Hydrogeochemical Parameters in Part of Thiruvallur District, Tamil Nadu, India

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Abstract- *The study area lies in central part of Araniyar and Korattaiyar river basin and includes three Blocks of Thiruvallur District, Tamilnadu. The aim of the study is to determine the hydrogeochemical properties of groundwater. Totally, fifty-nine groundwater samples were collected during January 2016 and June 2016 to represent post- and pre-monsoon seasons. The samples were analysed for chemical parameters (pH, EC, TDS, TH, Na, K, Ca, Mg and Cl, HCO3, SO4). The results were compared with the BIS 2012 standards, in order to understand the hydro geochemistry of the groundwater.*

Keywords- Hydro-geochemistry, Arani & Korattalai River, Thiruvallur district.

I. INTRODUCTION

Groundwater is one of the important sources of water used for drinking, domestic, agricultural and industrial purpose. The quality must be considered in any of water resources evaluation (Anon 1993). Detailed works on groundwater investigation, assessment, evaluation and management in relation to hydrogeology and water resources engineering were initiated by several authors (Todd 1980; Prince 1985; Karanth 1987). Lawrence, J.F., (1995) has applied digital evaluation of ground water resources. Hydro-geochemical processes are the major responsible for the modification of groundwater in their chemical composition. The quality of ground water depends on the nature of the soil and the lithology present in groundwater saturation zone (Olayinka et al., 1999; Foster et al., 2000; Chidambaram et al., 2008). There are many processes involved during the movement of groundwater from recharge to discharge areas that include precipitation, mixing, ion exchange, redox condition, leaching and dissolution. The chemical and biological characteristics of water determine whether or not it can be used for domestic, industrial or agricultural supply. Nevertheless, groundwater is a complex chemical substance that owes its composition mainly to the solution in, and chemical reaction between water and the rock or soil masses through which it travels. Water also remains the most important factor of illness and infant mortality in many developing countries and even in industrialized countries, where the number of cases of infectious intestinal diseases continues to increase (Jones and Watkins 1985). Water contamination can be classified as having either natural or anthropogenic sources. In this situation, water quality and chemistry gain their importance for the management and assessment of groundwater. Natural and anthropogenic sources along with chemical and biogeochemical constituents have been considerably altering groundwater quality in recent years (Senthil kumar and Gowtham 2014). Hence, the study focuses on the assessment of the quality and geochemistry of groundwater in part of Tiruvallur district of Tamil Nadu.

II. STUDY AREA

The study area has been sub divided in to three blocks Thiruvallur ,Ellapuram and Poondi of Thiruvallur district, and is located in northern part of Tamil Nadu with an aerial extent of 792 Sq.kms. The entire study area falls in toposheet no. 66C/3, 66C/4, 57O/16 and 57O/15 .The geographical location of North Latitude between 12°10’00” and 13°15’00”East Longitude between 17°15’00” and 80°20’00”. The region is mainly occupied by sedimentary formation and rocks belonging to Archean and Proterozoic. The area under investigation is a part of the east flowing Araniar–Korattaiyar and Cooum sub-basins. The Monsoon Rivers like Araniyar and Korattalayar, are the important rivers and the drainage pattern is generally dendritic. (Figure: 1). Ground water occurs under phreatic conditions in the weathered mantle and under semi-confined conditions in the fissured and fractured zones at deeper levels. The depth to water level in the district varied between 2.38 and 7.36 m bgl (CGWB 2007). The study area is mainly influenced by agriculture activities chiefly donated for Groundnut, Rice, Sugarcane, Ragi, Cumbu. Hydrogeomorphological units such as Flood plain, Low land, Alluvialplain, Buried channel, and Upland are observed in the regions. Among the fluvial geomorphic units, flood plain, buried channel, alluvial plain, and valley fill contribute to more ground water resources to the area. The aim of the study is to assess the water quality for irrigation and drinking water purposes in part of Tiruvallur District, Tamil Nadu, India.

