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Suitability of Groundwater and River water for Irrigation and Domestic Purposes in Mettupalayam Taluk, Coimbatore District, Tamil Nadu

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Abstract : Groundwater is one of the most important natural resource available to humans, it is, therefore, essential to manage and preserve it. It is a major source of fresh drinking water in both the rural and urban area. Many Industries are present near Bhavani river in Mettupalayam in Coimbatore district, Tamil Nadu which is the source for river water pollution. The study emphasizes evaluating groundwater and surface water quality for drinking and irrigation purposes during both pre-monsoon and post-monsoon in Mettupalayam taluk. Samples were collected during pre-monsoon and post-monsoon period; 33 samples were collected which includes 3 river water samples and 30 groundwater samples from bore well. Groundwater sample was collected in 15 villages each comprising of 2 sample points fixed randomly. The groundwater quality information maps of the entire study area have been prepared using GIS spatial interpolation technique for all the above parameters. The chemical relationships in piper diagram identify the mixed CaMgCl and and few samples falls in NaCl types and $CaHCO_3$ types. High TDS and Hardness in few places identify the unsuitability of groundwater for drinking and irrigaiton. The most effectve irrigation indices are USSL diagram, Wilcox diagram, Residual sodium carbonate, Magnesium hazard, Kelly ratio and salinity hazard to evaluate the quality of groundwater for irrigation purpose. Based on indices majority of groundwater samples were suitable for irrigation and some sample locaiton s are unfit for irrigation use due to anthropogenic activities. Analysis of parameter concentration was carried out and spatial distribution in the area was prepared using ArcGIS and variation in the area was found. In general, the concentration is higher in Tholampalayam and Chikkaramapalayam village. Based on the study, it was found that most of the samples are suitable for irrigation purposes.

Keywords: Groundwater and river water- Spatial variation-domestic and Irrigation water quality.

I. Introduction

Groundwater is main sources of water supply for many countries. Degradation of water quality is one of the problems of the 21st century [1]. Globally, anthropogenic activities such as urbanization, industrial development and agricultural intensification are degrading groundwater quality [2]. There is no doubt that the developments of industries are essential for the growth of a nation but the side effects of industrial growth and urbanization have threatened the mankind in the form of pollution. Many industries, particularly textile processing units, tanneries and distillery units are situated on the banks of Bhavani River. Bhavani river is polluted and the environment is degraded due to flow of untreated sewage/ waste water into the river. Mapping spatial variation of groundwater parameters are important for proper developing of new groundwater schemes and management of groundwater resources [3]. Spatial variation of groundwater quality depends on geological formation through which it flows and anthropogenic activities in area of groundwater basin [4]. A geographic information system (GIS) interpolation technique is widely used to produce groundwater quality map and groundwater potential zone demarcation. The discharge of industrial effluents is also accountable for the deterioration of groundwater quality parameters. The environmental impacts on the groundwater contaminants may seriously affect the economic condition of the country. Hence the hydrogeochemistry study was conducted in the Mettupalayam taluk by collected during pre-monsoon and post-monsoon period; 33 samples were collected which includes 3 river water samples and 30 groundwater samples from bore well. Groundwater sample was collected in 15 villages each comprising of 2 sample points fixed randomly. Various analysis was carried out to check the suitability for drinking and irrigation purpose

II. STUDY AREA AND SAMPLING

Mettupalayam is a taluk and municipality of Coimbatore rural district, located to the north of the city of Coimbatore on the way to Ooty. It is located in the foothills of Nilgiri hills about 35 km north of downtown Coimbatore. Mettupalayam is located at 11°18'00" N 76°57'0" E. It has an average elevation of 314 meters (1033 feet). Mettupalayam is situated on the bank of the Bhavani river at the foot of the Nilgiri mountains. Mettupalayam taluk is an important trading hub and transit centre for the hill products including vegetables, potatoes, fruits, arecanut, tea and coffee, which are grown in the Nilgiris. In recent years, many industries have been established near to the Bhavani river, which is one of the sources of water to the people in the taluk, other sources are boreholes, hand-dug wells and pipe-borne water. [5], reported that the groundwater quality at Thekkampatty, Jadaampalayam and Irumborai, whaich are the villages in Mettupalayam, have been affected by Industrial pollution. Table.1gives the Mettupalayam location detail. Mettupalayam taluk consists of 19 revenue villages as shown in Fig.1 shows the digitized map of Mettupalayam.The groundwater samples collected randomly in 15 revenue villages in Mettupalayam taluk and at three spots along the Bhavani river. Samples were collected, 2 from each village, totally 33 samples were collected (Table.1). The samples were collected in plastic bottles, which had been cleaned with distilled water before being rinsed thoroughly with the collected groundwater. The analysis was performed by referring the standard procedure recommended by the American Public Health Association [6].

