35	2195	890	300
6	6.6	120	117	438	20	389	173	861	31	0.57	1956	780	318
7	6.9	80	100	401	11	444	237	584	21	1	1656	612	364
8	6.5	133	121	453	24	375	157	948	34	0.45	2059	831	307
9	6.6	113	118	431	18	383	184	832	30	0.59	1918	767	314
10	7	68	100	385	7	441	250	253	18	1	1574	581	361
11	6.9	86	117	392	11	376	212	692	24	0.73	1722	696	308
12	6.6	132	122	456	24	371	159	947	34	0.44	2057	833	304
13	6.7	118	117	422	20	375	154	857	30	0.5	1908	775	308
14	7	82	121	377	9	354	202	694	23	0.65	1687	703	290
15	6.9	89	115	377	11	368	175	705	23	0.6	1681	696	301
16	6.9	92	108	365	12	374	147	693	22	0.58	1634	673	306
17	6.9	83	97	326	10	371	120	608	18	0.58	1459	606	304
18	7.1	58	66	220	3	344	65	373	9	0.56	982	416	282
19	7	76	97	312	7	373	118	571	16	0.6	1400	588	306
20	7	76	119	360	7	355	192	654	21	0.66	1612	678	291

3.1. PH

PH of solution is taken as negative logarithm of H_2 ions for many practical practices. The pH of selected site lies from 6.4 to 7.2.

3.2 Total Dissolved Solids (TDS)

TDS is used to determine how the ions are dispersing in the water The acceptable and permissible limit as per BIS is 500 and 2000 mg/L respectively. Here the value ranges from 473 to 2195 mg/L.

3.3. Total Hardness

The scale formation is caused by hardness. The acceptable and permissible limit as per BIS is 300 and 600 mg/L respectively. Here the value ranges from 185 to 970 mg/L.

3.4. Sulphate

The solubility nature of water is determined based on the sulpate availability. The acceptable and permissible limit as per BIS is 200 and 400 mg/L respectively. Here the value ranges from 10 to 314 mg/L.

3.5. Nitrate

Nitrogen availability is used to identify the quantity of Nitrate in water. The acceptable and permissible limit as per BIS is 45 and 100 mg/L respectively. Here the value ranges from 4 to 38 mg/L.

3.6 Total Alkalinity

The acceptable and permissible limit of alkalinity in groundwater as per BIS is 200 and 600 mg/L respectively. Here the value of alkalinity ranges from 225 to 475 mg/L.

3.7 Chloride

The acceptable and permissible limit of chloride in groundwater as per BIS is 250 and 1000 mg/L respectively. Here the value ranges from 121 – 1046 mg/L.

3.8 Fluoride

The nature of earth crust determines the availability of fluoride in groundwater. The acceptable and permissible limit of fluoride as per BIS is 1 and 1.5 mg/L respectively. Here the value ranges from 0.4 to 1.58 mg/L.

3.9 Potassium

Potassium occurs naturally in minerals and from soils. The acceptable and permissible limit as per BIS is 10 and 10 mg/L respectively. Here the value ranges from 0 to 28 mg/L.

3.10 Calcium

Calcium is an important nutrient for aquatic, organism and it is commonly present in all water bodies. The acceptable and permissible limit as per BIS is 75 and 200 mg/L respectively. Here the value ranges from 36 to 148 mg/L.

3.11 Magnesium

Magnesium is directly related to hardness. Magnesium in the groundwater samples is from 22 to 134 mg/L. The BIS acceptable and permissible limit is 30 and 100 mg/L respectively.

3.12 Sodium

Sodium is a natural constituent of raw water, but its concentration is increased by pollution sources such as rock salt, precipitation runoff, soapy solution and detergent. Presence of high concentration gives bitter taste to water. In the present study, the sodium concentration varies from 110 mg/L to 478 mg/L. Its acceptable limit as per BIS is 200 mg/L.

3.13 Bicarbonate

The bicarbonate concentration in groundwater ranges from 275 to 580 mg/L. The BIS acceptable limit is 200 mg/L.

3.2 Water Quality Index

The WQI was calculated using the equations 1 to 4 and the results are presented below. The Table 5 shows the WQI calculation for the well no. 1. The Table 6 shows the WQI for 20 bore well groundwater samples based on BIS acceptable limit. From the Table 5, it may be noted that the WQI was determined as 208.67, indicates the groundwater quality from the well number 1 is very poor quality.

