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## Groundwater quality assessment in a North-East region of erode district, tamil nadu

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## ABSTRACT

Erode city is surrounded by dyeing industries, paper industries and tanneries. These industries directly dump the effluents into underground. Continuous effluent disposal leads to ground water pollution. Assessment of physio-chemical studies were carried out in erode city. Samples of Groundwater were collected from different locations and water quality parameters such as pH, Electrical conductivity, Chlorides, Alkalinity, Total Hardness, TDS, Sulphates and Turbidity were analyzed. In a few locations water quality level is surpassed due to discharge of effluent to underground without treatment from industries. The study area indicates that the ground water exceeds the permissible limit of turbidity upto 340 NTU, EC upto 5370 $\mu$  mhos/cm, chlorides upto 1846 mg/l, total hardness upto 988 mg/l, TDS upto 2130 mg/l, sulphates upto 1960 mg/l in BP Agraharam and Naripallam. The result shows that the groundwater in few areas are suitable for human consumption. The precautionary measure is necessary to implement remedial measures for groundwater in BP agraharam and Naripallam.

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## 1. Introduction

The groundwater quality depends on the different chemical components and their concentrations, most of which are derived from the geological data of particular places. Industrial waste has been one of the leading sources of groundwater. One of the serious health issue is the pollution of water resources with heavy metal ions and harmful microorganisms available for household and drinking purposes. People in the erode mostly depend on ground water for agriculture and domestic purpose. Continuous discharge of waste and waste water the area severely gets affected [1]. In this area urbanization and improper disposal of waste contribute to ground water pollution [2].

The water used in the industries should recycled and reused. By the industries do not recycle the water. Therefore they pollute the water bodies. The effluents from the industries make the water polluted and unfit for drinking. The living organisms in and around the water get affected. The excess or insufficiency cause severe damage to groundwater and which leads to be toxic to human health [3]. Thus there is a need to look for indicators, both physical

and chemical to monitor both drinking water and its performance. The main water source for the town is from Bhavani river which is situated on North side of the town [4]. The discharge of sewage, chemical waste from industrial effluents damage the environment. These effluents are treated properly and controlled but many industries lack the control measures. Good quality of water resources depend on large number of physio-chemical parameters and biological characteristics [5]. The periodic monitoring of groundwater quality can minimize the risk of health deterioration. Once the groundwater gets polluted, its quality cannot be restored by preventing pollutants from the source [6]. Hence, it is very important to examine the presence of toxic substances in ground water for portable purpose until it is used for drinking purpose. Thus in this paper an attempt has been made on parameters of groundwater in erode city.

## 2. Methodology

The groundwater samples were collected and problems have been identified. Analyses were done to the groundwater samples and the results are interpreted and correlation was carried out to identify the relationship between the parameters analysed. By using the WHO standards the results were compared and the sam-

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ples which are exceeding the permissible limits are identified. The WQI also carried out to categorize the quality of water. The methodology flow chart is shown in the Fig. 1.

### 2.1. Study area

To evaluate water quality parameters an effort was taken to examine the groundwater in erode district. It lies between  $11^{\circ}34'10''$  North latitude and  $77^{\circ}11'72''$  East longitude. Many tannery industries, paper mill and dyeing industries are located in the erode. The pollutants discharged from those industries The Noyyal, Bhavani, Kaveri rivers flows through the city. This water is used for drinking, household and agricultural purpose. The study area shown in the Fig. 2 and location of groundwater samples shown in Table 1.

### 2.2. Sample collection

In order to determine the water quality parameters 30 groundwater samples are collected in and around erode. The sampling locations are shown in Fig. 2. the groundwater samples results were recorded in laboratory.

## 3. Results and discussion

Table 1 represents the location of groundwater samples. Few study area samples were within the permissible limits. The samples of Hardness exceed the permissible limits in all regions. The water Quality index of parameters was resulted in Table 2. Few locations have excellent water sample. Statistical values of physico-chemical parameters are shown in Table 3. The pH of ground samples ranges from 6.67 to 7.35 with a mean value of 7.06. The turbidity has been exceeds to unacceptable value in