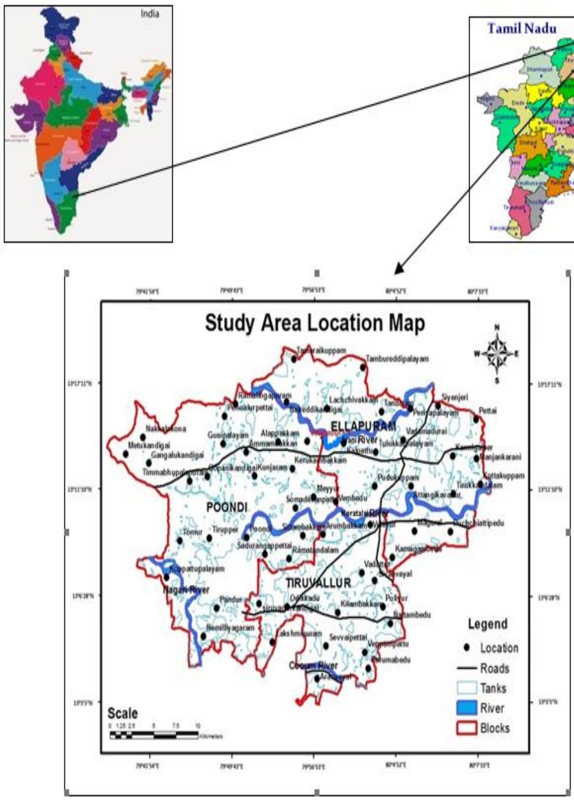

Figure 1. Location map of the study area

III. METHODOLOGY

Fifty-nine ground water samples were collected from open wells and bore wells in the study area (Figure: 1). Sampling and analysis was carried out using standard procedures (APHA 2012; Ramesh and Anbu 1996;). Five hundred milliliters of water samples was collected in polyethylene bottle. Bore water was collected by pumping out the stagnant water for 20 min with hand pump, to get representative samples. Then, it was sealed and brought to the laboratory for analysis, stored properly and filtered with 0.45-lm filter paper before analysis. The Temperature, Electrical conductivity (EC), and pH were measured using a Digital Water and Soil Analysis Kit Model-161 Aristocrat at the sample collection site itself. SO4 of the samples were determined by ELICO SL 27 Spectrophotometer. Na and K of the samples were determined by ELICO CL 354 Flame-photometer. The carbonate and bicarbonate were determined by titration with 0.2 N sulphuric acid using phenolphthalein and methyl orange indicators. The analytical precision of the measurements of ions was determined by calculating the ionic balance error, which was observed to be within the standard limit of ±10 %.

IV. RESULTS AND DISCUSSION

The results obtained from the water samples part of Thiruvallur for physicochemical parameters such as Water, Electrical conductivity (EC), pH, Total dissolved solids (TDS), Total hardness (TH), Calcium, Magnesium, Sodium, Potassium, Chloride and Sulphate for post monsoon and premonsoon seasons are shown in Tables 1 & 2.

Electrical Conductivity

The measurement of EC is directly related to the concentration of ionized substances in water and may also be related to the problems of excessive hardness and other mineral contamination. Dissolved solids present in natural water consist mainly of inorganic salts such as carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron, and small amount of organic matter and dissolved gases. The assessment of geochemical characteristics of water is essential to classify the ground water and surface water depending upon their hydrochemical properties based on their TDS values (Davis and De Wiest 1966; Freeze and Cherry 1979). The most desirable limit of EC in drinking water is prescribed as 1500 µs/cm (BIS 2012). The electrical conductivity can be classified as type I, if the enrichments of salts are low (EC: 1500 µs /cm); type II, if the enrichment of salts are medium (EC: 1500 and 3000 µs /cm); type III, if the enrichments of salts are high (EC 3000 µs /cm; Sarath Prasanth et al. 2012). According to the classification of EC In the study area, the value ranges from 358.52 – 1446.88 with an average of 1069.22 µmohs/cm in post monsoon and 428.13- 2198.44 µmohs/cm with an average of 1278.73 µmohs/cm in pre monsoon. This is quite medium in normal ground water type II and reason due to domestic waste, anthropogenic activity and municipal waste precipitation and similar were also reported by Manikannan et al. (2011), (Figure: 2). The proportion of electrical conductivity is increase during post monsoon than pre monsoon in Thiruvallur block of the area.

