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# Hydrogeochemical Quality of Groundwater in Vedaraniyam Town, TamilNadu, India

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**Abstract:** An attempt has been made in this present work to determine the groundwater quality in parts of Vedaraniyam region, Tamilnadu. Totally, eighty groundwater samples were collected from open and dug wells, covering three seasons (Postmonsoon, summer and premonsoon seasons) and analyzed for physicochemical parameters (pH, EC, TDS, TH, Na, K, Ca, Mg and Cl, $SO_4$, $HCO_3$, $NO_3$) it order to understand the hydro geochemistry of the water. The results of analysis were interpreted with geology and geomorphology of the area and also by various geochemical diagrams such as Piper trilinear plot and USSL classification diagram. Suitability of this water for its utility was verified using Indian standards. The result indicates irrespective of the seasons that only one well is suitable for drinking purpose, with remaining suitable for domestic and irrigation purpose. Further, the results points out that most of the well water falls in Na-Cl type indicating the influence of seawater in these wells which is confirmed by Piper plot. According to USSL classification of water quality of the samples belong to C4 S4, C4 S3 classes water are also found in the area which moderately suitable for irrigation. The influence of sea water on the fresh water aquifer in this coastal region needs special attention in terms of monitoring and for sustainable management.

**Key words:** Geochemistry, hydrogeochemical facies, irrigation water quality, major ion chemistry and seawater incursion

## INTRODUCTION

Intrusion of saline waters into aquifers in coastal regions occurs naturally and can be induced by exploitation of coastal aquifers as water sources. The intruded saline water can endanger, often practically irreversibly, the future exploitation of these water resources and so detection and monitoring of saline intrusion is essential to resource management. Early studies concentrated on major ion chemistry both as an ``ideal tracer'' (e.g., Cl) of saline water intrusion and in distinguishing active intrusion from freshwater flushing and understanding the relation-ships between saline water bodies and surrounding freshwater in coastal sandstone aquifers (Cederstrom, 1946; Back, 1966; Howard and Lloyd, 1983; Mercado, 1985).

The overexploitation of coastal aquifers for agricultural and drinking purposes, along with structural and climatic circumstances, increases possibility of seawater intrusion. The coastal zone of Vedaraniyam (Fig 1), chosen as the study area, is representative of seawater incursion because of the presence of thousands of wells disturbing the equilibrium between groundwater and seawater. The paper makes an attempt to carry out qualitative analysis of some physico-chemical parameters of ground water in study area.

**Study Area:** The study area, Vedaraniyam is situated in Nagai district of Tamilnadu. The study area lies between 10º 25′ to 11º40′ north longitude and 76º49′ to 80º01′ East longitudes and falls in the toposheet number 58N/15. The study area receives an average rainfall of 1327.11 mm. The maximum and minimum temperature ranges between 28ºC to 34ºC in the months of January to May, respectively. Geomorphlolgically, the study area consists of flood plains, delta plain and natural levee.

**Geology of the Study Area:** This study forms part of western gently undulating nature with central alluvial plains of the Cauvery delta. The region has fluvio marine deltaic N-S and E-W trending coastal chanier plain between Kollidam mouth in the north Muthupet in the southwest and Vedaranniyam in the south east. The area forms of Cauvery delta with a gentle slope towards Bay of Bengal. No surficial older formations are exposed except for small area in Mannarkudi 10º40′ , 79º29′ covered by Laterites soil over the Cuddalore formation of Miopliocene age. The quaternary deposits represent the rest of the areas. The thickness of the quaternary sediments increases south of Kollidam river. These sediments have been delineated as alluvial plain deposits (Cauvery formation) of the Cauvery river and it is distributaries, narrow fluvio marine deltaic plain deposits (Nagapattinam formation) and marine coastal plain deposits (East Coast formation). The fluvial deposits comprise flood plain, flood basins, point bar, channel bar and palaeo channel with admixture of sand, silt, clay and gravel. The deltaic plain includes palaeotidal flat, salt

