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## RESEARCH ARTICLE

# GROUNDWATER QUALITY INVESTIGATION IN ANDIMADAM AREA, PERAMBALUR DISTRICT, TAMILNADU, INDIA

**P. Subramanian[1*], R. Prabhakaran[2], K. Babu, S. Chidambaram, R.S. Kumar, B. Selvaraj M. Senthilkumar, K. Srinivasamoorthy**

Department of Earth Sciences, Annamalai University, Annamalainagar – 608002

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**ABSTRACT**

A study on geochemical characterization of ground water and its suitability for drinking and irrigation purposes was carried out in the Andimadam area of Perambalur district, Tamilnadu. Thirty Four groundwater samples were collected from bore wells and open wells during Pre and post monsoon seasons of 2008. The ground water samples have been analysed by various quality parameters such as pH, electrical conductivity (EC), Total dissolved solids (TDS). The water chemistry of various ions viz. $Ca^{2+}$, $Mg^{2+}$, $Na^{+}$, $K^{+}$, $HCO_{3-}$ , $Cl^{-}$, $SO4^{-}$, and $PO4^{-}$.Calcium, Sodium, Chlorite and sulphate are the dominant ions in the groundwater chemistry. The chemical composition of groundwater is controlled by rock water interaction with The formations comprise conglomerates, grey shale's, marl, calcarrious clays, gypseous clays, sandstones and fossiliferous limestone and alluvium deposits. The chemical quality was evaluated for drinking use following the guidelines of WHO (1984). Groundwater is potable except in some isolated pockets. The chemical relationships in Piper trilinear diagram suggest that the groundwater quality is characterized by alkali type. In USSL classification, majority of samples in ground water irrespective of season fall in C1S1 and C2S1 zone indicating medium to low salinity and low sodium hazard, satisfactory for plants having moderate salt tolerance on soils. All the groundwater samples except the few are suitable for domestic, agriculture as well as industrial purpose.



## INTRODUCTION

Water is a prime natural resource, a basic human need and a precious national asset and one of the most stable compounds as well as universal solvent. Besides drinking purpose, it is required for other human activities like cooking, bathing, washing, agriculture, industry, recreation, navigation, fisheries etc. Rapid growth of population, expansion of irrigation and increasing trend of industrialization have contributed towards rising demand for groundwater in many areas. Geochemical processes in groundwater involve the interaction of rocks with water, leading to higher concentration of chemical elements in water. The principles governing the chemical characteristic of groundwater were well documented in many parts of the world. The main objective of the present study area is estimate the water quality of ground water (Major elements) with respect to irrigation and drinking purpose.

### Study area

The chosen area of study, the Perambalur District, Andimadam block is spread an area 3691 sq.km. The area is located between the East longitudes 79 º 15' to 79 º 30'E and North latitudes 11 º 22' to 11 º 30'N of the Survey of Indian toposheet No- 58M/7 and 58M/8 .

***Corresponding author:*** geosubbu27@gmail.com

A major part of the study region is completely covered by red soil. In few places alluvial soil and sandy soil. Physiographically the area is flat with gentle slope towards eastern direction. This area shows dentritic, trills and combination of dentritic and parallel drainage patterns.

### Sample collection and analysis

Sampling was carried out in the post-monsoon season, January, 2008. Thirty–four ground water samples were collected from open wells and bore wells the different parts of the study area (Fig. 1). Samples were collected in clean polyethylene containers of one liter capacity from wells which are under regular use. The water samples have been analyzed to obtain various physical, chemical parameters anions and cations analyzed using (APHA, 1984) procedure. The chemical parameters were computed and various thematic maps prepared. Hydrogen ion concentration (pH), Electrical Conductivity (EC), Total Dissolved solids (TDS) were measured on-site using Consort C933 multi-parameters portable. Calcium ($Ca_2^{+}$) and magnesium ($Mg_2^{+}$) were determined titrimetrically using standard EDTA. Chloride (Cl-) was determined by standard AgNO3 titration. Bicarbonate ($HCO_3^{-}$) was estimated titrimetrically from total alkalinity using HCl, Sodium ($Na^{+}$) and potassium ($K^{+}$) were measured by flame photometry. Sulphate ($SO_4^{2-}$) by spectrophotometer turbidimetry and silica ($H4SiO_4^{-}$) and