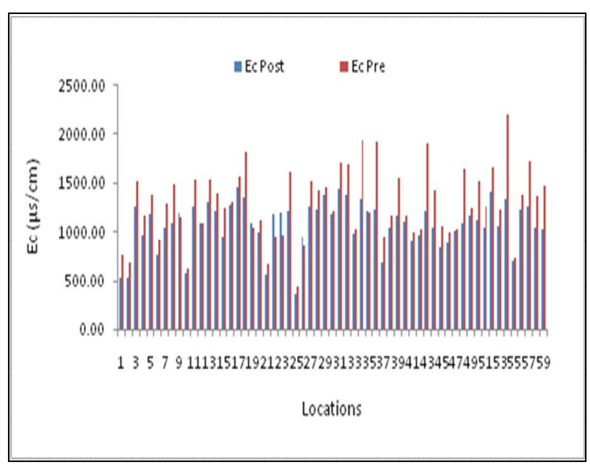

Figure 2. EC

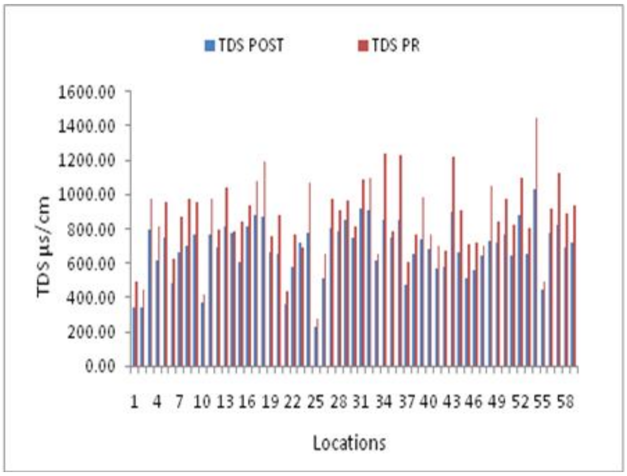

Figure 3. TDS

Total dissolved solids

Total dissolved solid (TDS) denotes the various types of minerals present in water in dissolved form. In natural waters, dissolved solids are composed of mainly carbonates, bicarbonates, chlorides, sulphate, phosphate, silica, calcium, magnesium, sodium and potassium. TDS affects water supply system (scaling), excessive soap consumption, calcification of arteries, may cause urinary concretions, diseases of kidney or bladder and stomach disorder. According to BIS specification, TDS up to 500 mg/l is highly desirable and up to 1500 mg/l is the maximum permissible limit. Degree of groundwater quality can be classified as fresh, if the TDS is less than 1000 mg/l; brackish, if the TDS is between 1000 and 10,000 mg/l; saline, if the TDS varied from 10,000 to 1,000,000 mg/l; brine, if the TDS is more than 1,000,000 mg/l (Todd 1980). The measured values of total dissolved solids in the study area ranged from 274 to 1437 mg/l in pre monsoon and 229.45 to 1022 mg/l in post monsoon (Table 2 & 3).All of the study area ground water sample TDS is within permissible limit. Overall TDS increase during Post monsoon compare with pre monsoon in the study area Thiruvallur block. It can be attributed mainly due to developing area addition of ions by weathering and leaching of non-resistant minerals from rocks (geogenic), although the influence of anthropogenic component prevailing in the study area.

pH

pH is the term used universally to express the intensity of the acid or alkaline condition of a solution. The pH of groundwater is a very important indicator of its quality and is controlled by the amount of dissolved CO2, carbonate and bicarbonate (Ghandour et al. 1985). The combination of CO2 with water forms carbonic acid, which affects the pH of the water. For the study area ground water pH range is 6.1-7.9 with intermediate value of 7.0 during pre monsoon and during post monsoon the values are 6.4-7.8 with medium value of 7.12 (Figure: 4). It clearly indicated that all the study area fall within the permissible limit (the permissible limit of pH is 6.5–8.5).