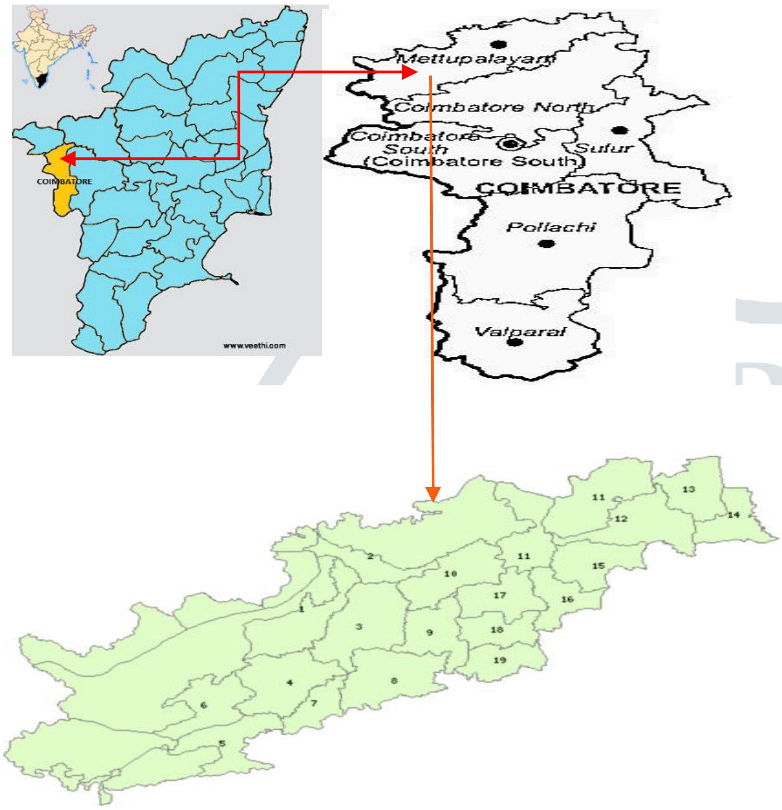

Fig.1 Location of the study area

Table .1 Description of Sample Location

Sample No	Location	Latitude	Longitude	Type of Well	Purpose
R1	River	11°17' 38.4" N	76° 53' 31.2" E	Surface Water	Irrigation and Domestic
R2	River	11° 18' 39.6" N	76° 55' 51.6" E	Surface Water	Irrigationand Domestic
R3	River	11° 20' 20.4" N	76° 58' 12" E	Surface Water	Irrigationand Domestic
1	Karamadai	11° 16' 1.2" N	76° 56' 31.2" E	Bore Well	Irrigation and Drinking
2	Karamadai	11° 14' 31.2" N	76° 57' 21.6" E	Bore Well	Drinking and Domestic
3	Marudur	11° 19' 48" N	77° 0' 28.8" E	Bore Well	Irrigation
4	Marudur	11° 19' 19.2" N	77° 0' 28.8" E	Bore Well	Drinking and Domestic
5	Kalampalayam	11° 14' 6" N	76° 56' 13.2" E	Bore Well	Drinking and Domestic
6	Kalampalayam	11° 14' 13.2" N	76° 54' 57.6" E	Open Well	Irrigation and Drinking
7	Kemarampalayam	11° 18' 43.2" N	76° 58' 12" E	Bore Well	Drinking and Domestic
8	Kemarampalayam	11° 18' 18" N	76° 56' 6" E	Bore Well	Irrigation
9	Tholampalayam	11° 16' 12" N	76° 58' 40.8" E	Bore Well	Irrigation
10	Tholampalayam	11° 15' 28.8" N	76° 58' 26.4" E	Bore Well	Irrigation and Drinking
11	Velliyangadu	11° 14' 56.4" N	76° 59' 38.4" E	Bore Well	Irrigation
12	Velliyangadu	11° 14' 9.6" N	76° 58' 1.2" E	Bore Well	Irrigation
15	Thekkampatti	11° 18' 36" N	76° 59' 24" E	Bore Well	Drinking and Domestic
16	Thekkampatti	11° 17' 24" N	76° 58' 51.6" E	Bore Well	Drinking and Domestic
18	Odanthorai	11° 21' 14.4" N	77° 7' 8.4" E	Bore Well	Drinking and Domestic
19	Odanthorai	11° 22' 22.8" N	77° 7' 44.4" E	Bore Well	Drinking and Domestic
20	Nellithorai	11° 22' 30" N	77° 6' 25.2" E	Open Well	Irrigation and Drinking
21	Nellithorai	11° 22' 55.2" N	77° 5' 49.2" E	Open Well	Drinking and Domestic

22	Jadayampalayam	11° 11' 60" N	76° 52' 33.6" E	Bore Well	Drinking and Domestic
23	Jadayampalayam	11° 12' 21.6" N	76° 52' 48" E	Bore Well	Drinking and Domestic
24	Sirumugai	11° 19' 48" N	77° 1' 4.8" E	Bore Well	Drinking and Domestic
26	Bellapalayam	11° 19' 15.6" N	76° 54' 57.6" E	Bore Well	Drinking and Domestic
27	Bellapalayam	11° 19' 22.8" N	76° 54' 21.6" E	Bore Well	Drinking and Domestic
28	Illuppanatham	11° 11' 24" N	76° 50' 60" E	Bore Well	Irrigation and Drinking
29	Illuppanatham	11° 11' 2.4" N	76° 50' 20.4" E	Bore Well	Drinking and Domestic
30	Sirumugai	11° 18' 43.2" N	11° 18' 43.2" N	Bore Well	Drinking and Domestic
31	Belladi	11° 18' 57.6" N	76° 53' 31.2" E	Bore Well	Drinking and Domestic
32	Belladi	11° 18' 46.8" N	76° 53' 45.6" E	Bore Well	Drinking and Domestic
33	Chikkaramapalayam	11° 13' 44.4" N	76° 51' 43.2" E	Bore Well	Irrigation
34	Chikkaramapalayam	11° 12' 43.2" N	76° 51' 14.4" E	Bore Well	Drinking and Domestic

III. RESULTS AND DISCUSSION

The simplest way of representing groundwater quality information on a map is to contour the concentrations of a particular substance of interest. Hence, an attempt has been made to infer spatial variations of crucial ions determining the quality of groundwater.

Potentz Hydrogen Ion (pH)

The pH measurement has got considerable environment and public health significance. It is an essential indicator of water quality and is vital to living systems because even minor variations in pH can influence cell structure and it function. pH in the 6.5 to 8.5 has no direct adverse effect on health. However, a lower value below 4 will produce sour taste and higher value above 9.6, a bitter taste. The pH for domestic purposes must be within 6.5- 8.5 The pH in the river sample ranges from 7.2 to 8.5 during pre-monsoon and 6.4 to 7.8 during the post-monsoon season. The pH in the groundwater sample ranges from 7.2 to 8.5 during pre-monsoon (2019) and 6.4 to 7.8 during the post-monsoon season (2020). This specifies that 6% of the sample in post-monsoon season falls slightly out of range. The pH of the groundwater samples in the study area is generally alkalinic. However. The Bureau of Indian Standards [7] gives the permissible range of pH for drinking water to be 6.5 to 8.5. The distribution of the pH for the groundwater samples is normal range is show in Fig.2. Hence, pH of water samples of the study area is not harmful to health.

