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A STUDY ON GROUNDWATER POLLUTION USING WATER QUALITY INDEX IN AND AROUND EDAMALAIPATTI PUDHUR AREA NEAR KORAIYAR RIVER, TIRUCHIRAPPALLI DISTRICT, TAMIL NADU, INDIA.

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ABSTRACT

The present work was aimed to assess the water quality index for the groundwater samples of Edamalaipatti pudhur area near Koraiyar River. It was determined by collecting 10 ground water samples on both side of the koriyar River and subjected to physico chemical analysis, The following 11 parameters have been considered: pH EC, TDS, DO, TH, BOD, COD, Ca, Mg, Cl and No_3 .The Calculated values WQI 216.4. The high value of WQI has been found to be mainly from the higher values of EC, TDS, TH, BOD, COD, Cl and Ca in the groundwater. The results have been used to suggest models for predicting water quality. The results reveal 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.

KEYWORDS: Groundwater Physico- Chemical parameters, Water quality index.

INTRODUCTION

Water is essential for the survival of any form of life. On average, a human being consumes about 2 liters of water every day. Water accounts for about 70% of the weight of a human body.About80% of the earth's surface (i.e., of the earth total 50,000 million hectares in area) is covered by water. Out of the estimated 1,011million km3 of the total water present on earth, only 33,400m^3 of water is available for drinking, agriculture, domestic and industrial consummation.[2] A water pollutant can be defined as physical, chemical or biological factors causing aesthetic or detrimental effects on aquatic life and on those who consume

water. Majority of water pollutants are however, in the form of chemicals which remain dissolved or suspended in water and give an environmental response which is often objectionable. Some times physical and biological factors also act as pollutants. Among the physical factors, heat and radiation are important factors which have marked effects on organisms.Certain micro- organisms present in water,especially pathogenic species, cause disease of man and animals, and can be referred to as bio-pollutants.[4]

Groundwater contamination is generally irreversible.ground water cannot be easily polluted when compared to surface water.but once polluted the restoration is possible but very difficult, time consuming and may be expansive.the quantity and quality of the ground water is influenced by many factors like rainfall, type of soil and vegetation.[7] The origin of pollutans can be treced to their natural occurrence on the earth ,formation by transformation and concentrations of natural substances and their man made synthesis. The pollutants may arise quite naturally to form part of the background concentrations in the enviornment.some pollutantscan be formed by way of concentration and transformation of naturally occuring compounds during their domestic,agricultural or industrial use.

Study Area

Tiruchirappalli is one of the most important industrial cities in Tamil Nadu. The study area Edamalaipatti pudhur is located nearby Koraiyar River at Tiruchirappalli. The population of the area is around 30,000. Many Hospitals and small scale industries are located in and around this area. They are discharging the hospital wastes and domestic sewages, untreated into the open lands and polluting ground water through percolation. Edamalaipatti pudhur has quite a large population depending only on the ground water as the main source for drinking purpose and other purpose.

