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Research Article

EVALUATION OF GROUNDWATER QUALITY IN LOWER VELLAR SUB BASIN, CUDDALORE DISTRICT, TAMIL NADU, INDIA

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ABSTRACT

The study aimed to evaluate groundwater quality and its suitability in Lower Vellar Sub basin of Cuddalore District. Totally, twenty groundwater samples were collected from bore well during pre monsoon seasons to understand the hydro geochemistry of the Ground water and parameters studied are pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Ca^{2+}, Mg^{2+}, Na+, K+, HCO_3, Cl, and SO_4^{2}. Besides, parameters like Sodium Absorption Ratio (SAR), were also calculated. Further, the groundwater samples were interpreted with various geochemical diagrams to understand the geochemical facies interpreted with Piper Trilinear diagram and Gibb's diagrams. Similarly, USSL diagrams represent C3S1 field utilization of ground water for agriculture.

INTRODUCTION

Groundwater has become the most important source of water used for domestic, industrial, and agricultural sectors of many countries. Now a day, the quality of groundwater is getting attention due to the increasing effects of over exploitation, agriculture practice, and industrial development, other natural and anthropogenic activities. In India, most of the population (85 %) resides in rural areas and they depend mostly on groundwater resources for their daily needs. In which, approximately 50-80 % of the irrigated land is under groundwater consumption (Raju 1998). The chemical composition of groundwater plays a important role in determining the quality of water for various purposes like domestic, agricultural, and industrial purposes. Criteria used for classification of water for particular purpose is not suitable for other standards; better results can be obtained by combining chemistry of all the ions than the individual or paired ionic character (Hem 1985). The Quality of groundwater is the function of its physical and chemical parameters which depend upon the soluble products of weathering, decomposition, and the related changes that occur with respect to time and space (Srinivasamoorthy 2011). Generally, the quality of groundwater depends on the composition of recharge water, the interaction between the water and the soil, the soil-gas interaction; the residence reactions of time take place within the aquifer (Freeze and Cherry 1979; Hem1959). The present studies to assess the hydrochemistry and groundwater quality for drinking and irrigation usage of Lower vellar Sub basin

Study Area

The present study area of Lower Vellar Sub basin is a part of Chidambaram and Bhuvanagiri Taluks of Cuddalore District. The area lies between the North latitudes 11° 25´ and 11° 35´ and East longitudes 79° 35´ and 79° 45´ with a geographical area of 270 km^2 shown in Figure.1.

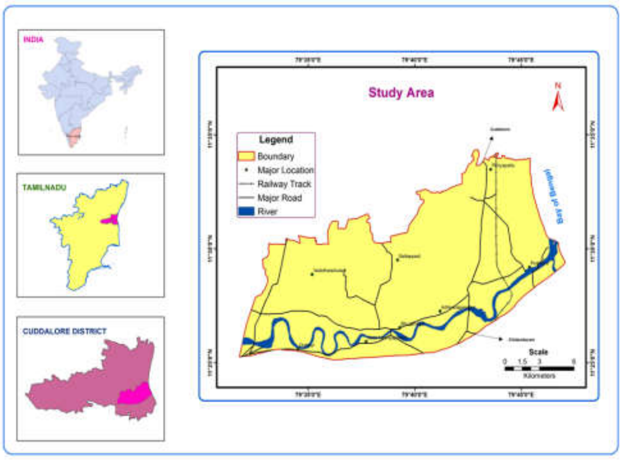

Figure 1 Study Area

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The study area is a flat plain, slopping very gently towards the sea on the east. Geologically the study area comprises of alluvium and Tertiary formations. The alluvium covers almost the entire area where as Tertiary formation occupied the northern side of the study area as shown in the Figure-2, Geomorphologically, the area is covered by flood plain along the river course and remaining area by alluvial plain and coastal plain.

