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# Physico-chemical contamination of groundwater in and around Tirunelveli district, Tamil Nadu

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## ABSTRACT

*A total of 10 ground water samples were collected from in and around Tirunelveli during the year 2010 were analysed for their physicochemical characteristics. The physicochemical parameter such as pH, Conductivity, total dissolved solids (TDS), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), sodium ($Na^{+}$), potassium ($K^{+}$),chloride ($Cl^{-}$), sulphate ($SO_4^{2-}$),nitrate ($NO_3^{-}$),Dissolved oxygen (DO), Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) were analysed. The results were compared with the World Health Organization (WHO 2003) standard values. The quality of ground water samples were discussed with respect to these parameters and thus an attempt was made to ascertain the quality of ground water is fit or not for drinking and other purposes.*

**Keywords:** physico-chemical parameters, ground water, Tirunelveli.

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## INTRODUCTION

Groundwater is the most vital natural resource required for drinking, irrigation and industrial purposes. Rapid increase in population along with enhancing trend in industrialization and urbanization has contributed towards rising demand for groundwater in many areas. Groundwater is used for domestic, agriculture and industrial purpose in most parts of the world. The human activities like agriculture and domestic release large number of pollutants into the water bodies. In India ponds, rivers and ground water are used for the domestic and agriculture purposes [1]. The quality of water invariably is contaminated in many ways by natural, agricultural and anthropogenic activities. Ground water is generally an excellent source of drinking, cleaning, bathing, irrigation and industrial purposes [2].Ground water quality depends on the quality of recharged water, atmospheric precipitation, in- land surface water, and on subsurface geochemical processes. Temporal changes in the origin and constitution of the recharged water, hydrologic and human factors, may cause periodic changes in groundwater quality. According to WHO, about 80% of all the diseases in human beings are caused by water, Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from their sources. Groundwater chemistry has been utilized as a tool to outlook water quality for various purposes [3]. The modern civilization and urbanization frequently discharging industrial effluent, domestic sewage and solid waste dump. The cause of ground water gets pollute and create health problems [4].The objective of this study is to investigate qualitative analysis of some physicochemical parameters of groundwater in study area. This may be considered as reference for the society to get cautious about the impending deterioration of their environment and health.