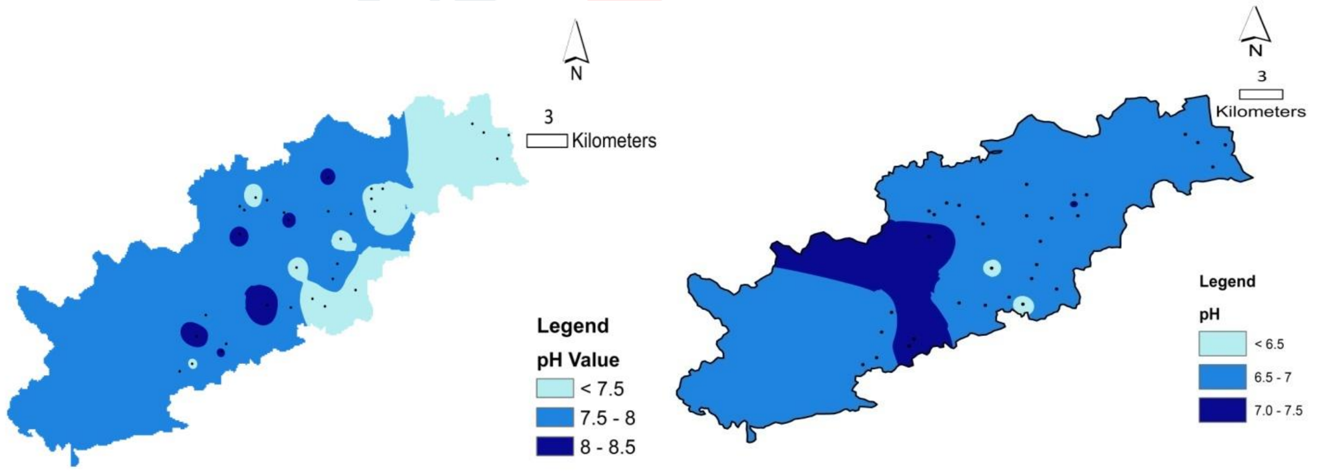

Fig.2: Spatial distribution of pH during premonsoon and postmonsoon

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) refer to the total amount of solid material dissolved in one litre of water and it is measured in milligrams. It is a measure of all constituents dissolved in water. The inorganic anions dissolved in water contain carbonates, chlorides, sulphates and nitrates and the cations consist of sodium, potassium, calcium and magnesium. To ascertain the suitability of groundwater for any purpose, it is essential to classify the groundwater depending upon its hydrochemical properties based on TDS values [8, 9]. The TDS value in pre-monsoon (2019) season ranges from 160mg/l to 1786mg/l and in post-monsoon (2020) season it ranges from 172mg/l to 1910mg/l. Fig.3, consequently, show that the groundwater samples have good (0-500 mg/l) to moderate (500-2000 mg/l) values. 90% of the samples from both pre-monsoon and post-monsoon falls within the permissible limit (2000 mg/l) as per BIS (2012) and the value is generally higher in Tholampalayam village.

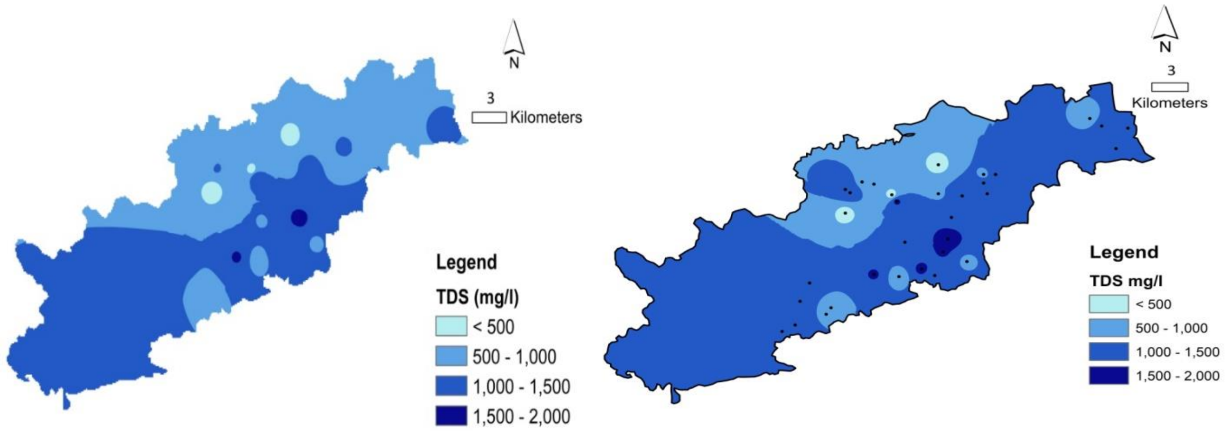

Fig.3:Spatial distribution of TDS during premonsoon and postmonsoon

Total Hardness (TH) The overall hardness of water is caused by dissolved Ca and Mg bicarbonates in water (temporary hardness) as well as dissolved Ca and Mg sulphates and chlorides in water (permanent hardness). Hardness of the water hinders soap lather development and makes it unsuitable for bathing and washing. The primary sources of calcium in groundwater are rock minerals such as gypsum and limestone. The National Research Council (National Academy of Sciences) states that hard drinking water generally contributes a small amount of total calcium and magnesium human dietary needs. Total hardness ranges from 27.5 to 700 mg/l in pre-monsoon (2019) and 80 to 985 mg/l in the post-monsoon (2020) season. It is found that 12% of pre-monsoon samples and 30% of post-monsoon sample values are higher than the desirable limit. From figure 5.12 and figure 5.13, it is clear that the value is generally higher in Tholampalayam and Belladi villages.

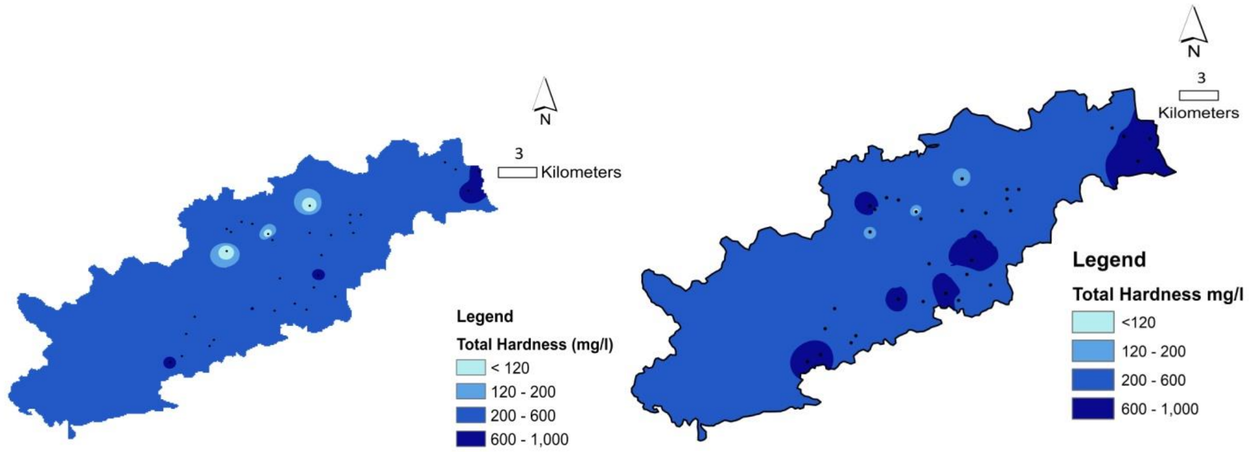

Fig.4: Spatial distribution of Total Hardness during premonsoon and postmonsoon

Calcium (Ca)