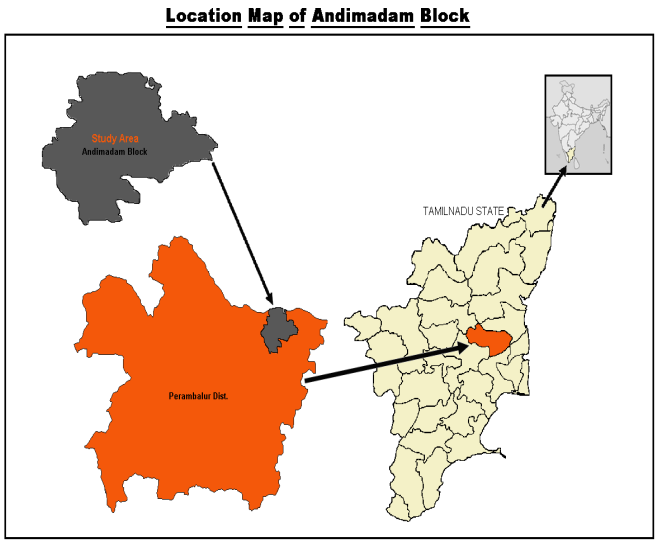
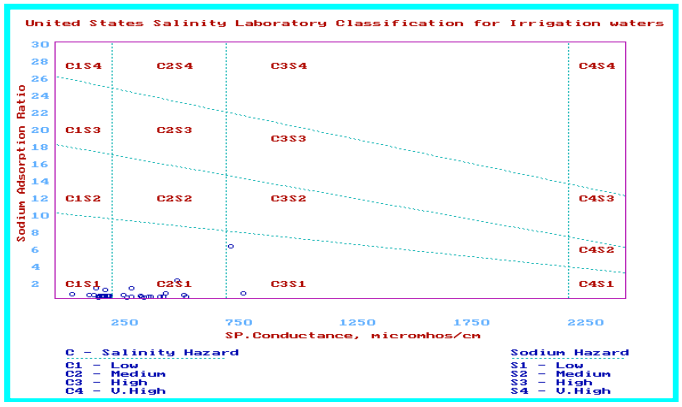
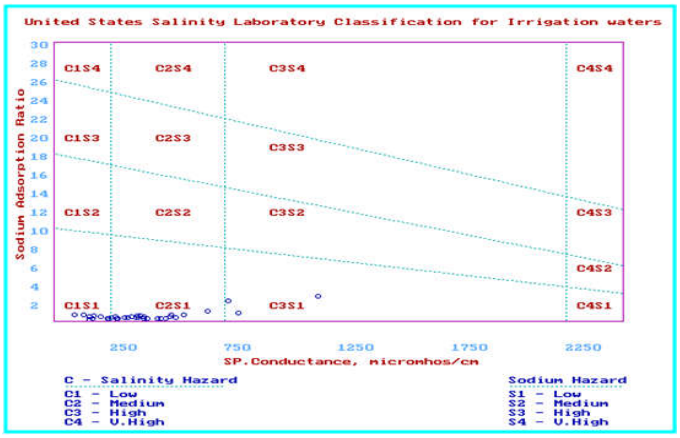



**Fig: 1. Location map of the study area**




**USSL Classification for the ground water of study area in pre - monsoon season**




**USSL Classification for the ground water of study area in post-monsoon season**

phosphate (PO4) by colorimetry with a UV-visible spectrophotometer. All the concentrations are expressed in mg/l except pH and EC in µS/cm. To assess the ground water suitability for drinking purposes, it is interpreted with WHO (1994) guidelines. For its suitability for irrigation purposes, SAR and RSC values were calculated and plotted in the USSL diagram. Chemical quality of ground water was evaluated by graphical technique developed by piper (1994) diagram.

