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A Study on Hydrogeochemical Characteristics of Agaram Aru watershed, Vellore District of Tamilnadu, India

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Abstract
Groundwater is the most important natural resource utilized for drinking, irrigation, and industrial purposes in everywhere in the surface of the earth. On the basis a preliminary investigation of hydrogeochemical characteristics of Agaram aru watershed has been studied in Vellore district of Tamil Nadu in order to assess their quality and suitability in relation to domestic and agricultural uses. Further, this study was conducted to bring out the relationship and the behavior of different physio chemical parameters of groundwater. Fourty groundwater samples were collected, and analyzed the major cations (Ca, Mg, Na, K) and anions (Cl, HCO_3, SO_4, NO_3, F). The analytical results reveals that dominant cations are calcium followed by sodium, magnesium and potassium. Whereas dominant anions are bicarbonate followed by sulphate and chloride. The concentration of fluoride is relatively lower in most of the area except at one location in the study area.
Key words- Hydrogeochemistry, Aaram aru, Watershed, Groundwater, Water quality

I. INTRODUCTION

Water is a finite resource, and it is becoming a scarce commodity in many parts of the world. In developing countries with scarce water resources, competition among agriculture, industry, and domestic uses of limited water is a constraining factor for economic development. In the last twenty years, groundwater has become an urgent environmental problem worldwide and constitutes one of the most widespread forms of water contamination. Hydrogeochemical processes occurring within the groundwater and reactions with aquifer minerals have significant impact on water quality. These geochemical processes are responsible for the seasonal and spatial variations in groundwater chemistry. The geochemical properties of groundwater depend on the chemistry of water and also on the different geochemical processes that are taking place in the sub-surface (Back and Hanshaw, 1965; Hem, 1959; Cheboterev, 1955). Groundwater exploration and aquifer delineation programmes on a river basins, especially over the crystalline terrain, have several shortcomings which are related to the methodology, field techniques and their reliability on interpretation of water sources and their quality. Under this circumstance of non availability of a technique providing unique results an integrated approach for the study of groundwater in hard rock terrain is essential (Singhal et al., 1988; Hendry et al.,1993). The river water carries significant quantities of matter with both natural and anthropogenic sources (Jarvie et al. 1998; Singh et al. 2005). Seasonal variations in precipitation, surface runoff, and groundwater flow have strong effects on river flow rate and, consequently, on the concentration of pollutants in ground water (Vega et al. 1998).

Over the year, this region which runs through the most industrialized zone of Tamil Nadu, having various types of industries dealing mainly with plastic, dyeing, chemical, pharmaceutical, battery making, etc., which dispose their treated or partially treated effluents indiscriminately causing a wide range of heavy metal contamination (Kumari et al. 2013). Moreover, groundwater and its suitability for agricultural and drinking rational have not been endeavored in the present study area dominantly hence an attempt has been made it in the study area.

Based on these observations this study was carried out in Agaram Aru watershed, Vellore District of Tamil Nadu, India. The main purpose of the study was to develop an areas groundwater

quality which is evaluates the susceptibility of groundwater in Agram watershed of Tamil Nadu area to contamination by natural and anthropogenic activities.

II. DESCRIPTION OF STUDY AREA

Agaram watershed is located in Vellore district of Tamil Nadu, India. It is also called as Agaram aru watershed as Agaram Aru is the main stream in the watershed, and is tributary of palar river and flows in the upper reaches of the river, located in Vellore and Tiruvannamalai districts of Tamil Nadu. The total area about 571.49 sq.km and most of the watershed falls in Vellore district covering Gudiyattam, Katpadi, Vellore, Vaniyambadi and Tirupattur taluks, whereas a part of the watershed falls in Tiruvannamalai district covering Polur and Chengam taluks. The Agaram Aru originates from an altitude of about 700 m above MSL in Javvadi hills in the state of Tamil Nadu, and flows north to join Palar river near Vettuvanam village. The major tributaries of the Agaram Aru are Kallaparai Aru, Uttarkaveri Aru and Periya Aru. The total length of the trunk of the river is 33.412km. The geology of the area is prominently comprises of gneisses and charnockites. The average rainfall in the region is about 929 mm with minimum of 784 mm and a maximum of 1073 mm (Source Department of Economics and Statistics, Chennai). In the study area geomorphological features are such as structural hills, residual hills, plateau, Valley fill, pediment, Buried Pediment, pediplain, alluvial plain.