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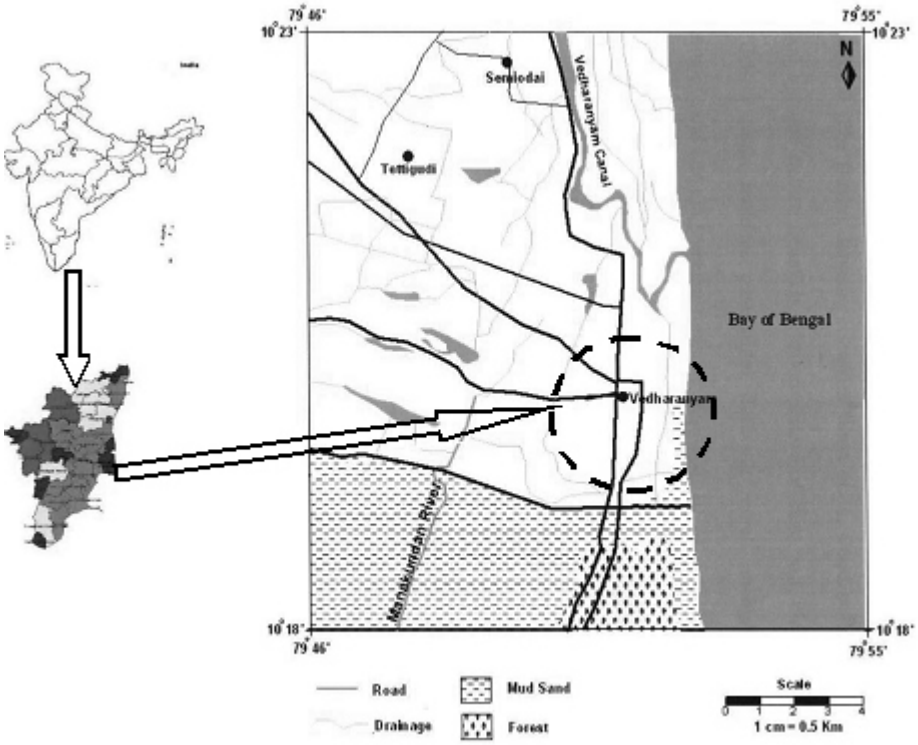



Fig. 1: Location map of Vedaranniyam, India

marsh, mangrove swamps, deposits of sand and clay reserve forest of Muthupet 10º24, 74º30 on either side of the Mullipalam creeks represents marshy area. Geological formations are ranging in age from the oldest Archaean to recent alluvium. The sedimentary section contains a number of transgressive and regressive episodes. The lithology varies from conglomerates, sandstone, limestone and dolomite. They represent an undulating topography and gently slope towards sea.

## MATERIALS AND METHODS

The water samples were collected from open and boreholes in the study area. One liter of water samples were collected polythene bottles from various wells during the month of February to September 2007 covering (Postmonsoon , Summer, Premonsoon). Totally eighty samples were collected from ten locations, for analysis various physic-chemical parameters, pH were measured portable pH meter, EC were measured Electrode, then TDS were done by calculation method. With respect to cation, Calcium, Magnesium was analyzed volumetric method. Sodium, potassium were analyzed by Flame photometer metery, with respect to anions Chloride, Bicarbonate were dun by volumetric method, Nitrate, Sulphate were estimated turbidity method. Analyzing method followed (APHA, 1998).

The quality of groundwater is affected by the pumpage and natural discharge. The water is also heterogeneous in nature due to recharge from precipitation and contact with different types of rocks. Hence in the case of groundwater, the fixations of suitable sampling sites are not so easy as compared to surface water because the elements influencing water quality are not easily known. Some general suggestions can be made for the selection of sampling sites.