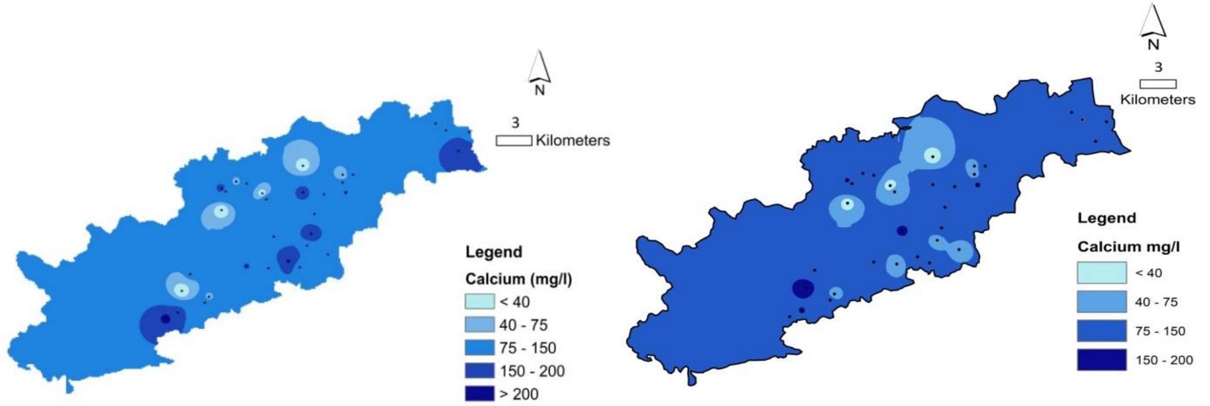

Fig.5: Spatial distribution of calcium during premonsoon and postmonsoon

Magnesium (Mg)

Calcium is naturally present in water. Water with high levels of calcium or magnesium is considered as hard and is undesirable for domestic and drinking water supplies. The concentration up to 100 mg/l of calcium is capable of forming scales in pipes and boilers. But it has no adverse impact on the human system. Calcium is important for proper bone growth. The desirable limit of calcium in drinking water is 75mg/l. In the study area, the value ranges from 10.019 to 212 mg/l during the pre-monsoon (2019) season and 18.035 to 190.37 mg/l during the post-monsoon (2020) season. About 78% and 66% sample falls out of desirable limit during pre-monsoon and post-monsoon respectively. From the figure, it is observed that the value is higher in Karamadai and Illuppanatham village and the value is above 200mg/l.

Magnesium (Mg)

Magnesium is the major scale forming cation in industrial water. It is often found in lower concentrations than calcium. Magnesium is an important element of chlorophyll; without it the environment cannot function correctly. The desirable limit of calcium in drinking water is 30 mg/l. In the study area the value ranges from 1.215 to 91.125 mg/l during pre-monsoon season and 8.506 to 147.045 mg/l during post-monsoon season. From the analysis, it is found that 33% of the pre-monsoon (2019) sample and 81% of the post-monsoon (2020) sample shows a value higher than the desirable limit. From the figure, it is observed that the value is higher in Thekkampalayam and Odanthorai village in pre-monsoon and Tholampalayam and Odanthorai during post-monsoon season.

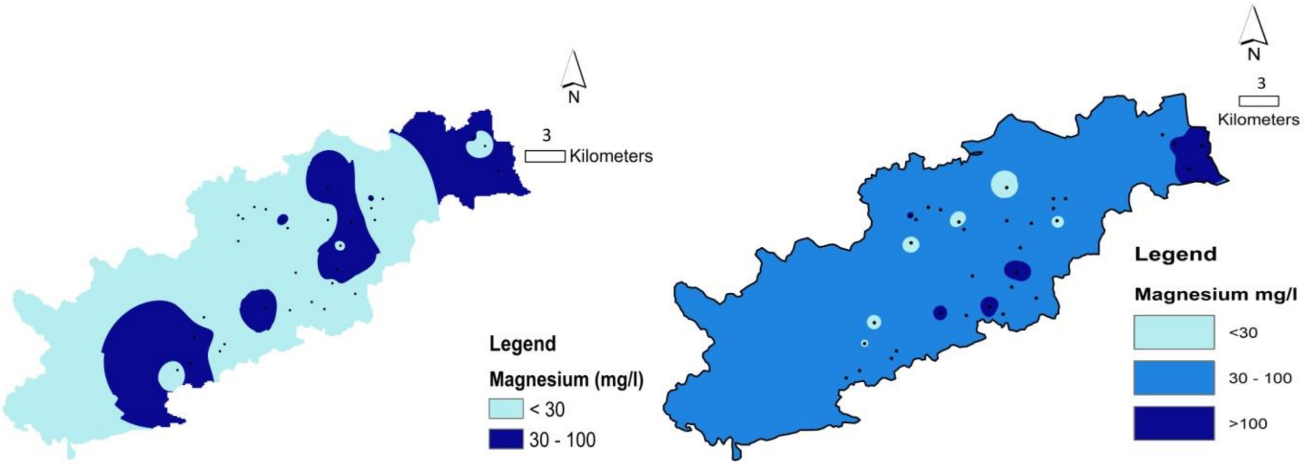

Fig.6: Spatial distribution of magnesium during premonsoon and postmonsoon

Chloride (Cl)

Chlorides occur in all-natural waters in widely varying concentrations. It is commonly found in soils and rocks. There are several potential human-related sources of chloride and sulfate to aquifers. These include agricultural activity, household sewage, landfill leachate, industrial effluent and road salting. The chloride ion occurs in natural waters in fairly low concentrations, usually less than 100 mg/L, unless the water is brackish or saline. Chloride concentrations above 250 mg/L could affect the taste of drinking water and above 150 mg/L are toxic to crops and generally unsuitable for irrigation. Water containing more than 350 mg/l chloride is unsuitable for most industrial uses [10].In the study area, the value ranges from 27.49 mg/l to 444.86 mg/l with an average of 175.38 mg/l in pre-monsoon (2019) season and from 24.992 to 524.83 mg/l with an average of 195.45 mg/l in post-