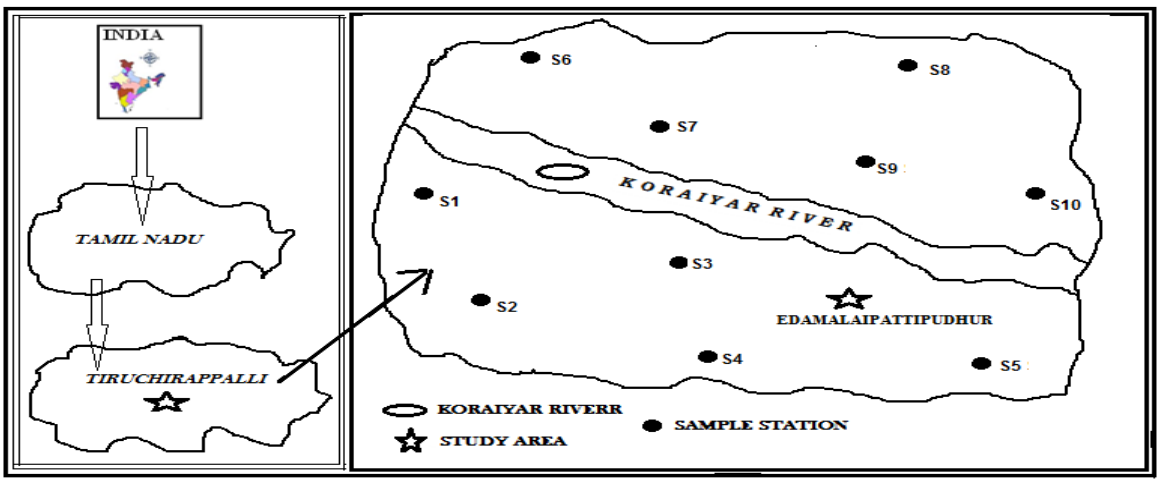

Fig: 1 Location Map of the Study Area

MATERIALS AND METHOD

Ten ground water samples were collected from either side of Koraiyar River near Edamalaipatti pudhur area. The distance between one stations to another was maintained about 1 kilometers. Samples were collected in a clean and dry polyethylene cane from bore wells after running it for 3 mins. All the samples were collected in the month of May and August 2013. In the present study, various physico- chemical parameters such as pH, EC, TDS, TH, BOD, COD, NO_3 of ground water samples were determined using standard procedures. (APHA 1998).

RESULT AND DISCUSSION

Table: 1 Physico- Chemical parameters of groundwater samples collected in and around Edamalaipatti pudhur area in the month of May 2013.

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
pH	7.6	7.6	7.5	7.3	7.6	7.6	7.6	7.5	7.5	7.4
EC	5718	3340	5786	1456	7270	9403	3909	8754	1313	7988
TDS	3979	2324	4027	1013	5059	6544	2720	6092	913	5559
TH	500	500	635	950	900	1660	825	940	1540	1025
DO	15	7	8	7	10	5	6	8	12	15
BOD	25	24	15	15	15	15	14	15	19	16
COD	53	64	79	37	37	50	62	41	30	36
Cl	183	120	134	508	240	328	134	271	465	300
Ca	160	120	152	280	200	176	190	500	446	300
Mg	24	49	62	61	98	300	86	108	101	67
No_3	26	18	26	22	30	18	18	13	16	11

Table 2 Physico- Chemical parameters of groundwater samples collected in and around Edamalaipatti pudhur area in the month of August 2013.

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
pH	7.7	7.6	7.7	7.4	7.7	8.0	7.9	7.7	7.9	7.6
EC	6498	9224	5987	5214	5770	4054	3890	4700	8171	7425
TDS	2403	3449	1627	1935	2137	1502	1480	1269	3006	3163
TH	600	825	1375	700	775	750	1015	1425	100	750
DO	5	5	8	9	5	6	6	7	6	9
BOD	18	12	24	9	24	29	27	19	27	27
COD	74	69	74	62	64	63	66	62	69	74
Cl	643	859	213	468	440	414	244	320	572	407
Ca	120	300	450.8	144	260	220	240	440	300	200
Mg	73	18	60	82	30	48	101	79	85	60
No_3	18	23	26	18	23	20	17	17	22	20

Table: 3 Mean values of Physico- Chemical parameters of groundwater samples collected in and around Edamalaipatti pudhur area in the month of May-August 2013.

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
pH	7.6	7.6	7.6	7.3	7.6	7.8	7.7	7.9	7.7	7.5
EC	6108	6282	5886	3335	6520	6728	3899	5396	4742	7706
TDS	3191	2886	2827	1474	3598	4023	2100	5011	1956	4361
TH	55O	662	1005	825	837	1205	920	1182	820	887
DO	5	5	8	9	5	6	6	7	6	9
BOD	22	18	19	12	20	22	20	17	23	22
COD	63	66	76	50	50	56	64	51	49	55
Cl	330	489	173	488	340	371	189	295	519	354
Ca	140	210	301	212	230	198	215	470	373	250
Mg	48	33	61	72	64	174	93	93	93	64
No_3	22	20	26	20	27	19	17	15	19	16

All the values are expressed in ppm except pH and EC micromho

pH

pH is a measure of the hydrogen ion concentration of a solution. Solutions with a high concentration of hydrogen ions have a low pH and solutions with low concentrations of H^+ ions have a high pH.[3] The pH values of water samples varied from 7.3 to 7.9 and were found below the limit prescribed by WHO (6.5 to 8.5).