## RESULT AND DISCUSSION

### Hydrochemistry of ground water

The statistical parameters of the variable like minimum, maximum mean and standard deviation of different geochemical parameters of ground water is summarized in table 1. The pH of an aqueous solution is controlled by interrelated chemical reactions that procedure or consume hydrogen ions (Hem, 1985). The logarithm of the reciprocal of the hydrogen ion concentration pH in the pre-monsoon water samples varies from 5.69 to 7.89 to with an average around 6.518 and in the post monsoon samples from 5.9 to 8.1 with an average 6.76 with indicating near acidic to alkaline nature. As per ISI (1995) standards eighty percentages of the samples in irrespective seasons respectively are within the recommended limits (6.5 to 9.2) for human consumption. The electrical conductivity depends upon temperature, ionic concentration and types of ions present in the water (Hem, 1985). The electrical conductivity are found to be within the range of 300 to 4550 microsimens /cm at 25˚C with an average of about 335.794 microsimens /cm at 25˚C in the pre-monsoon periods, and with an average of 391.724 microsimens /cm at 25˚C in the post monsoon periods. The concentration of todal dissolved solids ranges varies from 49.772ppm to 529.43ppm in the pre-monsoon and with an average of 46.24ppm to 581.8ppm in the post monsoon samples.

The water samples have been classified based on the concentration of TDS (ICMR, 1975). According to ICMR classification majority of the study area ground water samples fall in desirable for drinking. Sodium percentage shows that 94% of Groundwater samples in pre-monsoon, 100% of groundwater samples in post-monsoon and all the samples in surface water fall in safe zone indicating suitable for irrigation purposes. Na concentration varies from 3.3 to 222.6 mg/l with an average of 16.34 mg/l. the Ca ionic concentration is varying from 5mg/l to 87mg/l with an average of 31.03 mg/l in the pre-monsoon periods, and with an average of 23.1765 in the post monsoon periods. The concentration calcium is due to interaction of minerals like feldspar, amphiphole, pyroxenes and weathering process.

Potassium ion concentration in ground water samples in irrespective seasons more than permissible limit with an average of 3.846 mg/l to 2.638 mg/l for drinking water, occur in the seventy percentages samples in irrespective seasons. Mg ion concentration in the Groundwater samples is mainly due to the leaching of magnesium bearing minerals. Mg ion concentration ranges from 1 to 25.6 mg/l with an average value of 7.91 mg/l in the pre-monsoon and post-monsoon. Mg average value of 0 to 33.6 mg/l. Bicorbonate is the dominant anion followed by Cl, Phosphate and $SO_4$. The $HCO_3$ concentration in the Groundwater samples ranges from 11.23 to 398.2 mg/l with an average of 89.64 mg/l to 24.4 to 353.8mg/l with an average of 130.97mg/l. Cl ion concentration in the Ground of water is due to the influence domestic sewage and industrial effluents (karanth, 1987, Craig and Anderson,1979). Cl ion concentration in the Ground water is varying from 22.3mg/l to 267.8mg/l with an average a 67.16mg/l in the pre monsoon. Post monsoon Cl average value of 85.497 mg/l. The phosphate ion concentration in the irrespective seasons varying from 0.011mg/l to 0.67 mg/l and