In case, where the investigation does not take into account the changes in groundwater quality, the key constituents determined in a large number of samples collected over the entire area is utilized to determine the water quality of the study area. From this, sites for selection of samples for comprehensive analysis can be fixed. If the key constituents are not known at the beginning, the water quality pattern is arrived at, by first making a comprehensive analysis and thus partial analysis at other site

## RESULTS AND DISCUSSION

The maximum minimum and average data showed in Table 1. The pH value ranged from 6.5 to 8.5, this indicating study area water falls in alkaline nature, some well water having higher concentration of pH due to weathering of plagioclase feldspar by dissolved atmospheric carbon dioxide that will release sodium and calcium which progressively increase the pH and alkalinity this kind of result observed by Njitchoua *et al.* 1997. Electrical conductivity and Total dissolved solid

Table 1: Physico-chemical parameters of the groundwater samples

| Water quality parameter in epm | Concentration in study area mg/l | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Postmonsoon | | | Summer | | | Premonsoon | | |
| | Min. | Max. | Average | Min. | Max. | Average | Min. | Max. | Average |
| pH | 6.9 | 7.8 | 7.3 | 7.3 | 7.8 | 7.6 | 7.3 | 7.7 | 7.5 |
| EC (µs/cm) | 913.4 | 7.419.6 | 3666.7 | 859.2 | 5540.9 | 3297.9 | 750.1 | 5699.7 | 2824.6 |
| TDS (mg/L) | 584.5 | 4748.5 | 2230.5 | 549.9 | 3546.2 | 2127 | 480.06 | 3647.8 | 2824.6 |
| Calcium (Ca) | 1.0 | 17.0 | 7.6 | 0.6 | 10.3 | 4.6 | 0.05 | 0.85 | 0.38 |
| Magnesium (Mg) | 1.2 | 12.8 | 5.1 | 1.0 | 10.6 | 4.5 | 0.35 | 8.29 | 3.32 |
| Sodium (Na) | 2.2 | 48.1 | 19.2 | 1.6 | 51.3 | 21.0 | 1.0 | 41.81 | 15.86 |
| Potassium (K) | 0.2 | 8.5 | 4.0 | 0.2 | 9.6 | 3.8 | 0.35 | 5.51 | 2.46 |
| Bicarbonate ($HCO_3$) | 2.6 | 10.2 | 6.0 | 3.1 | 7.5 | 5.2 | 2.56 | 6.62 | 4.64 |
| Sulphate ($SO_4$) | 2.4 | 20.5 | 12.4 | 2.2 | 19.8 | 12.6 | 2.92 | 17.7 | 9.70 |
| Chloride (Cl) | 5.3 | 51.9 | 21.8 | 6.2 | 32.2 | 18.7 | 5.24 | 42.77 | 18.76 |
| Nitrate ($NO_3$) | 7.3 | 19.3 | 12.0 | 5.5 | 12.3 | 9.6 | 6.5 | 12.03 | 9.54 |

closely related to each other, higer concentration of Electrical conductivity recorded in postmonsoon season is likely due to seawater influence, and irrigation enriched in total dissolved solids. In the present study Electrical conductivity low in freshwater recharge area and progressively increases towards the coastline. Total dissolves solids also observed in same Trent; higher concentration of total dissolved solids is likely due to mixing of groundwater with seawater, which has a local and limited effect on a few well in coastal area, the same kind of result observed by Aiuppa *et al.* 2003.

