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Hydrogeochemical Characteristics of the Shallow Aquifer Along a Stretch of East Coast in Cuddalore District, Tamil Nadu, India

B. Kumaravel

Abstract: ***The hydro geochemical characteristics of groundwater were studied in the shallow aquifer along the east coast of Cuddalore district. Tamilnadu, India to identify the chemical processes mainly involved in affecting the quality of water present in the aquifers of the chosen study area. The water samples were gathered for conducting various tests from fifty borewells in the study area at every fortnight. The samples were tested and analyzed with the selected physiochemical properties such as pH, EC, TDS, and the major iron strength Ca, Mg, Na, K Cl, HCO3 and SO4. Interpretation of hydro geochemical data suggested that various ions with high concentration were present in the groundwater. But, it remains no change in the order of abundance for both cation and anion due to the seasonal effects. In fact, it was found that the characteristics of groundwater quality commonly mixed with sea water composition.***

Index Terms: ***Hydrogeochemical, Coastal aquifer, Groundwater quality, Seawater Intrusion.***

I. INTRODUCTION

Water is an important element for all existing things in the world. In recent years, the demand for good quality water was increased enormously in developed and developing countries like India. At this juncture, the groundwater acts as the viable option for farming and household purposes in India. Water is also an essential resource, major portion was drawn by agronomists across the country [1]. Impact of huge growth in population, urbanization, and innovation in industrial revolutions had increased groundwater exploitation in large areas [2]. The groundwater quality is affected by overexploitation and improper waste disposal and waste management. Hence, adequate quantity and quality of groundwater must be provided for plant growth and human health [3]. Groundwater available in the surroundings of coastal areas are susceptible to salinization by seawater, were not suitable both for drinking or agriculture practice. Moreover, natural process and anthropogenic factors are affected due to groundwater salinization [4] - [7]. Salinization of aquifers in shoreline territories is the consequence of contaminant forms identified with both seawater interruption and weathering of rock, also in some cases are almost practically indistinct.

The hydrogeochemical analysis is a valuable instrument to recognize the procedures include accountability for chemistry in groundwater [8]. On the other hand, movement of groundwater and geological environment are the major dependents for concentration types present in ground water with salts [9].

Aggression of backwaters from the sea had made saltwater intrusion that had created a serious threat for different locations in India having coastal aquifers along with coast line of Tamil Nadu and present study area, Cuddalore region was covered with a different variety of lithological units such as sand forms of complex hydro geochemical environs. In the chosen study area was embedded with tertiary sandstone can hold large quantities of good ground water in addition, the sandstone was deviated after the alluvial development of impermeable clay layer and there after the water under the ground ensues with a narrowed state of sandstones also with a phreatic state with alluvial aquifers shallow forms. Also, the area nearby the mining areas of Neyveli and water structure at Veeranam are identified as the major extractors of groundwater and had shown the impact on the environment [10]. The present study area suggests the groundwater quality analysis of various attributes of hydrochemical to draw the hydrogeochemical characters, further the need for governing the factors for quality in water in this coastal region.

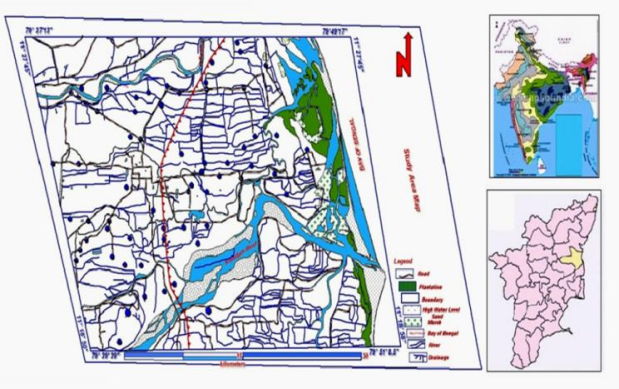

Fig. 1 Location and bore wells of the study region

II. STUDY REGION

This study region is located at the Southern part in Cuddalore district along the eastern coast between the river old Coleron and river Vellar. The recorded average rainfall is 1160.36 mm within the district; ground water is a foremost service for cultivation and industrialized purposes.

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***** Correspondence Author
Dr. B.Kumarvel*, Department of Civil Engineering, FEAT, Annamalai University, Annamalai nagar - 608002, Tamilnadu,India.

The study area lies in the middle of 79o 37' E to 79o 51'E longitude and 11o18'N to 11o 27'N latitude (Fig. 1).