Total Hardness

The Total Hardness (TH) is an important parameter of water quality, whether it is to be used for domestic, industrial or agricultural purposes. It is due to the presence of excess of Ca, Mg and Fe salts. The Total Hardness varies in the study area ranging from 200-1012 mg/l, with an average of 534.66 in pre monsoon and in post monsoon ranges from 139.7-833.40 mg/l with an average of 412.91. (Table 1 & 2) (Figure: 5). It was observed from the results that most parts of the study area urbanization Thiruvallur block are having quite high hardness, which exceeded the permissible level and this may be attributed to the mixing of sewage effluents into the ground water due to urban waste and industrial waste water to mixing in the study area.

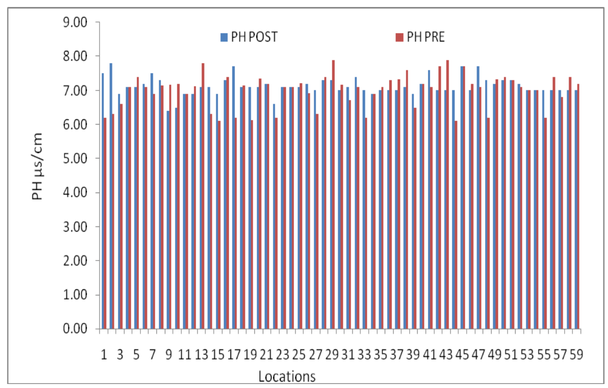

Figure 4. pH

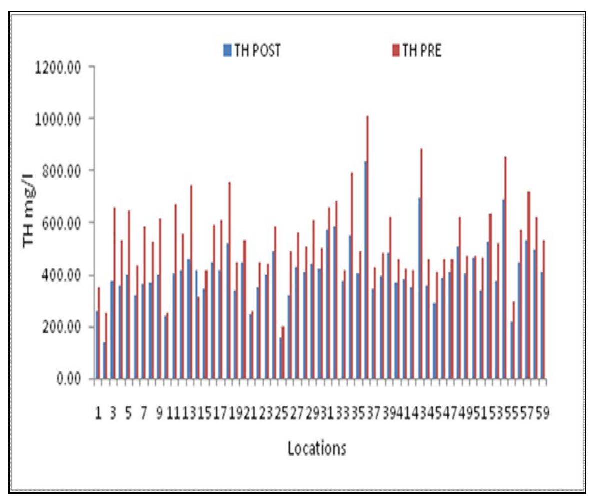

Figure 5. Total Hardness

Major Cations

Calcium

Calcium is an important constituent in natural water. The concentration of calcium in pre monsoon ranges from 15 to 225 mg/L with an average of 137.81 mg/L and in post monsoon the range of value is 28 to 201 mg/L with an average of 117.05 mg/L (Figure: 6). The high amount of calcium was observed in pre monsoon season, and it is observed that the minimum