Electrical Conductivity

Electrical conductivity is a measure of water capacity to convey electric current .It signifies the amount of total dissolved solids. EC values were in the range of 3335 micromho to 7706 micromho. High EC values were observed for all water samples prescribed WHO (500).[14] The presence of high amount of dissolved inorganic substance and in ionized form. High EC values may cause carcinoma and mortality problem.

Total Dissolved Solids

Total dissolved solid indicates the salinity behavior of ground water. TDS values varied from1474 ppm to 5011ppm. All the ground water samples showed higher TDS values than the prescribed limit given by WHO (500) ppm. This may due to disposal of effluent and chemical weathering of rocks. High TDS may cause lung cancer, arteriosclerotic and cardiovascular disease.

Total Hardness

The hardness of water mainly depends upon the amount of calcium and magnesium salts. The hardness values showed in range from550 ppm to 1205 ppm. TH values for all samples were found above the permissible limit prescribed by WHO (500ppm). The high values of hardness are probably due to regular addition of large quantities of sewage and oil industrial effect into water. High concentration of hardness causes heart disease and kidney stone formation.

Dissolved Oxygen

Dissolved oxygen is important parameter in water quantity assessment and reflects the physical and biological processes preventing in the water. The DO values indicate the degree of pollution in water bodies. Do values varied from 5.0 to 9.0 ppm. The DO values recorded above the permissible limit of WHO (5ppm), that the ground water samples were showed free from organic contamination. It is suitable for fish and fauna.

Biological Oxygen Demand

BOD is the amount of oxygen retained by the microorganisms to stabilize biologically decomposable organic matter in waste water under aerobic conditions. BOD values varied from 12ppm to 23 ppm. In the present study all the water samples are found beyond the limit prescribed by WHO (10 ppm). High BOD may affect the aquatic life.

Chemical Oxygen Demand

Chemical oxygen is widely used as means, measuring the organic strength of domestic and industrial waste water. COD values were in the range of 49 ppm to76 ppm. COD values of all ground water samples found above the permissible limite prescribed by WHO (10 ppm). This may be due to discharge of domestic sewage and industrial waste water to soil and water bodies. High COD may affect the aquatic life.

Chloride

Chloride ion is a predominant natural form of chlorine and it is extremely soluble in water. The chloride values ranged from173 ppm to 519 ppm. In the present study all the chlorides values are found within the limit prescribed by WHO (250 ppm), except the stations S2, S3 and S7. High chloride may due to the increased weathering and leaching sedimentary rocks soils and domestic waste discharge and it causes stomach discomfort, eyes irritation corrosive character of water.[17]

Calcium

Calcium is a major constituent of igneous rocks. The major source of calcium in ground water around basalts. The calcium varied between 140ppm to 470ppm. Calcium values of all ground water samples show higher than the prescribed limit set by WHO (100 ppm).[14] The high concentration of calcium may be due to deposits of limestone, dolomite, it may cause intestinal disease or stone formation.

Magnesium

Magnesium is directly related to hardness. Magnesium concentration ranged between33 ppm to 174ppm. In the present investigation Mg values of all ground water samples were found below the limit prescribed by WHO (150) expect the station S6. The high content of Mg is undesirable for house hold uses, such as washing, bathing and laundering because of consumption of more soap and other cleaning agent. High Mg causes stone formation and diuretic action.[11]

Nitrate

Nitrogen is a major constituent of atmosphere. Soil bacteria convert it into nitrite and nitrate.[12] The concentration of nitrate ranged from 15 ppm to 27ppm and the nitrate values in all ground water samples were found within the limit prescribed by WHO(50 ppm).

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.[13]

The Calculation Involves the Following Steps

First, the calculation of weight age of i^{th} 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 Weight age of i^{th} Parameter

$$W_i = k/S_i \quad (1)$$

Where W_i is the unit of weight age and S_i the recommended standard for i^{th} parameter (I = 11), k is the constant of proportionality.

