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GROUNDWATER QUALITY ASSESSMENT FOR DRINKING PURPOSES IN COIMBATORE CITY, TAMILNADU, INDIA

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Abstract:

Water is precious one. It is the basis for health, hygiene, progress and prosperity for all living being. Then efficient water management is essential to the society for betterment of quality of life. This study has conducted to assessing the groundwater quality of Coimbatore City, Tamilnadu. To complete this research work, 50 groundwater samples were collected from 5 zones of the study area. Physico-chemical parameters of the groundwater samples were analyzed and the results have been used to suggest models for predicting water quality. The parameters have been used to develop maps showing spatial variation of specific water quality parameters. The results of analyses have been used to suggest the water quality. The analysis reveals that the groundwater of the area needs some degree of treatment action taken before utilization, and it also needs to be protected from the hazards of contamination.

Key Words: Groundwater Quality, Physico-Chemical Parameters, Water Quality Standards & GIS

1. Introduction:

Water is the basic requirement for all life on Earth. The origin of life has been attributed principally to water, along with other basic elements. Any natural or man-made activity on the surface of the earth will impact most on the quality and quantity of water. This is taken into the biospheric systems and ultimately leads to hydrological extremes. Groundwater is one of earth's most vital renewable and widely distributed resources as well as an important source of water supply throughout the world. The quality of water is a vital concern for mankind since it is directly linked with human welfare. Groundwater is water that exists in the pore spaces and fractures of rocks and sediments beneath the Earth's surface. It originates as rainfall or snow, and then moves through the soil into the groundwater system, from where it eventually makes its way back to surface streams, lakes, or oceans. It is naturally replenished from above, as surface water from precipitation, streams, and rivers infiltrates into the ground [8]. Water covers about 71.4% of the earth. Water may occur in liquid, solid and gaseous form. Water plays a vital role for economic and social development for the environment [12]. Plants cannot grow without water and growth of plants also depends upon bacterial action, while microorganisms need water in order to flourish. In India water scarcity is expected to worsen as the overall population is expected to increase to 1.6 billion by the year 2050. Children in 100 million homes in the country lack water and one out of every two children are malnourished. Water quality indices are used to monitor the water quality. It is a mechanism based on numerical expression for defining the level of water quality [2].