Water naturally contains number of different dissolved inorganic constituents. The major cations are calcium, magnesium, sodium, and potassium. The anions are chloride, sulphate, carbonate and bicarbonate. Calcium and magnesium concentration exceeding permissible limit in most of the wells, higher concentration observed during post monsoon and premonson season rainwater contain 10 mg/l calcium geologically calcite, dolomite,magnesite, anhydrite, gypsum, feldspar, pyroxene amphiboles release considerable amount of calcium magnesium in to groundwater. Sodium concentration also exceed permissible limit, higher concentration of sodium was observed in summer compared to post monsoon and premonsoon , the increasing sodium in to groundwater is likely due to seawater influence and study area near to salt pan deposits and ionic exchange. Potassium concentration in to groundwater one or two well water coming under permissible limit, remaining well water exceeding permissible limit, higher concentration of potassium is likely due to silicate minerals, orthoclase, microcline, hornblende, muscovite and biotite in igneous and metamorphic rocks and evaporate deposits gypsum and sulphate release considerable amount of potassium in to groundwater. Main reason increasing potassium into groundwater due to agricultural activities. Chloride concentration exceeding permissible limit except one well, the increasing chloride in to groundwater is likely to seawater influence salt pan deposits agricultural return flow in to groundwater, this are main reason for increasing of chloride in groundwater. Bicarbonate concentration also exceed permissible limit is due to evaporate deposits and meteoric water contain considerable amount of bicarbonate, sewage, industrial waste also increase bicarbonate in to groundwater. Sulphates increasing main reason evaporate deposits. Nitrate increasing main source agricultural return flow and sewage.

**Hydrogeochemical facies:** The concentrations of major ionic constituents of groundwater samples were plotted in the Piper trilinear diagram (Piper, 1953) to determine the water type. The classification for cation and anion facies, in terms of major ion percentages and water types, is according to the domain in which they occur on the diagram segments (Back, 1996). The diamond shaped field between the two triangles is used to represent the composition of water with respect to both cations and anions. The points for both the cations and anions are plotted on the appropriate triangle diagrams. The plot of chemical data on diamond shaped trilinear diagram (Fig. 2) reveals that majority of groundwater samples fall in the Na, Mg, Ca facies and Cl, SO4 facies.

**Irrigation water quality (USSL Classification):** Irrigation water is classified based upon the Sodium Adsorption Ratio (SAR) and Electrical Conductivity (EC), USSL (United States Salinity Laboratory, 1954) classification, Sodium Absorption Ratio (SAR): Richards (1954) sodium adsorption ratio was calculated by the following equation (All values in meq/l).

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

In the study area most of the groundwater samples fall in the field of $C_4S_4$ and $C_3S_1$ indicating high to median salinity and high to low sodium water type which can be moderately suitable for irrigation purposes (Fig 3a-c). The same trend was observed during summer and premonsoon seasons.