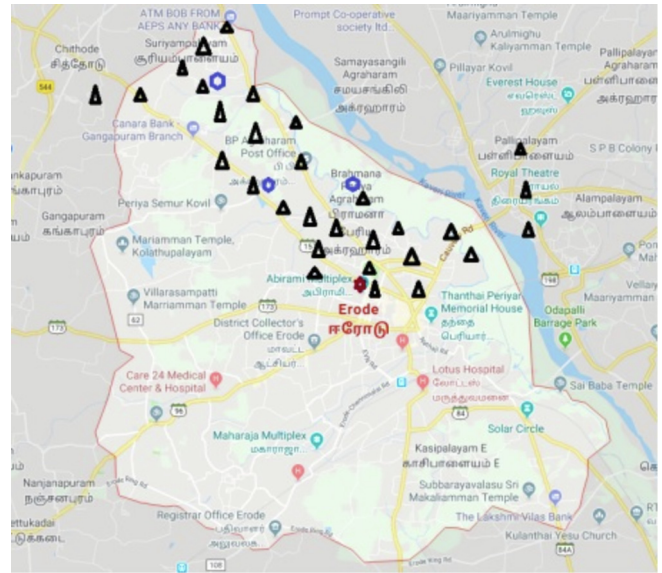


Fig. 2. Study area.

one region. The Electrical conductivity of ground samples ranges from 246.6  $\mu$  mhos/cm to 5270  $\mu$  mhos/cm with a mean value of 909.4  $\mu$  mhos/cm. The mean TDS value 571 mg/l. One sample exceeds the desirable limit this shows the groundwater has high salinity. The Hardness of ground samples ranges from 228 mg/l to 988 mg/l with a mean value of 454.44 mg/l. All samples exceed the permissible limit in sulfates for drinking water. Correlation coefficient between parameters is computed by the values as shown in the Table 4. Correlation is calculated between the parameters such as pH, Turbidity, Electrical Conductivity, Total hardness, Total dissolved solids, Chlorides, Sulphate, Alkalinity. The correlation between EC and Chlorides, a strong correlation ( $r \sim 0.9$ ) also existed between EC and TDS. The value pH showed opposite reaction with many parameters.

### 3.1. pH

The pH of drinking water ranges from normally 6.5–8.5 mg/l. The analysis showed that the pH value ranges from 6.5 – 7.5, indicating that they are neutral in the Fig. 3. All pH values are found to be within the permissible limit as per World Health Standards (WHO) (i.e., 6.5–8.5). The low pH does not cause any harmful effect [6].

### 3.2. Turbidity

In the present analysis the turbidity ranges from 290 to 340 NTU. The turbidity value exceeds in BP aghraharam. This high value is due to continuous discharge of effluent waste from the industries.

### 3.3. Electrical conductivity

The efficiency of water to allow electric current through it and expressed in ( $\mu$  mhos/cm). The EC value of fresh water ranges from 0 to 2000  $\mu$  mhos/cm. Maximum value of 5270 and 4360  $\mu$  mhos/cm was observed at Naripallam and BP Aghraharam shown in Fig. 4. These location are found to higher than permissible limit. The standard value of Electrical conductivity is 1500 ( $\mu$  mhos/cm) [7]. However Electrical Conductivity is less 2.25( $\mu$  mhos/cm) is considers as dangerous [8].

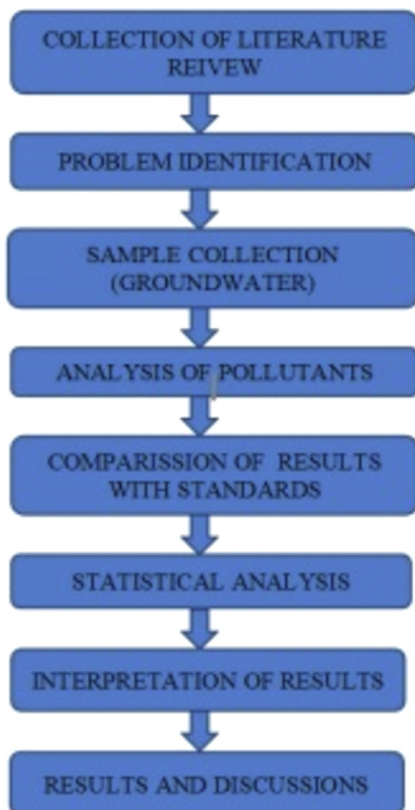


Fig. 1. Methodology flowchart.