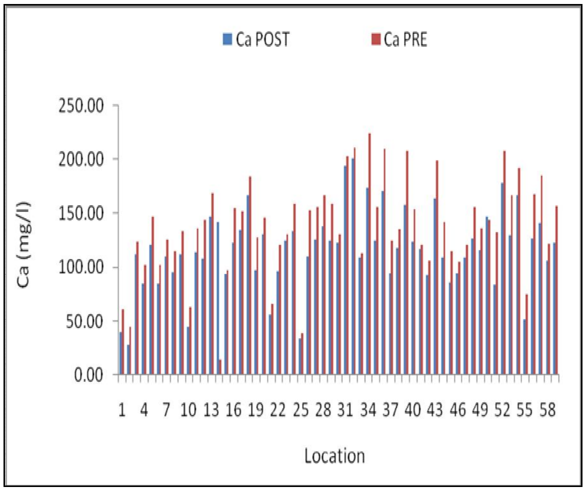

Figure 6. Calcium

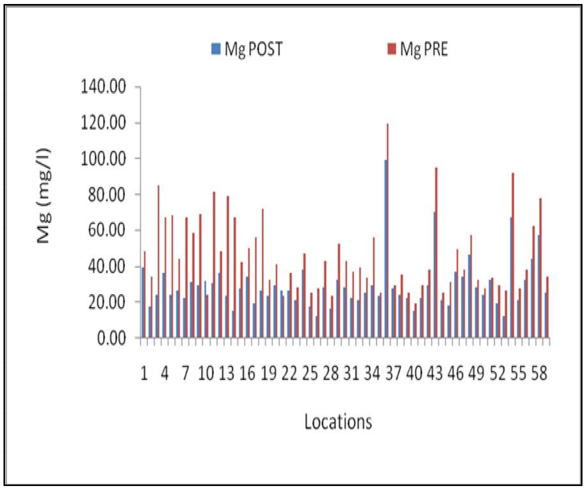

Figure 7. Magnesium

Concentration of calcium in Indian River water is reported as (30 mg/L) in summer and winter (Chandrasekaran, 2015). Here, the higher amount o f calcium concentration was f o u n d in Thiruvallur block of the study area due to the influence of industrial and municipal waste water. Hence when compared to the global average, it is suitable for aquatic systems (Sarin and Krishnaswamy, 1984).

Magnesium

The water concentration of magnesium in pre monsoon ranges between 19-119 mg/L with an average 46.37mg/L and in post monsoon ranges from 12-99 mg/L with an average 29.34 mg/L (Figure: 7). The natural adsorption of magnesium in rivers is from 0.85 mg/L to 12.1 mg/L (Meybeck et al., 1996, 1 99 2). The varied concentration is noted Thiruvallur block of the study area. In general magnesium commonly present in natural waters as Mg2+ and along with calcium they contribute hardness to water (Puvaneswari, 2015). The essential source of Magnesium is from the weathering of rocks containing Ferro magnesium minerals and from some carbonate rocks. Natural content of magnesium in fresh water are > 100 mg/L, based on the rock types within the catchment area. All though, magnesium is used in many industrial process this is moderately advanced in surface water. It is also reported that high magnesium values may be a result of soil erosion or to some extent by high density of phytoplankton (Maulood, 1989, Hassan, 2010).

Sodium

Sodium level in the samples of the study area ranges from 15.9- 76.10 mg/l, with an average of 16 – 210 mg/l during pre monsoon. In post monsoon, the sodium value is 11-198 mg/l, with an average of 87.19-62.51. This clearly indicates that the atmospheric recycling is the main source for sodium and is less influenced by physical weathering (Subramanian et al., 1987). A natural range of dissolved Sodium in rivers is from 8mg/l to 25.3mg/l (Meybeck, G. et al., 1992, 1996). (Figure: 8).