**Chemical composition of Groundwater during Pre-monsoon**

| Ground water | | Pre-Monsoon | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S.No | Name of the Location | EC | pH | Ca | Mg | Cl | K | $HCO_3$ | $SO_4$ | Na | $PO_4$ | $H_4SiO_4$ | TDS |
| 1 | Varadharajanpettai | 239.52 | 6.17 | 16.00 | 22.00 | 68.20 | 2.50 | 36.60 | 0.05 | 8.90 | 0.34 | 1.20 | 153.29 |
| 2 | Andimadam | 303.92 | 6.02 | 12.00 | 5.60 | 56.99 | 2.60 | 112.00 | 0.09 | 7.40 | 0.33 | 0.10 | 194.51 |
| 3 | Vilandai | 578.80 | 6.40 | 56.00 | 11.20 | 77.90 | 2.30 | 214.00 | 0.89 | 7.90 | 0.34 | 2.20 | 370.43 |
| 4 | Periyakrishnapuram | 209.58 | 6.43 | 33.00 | 6.70 | 45.70 | 2.40 | 36.60 | 0.06 | 8.90 | 0.67 | 2.50 | 134.13 |
| 5 | Thirukalapur | 827.23 | 6.34 | 14.00 | 11.10 | 88.09 | 2.20 | 398.20 | 0.89 | 14.20 | 0.35 | 2.60 | 529.43 |
| 6 | Karukkai | 338.47 | 6.11 | 22.00 | 5.20 | 36.70 | 2.20 | 144.20 | 0.09 | 5.60 | 0.23 | 2.60 | 216.62 |
| 7 | Nagampanthal | 379.33 | 6.45 | 16.00 | 5.20 | 44.70 | 4.30 | 168.90 | 0.04 | 6.60 | 0.13 | 1.20 | 242.77 |
| 8 | Viluthudiyan | 384.26 | 6.10 | 64.00 | 11.50 | 48.00 | 6.70 | 113.60 | 0.08 | 6.70 | 0.45 | 1.60 | 245.93 |
| 9 | Olaiyur | 319.98 | 6.34 | 56.00 | 8.90 | 59.00 | 6.90 | 73.20 | 0.06 | 5.70 | 0.23 | 1.70 | 204.79 |
| 10 | Alagapuram | 412.77 | 6.89 | 35.00 | 9.90 | 30.70 | 5.70 | 178.00 | 0.03 | 7.80 | 0.63 | 2.11 | 264.17 |
| 11 | Sriraman | 181.75 | 6.08 | 5.00 | 1.00 | 59.90 | 2.30 | 36.60 | 0.04 | 11.40 | 0.23 | 2.15 | 116.32 |
| 12 | Rangiyam | 487.16 | 7.10 | 35.00 | 13.50 | 99.09 | 5.60 | 144.60 | 0.05 | 16.70 | 0.22 | 2.62 | 311.78 |
| 13 | Kodukkur | 479.47 | 7.89 | 67.00 | 5.80 | 35.70 | 13.50 | 189.00 | 0.03 | 7.70 | 0.53 | 1.10 | 306.86 |
| 14 | Vallm | 464.69 | 6.20 | 87.00 | 6.90 | 68.90 | 3.50 | 124.90 | 0.08 | 7.80 | 0.22 | 1.60 | 297.40 |
| 15 | Kuvagam | 217.92 | 5.69 | 34.00 | 1.20 | 59.00 | 3.40 | 36.60 | 0.03 | 6.60 | 0.34 | 1.70 | 139.47 |
| 16 | Ayyur | 199.19 | 6.84 | 34.00 | 13.50 | 44.80 | 2.20 | 24.40 | 0.19 | 7.80 | 0.53 | 2.26 | 127.48 |
| 17 | Kattathur | 566.99 | 6.03 | 45.00 | 11.60 | 267.80 | 26.70 | 24.40 | 0.05 | 12.00 | 0.22 | 1.81 | 362.88 |