Individual quality rating is given by the expression

$Q_i = 100V / S_i$ (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 i^{th} parameter.

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

$WQI = \sum_{i=1}^{n}(Qi\ Wi) / \sum_{i=1}^{n} Wi$ (3)

Where, Q_i is the sub index of i^{th} parameter. W_i is the unit weight age for i^{th} parameter, n is the number of parameters considered. Generally, the critical pollution index values is <75.

Table: 4 Calculation of WQI for groundwater samples collected in and around Edamalaipatti pudhur area.

Parameters	Mean value in ppm (v_i)	Highest permitted value (WHO) (s_i)	Unit weight age (W_i)	$W_i \times Q_i$
pH	7.6	8.5	0.2334	20.86
EC	5660	500	0.0039	4.2147
TDS	3142	500	0.0039	2.6512
TH	927	500	0.0039	0.7230
DO	6.0	5	0.3968	52.3
BOD	19	20	0.0992	9.9249
COD	58	10	0.1984	116.2
Cl	354	250	0.0079	2.0626
Ca	259	100	0.0198	5.1539
Mg	80	150	0.0132	0.7035
NO_3	20	50	0.0396	1.6236

$WQI = \sum_{i=1}^{n}(Qi\ Wi) / \sum_{i=1}^{n} Wi$ WQI = 216.4

Table: 5 Status categories of WQI

WQI	Quality of water
0 - 25	Very good
26 - 50	good
51 - 75	poor
Above 75	Very poor (unsuitable for drinking)

In this study, the computed WQI values range 216.4and therefore can be categorized into four types, excellent water to unsuitable water. Table 5 shows the percentage of water samples that falls under different quality. The high values of WQI at these stations have been found to be mainly from higher values of EC, TDS, TH, BOD, COD, Cl and Ca in the groundwater.[10]

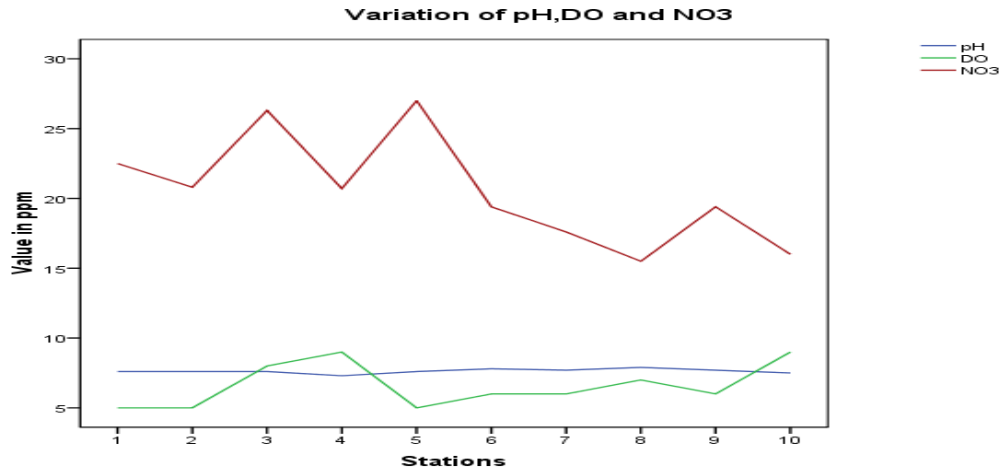

Fig: 2 Seasonal Variation in mean values of pH, DO, and NO_3 collected from different sampling from Edamalaipatti pudhur area.