**Table 1**  
Location of groundwater samples.

Sl.no	Location of samples	Latitude	Longitude	Sl.no	Location of samples	Latitude	Longitude
1	Asokapuram	11°37'55"N	77°69'66"E	16	Rayapalayam	11°31'33"N	77°64'07"E
2	Devi mahal	11°35'90"N	77°71'43"E	17	Cm nagar	11°34'19"N	77°62'19"E
3	Perumal malai	11°26'55"N	77°54'51"E	18	Devikapuram	11°38'83"N	77°68'77"E
4	Bp agrapharam	11°20'32"N	77°43'41"E	19	Anna nagar	11°32'85"N	77°71'77"E
5	Sunnambu odai	11°81'05"N	77°42'05"E	20	Annai sathya nagar	11°35'98"N	77°70'44"E
6	Rn pudur	11°39'17"N	77°68'51"E	21	Krishnapalayam	11°35'53"N	77°73'02"E
7	Ravi mahal	11°37'85"N	77°70'20"E	22	Indira nagar	11°32'11"N	77°76'09"E
8	Kalingarayan vaikal	11°20'32"N	77°43'41"E	23	Raghavendra madam	11°33'98"N	77°73'39"E
9	Pallipalayam	11°34'10"N	77°71'72"E	24	Nehru nagar	11°34'54"N	77°72'14"E
10	Naripallam	11°33'80"N	77°73'09"E	25	Ayyankadu	11°35'82"N	77°71'03"E
11	Samayapuram	11°37'45"N	77°68'79"E	26	Ayyankarai thottam	11°36'01"N	77°71'02"E
12	Voc park	11°35'17"N	77°71'91"E	27	Pkd nagar	11°36'41"N	77°69'68"E
13	Marayapalayam	11°38'80"N	77°68'39"E	28	Senguthar nagar	11°37'03"N	77°68'69"E
14	Thaneerpandal palayam	11°36'12"N	77°72'47"E	29	Kongapalayam	11°37'45"N	77°67'37"E
15	Amaravati nagar	11°38'39"N	77°69'13"E	30	Suriyapalayam	11°37'45"N	77°40'46"E

**Table 2**  
Water quality index.

Sample no	WQI	Remarks	Sample no	WQI	Remarks
S1	28.451	Excellent	S16	16.701	Excellent
S2	18.496	Excellent	S17	14.065	Excellent
S3	31.52	Excellent	S18	18.582	Excellent
S4	87.12	Good	S19	19.984	Excellent
S5	15.469	Excellent	S20	18.254	Excellent
S6	58.218	Good	S21	18.926	Excellent
S7	6.714	Excellent	S22	21.222	Excellent
S8	15.376	Excellent	S23	17.981	Excellent
S9	16.726	Excellent	S24	15.583	Excellent
S10	22.186	Excellent	S25	18.293	Excellent
S11	15.469	Excellent	S26	16.68	Excellent
S12	12.882	Excellent	S27	13.075	Excellent
S13	15.523	Excellent	S28	18.57	Excellent
S14	27.648	Excellent	S29	18.481	Excellent
S15	15.707	Excellent	S30	17.348	Excellent

**Table 3**  
Statistical analysis.

Parameters	Min	Max	Mean	Median	Mode	S.D
pH	6.67	7.35	7.06	7.005	7.06	124.15
Turbidity	0	340	340	0	0	57.81
EC	246.66	5270	909.4	513.33	436.66	1129.11
Chlorides	86	1846.4	367.4	259.16	144.8	393.05
TDS	172.33	2130	571	436.33	414.33	432.63
Hardness	228.3	988	454.44	425.81	372.1	146.81
Sulfates	497.5	1690	824.47	838.52	859.8	301.09
Alkalinity	0	1073	357.6	0	0	120.51

**Table 4**  
Correlation between parameters.

Parameters	pH	Turbidity	EC	Chlorides	TDS	Hardness	Sulphate	Alkalinity
pH	1							
Turbidity	-0.03395	1						
EC	-0.01478	0.572442	1					
Chlorides	-0.04958	0.574599	0.91787	1				
TDS	-0.0226	0.666865	0.927326	0.89686	1			
Hardness	0.116799	0.686218	0.699996	0.605991	0.690826	1		
Sulphates	-0.06227	0.501991	0.425474	0.471044	0.489463	0.350457	1	
Alkalinity	-0.05597	0.73537	0.888149	0.857582	0.794963	0.709738	0.382039	1

### 3.4. Chlorides

Chlorides are found to be high ranged from 1571 mg/l to 1846 mg/l. similar reports were reported by [9] showed that higher concentration of chlorides is associated with increase in level of pollution. The Chlorides of BP Agrapharam & Naripallam water samples were not in prescribed under the limit shown in Fig. 5. It may

cause elevated levels in drinking water supplies and adverse effect on domestic use.

