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Physico-Chemical Study of the Ground Water Quality at Selected Locations in Periyakulam,
Theni district, Tamilnadu, 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 Periyakulam. It is one of the important places for chemical industries. There are 272 house hold industries in Periyakulam area [1] Groundwater is the main source of drinking water in Periyakulam. The various industries in and around the Periyakulam 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 Periyakulam. Various water samples were taken at three 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 Standards (WHO 2011). Further the correlation studies among the different parameters of water were estimated.

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1. Introduction:

Ground water is the basic resource of drinking water. The ground water is potable when compared to surface water. The ground water is susceptible to pollution due to excessive usage of fertilizers, pesticides, increased anthropogenic activities and fast growth of industries. Thus, groundwater is ultimate and most suitable fresh water resource with nearly balanced concentration of the salts for human consumption [2]. Unfortunately, water resources are getting polluted and getting unfit for usage [3]. Pollution of ground water aquifers has made many of the wells unfit for consumption [4]. The availability of pure water through surface and groundwater resources has become more critical day today. Only 1% is available on earth for drinking purpose, agricultural purpose, domestic purpose,

power generation, industrial consumption, transportation and waste disposal [5, 6]. There are several states in India where more than 90% of the total populations are dependent on groundwater for drinking and other purposes [7, 8].

The present study was taken under investigation to analyze the impact of groundwater quality of certain open wells and bore well water samples in selected locations in Periyakulam district. Thus, in this research study an attempt has been made to assess the physic- chemical parameters of groundwater for 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 then compared with the standard values of WHO. Correlation coefficients were calculated to assess the relationship between the selected parameters.

2. Materials and methods

2. 1. Collection of water samples

Water samples were collected in 2.0 litre water cans from bore wells at three different locations in Periyakulam district based on the area which is important for the place of industries.

2.2. Study area

The study area Periyakulam town has an area of 21 km, within a semi urban area now extending over as much as 55 km and it is located at 10.07°N 77.33°E with an average elevation of 356 meters above the mean sea level. The climate in Periyakulam town is dry and hot, with northeast monsoon rainfall during the month of October to December. Temperatures during summer reach a maximum of 40°C and winter temperatures up to 18 °C. The average annual rainfall is about 135 cm.

2.3. Choice of the study area

Groundwater in Periyakulam area is highly polluted due to industrial effluents from the local chemical industries. Industries and houses are found together very close around the selected locations namely Melmangalam (S_1), Tenkarai (S_2) and Vadakarai (S_3). People living in and around these areas depend on ground water and also well water. So the ground water being very vital was taken for the study. During various seasons (monsoon and post monsoon), many industries discharge their industrial effluents into the water sources without any treatment. As a result the polluted water seeps into the ground water. Due to percolation of the polluted water into the ground water the quality of ground water in and around the sampling sites are affected very severely and become unfit for domestic purpose.

2.4. Physic-Chemical Analysis

Water quality parameters were analyzed using standard methods [9]. During the sample collection temperature was noted using thermometer and details of different methods relevant to parameters are shown in (Table.1)

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	$\mu\text{S/cm}$	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

3. Results and discussion

3.1. Results of physic-chemical parameters of drinking water in selected locations of Periyakulam were estimated and are shown in Table 2.

Table 2 Results of the physic-chemical parameters of water samples at different locations in Periyakulam

Parameter	Unit	S ₁	S ₂	S ₃	BIS(IS10500)	WHO(2011)
		Melmangalam	Thenkarai	Vadakarai		
Temp	$^{\circ}\text{C}$	23	25	24	-	-
pH	-	7.24	7.05	7.21	6.5-8.5	7.5-8.5
EC	$\mu\text{S/cm}$	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

Temperature

Temperature is the most important biologically significant factor, which plays a vital role in the metabolic activities of the organism. The temperature ranges from 23°C at S₁ to 24°C at S₃ in the selected study areas. There is no much difference in the change of temperature at the locations.

p^H

The intensity of the acid or alkaline conditions of a solution is expressed by the term pH. pH is considered as an important ecological factor and provides information on many types of geochemical equilibrium and solubility calculations [10]. The maximum pH was recorded as 7.24 at sampling location Melmangalam and the minimum was

7.05 at Thenkarai. When compared with the standard values of WHO the water samples are found to be in permissible limit at all the three locations.

Electrical Conductivity (EC)

Electrical conductivity (EC) is the measure of the water's ability to convey the transport of electric current. It signifies the amount of total dissolved salts [11] and is a useful tool in evaluating the purity of water. Conductivity shows significant correlation with around ten parameters of water. In the study area the EC values were in the range of 870-2646 $\mu\text{S}/\text{cm}$. Higher EC values were observed indicating the presence of high amount of dissolved inorganic substances in ionized form.