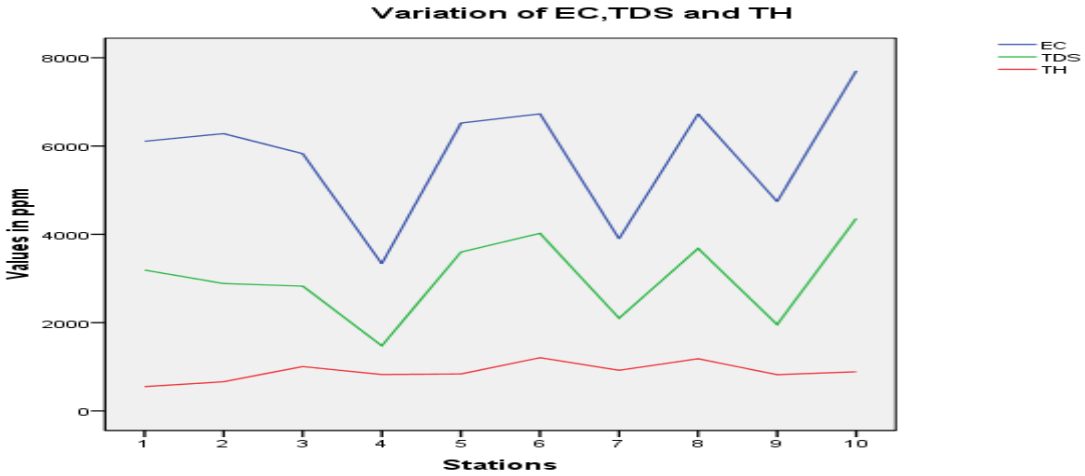

Fig: 3 Seasonal Variation in mean values of EC, TDS and TH collected from different sampling from Edamalaipatti pudhur area.

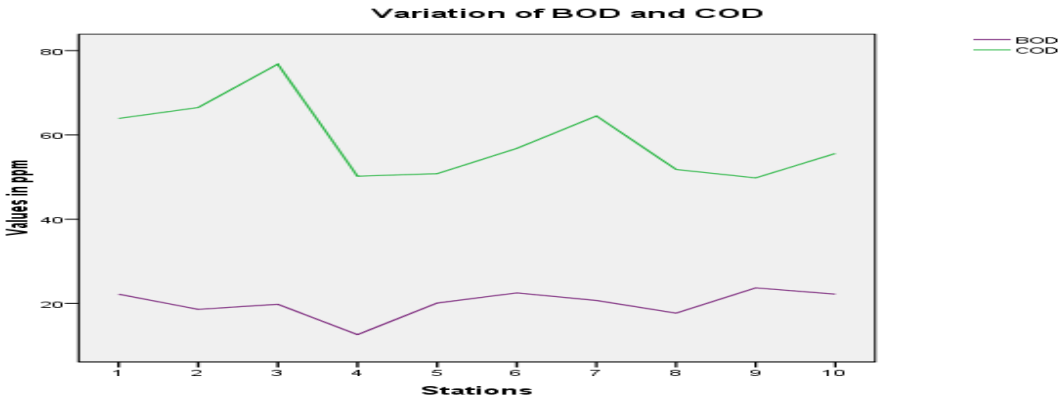

Fig: 4 Seasonal Variation in mean values of BOD and COD collected from different sampling from Edamalaipatti pudhur area.

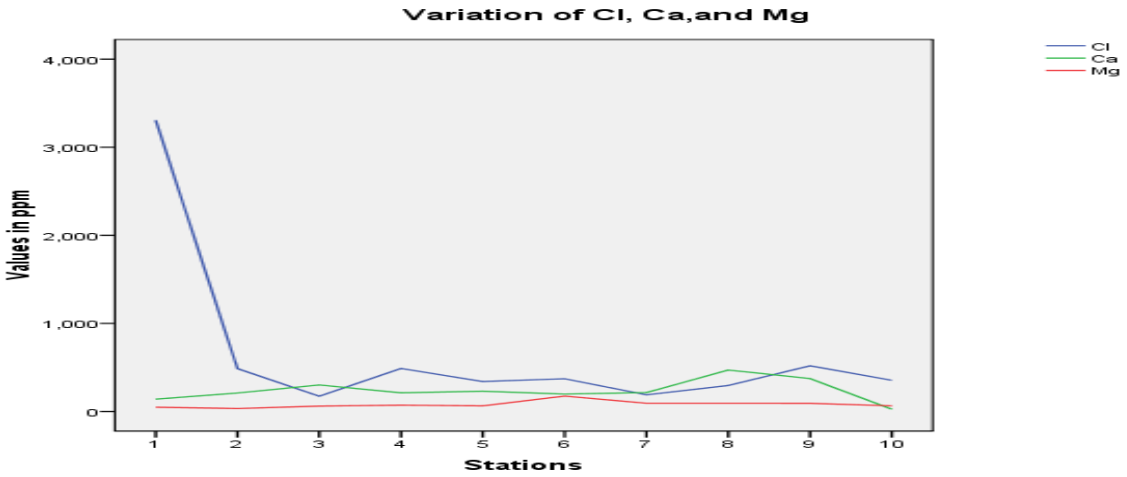

Fig: 5 Seasonal Variation in mean values of Cl, Ca, and Mg collected from different sampling from Edamalaipatti pudhur area.