Table 5: WQI based on BIS Acceptable Limit

Parameters	Acceptable Limit (si)	Observed Values (Ci)	Weight Factor (wi)	Relative Weight Factor (Wi)	Quality Rating (Qi)	Water Quality Index (Si)
pH	7	7.1	5	0.11	101.43	11.27
Ca	75	88	2	0.04	117.33	5.21
Mg	30	182	1	0.02	606.67	13.48
Na	200	433	4	0.09	216.50	19.24
K	10	3	2	0.04	30.00	1.33
HCO_3	200	580	2	0.04	290.00	12.89
SO_4	200	104	5	0.11	52.00	5.78
Cl	250	922	4	0.09	368.80	32.78
NO_3	45	9	4	0.09	20.00	1.78
F	1	0.61	2	0.04	61.00	2.71
TDS	500	2032	5	0.11	406.40	45.16
TH	300	970	5	0.11	323.33	35.93
TA	200	475	4	0.09	237.50	21.11
			45			**208.67**

Table 6: Remarks of WQI based on BIS acceptable limit

Wells	Water Quality Index	Remarks
1	208.67	Very Poor
2	63.30	Good
3	165.32	Poor
4	145.62	Poor
5	219.63	Very Poor
6	198.62	Poor
7	173.85	Poor
8	207.62	Very Poor
9	194.92	Poor
10	156.00	Poor
11	177.48	Poor
12	207.76	Very Poor
13	194.24	Poor
14	173.30	Poor
15	173.28	Poor
16	168.84	Poor
17	153.03	Poor
18	109.25	Poor
19	147.24	Poor
20	166.3	Poor

From the Table 6, it may be observed that the only well number 2 is most suitable for drinking purpose, because the well 2 was located in the upstream of the Ambattur Industrial Estate. The wells number 3, 4, 6, 7, 9, 10, 11, and 14 to 20 are observed as poor quality, further, the wells number 1, 5, 8, and 12 are observed as very poor quality, results groundwater from the above wells are not suitable for drinking uses.

The GIS is used to assess the groundwater quality parameters against drinking in the study area by Ambiga [1]. The groundwater quality index indicated that 82 % of the groundwater samples drop within the poor type and are unsuitable for drinking purposes. The six water samples from ten villages of Koilwar block were collected and analyzed for eleven basic water quality parameters and determined WQI. WQI ranged from 40.67 to 69.59 indicated that some pre-treatments are required before consumption [2].

Physico-chemical investigations were carried out for the parameters of Temperature, anions, cations, TDS and hardness. The physico-chemical results were related to drinking water strategies of Indian Standard (IS) for its purification [3].

The twelve basic water quality parameters were considered for determining WQI and WQI ranges found between 89.21 and 660.56. The presence of high amount of iron, nitrate, TDS, hardness, bicarbonate, fluorides and manganese in the groundwater contribute the high WQI in Tumkur [4].

The ten basic water quality parameters was considered for determining WQI and the results of WQI indicated that groundwater samples ranged between 244 and 383.8 [5].

This study presented the assessment of groundwater quality in Ambattur Industrial Estate, Chennai for its suitability of drinking water using WQI. The selected paramters are pH, TDs, TH, Calcium, Magnesium, Sulphate, Nitrate, Total alkalinity, Chloride, Fluoride, Sodium, Bicarbonate and Potassium. WQI observed from those selected 20 groundwater bore wells are ranging from 63.30 to 219.63. High values of TDS and chloride are contributing high value of WQI of this study area. Similarly total hardness concentration was found to be higher in some sample station. Few sample station showed higher value of alkalinity, sodium and bicarbonate.

4 Conclusions

The study was conducted to assess the quality of groundwater using WQI. The groundwater samples were collected from 20 bore wells located in Ambattur Industrial Estate in Chennai city. The samples were subject to physico-chemical analysis. The WQI results showed that the water quality of bore wells around Ambattur Industrial Estate is poor for drinking purpose. Groundwater of this area requires some prior treatment before consumption for all purposes. It is recommended that groundwater quality checking would be done in terms of basic water quality parameters whenever environment change. It is also recommended to be organized some awareness programs to make them aware about the possible ill effects of ground water pollution.

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