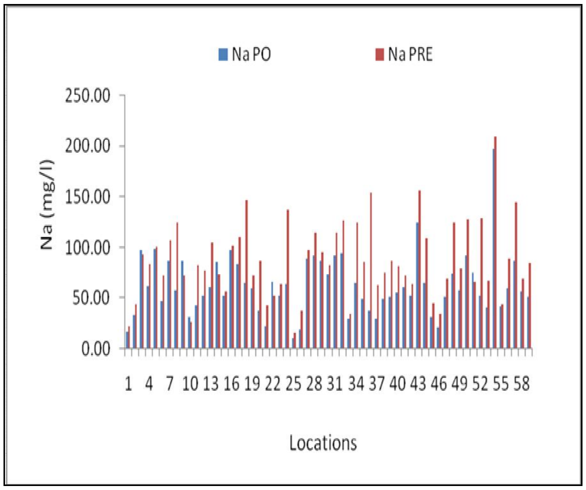

Figure 8. Sodium

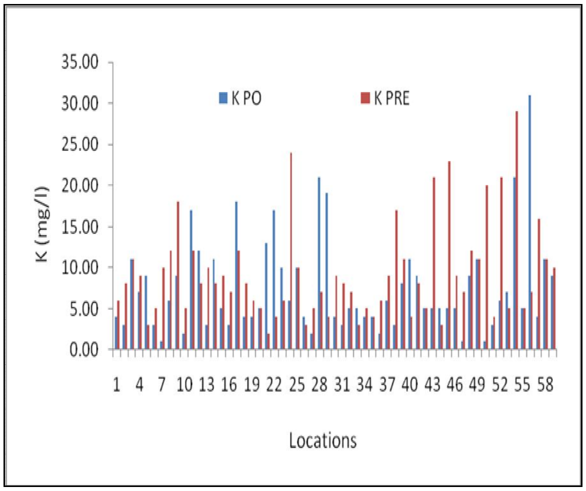

Figure 9. Pottassium

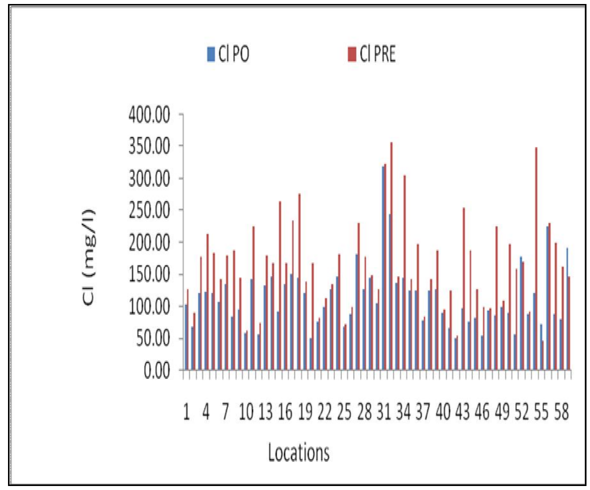

Figure 10. Chloride

Potassium

The concentrations of potassium in natural water are usually less than 10mg /L, but the concentration of potassium in this study displays a range of 1-31 mg/L with an average of 7.58 mg/L in post monsoon and 2 to 29 mg/L with an average of 9.27 mg/L in pre monsoon season (Figure: 9). The proportion of potassium is moderately stronger when compared to winter season. The increase in level in winter is by the effluent discharge from industries since potassium salts are commonly used in industry and in fertilizers for agriculture (Meybeck et al., 1996, 1992).

Chloride

Natural distribution of dissolved chloride in rivers is 0.62 - 25 mg/l (Meybeck et al., 1996, 1992). In the study area the determined chloride ranges from 45 to 356 mg/L with an average of 165.25 mg/l in pre monsoon and 49.7 to 319.5 mg/l with an average of 113.68 mg/L in post monsoon season (Figure: 10). The higher concentration of chloride content was found during the monsoon season may be attributed by the increasing organic waste of human origin with runoff water (Puvaneswari, 2015). Chlorides occur naturally in all types of waters. In natural freshwaters, however, its concentration remains quite low and is generally less than that of sulphates and bicarbonates. Therefore, the chloride concentration serves as an indicator of pollution. The sewage water and industrial effluent are rich in Cl- and hence the discharge of these wastes result in high chloride level in fresh water (Hasalam, 1991; Puvaneswari, 2015).