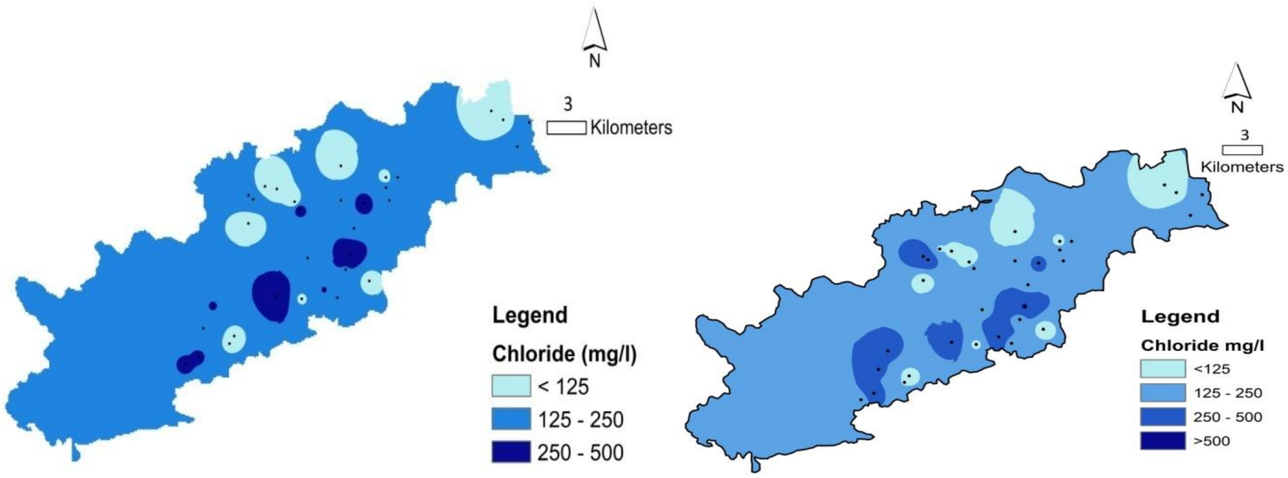

Fig.7:Spatial distribution of chloride during premonsoon and postmonsoon

monsoon (2020). The desirable value according to BIS is 250mg/l. About 24% of samples fall above the desirable limit during pre-monsoon and 30% samples fall above the desirable limit during post-monsoon.

Sulphates (SO4)

Sulphate is a substance that occurs naturally in drinking water. Generally, sulphate is considered beneficial in irrigation water, especially in the presence of calcium. Domestic sewage, industrial effluents besides biological oxidation reduces the sulphur content of water. In the atmosphere sulphur is present as a result of industrial and automobile emission. However, sulphate gives a bitter or medicinal taste to water if it exceeds a concentration of 250 mg/l. High sulphate levels may also be corrosive for plumbing, particularly copper piping. In areas with high sulfate levels, it is common to use corrosion-resistant plumbing materials, such as a plastic pipe. High levels of sulphate with calcium, form a hard scale in steam boilers. High sulphate and chloride concentrations also affect the taste of water. For irrigation waters with sulfate above 500 mg/L, plant life may be harmed. In the study area, the value ranges from 32.7 mg/l to 291.09 mg/l with an average of 154.65 mg/l in pre-monsoon (2019) season and from 16.93 to 287.44 mg/l with an average of 109 mg/l in post-monsoon (2020). 15% of the sample during pre-monsoon and 3% of the post-monsoon sample is found to have a value higher than the desirable limit. The desirable value according to BIS is 200mg/l.

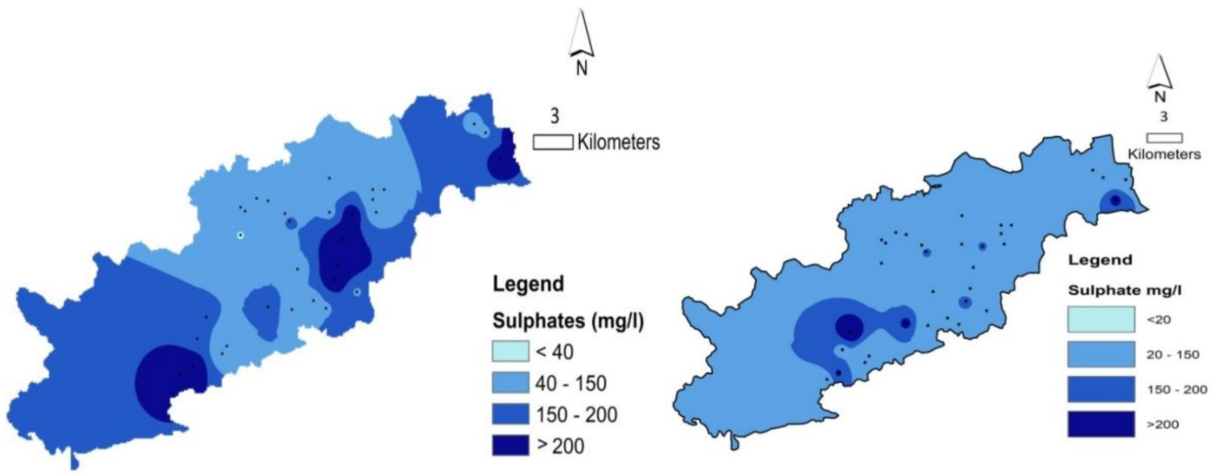

Fig.8:Spatial distribution of sulphates during premonsoon and postmonsoon

Sodium (Na)

Sodium is present in almost all groundwater in variable amounts ranging from negligible amounts to substantial concentrations. Sodium salts are generally highly soluble in water and are leached from the terrestrial environment to groundwater and surface water. High levels of sodium in the water can cause soil particles to disperse and form crusts on the soil surface that impede the infiltration of water. However, excessive amounts of sodium may cause harm to human beings suffering from cardiac disorders and renal and circulatory diseases. Sodium ranges from 4.79 to 308 mg/l during pre-monsoon (2019) and 15.45 to 354.45 mg/l in the post-monsoon season (2020). Sodium value is much higher in Tholampalam during pre-monsoon and post-monsoon.

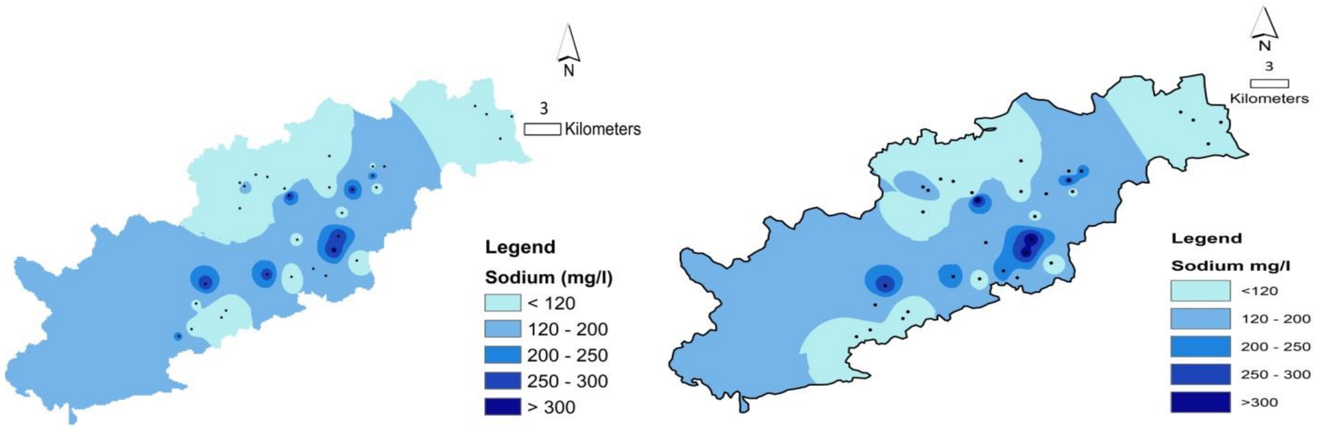

Fig.9:Spatial distribution of sodium during premonsoon and postmonsoon

Potassium (K)