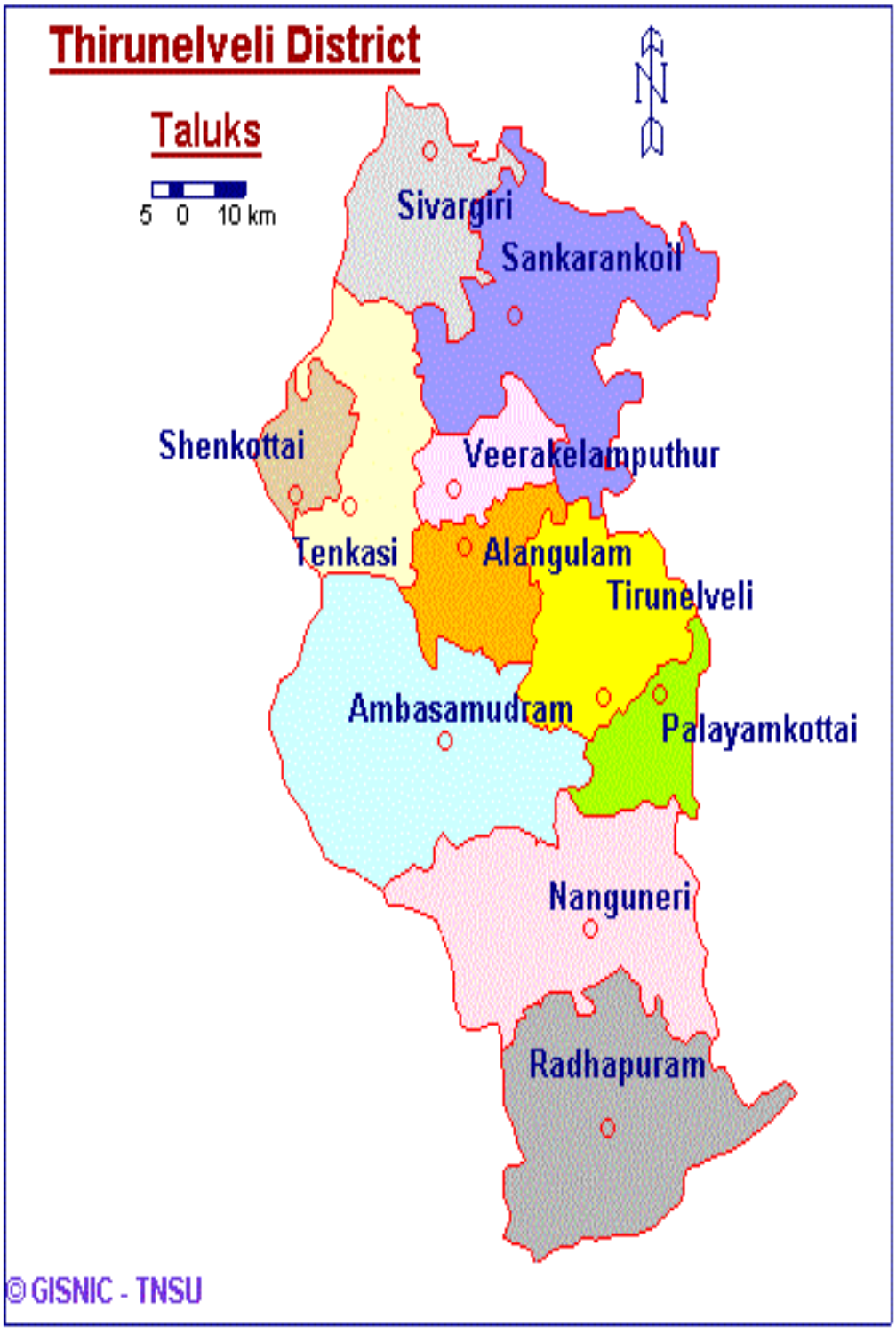
## MATERIALS AND METHODS

### STUDY AREA

Tirunelveli District is a district of Tamil Nadu state in southern India. The city of Tirunelveli is the district headquarters. The district is located in the southern part of Tamil Nadu. It borders Virudhunagar District to the north, the Western Ghats to the west, Kanyakumari District to the south and Thoothukudi District to the east. The district covers an area of 6,823 $km^2$. It lies between 8°05' and 9°30' north latitude and 77°05' and 78°25' east

longitude. The district contains mountains (a stretch of the Western Ghats) and lowland plains, including sandy soil and fertile alluvium, and a variety of flora, fauna and protected wildlife. The district also has inland and mountainous forests. Pachaiyar river, which flows into the perennial Tambaraparani river. The Tambaraparani and Manimuthar rivers have many dams, with reservoirs providing water for irrigation and power generation. The Tamiraparani River provides consistent irrigation to a large agricultural area The Chittar river also originates in this district. The Courtallam and Manimuthar waterfalls are the two major falls in the district.

**Location map of the Study area**



## COLLECTION OF SAMPLES

The ground water samples were collected from different locations to evaluate the physico-chemical contamination during summer season. Samples were collected in polyethylene bottles (2.5lit) which had been thoroughly washed and filled with distilled water and then taken to the sampling site. The physico-chemical parameters as such pH, Conductivity, total dissolved solids (TDS), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), sodium ($Na^{+}$), potassium ($K^{+}$),chloride ($Cl^{-}$), sulphate ($SO_4^{2-}$),nitrate ($NO_3^{-}$),Dissolved oxygen (DO), Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD). The results were compared with WHO standard values (2003). The details of sampling locations are illustrated below the table1.

**Table 1: Water sampling locations and sources**

| S. No | SAMPLING STATION | SOURCE |
|---|---|---|
| S1 | Nambinagar | Bore well |
| S2 | Nanguneri | Bore well |
| S3 | Puthur | Bore well |
| S4 | Annasalai | Bore well |
| S5 | Moolaikkaraipatti | Bore well |
| S6 | Kelavaneri | Bore well |
| S7 | Madapuram | Bore well |
| S8 | Valliyur | Bore well |
| S9 | Kallikulam | Bore well |
| S10 | Thisayanvilai | Bore well |

## RESULTS AND DISCUSSION

### pH

pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. The pH values of water samples varied between 6.67 to 7.75 and were found within the limit prescribed by WHO (6.5-8.5).All the sample shows neutral values.