| 18 | Kavarapalayam | 77.77 | 6.54 | 5.00 | 3.30 | 22.30 | 2.20 | 11.23 | 0.02 | 6.60 | 0.02 | 1.30 | 49.77 |
| 19 | Andimadam | 214.36 | 6.66 | 11.00 | 2.40 | 56.70 | 2.10 | 61.00 | 0.05 | 4.60 | 0.04 | 1.40 | 137.19 |
| 20 | Vilandai | 422.80 | 6.75 | 15.00 | 11.40 | 68.90 | 2.20 | 167.90 | 0.06 | 5.70 | 0.03 | 1.60 | 270.59 |
| 21 | Kovilvalkai | 335.27 | 6.80 | 13.00 | 12.40 | 99.00 | 2.10 | 61.00 | 0.05 | 26.70 | 0.02 | 2.40 | 214.57 |
| 22 | Agaram | 173.55 | 5.94 | 15.00 | 5.70 | 67.90 | 2.40 | 12.20 | 0.05 | 7.70 | 0.02 | 2.50 | 111.07 |
| 23 | Silampur | 154.38 | 7.32 | 22.00 | 5.20 | 24.60 | 2.10 | 35.70 | 0.03 | 8.70 | 0.02 | 2.55 | 98.80 |
| 24 | Idayakuruchi | 234.17 | 6.54 | 45.00 | 1.10 | 45.70 | 2.10 | 48.80 | 0.05 | 7.70 | 0.02 | 1.50 | 149.87 |
| 25 | Marudur | 393.74 | 6.47 | 56.00 | 6.80 | 68.90 | 5.20 | 112.90 | 0.07 | 5.70 | 0.02 | 1.60 | 251.99 |
| 26 | Variyankaval | 224.77 | 5.90 | 22.00 | 2.90 | 60.40 | 2.40 | 36.60 | 0.04 | 20.30 | 0.01 | 1.60 | 143.85 |
| 27 | Elaiyur | 240.19 | 6.45 | 11.00 | 1.10 | 45.70 | 1.10 | 89.80 | 0.07 | 4.40 | 0.05 | 1.60 | 153.72 |
| 28 | North pudukkudi | 210.13 | 6.59 | 21.00 | 2.50 | 78.60 | 5.20 | 24.40 | 0.12 | 6.30 | 0.02 | 1.54 | 134.49 |
| 29 | Melur | 194.88 | 6.90 | 11.00 | 15.20 | 45.60 | 1.10 | 45.89 | 0.08 | 4.50 | 0.01 | 2.44 | 124.72 |
| 30 | Devanur | 198.32 | 6.30 | 34.00 | 12.60 | 56.70 | 1.10 | 12.20 | 0.05 | 8.80 | 0.01 | 2.56 | 126.92 |
| 31 | kulathur | 771.41 | 7.01 | 56.00 | 25.60 | 67.80 | 1.10 | 119.00 | 0.03 | 223.00 | 0.01 | 2.66 | 493.70 |
| 32 | Ayyur | 216.79 | 7.02 | 22.00 | 3.30 | 37.70 | 0.98 | 67.93 | 0.08 | 5.60 | 0.02 | 2.11 | 138.74 |
| 33 | Kuvathur | 190.16 | 6.55 | 19.00 | 1.20 | 46.70 | 1.20 | 48.80 | 0.06 | 3.30 | 0.02 | 2.62 | 121.70 |
| 34 | Anikudhichan | 539.29 | 6.79 | 46.00 | 5.60 | 198.90 | 1.20 | 36.60 | 0.09 | 56.70 | 0.01 | 1.24 | 345.14 |
| | Max | 827.23 | 7.89 | 87.00 | 25.60 | 267.80 | 26.70 | 398.20 | 0.89 | 223.00 | 0.67 | 2.66 | 529.43 |
| | Min | 77.77 | 5.69 | 5.00 | 1.00 | 22.30 | 0.98 | 11.23 | 0.02 | 3.30 | 0.01 | 0.10 | 49.77 |
| | AVERAGE | 334.79 | 6.52 | 31.00 | 7.92 | 67.16 | 3.85 | 89.64 | 0.11 | 16.30 | 0.19 | 1.89 | 214.27 |