2. Study Area:

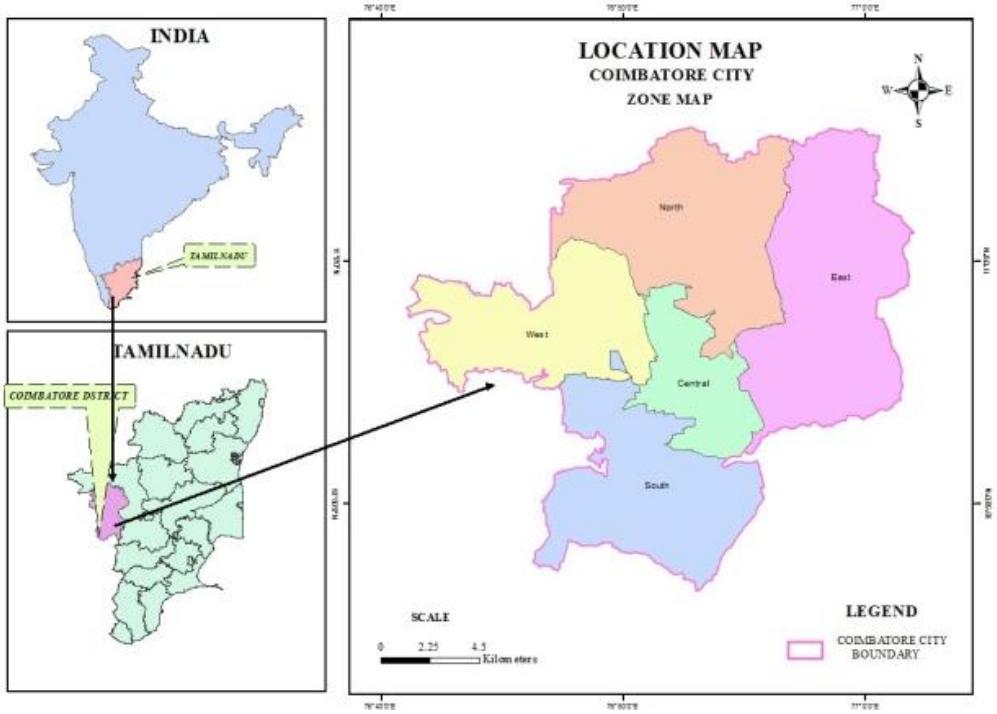

Figure 1: Location map of the Study Area

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Coimbatore city is the district headquarters of Coimbatore district. It is the third largest city in Tamil Nadu. The city is situated at 11º00' N latitude and 77º00' E longitude and (Figure 1) occupies an area of about 257.04 Sq.km. It has the distinction of housing various types of industries like textile machinery, cement, rubber, transport equipment, foundry engineering and a variety of engineering industries. The Coimbatore district is flanked on the northwest and south by steeply raising mountains of Western Ghats. Of these, the Nilgiris on the North West and Anamalai on the south are the important ranges, which attain a height of over 2500 m above mean sea level and the highest elevation in the valleys adjoining the hills is 600 m above mean sea level. Generally sub-tropical climatic condition prevails throughout the district and there is no sharp variation in climate. The temperature slowly rises to its maximum up to May and afterwards shows a general decline. The maximum temperature ranges from 36 to 41°C and the minimum temperature varies from 14 to 31°C. The average annual rainfall of this district is 647.2 mm from four distinct seasons such as winter, hot weather period, south west monsoon and north east monsoon. Granitic gneiss is the predominant unit which covers almost the study area, which includes granites, partially weathered granitic gneiss, highly weathered granitic gneiss and fissured rock. Soil type of study area consists of red calcareous, red non calcareous soil, black soil, colluvial, alluvial soil and brown soil.

3. Objectives:

To assess the Groundwater Quality for human consumption based on computed water quality parameters of Coimbatore City.

4. Methodology:

Groundwater samples were collected from 50 locations of 5 zones during pre-monsoon period (May 2015) (Figure 2). The groundwater sample locations cover widely includes populated, commercial, industrial, agricultural and residential colonies. Each of the groundwater samples was analyzed for 12 parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), sulphate (SO_4), chloride (Cl), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), Nitrate (NO_3), Total alkalinity (CaCO3) and total hardness (TH) using standard procedures recommended by APHA[1]. The locations of the GPS points of the groundwater locations were plotted on a map use of ArcMap 10.3. Water quality statistics is calculated from the point of view of suitability of groundwater for human consumption.

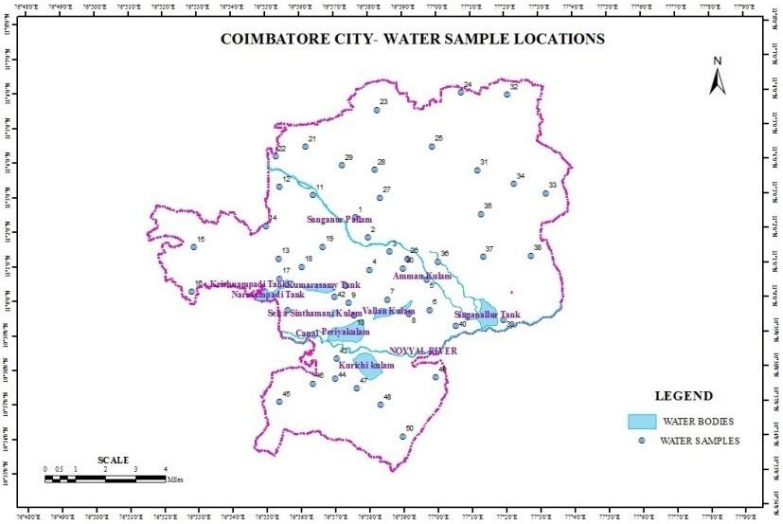

Figure 2: Groundwater Sampling Locations

5. Results and Discussion:

The physico-chemical analyses of the groundwater of the different locations of Coimbatore city are compared with the related standards for drinking water prescribed by IS:10500. The drinking water standard is given in the table 1. Table 2 presents the statistics of physico-chemical parameters of groundwater in Coimbatore City, Tamilnadu.