High potassium is generally not a concern for plant growth. Levels above 10 mg/l may indicate water contamination from fertilizers or other man-made sources. Water concentrations are useful simply for determining the overall fertilization requirements for plants receiving the irrigation water. Potassium ranges from 1 to 60.3 mg/l during pre-monsoon (2019) and 0.75 to 53.16 mg/l in post-monsoon (2020) season. Sodium value is higher in Kemarampalayam during pre-monsoon and Tholampalayam post-monsoon.

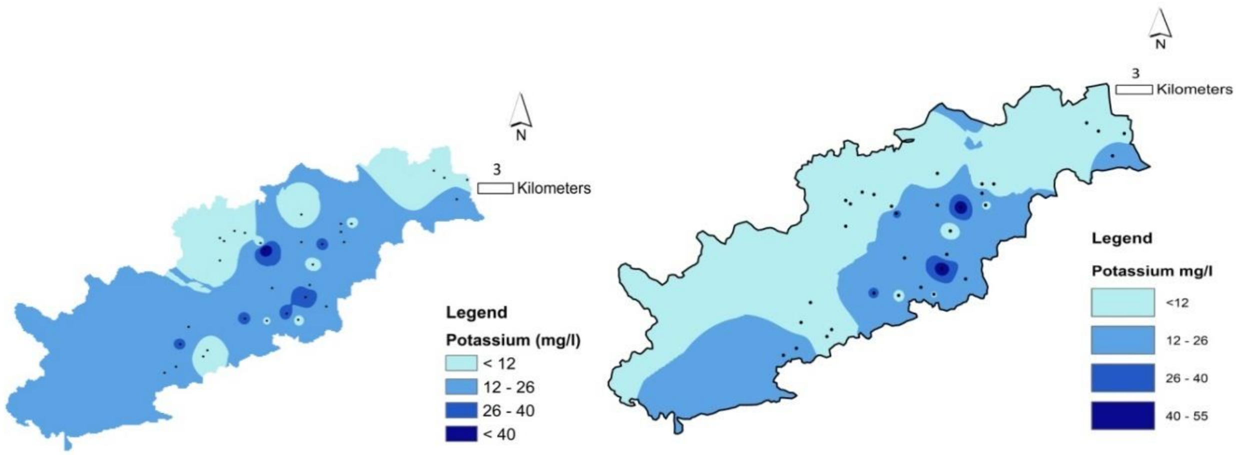

Fig.10:Spatial distribution of potassium during premonsoon and postmonsoon

Turbidity

Turbidity in natural water is caused by the presence of substances like clay, silt, organic matter etc, which will not form true solution. It is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity. The turbidity controls the amount of photosynthesis in an aquatic ecosystem. Turbidity is considered as a good measure of the quality of water. According to BIS standards desirable limit is 1 NTU and the permissible level is 5 NTU. In river water, the turbidity value is as high as 30 NTU. The high turbidity during the monsoon is due to the increased inflow of turbid water into the canal as observed elsewhere. Usability of water for many purposes like drinking, washing depends upon turbidity limits.

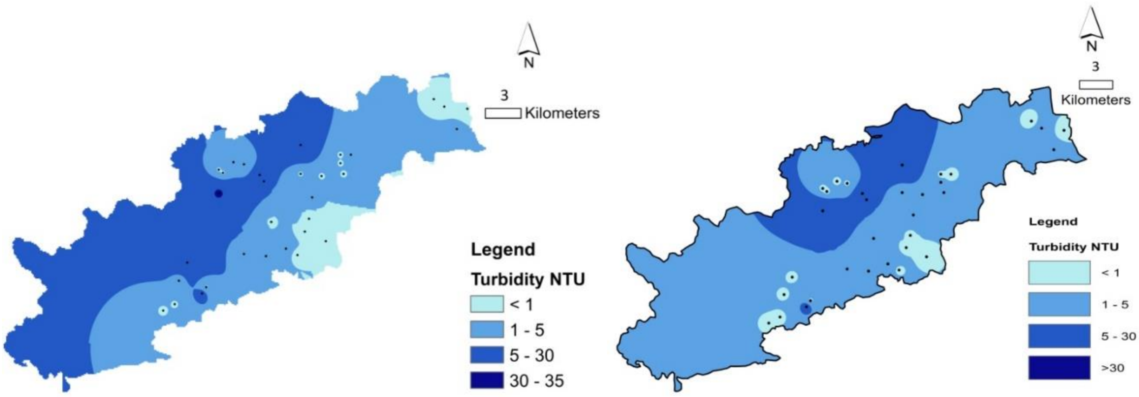

Fig.11:Spatial distribution of Turbidity during premonsoon and postmonsoon

Piper Plot

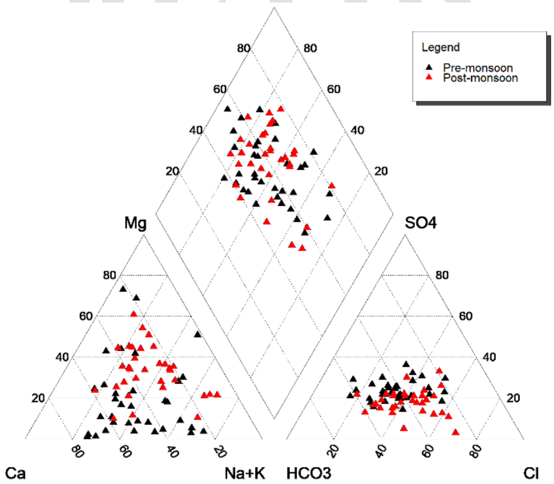

Fig.12:Piper plots during premonsoon and postmonsoon

The geochemical evolution of water, in general, can be understood by constructing [11] (1944) trilinear diagram and Durov's (1948) plot. The figure 5.33 shows that majority of the groundwater samples analyzed during the premonsoon and post-monsoon season in mixed CaMgCl and and few samples falls in NaCl types and $CaHCO_3$ types (Fig.12).The Piper reveals that in pre-monsoon the dominant cation is no dominant type and other cations are Ca^{2+}, Na^+, K^+ and the dominant anion is no dominant type and another type is HCO_3^{2-} and corresponding to the water type, 45% of the sample falls under earth alkaline water with increased portions of alkalies and 27% falls under alkaline water. During post-monsoon, no dominant type cation was observed and the dominant anion is HCO_3^{2-} and Cl^-. The water type is 66% of the sample falls under earth alkaline water with increased portions of alkalies.

