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Study of Ground Water Quality at Selected Locations in Dindigul District, India

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ABSTRACT

The use of groundwater has increased significantly in the last decades due to its widespread occurrence and overall good quality. The present study aims at determining the suitability of ground water quality for drinking purpose at selected locations in Dindigul district. Dindigul is one of the important places for its tannery units. It has more than 80 tannery units in and around the city and nearly 50 units are under processing of leather. It is the fact that the processing of leather requires large amount of freshwater along with various chemicals. Groundwater is the main source of drinking water in Dindigul. The leather industry in and around the Dindigul city pollute both surface and groundwater by discharging their wastes. Hence the present study has been undertaken to determine the physico-chemical characteristics of groundwater in some selected locations of Dindigul district. Various water samples were taken at four different locations. The samples are analysed for physico-chemical parameters. The results were compared with Drinking water standards of Bureau of Indian Standards (IS: 10500) and World Health Organisation (WHO 2011) standards. Further the correlation studies among the different parameters of water were estimated.

1. Introduction

Ground water is the major resource of drinking water. The ground water is clean and free from pollution when compared to surface water. The ground water is polluted due excessive use of fertilizers and pesticides, increased human activities and rapid growth of industries. Groundwater is ultimate, most suitable fresh water resource with nearly balanced concentration of the salts for human consumption [1]. Unfortunately, water resources are getting polluted and getting unfit for use [2]. Pollution of ground water aquifers has made many of these wells unfit for consumption [3]. The availability of water through surface and groundwater resources has become a critical day today. Only 1% part is available on land for drinking, agriculture, domestic power generation, industrial consumption, transportation and waste disposal [4, 5]. There are several states in India where more than 90% populations are dependent on groundwater for drinking and other purpose [6, 7].

The present study was undertaken to investigate the impact of groundwater quality of some open wells and bore well water samples in selected locations in Dindigul district. Thus, in this research work an attempt has been made to assess the physical and chemical parameters of groundwater like, Temperature (T), pH, Electrical Conductivity (EC) Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Chloride (Cl^-) and Fluoride (F^-). The analyzed data were compared with standard values recommended by WHO and also correlation coefficient was calculated to assess the relationship between various parameters.

2. Experimental Methods

2.1 Sample collection

Water samples were collected from bore wells at three different localities in Dindigul based on the area importance. The samples were collected in 2.0 litre water cans.

2.2 Study area

The study area lies between 77°15' and 78°15' E longitude and 10°0' to 10°45' N latitude covering a total area of 6,066 km^2. The elevation varies from 158 to 2,529 m above MSL. Dindigul district is bounded by Palani hill ranges of Western Ghats in the west, Sirumalai hills in the south and east. The northern part of the district covers plain terrain. This study area enjoys sub-tropical climate with the temperature ranges from 21.8 °C to 41.80 °C.

2.2.1 Choice of the study area

Groundwater in Dindigul area is highly polluted due to industrial effluents from the local tanneries and sewage. Tanneries and houses are found together very close around the selected locations namely Ponmandurai Pudhupatty (S_1), Kottapatty (S_2) and Pallapatty (S_3). People living in and around these areas depend on ground water and well water. So the ground water was taken for the study. During the monsoon and post monsoon seasons, many industries discharge the industrial effluents without any treatment. The polluted water seeps into the ground water. Due to percolation of the polluted water the quality of ground water in and around the sampling sites is affected very much and becoming unfit for drinking purpose.

2.3 Physico-Chemical Analysis

Water quality parameters were analysed using standard methods [8]. During the sample collection temperature was noted using thermometer and details of different methods relevant to parameters are shown in Table 1.

3. Results and Discussion

The results of physico-chemical parameters of drinking water in selected locations of Dindigul were estimated and it is shown in Table 2.

3.1 Temperature

Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism. The temperature was ranging from 23 °C at S_1 to 24 °C at S_3 in the study areas. There is no difference in change of temperature between the locations found.

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Table 1 Different water quality parameters and estimated standard methods

S.No.	Parameter	Unit	Test method
1	Temp	°C	Thermometer
2	pH	-	pH meter
3	EC	µS/cm	Digital conductivity meter
4	TDS	mg/L	Digital meter
5	Alkalinity	mg/L	Acid titration
6	Hardness	mg/L	EDTA titration
7	Calcium	mg/L	EDTA titration
8	Magnesium	mg/L	EDTA titration
9	Chloride	mg/L	Argentometric titration
10	Fluoride	mg/L	Selective Ion electrode analysis

Table 2 Results of physiochemical parameters of water at different locations in Dindigul

Parameter	Unit	S_1 Ponmandhurai pudhupatty	S_2 Kottapatty	S_3 Pallapatty	BIS (IS10500)	WHO (2011)
Temp	°C	23	25	24	-	-
pH	-	7.24	7.05	7.21	6.5-8.5	7.5-8.5
EC	µS/cm	870	2247	2646	-	-
TDS	mg/L	609	1573	1852	500	500
Alkalinity	mg/L	192	280	370	-	-
Hardness	mg/L	260	464	596	500	500
Calcium	mg/L	56	120	138	75	75
Magnesium	mg/L	29	39	60	30	30
Chloride	mg/L	138	580	580	250	200
Fluoride	mg/L	0.6	8	8	1-1.5	1-1.5

3.2 pH

pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. pH is considered as an important ecological factor and provides an important piece factor and piece of information on many types of geochemical equilibrium or solubility calculation [9]. The maximum pH was recorded as 7.24 at sampling location Ponmandurai Pudhupatty and the minimum was 7.05 at Kottapatty. When compared with the standard values of WHO the water samples are found to be in the permissible limit at all locations.