### Electrical conductivity (EC)

Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts [4]. EC values wherein the range of 1274 to 4510 microohms/cm. High EC values were observed for all sampling points indicating the presence of high amount of dissolved inorganic substance. When EC values exists 600microohms/cm, the generation of almost all the crops would be affected and it may result in much reduced yield [6].

### Total Dissolved Solids (TDS)

Total dissolved solids indicate the salinity behaviour of water. Water containing more than 500ppm of TDS is not considered desirable for drinking water supplies. TDS values varied from 823 to 2925ppm. In the present investigation TDS values are showed higher than the prescribed limit given by WHO. The TDS concentration was found to be above the permissible limit may be due to the leaching of various pollutants into the ground water which can decrease the potability and may cause gastrointestinal irritation in human and may also have laxative effect. High level of TDS may aesthetically be unsatisfactory for bathing and washing.The accumulation of organic and inorganic solids also contribute to high total dissolved solids [7].

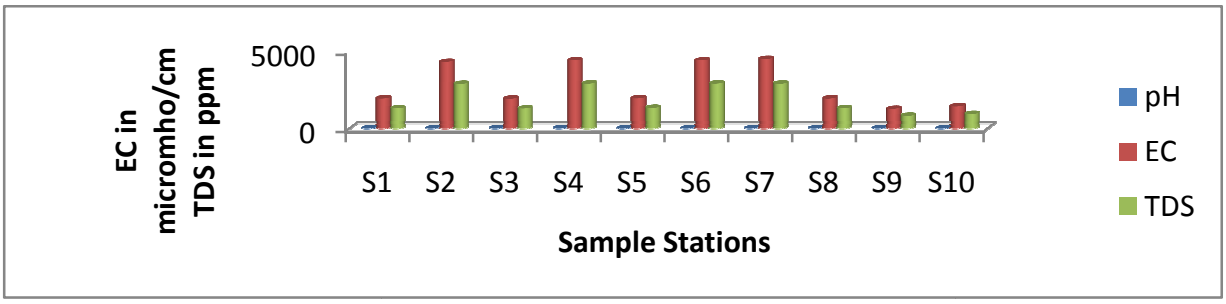
**Table 2: Physico chemical parameters of groundwater samples**

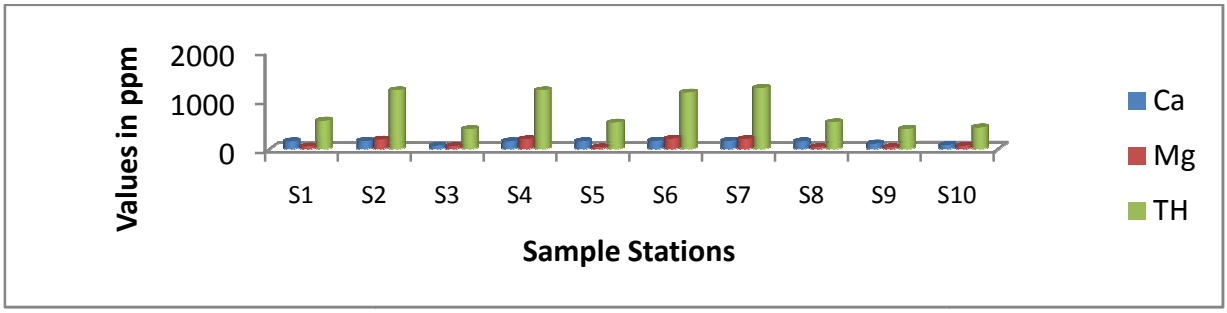
| Station | pH | EC | TDS | Ca | Mg | TH | Na | K | $NO_3$ | $PO_4$ | Cl | DO | BOD | COD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 7.21 | 1954 | 1310 | 154 | 51 | 580 | 194 | 17 | 4 | 0 | 420 | 6.54 | 1.5 | 3.7 |
| S2 | 6.67 | 4326 | 2898 | 160 | 192 | 1200 | 485 | 90 | 11 | 0.32 | 240 | 6.47 | 1.3 | 3.1 |
| S3 | 7.46 | 1936 | 1297 | 67 | 58 | 408 | 210 | 14 | 3 | .08 | 330 | 5.96 | 1.6 | 3.5 |
| S4 | 7.32 | 4423 | 2919 | 155 | 201 | 1200 | 491 | 86 | 11 | 0.41 | 390 | 6.32 | 1.1 | 3.3 |
| S5 | 7.2 | 1964 | 1340 | 157 | 35 | 540 | 196 | 21 | 6 | 0 | 440 | 5.92 | 1.4 | 3.1 |
| S6 | 7.21 | 4420 | 2925 | 167 | 210 | 1156 | 520 | 102 | 12 | 0.41 | 354 | 6.32 | 1.6 | 3.3 |
| S7 | 7.35 | 4510 | 2910 | 165 | 202 | 1250 | 486 | 96 | 13 | 0.33 | 386 | 6.47 | 1.2 | 3.5 |
| S8 | 7.2 | 1950 | 1311 | 155 | 41 | 546 | 185 | 16 | 4 | 0 | 440 | 6.71 | 1.4 | 3.3 |
| S9 | 7.28 | 1274 | 823 | 110 | 39 | 412 | 110 | 11 | 12 | 0 | 252 | 6.47 | 1.1 | 3.6 |
| S10 | 7.75 | 1440 | 935 | 87 | 64 | 440 | 117 | 26 | 9 | 0.14 | 182 | 6.72 | 1.3 | 3.7 |