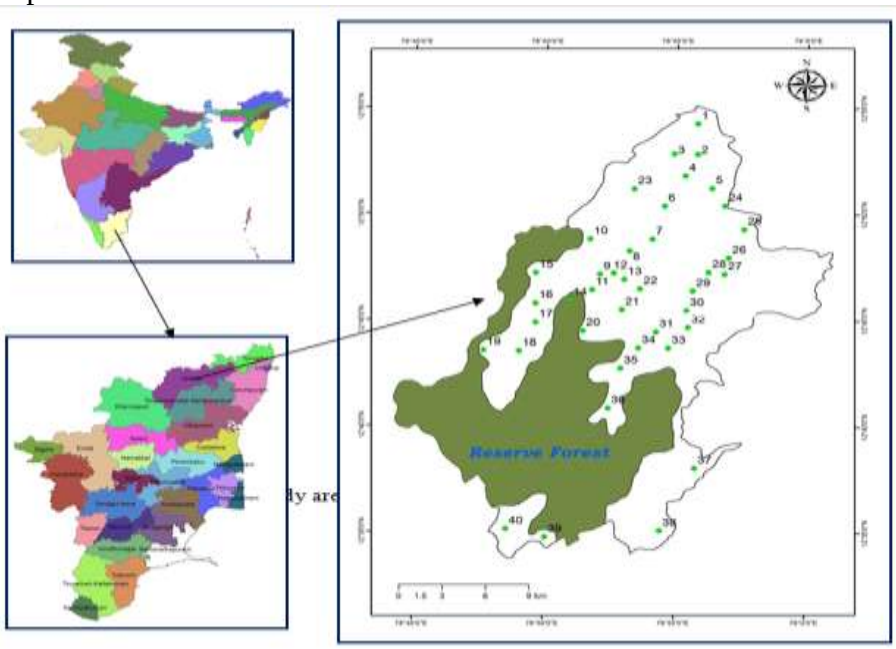

Fig 1. Study area and sampling locations

III. MATERIAL AND METHODS

Water samples were collected from 40 locations which include open wells and bore wells situated in different parts of the study area. The samples were collected in cleaned polythene bottles from various wells during premonsoon season during the year of 2013. pH of the water was measured in the field using field kit. One litre of water samples were collected in polyethylene bottles for the determination of Ca, Mg, Na, K, Cl, HCO_3, SO_4 and NO_3 in the laboratory. They were store in refrigerator till analysis. Calcium, Magnesium, Chloride, Bicarbonate were analyzed by volumetric and Sodium, Potassium were measured by flame photometer. Sulphate, Nitrate was analyzed by using spectrophotometer. Water quality parameters like TDS, pH, Ca, Na, K, Mg, Cl, SO_4, EC and HCO_3 were analyzed in the present study to determine the quality of the water. The GIS software was used for the preparation of various thematic maps in the study area.

IV. RESULT AND DISCUSSION

pH

In the present study (2013) groundwater samples were collected from selected locations. During pre monsoon season, the pH values ranged from 7.3 to 8.3 with an average of 7.7. The maximum pH 8.3 was observed at location 18 (Kollimottu mayeilvagan). The minimum pH 7.3 was noted at Kovilur (location 35). The reason for increased pH of groundwater in the study area is controlled by total alkalinity of the ground water and partially by sea water mixing (Senthilkumar et al., 2012).

Electrical Conductivity (EC)

Generally electrical conductivity is the measures of the ability of water to pass on electrical current and is affected by the presence of dissolved solids. As the level of total dissolved solids (TDS) raises, the conductivity will also increases. Conductivity will vary with water source: ground water, water drained from agricultural fields, municipal waste water, rainfall.