Table 1: Drinking Water Standards (IS:10500-2012)

S.No	Parameters	Permissible Value	Standard
1	pH at 25 ˚C	6.5-8.5	IS:10500
2	Electrical Conductivity	300	IS:10500
3	Total Dissolved Solids	500	IS:10500
4	Total hardness as $CaCO^3$	200	IS:10500
5	Calcium as Ca	75	IS:10500
6	Magnesium as Mg	30	IS:10500
7	Total alkalinity as CaCO3	200	IS:10500
8	Chloride as Cl	250	IS:10500
9	Sulphates as SO_4	150	IS:10500
10	Nitrate as NO_3	45	IS:10500
11	Turbidity	5	IS:10500

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12	Fluoride as F^-	1	IS:10500
13	Potassium K	10	IS:10500

Table 2: Minimum, Maximum Mean and standard deviations obtained from the pre-monsoon

S.No	Parameters	Pre-Monsoon		
		Minimum	Maximum	Mean
1	pH at 25 ˚C	6.81	7.96	7.39
2	Electrical Conductivity (µmhos/cm)	111.8	4660	1870
3	Total Dissolved Solids (mg/L)	72.7	3030	1216
4	Total hardness as CaCO3 (mg/L)	20.8	2142.4	644.8
5	Calcium as Ca (mg/L)	6.25	464.85	150.05
6	Magnesium as Mg (mg/L)	1.26	270.52	60.67
7	Total alkalinity as CaCO3 (mg/L)	20	850	390
8	Chloride as Cl (mg/L)	15.42	1644.88	277.57
9	Sulphates as SO_4 (mg/L)	2.35	1080.8	183.82
10	Nitrate as NO_3 (mg/L)	3.25	38.82	13.885
11	Sodium as Na (mg/L)	7	139	64
12	Potassium as K (mg/L)	5	97	21

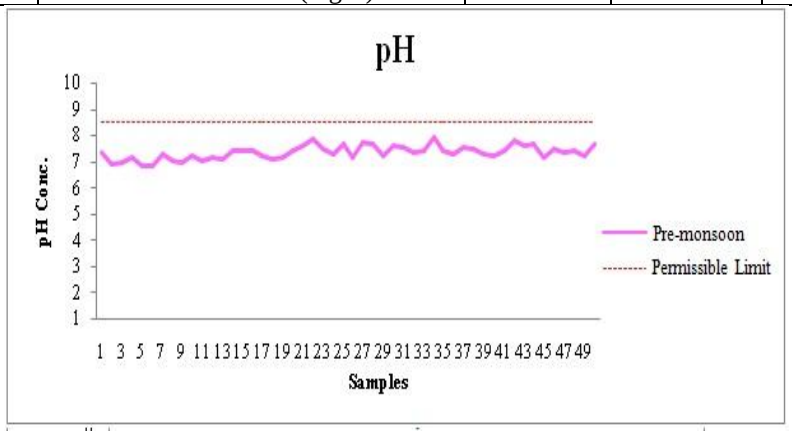

Figure 3: Distribution of pH

Fig. 3 shows the spatial distribution of pH in the study area. The pH is a measure of the balance between the absorption of hydrogen ions and hydroxyl ions in water. The pH of water provides vital information in many types of geochemical symmetry [6]. The limit of pH value for drinking water is specified as 6.5–8.5 [3 and 14]. The pH value of most of the groundwater samples in the study area varies from 6.81to 7.96 and mean is 7.39, which clearly shows that the groundwater in the study area is alkaline in nature. However pH has no direct effect on human health, its higher range accelerates the scale formations in water heating apparatus. The pH parameter is one of the most important operational water quality parameters.