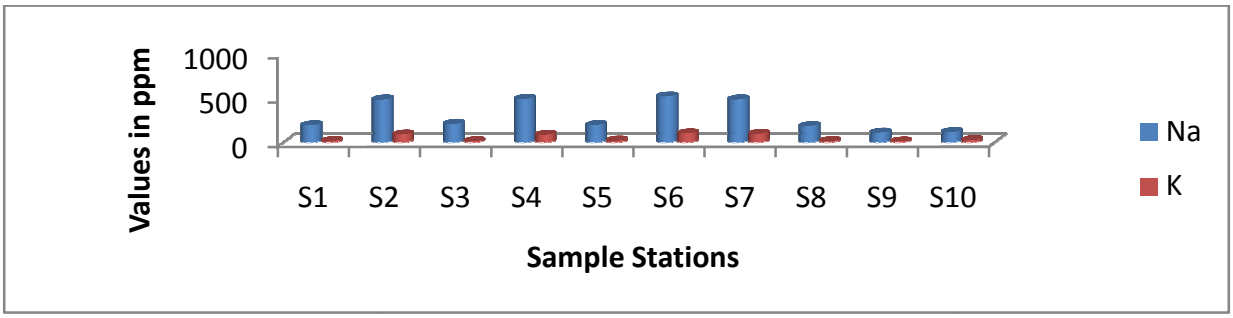
### Total Hardness, Calcium and Magnesium

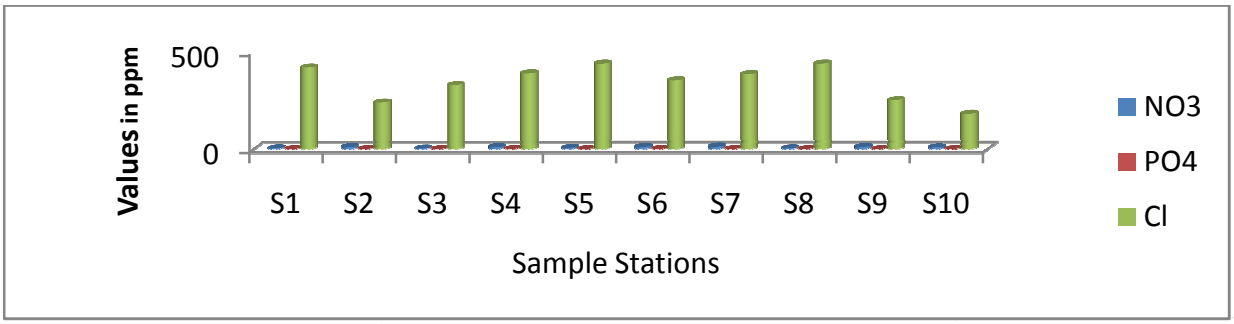
Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values are ranged from 412 to 1250ppm. The TH values of some samples found higher than the prescribed limit WHO (500ppm).This may be mainly due to the contamination by the large quantities of sewage and detergents and the high total hardness would lead to heart disease and kidney stone formation. Hardness is the property of water which