Irrigation Suitability

USSLdiagram

Wilcox and USSL diagrams have been used to assess groundwater quality for irrigation purposes. The various study has applied Wilcox and United State Salinity laboratory (USSL) diagrams to assess the groundwater quality for irrigation purposes. [12] have assessed the suitability of groundwater for drinking and agricultural purposes. EC is a good measure of salinity hazard to crops as it reflects the TDS in groundwater. Graphical representation of the chemical data on the irrigation suitability diagram brings out the seasonal variations and suitability of the water to irrigation. During both the seasons, the US salinity diagram demonstrates that the groundwater samples fall in the fields of C2S1, C3S1, C4S1 and C4S2.

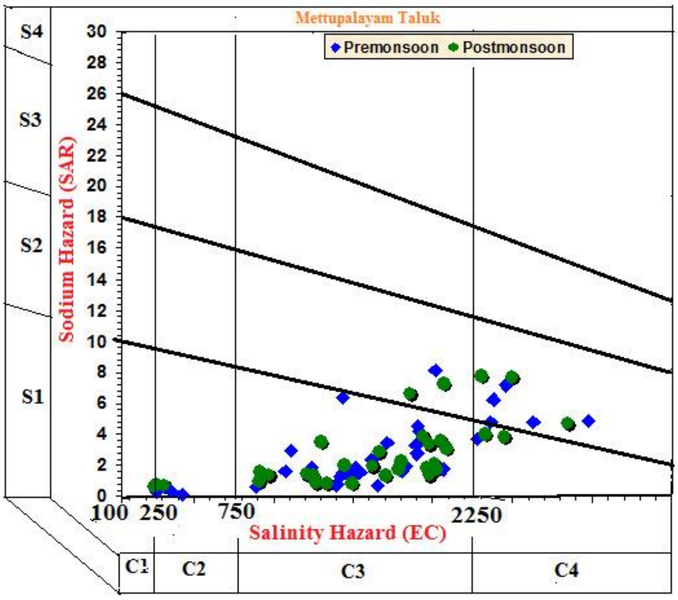

Fig.13: USSL diagram during premonsoon and postmonsoon

Water samples fall in the fields of C2S1, C3S1, C4S1 and C4S2. About 69.69 % of the pre-monsoon and post-monsoon samples fall in the field of C3S1, reflecting high salinity and low sodium water which can be used for irrigation on almost all types of soil with only a minimal risk of exchangeable sodium (Fig.13). The water of this type can be used for plants having good salt tolerance [13]. 9.09% of pre-monsoon and post-monsoon samples fall under the C1S1 and C2S1 category indicating low salinity, low sodium hazard and medium salinity, low sodium hazard which reveals that these water samples can irrigate all soils for semi-tolerant and tolerant as well as sensitive crops. In the C3S2 category that is high salinity-medium sodium hazard, 3.03% of pre-monsoon and 6.06% of post-monsoon samples falls under this category, this type of water cannot be used on soils with restricted drainage. In the C4S1 category, high salinity-medium sodium type, 6.06% of both pre-monsoon and post-monsoon samples fall under this category which indicates adequate drainage is required. 9.09% of pre-monsoon samples and 12.12% of post-monsoon samples belonging to very high salinity-medium sodium type (C4S2), the soil must be permeable need adequate drainage to overcome the salinity problem. In addition to this, plants tolerating salinity should be chosen.

Wilcox diagram

The suitability of groundwater to irrigation can be evaluated using the Wilcox diagram (Fig.14). For this purpose, [14] used % sodium and specific conductance in evaluating the suitability of groundwater to irrigation. Sodium percentage determines the ratio of sodium to the total cations, sodium, potassium, calcium and magnesium. While a high salt concentration in water leads to the formation of a saline soil, high sodium levels lead to the development of an alkali soil. An alkali soil has an unfavorable structure, puddles easily and restricts aeration. Further, high sodium saturation directly causes calcium deficiency. Percent of sodium is calculated as follows:

$$\%\mathrm{Na} = \frac{\mathrm{Na}}{\mathrm{Na} + \mathrm{K} + \mathrm{Ca} + \mathrm{Mg}}$$

The Wilcox diagram during premonsoon shows that 9.09% of the sample falls under excellent to a good category, 57.57 % falls in the good to permissible region, 3 % of the groundwater samples are in the permissible to doubtful region, and the remaining 24.24% samples are in the doubtful to unsuitable region. During post-monsoon, the groundwater shows that 9 % of the samples fall in the excellent to good region, 57.57 % falls in the good to permissible region, 9.09 % of the groundwater samples are in the permissible to doubtful region and remaining sample show doubtful to unsuitable for irrigation. The agricultural yields are generally low in lands irrigated with water belonging to doubtful to unsuitable category. This could be due to the presence of excess sodium salts which cause osmotic effects on soil-plant system. Wilcox diagram clearly shows the variations in water quality during the two seasons.

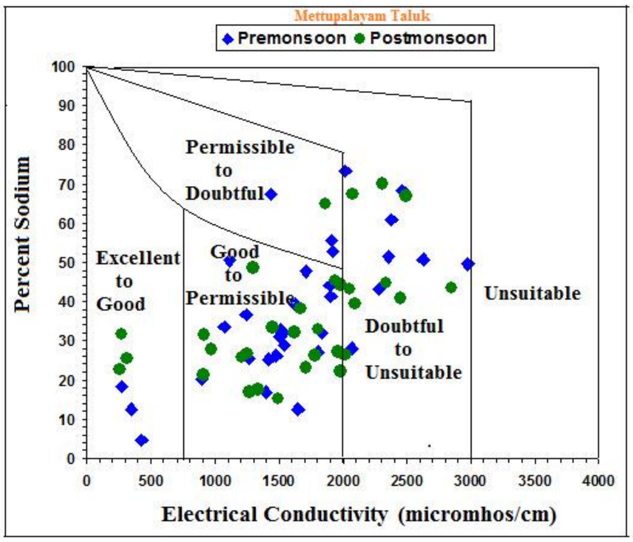

Fig.14: Wilcox diagram during premonsoon and postmonsoon

Residual Sodium Carbonate

Residual sodium carbonate (RSC) has been calculated to determine the hazardous effect of carbonate and bicarbonate on the quality of water for agricultural purpose and is expressed by the equation

$$RSC = (CO_3^{-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$$

where all ionic concentrations are expressed in meq/l [15]. The classification of irrigation water according to the RSC values (Table.2) waters containing more than 2.5 meq/l of RSC are not suitable for irrigation, while those having 1.25 to 2.5 meq/l are doubtful and those with less than 1.25 meq/l are good for irrigation. Based on this classification, all of the groundwater samples belong to the safe category.