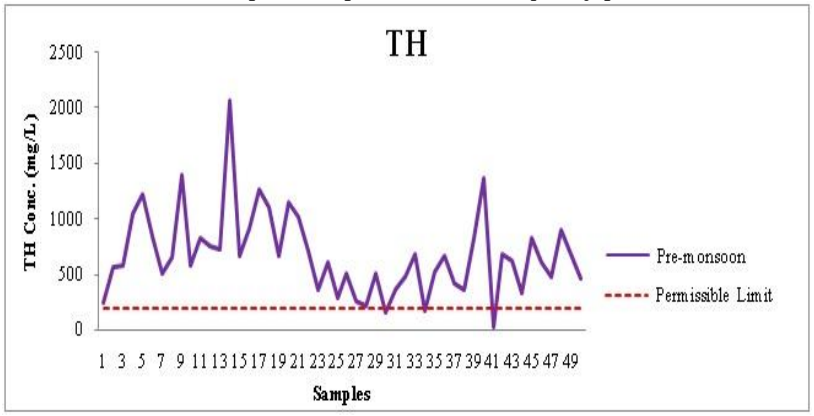

Figure 4: Distribution of TH

Fig. 4 shows the spatial distribution of Total Hardness in the study area. The permissible limit of TH for drinking water is 200 mg/L samples are not suitable for drinking supply pipes and well pumps [9]. It ranges between 20.8 mg/l to 2142.4 mg/l with an average of 644.8mg/L. In the study area most of the groundwater samples (94%) lies above the maximum permissible limit. Total hardness in water is caused mainly due to the presence of carbonates and bicarbonates of calcium and magnesium, sulphate, chloride and nitrate. Total hardness in water is a content of calcium (Ca2+) and magnesium (Mg2+) as equivalent of CaCO3. High concentration of total hardness in study area is due to high concentration of calcium and magnesium whereas lower concentration in eastern part is due to the contribution of the continuous recharge of freshwater.

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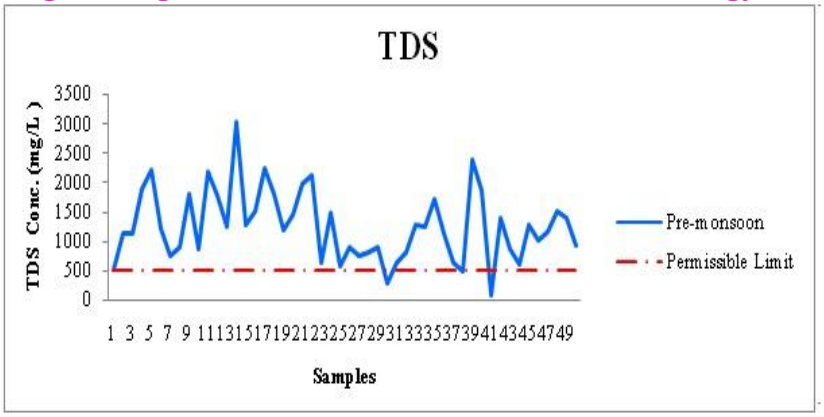

Figure 5: Distribution of TDS

Fig. 5 shows the spatial distribution of TDS in the study area. According to Indian specification TDS up to 500 mg/L is clear that most of the groundwater samples fall beyond the permissible limit. In the study area the TDS value varies between a minimum of 72.7mg/L and a maximum of 3030 mg/L, indicating that 94% groundwater samples not suitable for drinking. A higher concentration of TDS usually poses no health threat to humans until the values exceed 10,000 mg/L where it causes a gastrointestinal irritation in the consumers [13].