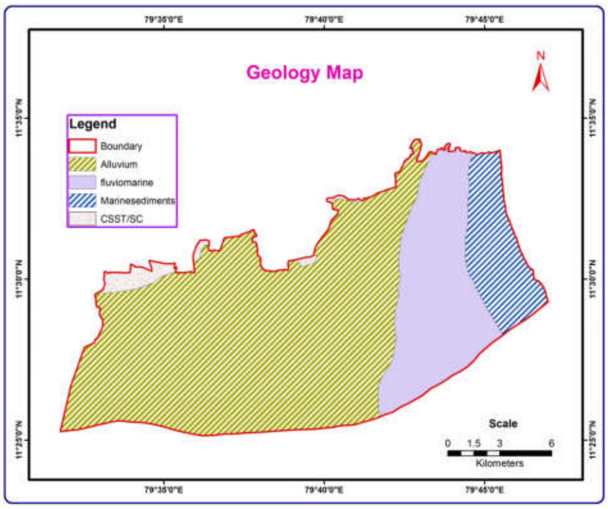

Figure 2 Geology Map

METHODOLOGY

In order to understand the water quality, about 20 groundwater samples were collected from bore wells during pre-monsoon shown in Figure.3.

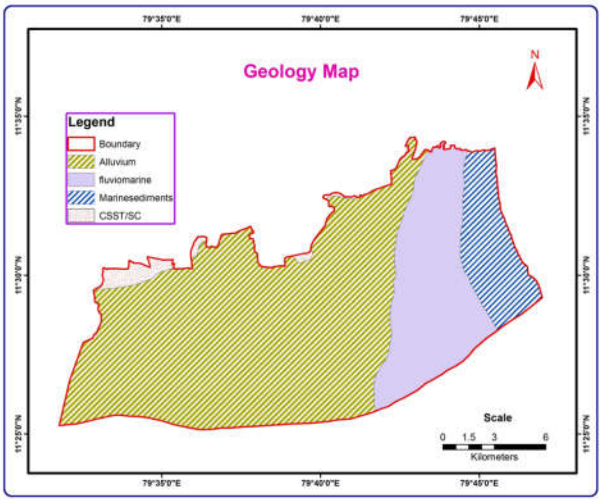

Figure 3 Water sample Location

Table 1 Geochemistry of Analytical data

Parameter	Minimum	Maximum	Average
PH	6.39	8.64	7.189
EC	596	19600	2465.57
TDS	296	4670.5	1451.29
CA	54.9	167	104.67
MG	51.027	270.85	94.95
NA	49.5	635	212.63
K	1.35	47.75	15.65
SO4	120.631	210	164.49
CL	40.7	796	270.75
HCO3	37	547.6	89.10
SIO2	33.1	98	58.05

The samples were collected in clean polythene bottles prescribed by (APHA 1998). The analysed data interpreted using WATCLAST software (Chidambaram *et al*. 2004) for better understanding the quality status and their controlling factors. The groundwater sample analysis results shows in Table-1.

RESULTS AND DISCUSSION

Potential hydrogen (pH)

The pH of water is an important indication of its quality and provides important information of geochemical equilibrium or solubility calculation (Hem 1985). The hydrogen-ion-concentration (pH) samples vary from 6.39 to 8.64 with an average of 7.1. The values for all the samples are within the limits specified as 7.0 to 8.0 (WHO 2011), except two location above the permissible limit. this indicating study area, 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.

Electrical conductivity

In the study area the Electrical conductivity value varies between a minimum of 596 mg/l and a maximum of 19600 mg/l with an average of 2465.5 mg/l. The maximum limit of EC in drinking water is prescribed as 1500 microsimns/cm (WHO 2011). Hence, high concentration of TDS in the groundwater sample is due to leaching of salts from soil and also domestic sewage may percolate into the groundwater, which may lead to increase in TDS values. The high conduction was observed in 6 locations which may attribute to high chloride concentration in ground water (Davis and Dewist 1996). The classification proposed by (Wilcox 1955).