Table2: Residual Sodium Carbonate classification

RSC meq/l	Irrigation Class	% Sample Pre- monsoon	% Sample Post-monsoon
< 1.25	Safe	100.00%	96.96%
1.25 - 2.50	Marginal	Nil	3.03%
> 2.50	Unsuitable	Nil	Nil

Residual sodium carbonate value is obtained, by substituting water quality data in the above equation. All the samples including river and groundwater samples, fall from the range -7.1 to 1, during pre-monsoon and in the range of -13.66 to 1.29 during post-monsoon. From the value so obtained, in pre-monsoon the samples fall under safe category, this indicates that the water can be best used for irrigation purposes and in post-monsoon 3.03% of the sample falls under marginal category.

Kelly's Index (KI)

Suitability of water for irrigation purposes is also assessed on the bases of Kelly's index (Kelly 1951). The ratio of sodium versus calcium and magnesium is used in [16]. Groundwater having Kelly's index more than one is considered not-suitable for irrigation purposes.

$$KI = Na^{2+}/(Ca^{2+} + Mg^{2+})$$

Table:3 Kelly's index classification

Kelly's index	Suitability	% Sample Pre-monsoon	% Sample Post-monsoon
< 1	Suitable	87.87%	87.87%
> 1	Unsuitable	12.12%	12.12%

Kelly's index is obtained by substituting sodium, magnesium and calcium value in the above equation. It is calculated for both river and groundwater samples. According to the result, during both the seasons, 87.87% of samples were within the limit of 1 and it's suitable for irrigation purposes whereas 12.12% exceed 1 shows an extra concentration of sodium in water, falling under unsuitable for irrigation category(Table.3). In the case of high KI values gypsum is advised to decease the effects of Na ion.

Salinity Hazard

Electrical conductivity is a potential tool to measure the salinity hazards to crops. EC reflects the TDS in groundwater. The higher EC value, the less water is available to plants, even though the soil appears wet, because plants can only transpire pure water and also yield reductions from irrigating water with high EC value. The EC of the area is compared with EC classification (Table.4). From the result, it is found that 9% of the sample belongs to good category which are river water samples,75.75% belong to a doubtful category and 15.15% of the sample are unsuitable for irrigation purposes. There is no variation between pre-monsoon and post-moon the same percentage of the sample falls under each category, therefore no significant difference.

Table.4 Electrical conductivity classification

EC	Quality of Water	% Sample Pre-monsoon	% Sample Post-monsoon
< 250	Excellent	Nil	Nil
250 - 750	Good	9%	9%
750 - 2250	Doubtful	75.75%	75.75%
> 2250	Unsuitable	15.15%	15.15%

Sodium Percentage

Sodium percent is an important criterion in classifying irrigation water. A set proportion of air and water in the pore spaces is required for the proper growth of plants. The sodium content of water reacts with the soil and accumulates in the pore spaces thus reducing its permeability. Sodium contents are expressed in terms of percent sodium or soluble sodium percentage. The Indian standards suggest a maximum of 60% sodium is permissible for irrigation water

$$SP = \frac{(Na + K) \times 100}{Ca + Mg + Na + K}$$

Table.5 Sodium percentage classification

% Na	Water Quality	% sample Pre-mosoon	% sample Post-mosoon
<20	Excellent	15%	9%
20 - 40	Good	42.42%	57.57%
40 - 60	Permissible	30.30%	21.21%
60-80	Doubtful	12.12%	12.12%
> 80	Unsuitable	Nil	Nil

From the result, it is found that the water quality ranges from excellent to doubtful category and none of the samples falls under the unsuitable category (Table.5). During pre-monsoon, 15% of the sample falls under the excellent category, 42.42% falls under good category, 30.30% falls under permissible category and 12.12% falls under doubtful category. Whereas in post-monsoon, 9% of the sample falls under excellent category, 57.57% falls under good category, 21.21% falls under permissible category and 12.12% falls under doubtful category. A maximum of 60% of the sodium is recommended for irrigation water for better crop yields (BIS, 1991). Therefore 12.12% of the sample imparts plant growth.

Magnesium Hazard (MH)

Calcium and magnesium in water are, generally, in the state of equilibrium. A large amount of presence of magnesium in water adversely affects soil-quality. It converts the soil into alkaline in nature thus reducing its crop yield and poor agricultural returns. Calcium and magnesium do not behave equally in the soil system, and magnesium deteriorates soil structure particularly when waters are sodium dominated. A high level of Mg is usually due to the presence of exchangeable Na in irrigated soils.

$$MH = [Mg / (Ca + Mg)] \times 100$$

Table.6 Magnesium ratio classification

MH	Water Quality	% of Sample Pre-monsoon	% of Sample Post-monsoon
< 50	Suitable	81.81%	36.36%
> 50	Unsuitable	18.18%	63.63%

During pre-monsoon, 81.81% of the sample is found to be suitable for irrigation and 18.18% unsuitable for irrigation and it is poisonous to plant. During post-monsoon, more than 50% of samples are poisonous to plants (Table.6). The value ranges from 15.09 to 72.68. From the result obtained using magnesium ratio formula, it is found that 63.63 % of the sample is unsuitable, indicating their adverse damages the soil structure which effects on crop yield.

CONCLUSION

In the present study the physic-chemical characteristics of groundwater and river water were analyzed during pre and post-monsoons of 2020 in Mettupalayam taluk of Coimbatore district. Groundwater samples were collected from 15 villages and 2 samples from each village and 3 samples were collected from Bhavani river. The samples were analyzed for their chemical properties. The spatial variation of each parameters in the study is plotted using ArcGIS, it gives the variation across the study area and helps in identifying the high concentration area. In general, the concentration is higher in Tholampalayam and Chikkaramapalayam villages. According to Wilcox diagram, 57% of both pre-monsoon and post-monsoon sample falls under good to permissible category and from USSL diagram, 69% of samples fall under C3S1 category indicating high salinity low sodium content. From the study was extended to the river water can be analyzed along the stream length at a certain interval since major disposal of industrial waste is done in rivers. Due to discharge of industrial effluents and applications of chemical fertilizers, pesticides herbicides by the farmers are the main contributors to the pollution of groundwater in the study area. From the interaction with the village people it is clear that at the time of disposal, the water is highly polluted.

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