### 3.5. Total hardness

Hardness in water occurs due to presence of carbonates and bicarbonates of calcium and magnesium, sulphates, chlorides. TH

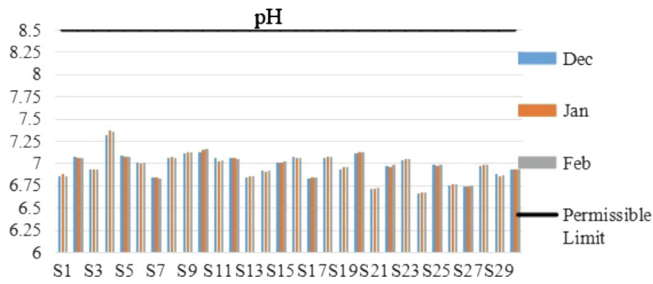


Fig. 3. Variation of pH.

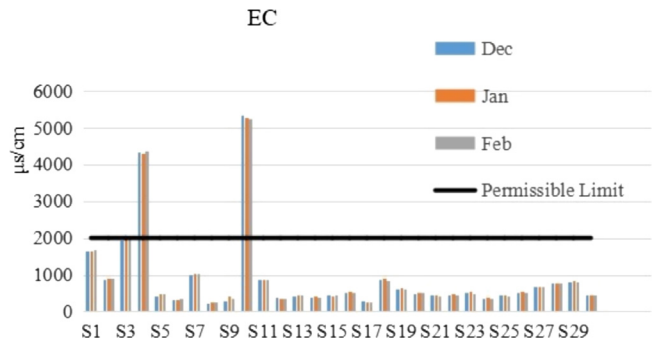


Fig. 4. Variation of electrical conductivity.

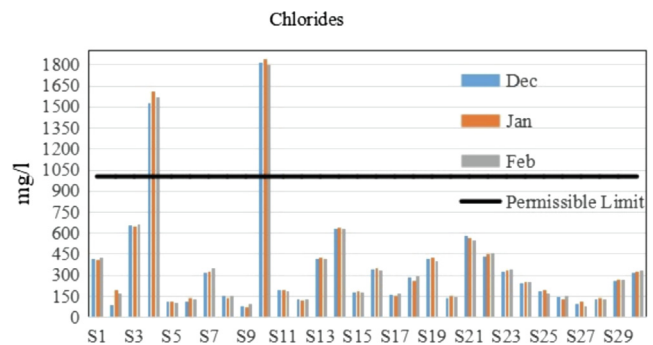


Fig. 5. Variation of chlorides.

value ranges from 300 to 600 mg/l. The maximum value occurs at BP aghraharam and Naripallam with the range of 988 mg/l and 705 mg/l shown in Fig. 6. It may lead to Encrustations to water supply structures and adverse effect on domestic use [10].

### 3.6. Total dissolved solids

Concentration of dissolved solids in groundwater shows its applicability for drinking purpose. TDS in groundwater ranges from

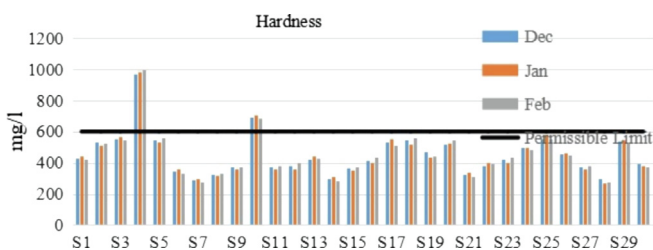


Fig. 6. Variations of total hardness.

400 mg/l – 2130 mg/l. Maximum TDS level occurs at BP aghraharam shown in Fig. 7. In this the potassium, sodium and chloride ions are more. These indicate groundwater of very high salinity [11].

### 3.7. Sulfates

The Sulfates ranges from 512 mg/l-1690 mg/l. All the samples are not within the permissible limit shown in Fig. 8. Excess of sulfates contains shrinkage in intestines and intestinal infection.

### 3.8. Alkalinity

Alkalinity occurs due to the presence of carbonates, bicarbonates and hydroxides of magnesium, calcium, potassium and sodium. The most popular component that causes alkalinity is calcium carbonate. The standard limit of drinking water is 200 mg/l. The maximum value occurs in BP aghraharam and Naripallam. These values are not within the permissible limits shown in Fig. 9.

### 3.9. Water quality index

The WQI provides a single number that express overall the water quality of a certain time and location, based on several water quality parameters. Here we used 5 parameters for calculating for water quality index. The Water quality index results are shown in Table 2. Most of the samples are having excellent water quality. BP aghraharam and Pallipalayam having good water quality. Water Quality Index is used for communicating the information on quality of water [12].