Classification	Values Range (ppm)	No. of samples
Excellent	Less than 250	Nil
Good	250 - 750	5
Permissible	750 - 2250	10
Doubtful	2250 - 5000	5
Unsuitable	Greater than 5000	Nil

Total dissolved solids

The principal ions contributing to TDS are bicarbonate, carbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium (EPA 1976). The TDS of ground water varies from of 296 mg/l and a maximum of 4670.5 mg/l with an average of 1451.2 mg/l. The groundwater samples have been classified based on the concentration of TDS (USSL 1954).

Classification	Values Range (ppm)	No. of samples
Desirable	Less than 250	Nil
Permissible	200 - 500	5
Useful	500 - 1500	9
Unfit	1500 - 3000	6

Cations

The major cation concentrations (Ca^+, Mg^+, Na^+, K) in the groundwater. Calcium and magnesium ions present in ground water is particularly derived from leaching of limestone, dolomites, gypsum and anhydrites Whereas the calcium ions is also derived from Cation exchange process (Garrels 1976). The concentration of Ca is varied from 54.9 mg/l to 167 mg/l with an average of 104.6 mg/l. The limit of Ca for drinking water is specified as 200 mg/l (WHO 2011).The Magnesium concentration is varied from 51.0 mg/l to 270.8 mg/l with an average of 94.9 mg/l. The limit of Mg for drinking water is 30 to 150 mg/l (WHO 2011). Similarly, the Sodium concentration is varying from 49.5 mg/l to 635.0 mg/l with an average of 212.6 mg/l. The limit for drinking water is specified as 200 mg/l (WHO 2011). The Potassium concentration is varied from 1.3 mg/l to 47.7 mg/l with an average of 16.6 mg/l. The limit of K for drinking water is specified as 25 mg/l (WHO 2011).

Anions

The major anion like Cl concentration is varied from 40.7 mg/l to 796.0 mg/l. The limit of chloride concentration for drinking water is specified as 600 mg/l (WHO 2011). The bicarbonate presence varied from 37 mg/l to 547.6 mg/l. The Sulphate concentration is varied from 120 mg/l to 210 mg/l. The limit of sulphate for drinking water is specified as 400 mg/l (WHO 2011). All the sample locations are within the limit in the study area. A part from the natural rock sources, sulphates could be introduced through the application of sulphatic soil conditioners (Karanth 1987).

Hydro geochemical Facies

The concentrations of major ionic constituents of groundwater samples were plotted in the Morden Piper trilinear diagram 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 (Piper 1953). The Piper trilinear diagrams are very useful to bringing out the chemical relationships among ground waters in more definite terms (Walton 1970). Hence, the present study area ground water samples have been plotted 1 and 12 filed followed by Ca+Na and So4+Cl facies shown in Figure.4

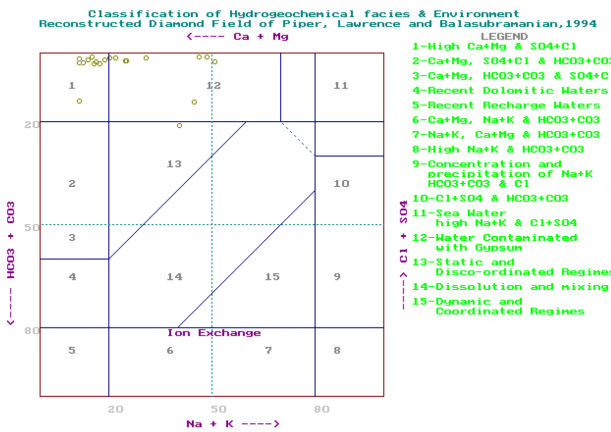

Figure 4 classification of Hydrogeochemical facies

USSL classification

The USSL Diagram has been used to understand the alkali hazard of the groundwater samples for the study area, because this interpretation is very much useful for judging the quality of groundwater for the use of agricultural purpose (Todd 1980). Where the sodium adsorption ratio is plotted against specific conductance. The sixteen classes in the diagram indicate the extent that waters can affect the soil in terms of salinity hazard as low (C1), Medium (C2), high (C3), and very high (C4) and similarly sodium hazard as low (S1), medium (S2), High (S3) and very high(S4). The analytical data plotted most of the sample C3S1 and five sample C2S1. This categories are predominant in the study area and it is suitable for irrigations purposes shown in Figure. 5.