Total Dissolved Solids (TDS)

Total dissolved solids indicate the presence of inorganic salts and small amount of organic matter in groundwater. Water with TDS greater than 500 mg/L is not desirable for drinking purpose but very rarely TDS up 1500 mg/L is allowed [12], highly mineralized water may be used where better quality water is not available [13]. TDS values in the study area varied from 609 mg/L to 1852 mg/L. Excluding TDS value at Vadakarai (1852 mg/L) others were found within the permissible limits of WHO 1000 mg/L sample location.

Total Hardness (TH)

Hardness is the property of water, which prevents the lather formation with soap and increases the boiling points of water [14]. Hardness of water is expressed as the sum of calcium and magnesium salts or both. The total hardness of the present study areas ranges from 260 mg/L to 596 mg/L with Vadakarai location having the highest hardness of 596 mg/L which exceeds the WHO limit of 100 -500 mg/L.

Total alkalinity (TA)

It is the amount of alkali in the form of carbonates (CO_3^{2-}), bicarbonate (HCO_3^-) and hydroxides (OH^-) present in water and it also acts as a stabilizer for pH. It is the capacity of water to neutralize acids. Too high alkalinity in the study area is determined in the range of 192- 370 mg/L

Calcium (Ca^{2+})

Calcium is naturally present in water and is directly related to hardness and is the chief cation in the water. In the study area the calcium concentration ranged between 56 mg/L to 138 mg/L and is found within the permissible limits of WHO 75- 200 mg/L.

Magnesium (Mg^{2+})

Magnesium is responsible for water hardness. In the investigated water samples magnesium show very strong positive correlation which ranges from 29 mg/L to 60 mg/L which was found within the WHO limit.

Chloride (Cl^-)

The chloride content increases the electrical conductivity of water which in turn increases the corrosivity of water. People exposed to higher chloride content 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 Vadakarai and Thenkarai locations. This chloride may be supplied by the local discharge of industrial effluents from the nearby industries.

Fluoride (F⁻)

Fluoride is an ionic compound derived from fluorine and is naturally found in many rocks. 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 [16]. The most obvious health effect of excess fluoride exposure is dental fluorosis. Fluoride at a lower concentration at an average of 1 mg/L is regarded as an important constituent of drinking water (WHO, 2011). fluoride concentration in the study area was found to be in the range of 0.6 mg/L to 8 mg/L which is considered above the WHO permissible limit of 1- 1.5 mg/L.

3.2 Statistical analysis

The high positive correlation was found between TDS and EC (0.999999), Magnesium and Total Hardness (0.947598), Chloride and EC (0.9768113), Chloride and TDS (0.976857), Total Hardness and EC (0.982985). While the negatively correlated values were found between EC and pH (- 0.439652) and TDS and pH (-0.439845) Chloride and pH (-0.621756) as shown in (Table 3) & Graphical representation shows it clear in all 3 stations.

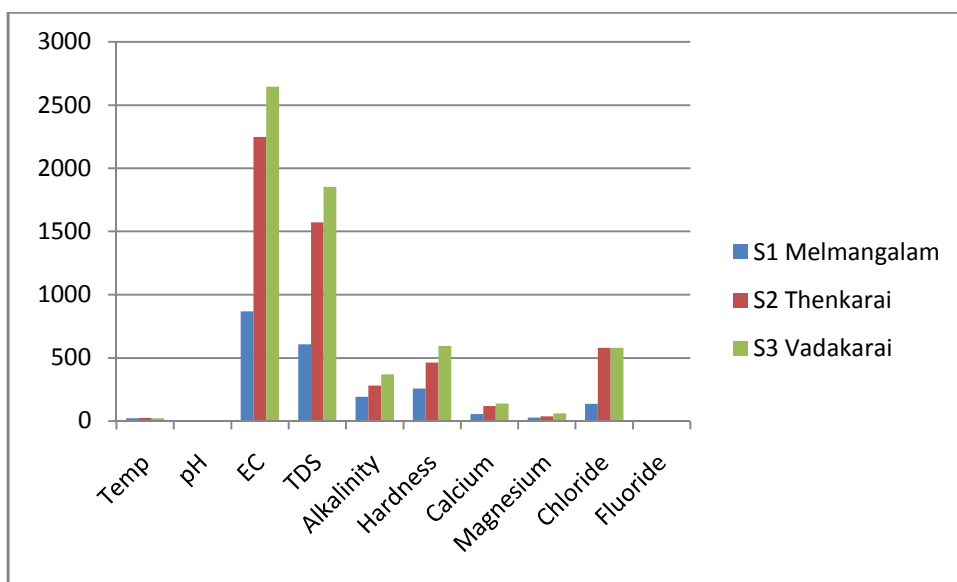


Table 3

Correlation among the estimated water quality parameters

	Temp	pH	EC	TDS	Alkalinity	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						
Alkalinity	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

4. Conclusion

Physico-chemical analysis was carried out to assess the water quality in selected locations of Periyakulam. 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 Melmangalam 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, S₂ (Thenkarai) and S₃ (Vadakarai) show high values of EC, TDS, TH, alkalinity, Ca²⁺, Mg²⁺, Cl⁻ and F⁻ because they are located close proximately to the 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.

Acknowledgements

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