During the year study period, the maximum electrical conductivity (2476.3µS/cm) was observed at Kuppampalayam and minimum electrical conductivity (846.8µS/cm) at Petturalangayum (location 20). The higher electrical conductivity values were observed during pre monsoon season (2476.3µs/cm) which was attributed to the due to infiltration of rain water after monsoon and thus increase the concentration of dissolved salts. Spatial distribution map of electrical conductivity is shown in Fig.3. The average conductivity of the study area is 1657.3µs/cm. The concentration of total dissolved solids and electrical conductivity is directly related. Normally higher value of electrical conductivity in groundwater is related to input of sewage water, agricultural activities and sea water incursion (Tutmet et al. (2006).

Total Dissolved Solids (TDS)

Generally, the total dissolved solid originates from natural sources, sewage, urban runoff and industrial wastes (Kurainan Joseph, 2001). In the year 2013, the concentration of total dissolved solids ranged from 912 mg/l to 1875 mg/l with an average of 1298.5mg/l. The lower concentration was noted at Pananthoppu (location 32) and higher concentration at Thanagkottai (location 29). The spatial distribution map of total dissolved solids (TDS) during pre monsoon season is shown in Fig.4. According to Thiyagarajan and Baskaran, (2011) the higher content of TDS can be attributed to the contribution of salts from the thick mantle of soil and the weathered media of the rock host belongs to alluvial sand suits, there can be some oxidation and reduction processes in groundwater thereby causing enrichment in the total dissolved solids.

Table:1 Hydrogeo chemical parameters results (All values in mg/l, except pH, EC- µs/cm)

Premonsoon 2013			
Parameters	**Min**	**Max**	**Avge**
pH	7.3	8.3	7.7
EC	846.8	2476.3	1657.3
TDS	912	1875	1298.5
Ca	101	312	205.5
Mg	35.4	318	138.6
Na	128.6	409.8	239.0
K	14.3	312.4	62.0
HCO_3	97.3	326.2	188.8
Cl	164.2	784.5	558.6
SO4	52.7	304.6	156.1
NO_3	11	49.3	27.4
F	0.06	1.7	0.9

Chemical Parameters

The spatial distribution pattern of anion and cation during the study period is shown in figure 5-9. During the study period, the concentration of calcium ranged from 101.0 to 312 mg/l with an average of 205.5 mg/l. The maximum concentration was observed at location 39 and minimum concentration was observed at location Agravaram (location 19). The higher concentration of magnesium was observed at Katterikuppam (location 34) with the value of 318 mg/l and the lower concentration was observed at Thattankuttai (location 3) with the values of 35.4 mg/l. The average concentration of the magnesium is 138.6mg/l. Higher magnesium might be due to cation exchange reaction in which magnesium is forced into the soil solution by elevated calcium and potassium, however this would be expected for both urban and agricultural areas (Beekman, 1991).

Sodium is found to be the most abundant ion in the groundwater of the study area. The maximum concentration of sodium was 409.8mg/l and minimum concentration was 128.6mg/l with an average of 239mg/l. The higher concentration of potassium was observed at Katterikuppam (location 34) with the values of 312.4 mg/l and the lower concentration was observed at Attikuppam (location 21). The average concentration of potassium in the study area was 62.0 mg/l.

The concentration of bicarbonate during pre monsoon season ranged from 97.3 to 326.2 mg/l with an average of 188.8 mg/l. Whereas post monsoon season its varied from 79.5 to 265.4 mg/l with an average of 171.7 mg/l. The maximum concentration was observed at Pichanatham (location 25) and lower concentration was observed at Pettur Alangayam (location 20). The general, the sources of bicarbonate includes limestone, decomposition of organic matter and chemical weathering process. Another reason for increasing of bicarbonate is by the meteoric water which contains considerable amount of CO_2 which on infiltration leads to introduction of bicarbonate. The concentration of chloride ranged from 164.2 mg/l to 784.5 mg/l with an average of 558.6 mg/l.

The average concentration of sulphate during premonsoon season was 135.8 mg/l. The higher concentration of sulphate in the study area are related to evaporation process. The sources of sulphate in water are many. It is not confined to evaporate deposit alone, but some time source water in contact with particular rock strata and mineral deposit will leads to increase in the concentration of sulphate. This is observed by Losinno el al., (2002). The fluoride concentration ranged from 0.06-1.7mg/l whereas the concentration of nitrate ranged from 11.00-49.3mg/l which varies with respect stations due variations in the topography and infiltration nature of the surface.