Statistical analysis

Pearson correlation

Pearson correlation coefficient is commonly used to measure and establish the strength of a linear relationship between two variables or two sets of data. It is a simplified statistical tool to show the degree of dependency of one variable to the other. The Pearson correlation coefficient (rxy) is computed by using the formula as given below.

Formula

$$r = \frac{n \Sigma x y - \Sigma x \Sigma y}{\sqrt{[n \Sigma x^2 - (\Sigma x)^2][n \Sigma y^2 - (\Sigma y)^2]}}$$

Where,

The variables x and y represents two different water quality parameters; n= number of data points/ number of groundwater samples. The inter dependence of different water quality parameters on each other was evaluated on the basis of rxy from equation (1). The correlation coefficient is always between -1 and +1. A correlation closer to +/- 1implies that the association is closer to a perfect linear relation. Interpretation of the Pearson correlation coefficients, adopted in the present study are: r = -1 to -0.7 (strong negative correlation); r = + 0.7 to + 1.0 (strong positive correlation); r = -0.7 to -0.3 (weak negative correlation); r = + 0.3 to + 0.7 (weak positive correlation); r = - 0.3 to + 0.3 (negligible or no correlation.[7]

Table: 6 Correlation co-efficient matrixes of water quality parameters

Correlations											
	pH	**EC**	**TDS**	**TH**	**DO**	**BOD**	**COD**	**Cl**	**Ca**	**Mg**	**NO_3**
pH	1										
EC	0.355887	1									
TDS	0.383254	0.957087	1								
TH	0.55191	0.191117	0.328066	1							
DO	-0.46483	-0.10922	-0.06665	0.324083	1						
BOD	0.476763	0.440683	0.421371	-0.01774	-0.42388	1					
COD	0.008253	0.048803	-0.02048	-0.13908	-0.08183	0.13335	1				
Cl	-0.10386	0.065913	0.036646	-0.62775	-0.36542	0.221364	0.133397	1			
Ca	0.566671	-0.20506	-0.27371	0.419695	-0.12721	-0.17458	-0.15238	-0.28471	1		
Mg	0.519586	0.013604	0.194282	0.752632	-0.00084	0.254931	-0.2966	-0.29041	0.181333	1	
NO_3	-0.30312	-0.05103	-0.12003	-0.31249	-0.27566	-0.04698	0.344693	0.162399	-0.03188	-0.32506	1
Correlation is significant at the 0.01 level (2-tailed).											
Correlation is significant at the 0.05 level (2-tailed).											

The results of the correlation analysis on the whole water data set are presented the correlation co efficient. Electrical conductivity (0.957) showed strong positive correlation total hardness (0.752) indicates strong positive correlation with magnesium and moderate correlation with Total hardness (0.055) and pH. The weak correlation with chloride -0.627 and Total hardness and Magnesium showed moderate correlation with pH and lastly nitrate shows weak correlation with COD (0.344). All of these correlations are summarized table following above.

CONCLUSION

The ground water samples were collected from ten different places in and around Edamalaipatti pudhur area near Tiruchirappalli. The samples were subjected to physico-chemical analysis. The results showed that the parameters like EC, TDS, TH, BOD, COD, Cl and Ca are well above the permissible limit prescribed by WHO. In this study the application of water quality index and statistical technique is used for the determination of groundwater. However the water quality index values in the investigation were reported to be greater than 75 (216.4) for the all samples indicating that the ground water is unsuitable for drinking and domestic purpose. The results reveal that the ground water of these areas needs some degree of treatment before consumption.

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