**Chemical composition of Groundwater during Post – monsoon**

| Ground water | | Post-Monsoon | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S.No | Name of the Location | EC | pH | Ca | Mg | Cl | K | $HCO_3$ | $SO_4$ | Na | $PO_4$ | $H_4SiO_4$ | TDS |
| 1 | Varadharajanpettai | 235 | 6.2 | 12 | 12 | 88.63 | 2.5 | 48.8 | 0.035 | 7.7 | 0.042 | 1.7 | 117.9 |
| 2 | Andimadam | 343 | 6.3 | 16 | 4.8 | 88.63 | 2.7 | 122 | 0.05 | 8.9 | 0.021 | 1.5 | 171.4 |
| 3 | Vilandai | 510.5 | 6.6 | 24 | 7.2 | 88.63 | 2.2 | 171 | 0.075 | 11.7 | 0.156 | 1.3 | 255.2 |
| 4 | Periyakrishnapuram | 571.1 | 6.8 | 20 | 12 | 88.63 | 2.4 | 244 | 0.099 | 16.1 | 0.158 | 1.941 | 284.7 |
| 5 | Thirukalapur | 813.5 | 6.9 | 4 | 33.6 | 106.4 | 2.5 | 354 | 0.048 | 25.7 | 0.172 | 1.5 | 406.8 |
| 6 | Karukkai | 159.9 | 6.5 | 36 | 12 | 53.18 | 2.6 | 97.6 | 0.029 | 7.9 | 0.352 | 1.6 | 94.78 |
| 7 | Nagampanthal | 372.7 | 6.6 | 28 | 4.8 | 88.63 | 1.5 | 146 | 0.178 | 9.1 | 0.297 | 1.5 | 187.3 |
| 8 | Viluthudiyan | 173.1 | 6.3 | 28 | 9.6 | 53.18 | 2.3 | 73.2 | 0.028 | 8 | 0.328 | 2.6 | 86.57 |
| 9 | Olaiyur | 395.2 | 7.1 | 44 | 7.2 | 70.9 | 2.1 | 122 | 0.188 | 8.5 | 0.4 | 2.46 | 197.7 |
| 10 | Alagapuram | 244.7 | 6.9 | 24 | 7.2 | 35.45 | 1.5 | 85.4 | 0.098 | 7.6 | 0.328 | 2.62 | 112.5 |
| 11 | Sriraman | 396.4 | 6.6 | 28 | 0 | 70.9 | 2.3 | 146 | 0.061 | 10.6 | 0.315 | 2.187 | 199.1 |
| 12 | Rangiyam | 679.7 | 7.4 | 32 | 9.6 | 106.4 | 2.6 | 232 | 0.049 | 28.8 | 0.284 | 2.61 | 340.2 |
| 13 | Kodukkur | 493 | 8.1 | 40 | 14.4 | 35.45 | 2.3 | 232 | 0.094 | 10.6 | 0.344 | 2.76 | 246.6 |
| 14 | Vallm | 470.8 | 6.8 | 40 | 4.8 | 70.9 | 0.3 | 171 | 0.08 | 9.5 | 0.322 | 2.5 | 235.5 |
| 15 | Kuvagam | 325.3 | 6.5 | 20 | 2.4 | 70.9 | 15 | 97.6 | 0.049 | 8.4 | 0.32 | 2.256 | 162.5 |
| 16 | Ayyur | 367.7 | 6.6 | 20 | 0 | 88.63 | 2.1 | 134 | 0.069 | 11.3 | 0.045 | 1.808 | 184.5 |
| 17 | Kattathur | 538 | 6.7 | 48 | 21.6 | 301.3 | 15 | 159 | 0.058 | 16 | 0.058 | 1.631 | 268 |
| 18 | Kavarapalayam | 132.9 | 5.9 | 4 | 2.4 | 53.18 | 2.7 | 24.4 | 0.044 | 7.9 | 0.027 | 1.19 | 63 |
| 19 | Andimadam | 273 | 6.3 | 8 | 4.8 | 88.63 | 2.6 | 36.6 | 0.06 | 8.4 | 0.027 | 1.593 | 129.6 |
| 20 | Vilandai | 519.1 | 7.1 | 16 | 9.6 | 88.63 | 2.2 | 122 | 0.051 | 15.8 | 0.189 | 1.97 | 260.5 |
| 21 | Kovilvalkai | 765.7 | 8.1 | 16 | 9.6 | 106.4 | 1.8 | 317 | 0.048 | 47.1 | 0.159 | 2.383 | 383 |
| 22 | Agaram | 157.5 | 6.3 | 8 | 4.8 | 70.9 | 2.7 | 61 | 0.031 | 8.1 | 0.252 | 0.985 | 78.55 |
| 23 | Silampur | 281.7 | 7.1 | 28 | 9.6 | 35.45 | 2.7 | 97.6 | 0.041 | 7.7 | 0.263 | 1 | 148.8 |
| 24 | Idayakuruchi | 459.7 | 6.9 | 32 | 2.4 | 53.18 | 0.7 | 195 | 0.124 | 8.7 | 0.317 | 2.285 | 230.3 |
| 25 | Marudur | 279.7 | 6.6 | 32 | 7.2 | 88.63 | 0 | 61 | 0.053 | 7.7 | 0.056 | 1.89 | 139.8 |
| 26 | Variyankaval | 382.7 | 6.6 | 16 | 4.8 | 70.9 | 0.3 | 110 | 0.194 | 12.4 | 0.063 | 1.081 | 191.2 |
| 27 | Elaiyur | 92.42 | 6.1 | 4 | 2.4 | 53.18 | 0.5 | 48.8 | 0.048 | 8 | 0.068 | 1.97 | 46.24 |
| 28 | North pudukkudi | 176 | 7.2 | 4 | 7.2 | 88.63 | 0.4 | 110 | 0.061 | 9.3 | 0.074 | 1.119 | 88.1 |
| 29 | Melur | 311.7 | 6.9 | 4 | 14.4 | 70.9 | 1.8 | 85.4 | 0.092 | 8.3 | 0.09 | 2.91 | 156 |
| 30 | Devanur | 361.1 | 7.2 | 24 | 9.6 | 70.9 | 1.6 | 134 | 0.047 | 9.9 | 0.044 | 1.044 | 180.7 |
| 31 | kulathur | 413.9 | 6.3 | 44 | 21.6 | 88.63 | 2.1 | 171 | 0.05 | 12.3 | 0.048 | 2.2 | 207.1 |
| 32 | Ayyur | 252.8 | 6.5 | 12 | 4.8 | 53.18 | 1.1 | 97.6 | 0.058 | 7.9 | 0.055 | 2.1 | 126.4 |
| 33 | Kuvathur | 207.1 | 7.1 | 16 | 0 | 53.18 | 3.2 | 61 | 0.049 | 7.6 | 0.049 | 1.304 | 103.6 |
| 34 | Anikudhichan | 1162 | 6.7 | 56 | 4.8 | 265.9 | 2 | 85.4 | 0.045 | 78.7 | 0.065 | 1.854 | 581.8 |
| | Max | 1162 | 8.1 | 56 | 34 | 301 | 15 | 354 | 0.19 | 78.7 | 0.4 | 2.91 | 582 |
| | Min | 92.4 | 5.9 | 4 | 0 | 35.5 | 0 | 24 | 0.03 | 7.6 | 0.02 | 0.985 | 46.2 |
| | AVERAGE | 392 | 6.8 | 23 | 8.3 | 85.5 | 3 | 131 | 0.07 | 13.9 | 0.17 | 1.8633 | 196 |