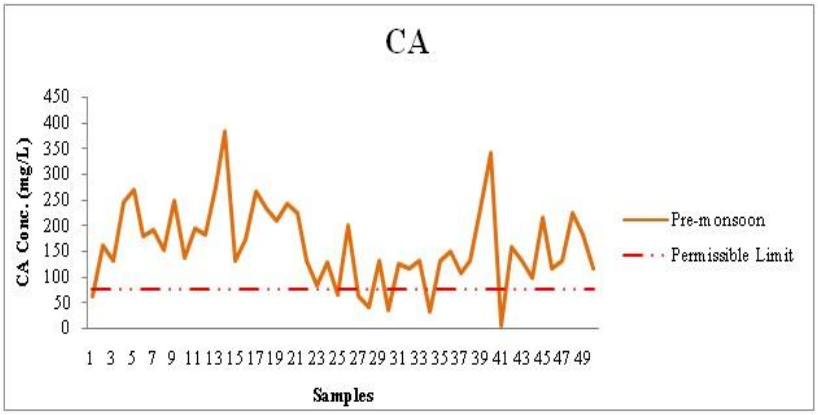

Figure 6: Distribution of CA

Fig. 6 presents the spatial distribution of Calcium in the study area. Calcium is a fundamental nutritional constituent for humans. Thus, the optimum concentration of Ca^{2+} is required to prevent cardiac disorders and for proper performance of metabolic processes. Calcium concentrations are varying from 6.25 to 464.85 mg/L with a mean value of 150.05 mg/L. According to Indian standard the desirable limit of calcium concentration for drinking water is specified as 75 mg/l [3] which shows that 86% of groundwater samples fall beyond the permissible limit. Calcium occurs in water mainly due to the presence of limestone, gypsum, and dolomite minerals. Magnesium content is varying from 1.26 to 270.52mg/L with a mean value of 60.67 mg/L. The Indian standard permissible limit of Mg Concentration of drinking water is specified as 30 mg/L [4]. The 24% of Samples fall below the permissible value. Fig. 7 presents the spatial distribution of Mg in the study area.

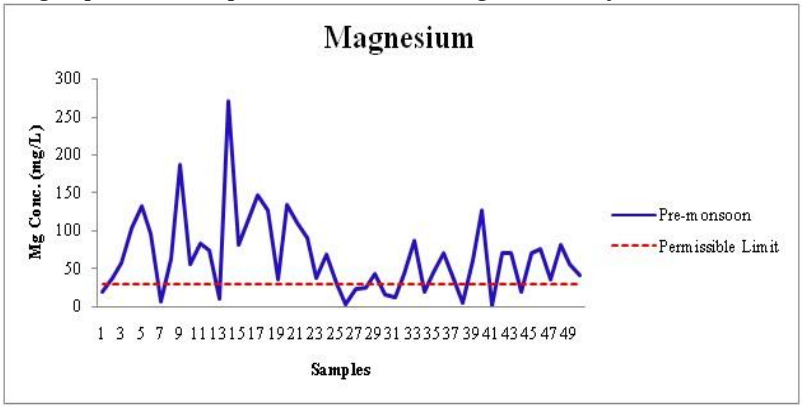

Figure 7: Distribution of Mg

The alkalinity ranged between 20 to 850 mg/L a mean value of 390 mg/L during the period. The Indian standard permissible limit of alkalinity Concentration of drinking water is specified as 200 mg/L. Maximum of 96% of samples values exceeded the permissible limits. This is due to the movement of pollutants into the groundwater. Maximum alkalinity gives the

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bitter feel. Also it is harmful for agriculture. Samples number BW30 and BW41 below the BIS limit as it shows a value of 160 and 120 mg/L respectively. Fig. 8 presents the spatial distribution of alkalinity in the study area.