3.3 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] and is a useful tool to evaluate the purity of water. Conductivity shows significant correlation with ten parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, COD and chloride and iron concentration of water. The underground drinking water quality of the study area can be checked effectively by controlling conductivity of water and this may also be applied to water quality management of other study areas. EC values were in the range of 870-2646 µS/cm. High EC values were observed indicating the presence of high amount of dissolved inorganic substances in ionized form.

3.4 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 [11], highly mineralized water may be used where better quality water is not available [12]. TDS values in the study area varied from 609 mg/L to 1852 mg/L which were found within the permissible limits of WHO 1000 mg/L, except at Pallapatty (1852 mg/L) sample location.

3.5 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. According to some classifications, water with hardness up to 75 mg/L is classified as soft, 76- 150 mg/L is moderately soft, 151- 300 mg/L as hard and more than 300 mg/L as very hard. The hardness values of the present study area ranges from 260 mg/L to 596 mg/L. The Pallapatty location having the highest hardness 596 mg/L which exceeds the WHO limit of 100 -500 mg/L.

3.6 Total alkalinity (TA)

It is composed primarily of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-), alkalinity acts as a stabilizer for pH. Alkalinity, pH and hardness affect the toxicity of many substances in the water. Alkalinity in boiler water essentially results from the presence of hydroxyl and carbonate ions. Hydroxyl alkalinity (causticity) in the boiler water is necessary to protect the boiler against corrosion. Too high a causticity causes other operating problems, such as foaming. Excessively high causticity levels can result in a type of caustic attack of the boiler called "embrittlement" [14] in the present analysis values were found in the range of 192- 370 mg/L.

3.7 Calcium (Ca^{2+})

Calcium is directly related to hardness and is the chief cation in the water. Calcium concentration ranged between 56 mg/L to 138 mg/L and found within permissible limits of WHO, 75- 200 mg/L range.

3.8 Magnesium (Mg^{2+})

Magnesium is directly related to hardness. Magnesium showing very strong positive correlation against hardness content in the investigated water samples ranges from 29 mg/L to 60 mg/L which was found within the WHO limit. Calcium and magnesium in surface water is more than the permissible limit, it causes unpleasant taste to the water.

3.9 Chloride (Cl^-)

The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects [10]. In the present analysis, chloride concentration was found in the range of 138 mg/L to 580 mg/L. Most of the water samples collected from study area was above the prescribed limits 0- 200 mg/L of WHO. 580 mg/L was recorded at Pallapatty and Kottaptty locations. This chloride may be supplied by the local discharge of tannery effluents from the nearby tannery industries.

3.10 Fluoride (F^-)

Probable source of high fluoride in Indian waters seems to be that during weathering and circulation of water in rocks and soils fluorine is leached out and dissolved in ground water [15]. Excess intake of fluoride through drinking water causes fluorosis on human being. Fluoride at a lower concentration at an average of 1 mg/L is regarded as an important constituent of drinking water (WHO, 2011). In the present analysis, fluoride concentration was found to be in the range of 0.6 mg/L to 8 mg/L which are considered above the WHO permissible limit of 1- 1.5 mg/L.

3.11 Statistical analysis

The high positive correlation was found between TDS and EC (0.99), Magnesium and Total Hardness (0.94), Chloride and EC (0.97), Chloride and TDS (0.97), Total Hardness and EC (0.98). While the negatively correlated values were found between EC and pH (- 0.43) and TDS and pH (-0.43) Chloride and pH (-0.62) as shown in Table 3.

Table 3 Correlation among the estimated water quality parameters

	Temp	pH	EC	TDS	TA	TH	Ca^{2+}	Mg^{2+}	Cl^-	F^-
Temp	1.00									
pH	-0.93	1.00								
EC	0.73	-0.43	1.00							
TDS	0.73	-0.43	0.99	1.00						
TA	0.49	-0.14	0.95	0.95	1.00					
TH	0.60	-0.26	0.98	0.98	0.99	1.00				
Ca^{2+}	0.74	-0.44	0.99	0.99	0.94	0.98	1.00			
Mg^{2+}	0.31	0.05	0.87	0.87	0.98	0.94	0.87	1.00		
Cl^-	0.86	-0.62	0.97	0.97	0.86	0.92	0.97	0.74	1.00	
F^-	0.86	-0.62	0.97	0.97	0.86	0.92	0.97	0.74	1.00	1.00

4. Conclusion

Physico-chemical analysis was carried out to assess the water quality in selected locations of Dindigul District. By observing the result, it can be concluded that the parameters which were taken for studying the water quality show that, the maximum pH of 7.24 was recorded at Ponmandurai Pudhupatty location, indicating that the water may be alkaline. Fluoride concentration was found in the range of 0.6- 8 mg/L. Most of the sample locations were found above the WHO permissible limits. High EC values were observed in almost all of the sampling points. Chloride concentration was found in the range of 138 mg/L to 580 mg/L. Positive correlated values were found between TDS and EC (0.999999), Magnesium and Total Hardness (0.947598).Comparing the three sampling sites, S_2 (Kottapatty) and S_3 (Pallapatty) show high values of EC, TDS, TH, Alkalinity, Ca, Mg, Cl and F because they are located close proximately to the tannery industries and even at low intensity effluent discharge they have negative effects on ground water. In this present investigation, it was found that the most of the parameters were exceeding the permissible limit of WHO, so that the water in the study area is not suitable for drinking purposes.

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