### 3.10. Statistical analysis

Statistical analysis were conducted with all parameters were shown in the Table 3. The pH of ground samples ranges from 6.67 to 7.35 with a mean value of 7.06. The turbidity has been exceeds to unacceptable value in one region. The Electrical conductivity of ground samples ranges from 246.6  $\mu$  mhos/cm to 5270  $\mu$  mhos/cm with a mean value of 909.4  $\mu$  mhos/cm. The mean TDS value 571 mg/l. One sample exceeds the desirable limit This shows the groundwater has high salinity. The Hardness of ground samples ranges from 228 mg/l to 988 mg/l with a mean value of 454.44 mg/l. All samples exceed the permissible limit in sulfates for drinking water. The high concentration of sulfates is likely related to wastewater leakage from industries. The mean value of alkalinity is 357.6 mg/l.

### 3.11. Correlation between parameters

Correlation coefficient between parameters is computed by the values as shown in the Table 4. Correlation analysis is a bivariate

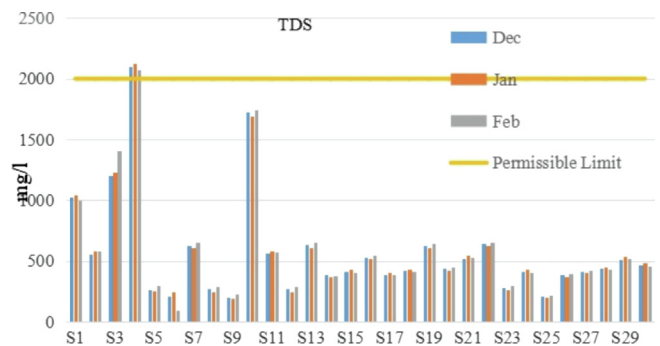


Fig. 7. Variations of TDS.



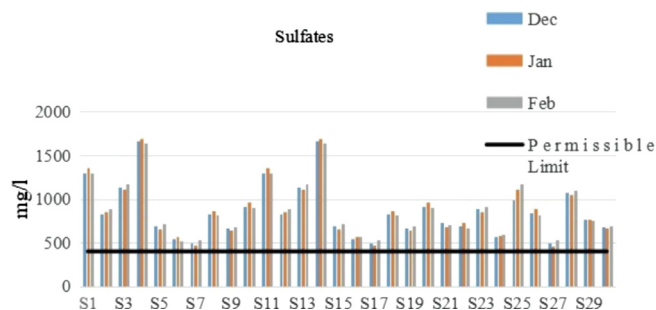


Fig. 8. Variations of sulfates.

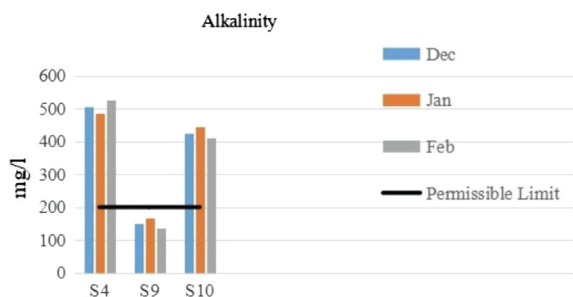


Fig. 9. Variations of alkalinity.

method, which basically shows how well one variable predicts the other [13]. Correlation is calculated between the parameters such as pH, Turbidity, Electrical Conductivity, Total hardness, Total dissolved solids, Chlorides, Sulphate, Alkalinity. The correlation between EC and Chlorides, a strong correlation ( $r \sim 0.9$ ) also existed between EC and TDS. pH showed opposite reaction with many parameters.

#### 4. Conclusion

All physical and chemical parameters are identified in the erode city. The results obtained from the investigation shows that few study area groundwater are within the permissible limits. The groundwater of BP agharam and Naripallam exceeds the permissible limits in many parameters. All the samples of sulfates are not within the permissible limit. Five parameters were used for calculating Water Quality Index. Most of the samples having excellent water quality. Water samples of BP agharam and Naripallam having good water quality. The statistical analyses were analyzed for all parameters. The relationship between various parameters has been studied by using pearson correlation coefficient. The

physico-chemical parameters such as Electrical conductivity, Turbidity, TDS and chloride are very well correlated for ground water samples. In about 84% of samples studied were suitable for drinking purpose. Therefore the physical and chemical parameters of ground water suggested that there is no harmful for drinking and agricultural purpose in few areas. The precautionary measure is necessary to implement remedial measures for groundwater in BP agharam and Naripallam.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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