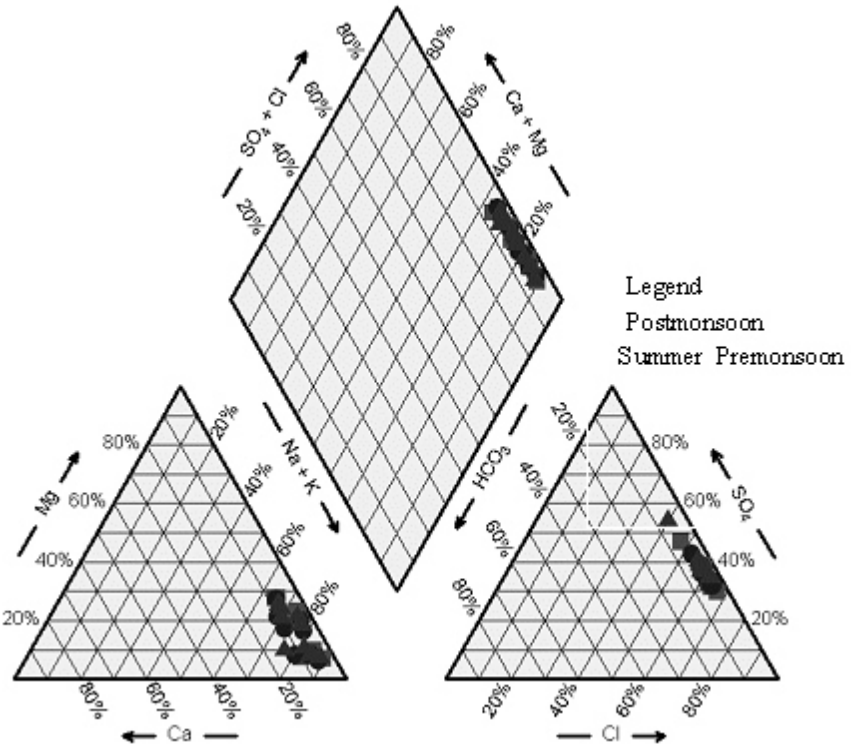
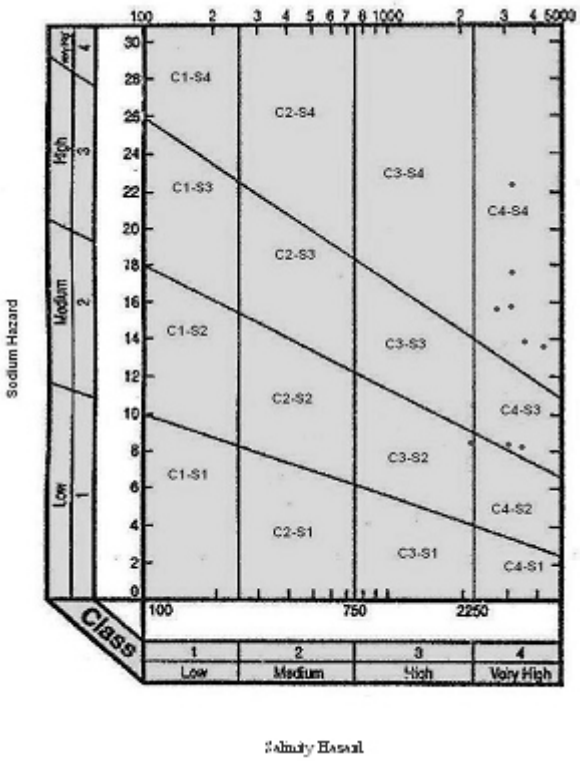



Fig. 2: Piper diagram for studied seasons



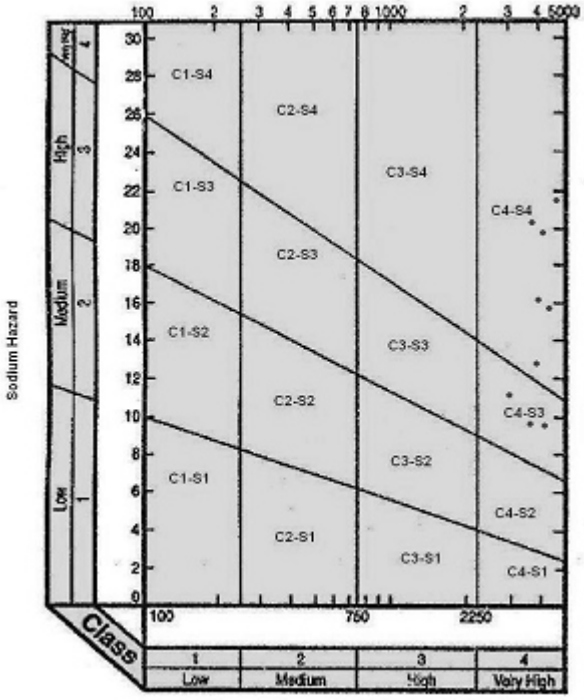




Fig 3a: USSL based classification of water (postmonsoon season) Fig 3b: USSL based classification of water (summer season)