**Table 2. Ground water quality Rating (WHO, 1996) for drinking purpose (irrespective season)**

| Parameters | Maximum permissible limit (WHO) | Range of observed values | Suitability of drinking |
|---|---|---|---|
| pH | 6.5to 8.5 | 5.69- 7.89 to 5.9-8.1 | Suitable for all location |
| Chloride mg/l | 250 | 2.3-267.82 to 35.45-301.33 | Not suitable−Location, 17 &34 |
| Calcium mg/l | 500 | 87 – 5 to 56 - 4 | Suitable -All |
| Magnesium mg/l | — | | - |
| Sulphate mg/l | 400 | 0.02-0.89 to 0.028-0.194 | Suitable for all location |
| TDS mg/l | 1000 | 49.77-529.43 to 46.24-581.8 | Suitable -All |

**Table 3. Classification of Sodium Adsorption Ratio in Groundwater SAR . Richards (1954)**

| S.No | Limiting Values | Water Quality | Pre - Monsoon (No. of Samples) | Post – Monsoon (No. of Samples) |
|---|---|---|---|---|
| 1 | 0 -6 | No Problem | All | All |
| 2 | 6 -9 | Increasing Problem | - | - |
| 3 | > 9 | Severe Problem | - | - |

**Table 4. Ground Water Classification based on USSL Diagram, (after USSL, 1954)**

| S. No | Category | Pre - Monsoon (No. of Samples) | Post – Monsoon (No. of Samples) |
|---|---|---|---|
| 1 | C1 – S1 | 12 | 9 |
| 2 | C2 – S1 | 20 | 22 |
| 3 | C3 – S1 | 2 | 3 |
| 4 | C4 – S1 | - | - |