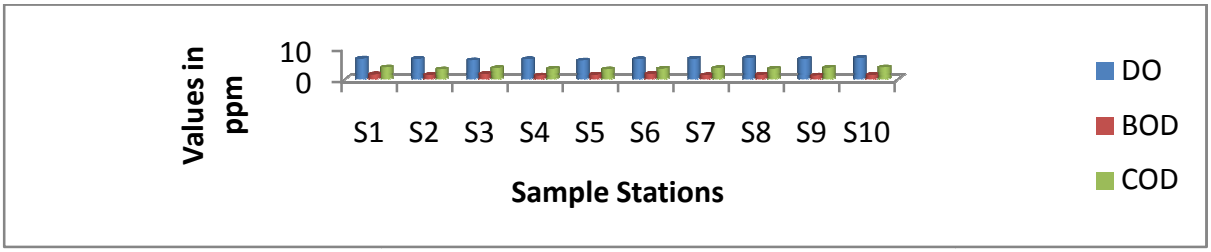
prevents the lather formation with soap and increases the boiling points of water [8].Calcium and Magnesium is directly related to hardness. In the present study TH values are all the within the permissible limits (WHO).




**Sodium and Potassium**

The mean values of sodium and potassium are within the range of 110-520ppm and 11-102ppm for groundwater samples in summer season. The sodium values exceed the desirable limit of WHO (220ppm and 12ppm) in some of

the groundwater samples. The values of potassium exceed permissible limit of 12ppm in some of the groundwater samples.

High concentration of potassium may be attributed to the contamination by sewage [9].

**Nitrate and Phosphate**

Groundwater can also be contaminated by sewage and other wastes rich in nitrates. The nitrate content in the study area varied in the range of 3 to 13ppm and found below the prescribed limit set by WHO (50ppm).The mean values of phosphate are recorded between the range of 0-0.43ppm groundwater samples in summer season.

**Chloride**

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 182 to 440ppm. Some of the values are observed higher than the limit WHO (250ppm). Higher chloride concentration in samples from sites may be due to big discharge of sewage near the sampling sites. It imparts a salty taste to water and accelerate corrosion of metals.High concentration of chloride is considered to be an indicator of pollution by organic wastes from industrial and other origin [11].

**Dissolved Oxygen**

Dissolved Oxygen is one of the important parameter in water quality assessment. Its presence is essential to maintain variety of forms of life in the water and the effect of waste discharge in a water body are largely determined by the oxygen balance of the system. It can be rapidly removed from the wastewaters by discharge of the oxygen demanding waste. The DO value shown range from 5.92 to 6.72ppm. DO values are obtained in the study were recorded most of the samples within the permissible limit of WHO (6ppm). It indicates the ground water samples are showed free from organic contamination. The higher value of DO can impart good aesthetic taste to drinking water [12, 13].

**Chemical oxygen demand (COD) and Biochemical oxygen demand (BOD)**

COD is a measure of pollution in aquatic ecosystems. It estimates carbonaceous factor of organic matter. In present study the COD values are ranged from 3.1 to 3.7ppm and below the permissible limit set by WHO (10ppm).BOD is the amount of oxygen required by the living organisms engaged in the utilization and ultimate destruction of organic water. It is a very important indicator of the pollution status of a water body. The BOD values shown ranged from 1.1 to 1.6ppm. The BOD values for all water sample were found below the prescribed limit WHO (10ppm).Both BOD and COD may be due to discharge of domestic sewage and industrial waste water to soil and water bodies and may be due to the logging of the industry wastes[14].

## CONCLUSION

The ground water samples were collected from ten different places in and around Tirunelveli area. The samples were subjected to physico- chemical analysis. The results showed most of the parameters like EC, TDS, TH, $Na^+$ and $K^+$ are well above the permissible limit prescribed by WHO. The ground water sample is and unfit for drinking and domestic purposes. So people should be made aware of the water quality importance on sanitation and economical water treatment methods like filtration and boiling would prove beneficial to avoid waterborne disease. The remedial measure must be taken immediately to safeguard and conserve the precious water resources from pollution for future generation.

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