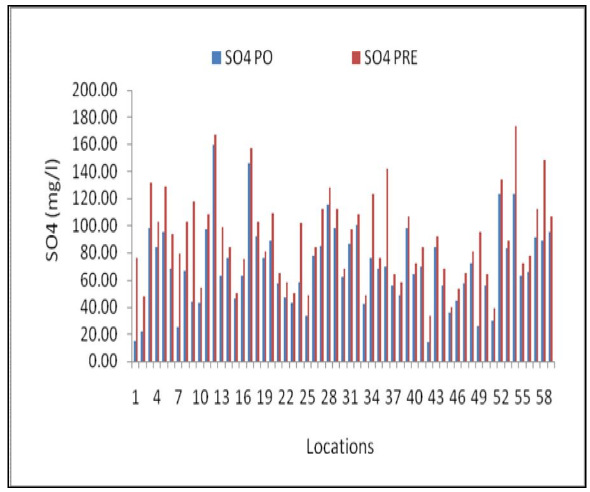

Figure 11. Sulphate

Sulphate

Sulphate proportion ranges from 34 to 173 mg/L with an intermediate 90.17 mg/L in pre monsoon and 14 to 159 mg/L with an average 70.05 mg/L in post monsoon season. The elevated values of sulphate were observed during pre monsoon and lowest during post monsoon (Figure: 11). Sulphate is a naturally occurring substance that contains sulphur and oxygen, which is present in various mineral salts in soil. Sulphate may be leached from the soil, fertilizers, decaying plant and animal matter commonly released into water (Ibbok et al., 2010). Biological oxidation increases the sulphate concentration; discharge of industrial wastes and domestic sewage waters tends to increase its concentration. The increased concentration of sulphate observed during the winter season may be influenced by rain water runoff, sewage waste, soil, fertilizers, decaying plant and animal matter and decomposition of sulphate rich effluents from the husk retting grounds.

Bi carbonate

Bi carbonate proportion ranges from 64 to 409 mg/L with an intermediate 316.19 mg/L in pre monsoon and 56 to 386 mg/L with an average 281.64 mg/L in winter season. The elevated values of sulphate were observed during pre monsoon and lowest during post monsoon (Figure: 12). Sulphate is a naturally occurring substance that contains sulphur and oxygen, which is present in various mineral salts in soil. Bicarbonate may be released from fertilizers, decaying plant and animal matter commonly released into water (Ibbok et al., 2010). Biological oxidation increases the sulphate concentration; discharge of industrial wastes and domestic sewage waters tends to increase its concentration. The increased concentration of sulphate observed during the winter season may be influenced by rain water runoff, sewage waste, soil, fertilizers, decaying plant and animal matter and decomposition of sulphate rich effluents from the husk retting grounds.

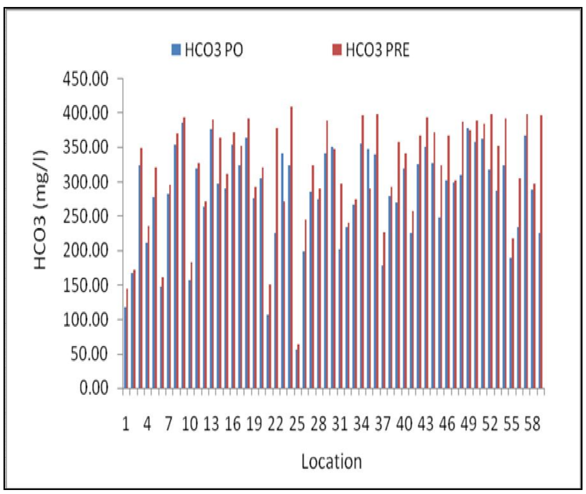

Figure 12. Bi-Carbonate

Table 1. Maximum and minimum concentration of major cations and anions during pre and post monsoon season (January 2016-June16).

Parameters	Post monsoon-2015		Pre monsoon-2015		BIS 10500 : 2012
	Minimum	Maximum	Minimum	Maximum	Acceptable Limit
EC(µS/cm)	358.52	1446.88	428.13	2198.44	-
Ph	6.40	7.80	6.10	7.90	6.5-8.5
TDS(mg/l)	229.45	1022.00	274.00	1437.00	500
Ca(mg/l)	28.00	201.00	15.00	225.00	75
Mg(mg/l)	12.00	99.00	19.00	119.00	30
Na(mg/l)	11.00	198.00	16.00	119.00	-
K(mg/l)	1.00	31.00	2.00	29.00	-
HCO_3(mg/l)	56.00	386.00	64.00	409.00	200
Cl(mg/l)	49.70	319.50	45.00	356.00	250
SO_4(mg/l)	14.00	159.00	34.00	173.00	200

V. CONCLUSION

The proportion of electrical conductivity is higher during post monsoon than pre monsoon in Thiruvallur block is due to municipal waste, precipitation. The total dissolved solids in ground water is high and due to addition of ions by weathering and leaching of non-resistant minerals from rocks (geogenic), although the influence of anthropogenic component prevailing in the study area. In the study area pH indicated average in all locations. The major cations and anions quite high in pre monsoon especially at Thiruvallur block due to mixing of sewage effluents into the ground water, urban waste, industrial waste influence through Korattalaiyar River in the study area.

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