V. CONCLUSIONS

The study reveals that the ground water samples in the study area, slightly alkaline in nature, based on total dissolved solids results showed the above the permissible limits according to WHO drinking water standards. On the basis of major ion chemistry the dominant cations are calcium followed by sodium, magnesium and potassium. Whereas dominant anions are bicarbonate followed by sulphate and chloride. The concentration of fluoride is relatively lower in most of the area except at one location. The identification of main sources of contamination of groundwater, and to identify the spatial distribution patterns of groundwater pollution in Agaram aru watershed, which added helps in the further studies. Based on this groundwater quality in the study area is slowly reaching alarming stage so that proper planning is essential to avoid groundwater pollution.

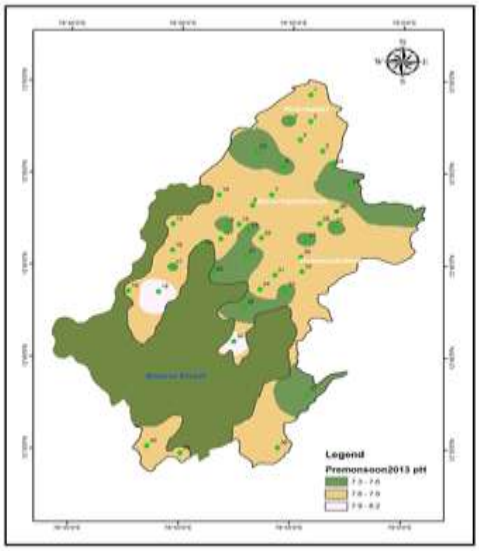

Fig 2. Spatial Distribution map of pH

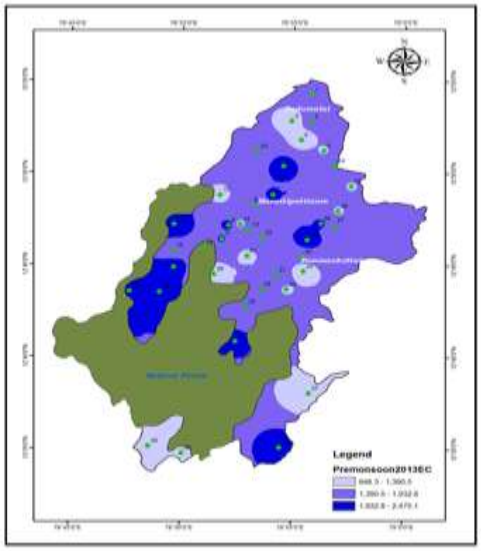

Fig 3. Spatial distribution map of EC

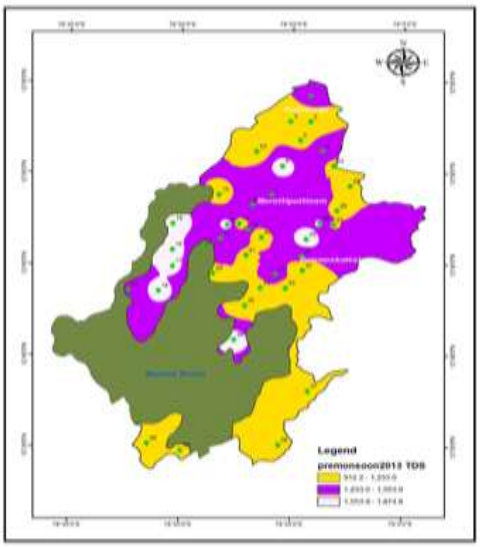

Fig. 4. Spatial Distribution map of TDS

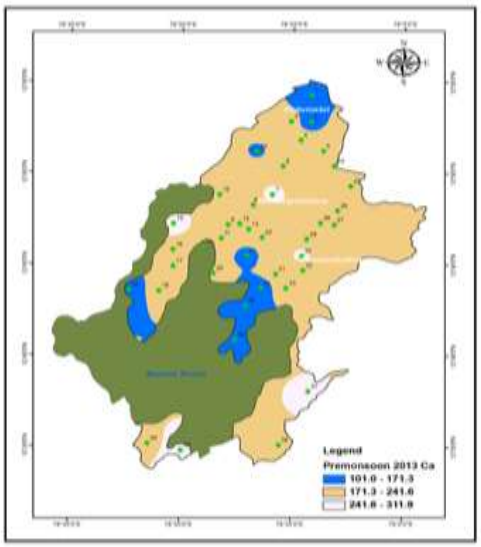

Fig. 5. Spatial distribution map of Ca

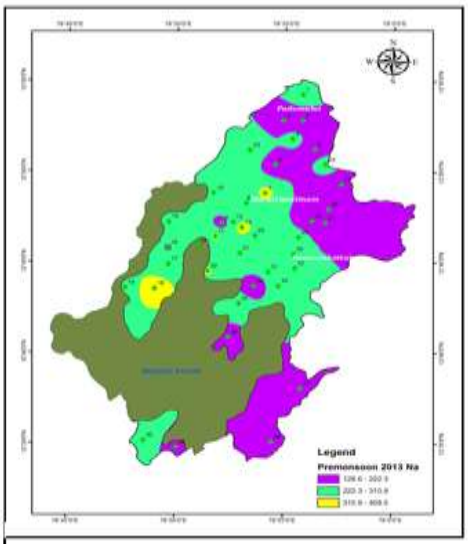

Fig.6. Spatial distribution map of Na

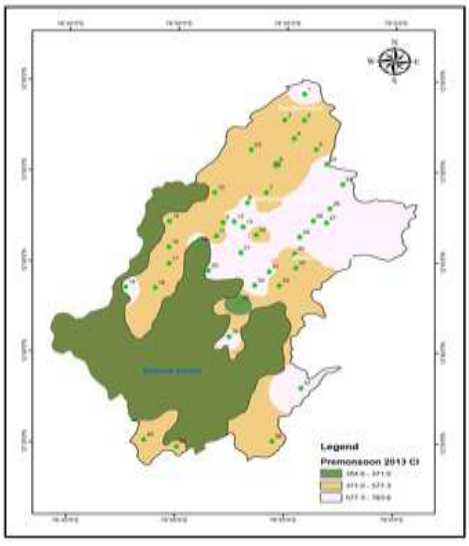

Fig.7 . Spatial distribution map of HCO_3

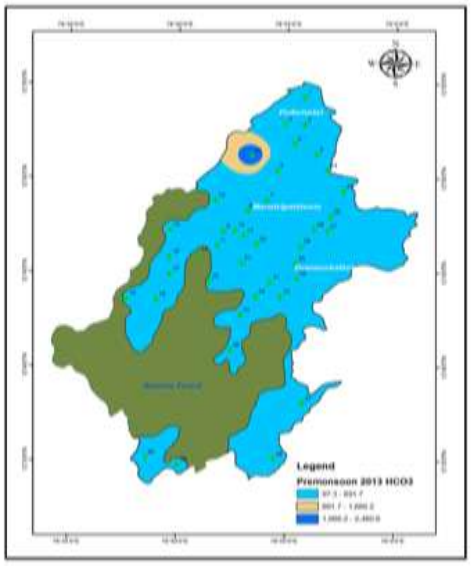

Fig.8. Spatial distribution map of Cl

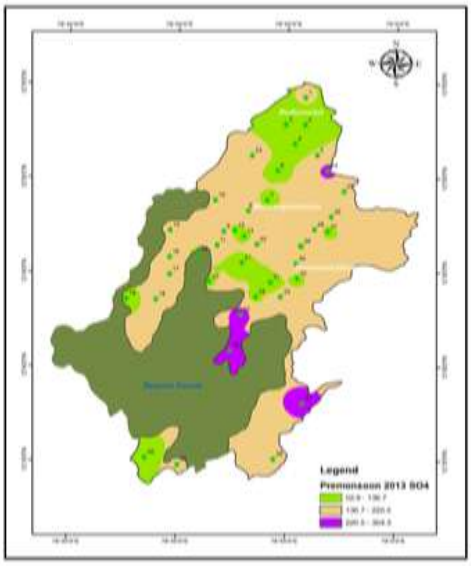

Fig.9 . Spatial distribution map of SO_4

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