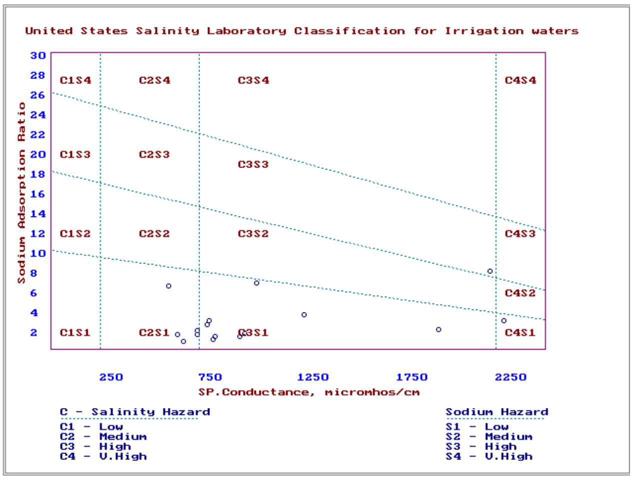

Figure 5 USSL classification

Gibb's Diagram

The mechanism controlling chemical relationships of groundwater based on aquifer Lithology and nature of geochemical reactions and solubility of interaction rocks has been studied following Gibbs (1970). According to the variation in the ratio of Na+K/Na+K+Ca and Cl/Cl+HCO3 as a function of TDS Figure 6. From These Gibbs plot, it could be confirm that the chief mechanism controlling the chemistry of ground water interaction of the study area dominated by rock water interaction and some location fall in evaporation zone

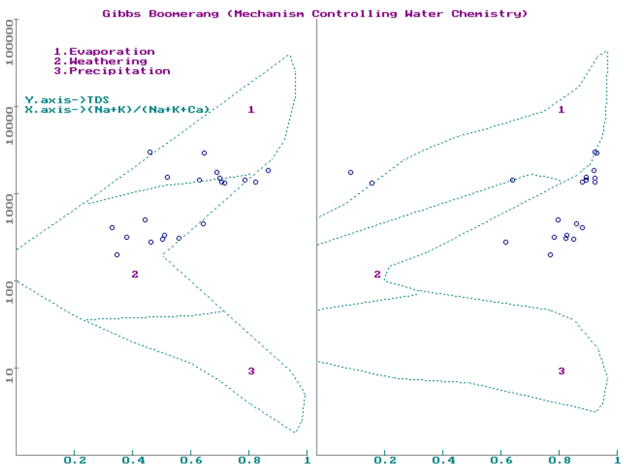

Figure 6 Gibb's Diagram

CONCLUSION

From the hydro geochemistry study of the groundwater quality of the study area has been evaluated using various techniques, it is observed that the most of the groundwater sample not exceeding the maximum permissible limit in their quality. The chemical relationship of groundwater facies of Ca+Na and So4+ Cl. It is possible ionic base reaction between Ca and Na from the study area. The USSL interpretation helped to understand the soil suitability for cultivation of crops. It indicate that High salinity and Low sodium hazard within the permissible limit and hence the water is not harmful to the soil and not affected the yield crop. The Gibb's diagrams too strongly favour the concentration of ions from rock water interaction. Hence the present amount of ionic concentration mainly from the subsurface formation such as clay, sandy clay, sand, shale by realising element into the groundwater. Thus, the study helps us to understand the hydrogeochemical characters and to determine the sources of dissolved ionic constitution in the eastern parts of lower Vellar Sub basin.

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