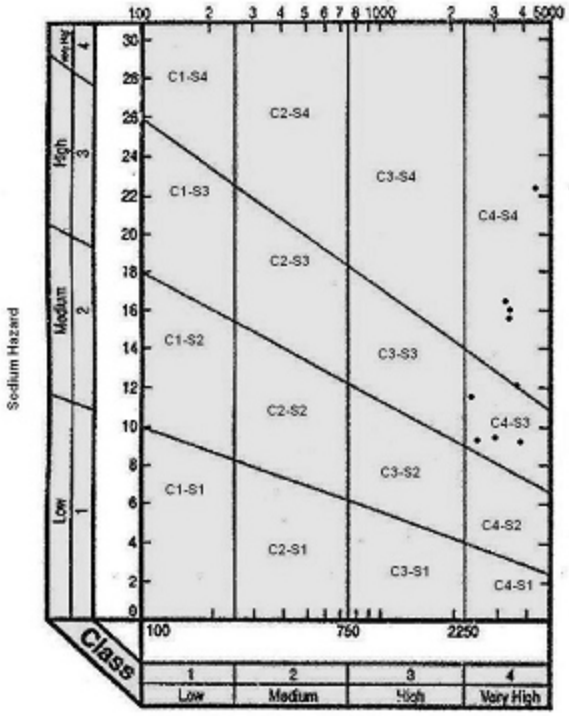



Fig. 3c: USSL based classification of water (premonsoon season)

## CONCLUSION

Groundwater in the study area is generally alkaline in nature. Total dissolved solid and Electrical conductivity exceeding BIS (1983) and WHO (1984) standards except two or three well water. With respect to cation and anion, dominating cation is sodium, dominating anion is chloride. The groundwater increases its major ions concentration in the summer season in comparison to the post and premonsoon period. This is because of evaporation, precipitation and environment weathering in the study area.

The groundwater nature is explained by the Piper trilinear diagram which indicates that most of the groundwater samples fall in Na, Ca, Mg facies followed by Cl, $SO_4$ facies. The groundwater quality of irrigation water is compared based on electrical conductance, sodium absorption ratio show that groundwater moderately suitable for irrigation. There is an increasing awareness among the people to maintain the groundwater at their highest quality and purity levels and the present study may prove to be useful in achieving the same.

## REFERENCES

Aiuppa, A., P.D. Allard, W. Alessandro, A. Michel, F. Parello, M. Treuil and M. Valenza, 2000. Mobility and fluxes of major, minor and trace metals during basalt weathering and groundwater transport at Mt. Etnavolcan (Sieity). Geochem. Cosmochim. Acta, 64: 1827-1841.

APHA, 1998. Standard methods for the examination of water and waste water. American Public Health Association, Washington.

Back, W., 1966. Hydrochemical facies and ground-water flow patterns in northern part of Atlantic Coastal Plain. U.S. Geol. Surv. Prof. Paper: 498-A. 42.

BIS, 1983. Standards for water for drinking and other purposes. Bureau of Indian standards publication. New Delhi.

Cederstrom, D.J., 1946. Genesis of ground waters in the coastal plain of Virginia. Econ. Geol., 41: 218-245.

Howard, K.W.F. and J.W. Lloyd, 1983. Major ion characterization of coastal saline ground waters. Ground Water, 21: 429-437.

Mercado, A., 1985. The use of hydrogeochemical patterns in carbonate sand and sandstone aquifers to identify intrusion and ushing of saline water. Ground Water, 23: 635-645.

Njitchoua, R., I. Dever, J. Fontes and E. Naoh. 1997. Geochemistry, origin and recharge mechanisms of groundwater from the Carona sandstone aquifer, Northern Cameroon. J. Hydrol., 190: 123-140.

Piper, A.M., 1953. A graphic procedure in the geochemical interpretation of water analyses. Trans. U.S. Geol. Surv. Groundwater Notes 12. Printing, Washington, pp: 42.

Richards, L.A., 1954. Diagnosis and improvement of saline and alkali soil, U.S. Department of Agriculture, Agriculture Handbook 60.

USSL, 1954. Diagnosis and improvement of saline and alkali soils. USDA Hand Book, 60: 147.

WHO, 1984. Guidelines for the drinking water quality. Recommendation WHO, Geneva, Vol: 1.