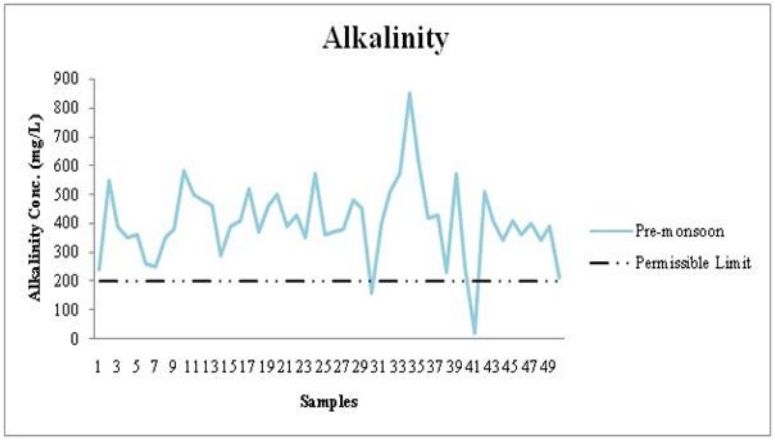

Figure 8: Distribution of Alkalinity

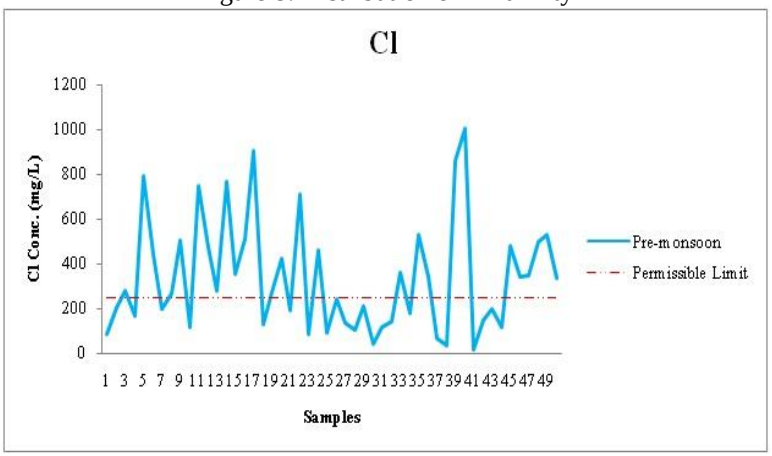

Figure 9: Distribution of Cl

Fig. 9 shows the spatial distribution of Chloride in the study area. The Indian standard permissible limit of Chloride Concentration for drinking water is specified as 250 mg/L. Chloride concentration ranged fluctuating from 15.42 mg/L to 1644.88 mg/L with a mean of 277.57 mg/L. High concentration of chloride is observed as 51% in the total no of samples. This may be due to pollution from industrial or domestic wastes. If this water used for construction the high chloride concentration corrode the concrete.

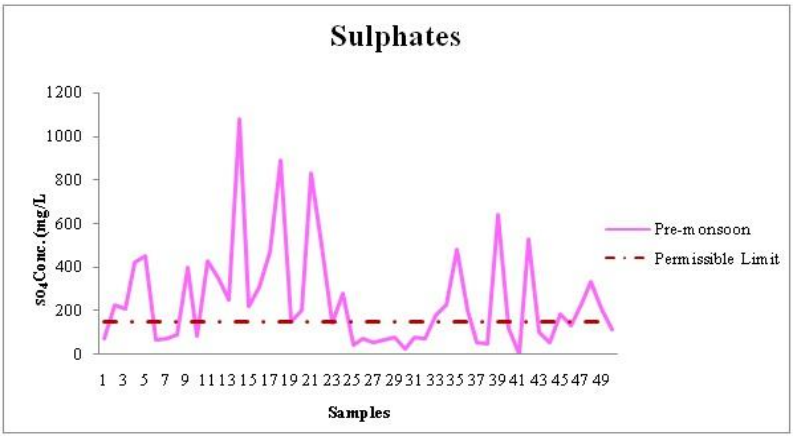

Figure 10: Distribution of SO_4

Fig. 10 shows the spatial distribution of Sulphates in the study area. Sulphates were found in the range from 2.35 to 1080.8 mg/L during pre-monsoon period. High concentration of sulphates is observed as 56% in the samples. According to Indian standard the desirable limit of sulphate concentration for drinking water is specified as 150 mg/L. Sulphates concentration is important in determining the suitability of water for public also industries. High sulphate concentration cause cathartic effects for human beings.