0.021 to 0.4 mg/l with an average value of 0.187 to 0.1702 mg/l. The concentration of $SO_4$ is varying from 0.02 to 0.89 with an average of 0.1105 mg/l in pre monsoon season. In the post monsoon sulphate is varying from 0.028 to 0.194 mg/l. with an average of 0.1702 mg/l in pre monsoon season. Apart from the natural rock sources. Sulphate could be introduced through the application of sulphate soil conditioners (Karanth, 1989). The evaluation of water and relationship between rock types and water composition has been evaluated by the Trilinear Piper (1994) diagram. The plot reveals that the chemical characters of the ground water samples are Ca+ Mg, SO4 + Cl & HCO3 + CO3 and also high Ca + Mg & SO4+Cl. Facies and the plot of the ground water samples of pre-monsoon data and post monsoon data falls in fields 1, 2 and 3 which suggest that alkaline earth exceeds alkalies and near weak acidic exceed strong acidic respectively.

**Suitability for Drinking use**

To estimate whether the ground water of the study area is suitable for drinking and irrigation purposes. It has been compared with the standard of World Health Organizations (WHO, 1996) and Indian Standard institute (ISI, 1995). The ground water samples were analyzed and compared with the prescribed standards and the result are presented in the table 2.Among the samples considerable were identified within the maximum permissible limits of the above mention standards of drinking purpose. According to WHO (1996) standard Na, Cl ion concentration exceeds the maximum limit in one location of the study area. Generally, the ground water samples of the study area are suitable for drinking and domestic purpose except in few locations.

**Suitability for irrigation use**

***Sodium Adsorption Radio (SAR)***

The parameters such as Sodium Adsorption Radio (SAR) and residual sodium carbonate (RSC) were estimated to assess the suitability of water for irrigation purpose. Sodium concentration in ground water is important since increase of sodium in waters deteriorates soil properties by reducing permeability. The processes leading to the cation exchange reaction in soil may be studied from Sodium Adsorption Radio.

SAR is expressed $SAR = Na/\sqrt{Ca} + Mg/2$
Where the concentration are expressed in epm.

Classification of water with reference to Sodium Adsorption Radio (Richards, 1954). The sodium absorption ratio (SAR) values in both groundwater and surface water falls in excellent category irrespective of seasons. Wilcox (1995) classification of electrical conductivity, majority of samples fall in excellent to good range irrespective of seasons.

***Residual Sodium Carbonate (RSC)***

Excess of Mg and Ca ions concentration trend to precipitate as carbonate. The sodium concentration increases and gets fixed in the soil thereby decreasing the soil permeability a high value of Residual sodium carbonate in water leads to an increase in the adsorption of sodium on soil. Irrigation of waters having Residual sodium carbonate values greater than 5 meql $^{-1}$ have been considered harmful to the growth of plants. RSC values between 2.5 meql $^{-1}$ are generally considered unsuitable for irrigation purpose. The RSC value of between 1.25 – 2.5 meql $^{-1}$ is marginal quality, while value of less than 1.25 meql $^{-1}$ indicate that water is safe. The RSC value of the water sample in the study area majority of samples in ground water and all samples fall in the fresh water category indicating water is fit for agriculture pyrpose. The irrigation water with high RSC is considered to be deleterious to the physical properties of the soil. The higher concentration of carbonate and bicarbonate ions is not suitable for irrigation.

***USSL diagram interpretation (AFTER USSL, 1954)***

Based on the USSL classification, majority of samples in ground water irrespective of season fall in C1S1 and C2S1 zone indicating medium to low salinity and low sodium hazard satisfactory for plants having moderate salt tolerance on soils.

**Summary and Conclusion**

The present study area deals with hydro geochemical parameters of the ground water in the andimadam block are near acidic to alkaline. Chemical data of majority of ground water samples show that the area Sodium is the dominant cation in groundwater and bicarbonate is the dominant anion in groundwater. According to ISI (1995) standard, all the parameters are within the limits of desirable. In general, the ground water samples of the study area are suitable for domestic and drinking purposes except few locations. The EC value of groundwater irrespective seasons fall within the maximum limit of WHO (1996). The classification of water based on TDS (ICMR, 1975), most of samples of the study area falls in desirable for drinking and few samples are fall in permissible for drinking. Gibbs diagram reveals that all the ground water samples except few location, fall in the rock dominance field.

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