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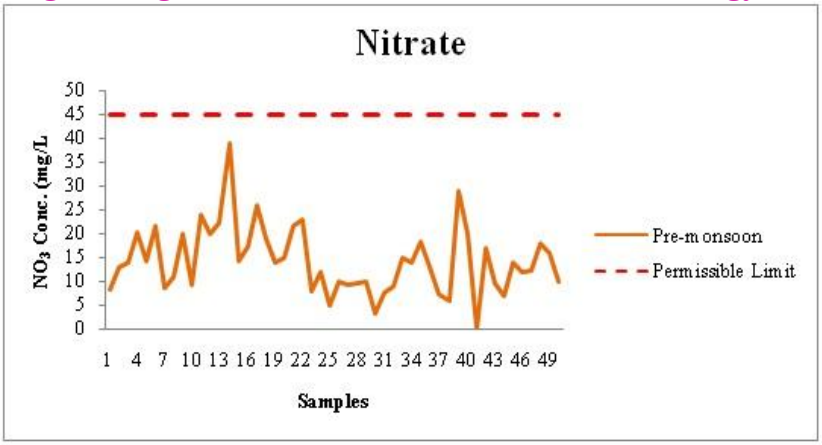

Figure 11: Distribution of NO3

Fig. 11 shows the spatial distribution of Nitrate in the study area. The Nitrate has a man-made pollution. The Nitrate concentration observed in the study area entire sample values fall below the permissible limits. The Indian standard permissible limit of Nitrate Concentration for drinking water is specified as 45 mg/L. Since the range varies from 3.25 to 38.82 mg/L and mean 13.885 mg/L. the high Nitrate for drinking purpose reduces the oxygen carrying capacity of the blood blue-baby" syndrome in which there is a reduction in the oxygen carrying capacity of blood or leads to formation of nitrosamines which is carcinogenic when it reaches the stomach or liver [5, 9, and 11]. None of the groundwater samples exceeds this limit so that the water is potable.

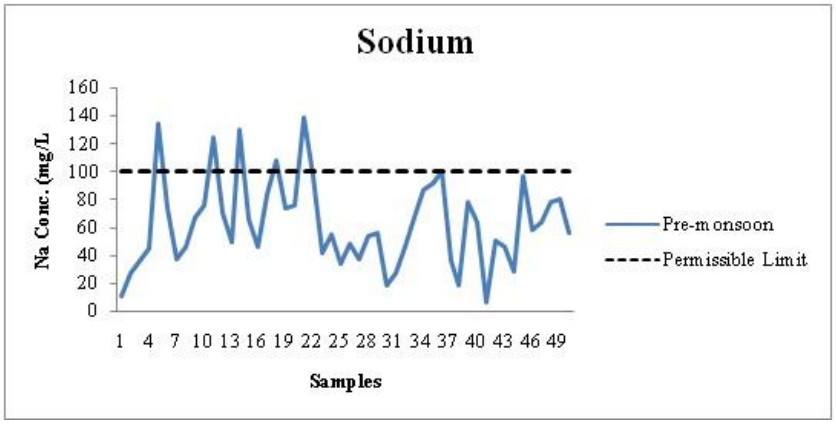

Figure 12: Distribution of Na

Fig. 12 showed the spatial distribution of Sodium in the study area. It varies from 7 mg/L to 139 mg/L with a mean of 64 mg/L. The major source of sodium content in the ground water is due to presence of salts. The prescribed safe limit of Na is 100 mg/L for drinking water [3]. The more than the recommended limit of 100 mg/L in potable water, causes hypertension or congenial heat diseases and also kidney problems. So, the people, who suffer from the hypertension, should be taken only sodium-restricted food [10].

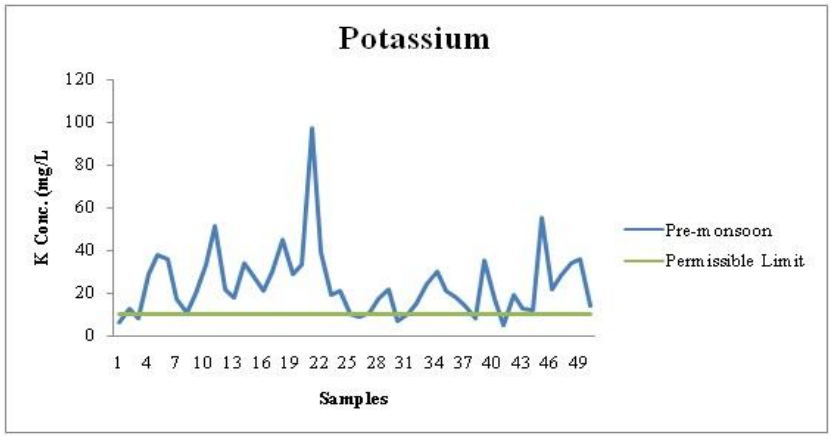

Figure 13: Distribution of Potassium

Fig. 13 showed the spatial distribution of Potassium in the study area. Potassium is essential to maintain the fluid in balance stage in the body. Generally, it is less than 10 mg/L in water. In the study area, Na varying from 5 to 97 mg/L and mean 21 mg/L, indicating that only six groundwater samples are fall within the recommended limit of Indian standard 10 mg/L.

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exceeding. The maximum permissible limit of potassium in the drinking water is 10 mg/l and it was found that 88% of the samples are above the permissible limit of BIS, 2012.

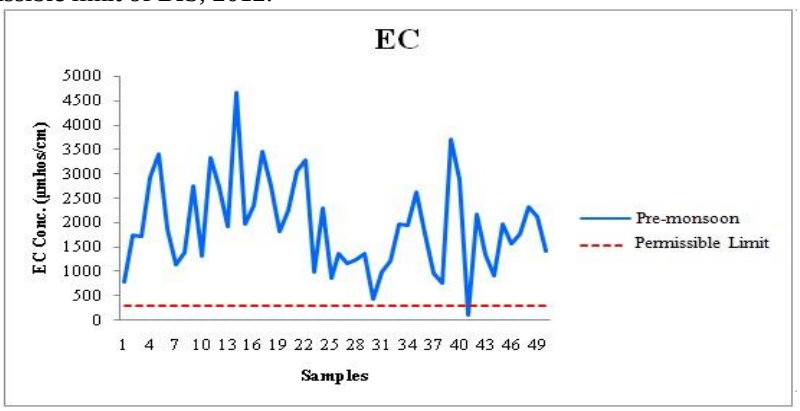

Figure 14: Distribution of EC

Fig. 14 indicates that the Electrical Conductivity (EC) in the study area ranges between 111.8 and 4660 µS/cm at 30°C with a mean of 1870 µS/cm. The Indian standard permissible limit of Electrical Conductivity Concentration for drinking water is specified as 300µmhos/cm. The taste perception was unsatisfactory in areas with high conductivity [7]. Groundwater points which reported high conductivity had also high total dissolved solids and this was consistent [4]. It is found out the inorganic dissolved solids presence in the water.

5. Conclusion:

The study of groundwater quality during pre-monsoon seasons in Coimbatore city has been usefully made. The changes in water quality parameters in the pre- monsoons show natural and human impacts on groundwater quality. The study suggests that GIS is one of the best techniques to analyze groundwater quality and the tools that are used in this study can be adopted for any other place to study groundwater quality. From present investigations we concluded that the quality of most of the water samples under study was not suitable for drinking purpose except few samples. House holders of the boreholes will be advised on whether the water will require more additional treatment before pumping for domestic consumption.

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