III. METHODOLOGY

Groundwater samples were collected at every fortnight from 50 chosen bore wells during the study period (2013-14). The locations of the borehole in the study were given in Fig.1. The test samples were gathered from boreholes later 10 minutes run from the pump, later into a polyethylene bottle. The samples were tested to find physic-chemical parameters. The identified samples had experimented to find the emerged cations, such as Calcium and Magnesium by Titration and Sodium and potassium by flame photometer experiment test of AMIL Company and also anions such as Cl and HCO3 were tested by Titration followed by SO4- by Spectrophotometer (JENWAY 6505). The analyses [11] was conducted with standard procedures as recommended.

Parameters	1st season		2nd season	
	Min.	Max.	Min.	Max.
PH	6.98	8.42	6.55	8.26
EC.	308	2646	322	2772
TDS	238	4080	217	4100
Ca	8	92	8	108
Mg	-2.4	148.8	0.80	8.50
Na	0.00	221.00	22.00	339.60
K	3.48	65.22	0.00	22.30
Cl	35.45	703.98	41.80	572.03
HCO_3	17.50	379.50	17.50	802.80
SO_4	3.00	19.00	0.30	21.50

Table-1: Hydrogeochemical Parameters

I. RESULTS AND DISCUSSION

The least, highest and moderate values in mg per liters were noted in Table-1. The absolute cations and complete anions steadiness from the results demonstrates the percentage error and change balance [12]. Majority of the samples tested were fallen ion balance errors within ±10%, showing the outcomes are considerably accepted. The average temperature of the collected water samples varied between 23^o C to 33^o C.

pH of the collected test sample exhibits the nature of alkaline with an average value of 7.7 and 7.4 during the 1st and 2nd seasons respectively. The pH is constrained by all-out alkalinity of the groundwater and some quantity with seawater blend. pH present with the study region varies from 6.98 to 8.42 with an average value of 7.7, but competitive with 1st season (August) and in the 2nd season (February) it ranges from 6.4 to 7.8 with an average value of 7.4.

Electrical Conductivity is a backhanded proportion of ionic quality and mineralization of the normal water sample. EC shifts from 308 to 2646 µs/cm in the first season and from 322 to 2772 µs/cm in the second season. The spatial and transient varieties of EC for both first and second season have shown in Fig. 1 and 2 separately. TDS ranges fluctuate with 238 – 4080 mg/l in the first season and 217 to 4100 mg/l in the second season. Spatial and sequential changes of TDS are likewise given in Fig. 3 and 4 for both the first and second seasons individually. The water tests of the present study region are named clean to saline naturally.

The first season shows the domination of bicarbonate anion based chloride, phosphate and sulphate, whereas the second season was also results the same but, in addition with nitrate. The predominant cations are as follows in both first and second season are calcium pursued by sodium, potassium, and magnesium. Discrete zones inside aquifers are having characterized water science properties are alluded to as hydro compound facies [13]. Deciding the nature and dispersion of hydro concoction facies can give understanding into in what way groundwater quality modifies inside and in bound with aquifers.

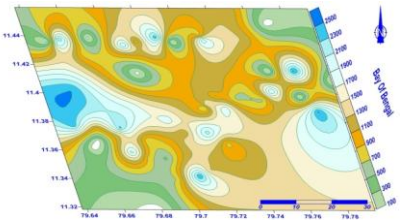

Fig.2. shows the EC for 1st Season

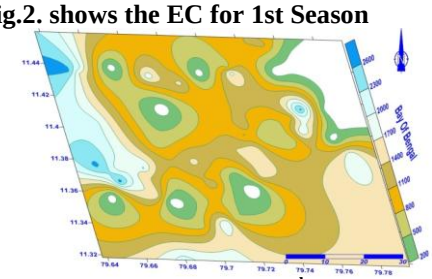

Fig.3. shows the EC for 2nd Season

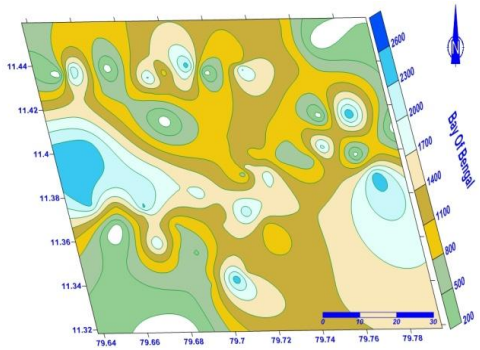

Fig.4. shows the TDS for 1st Season

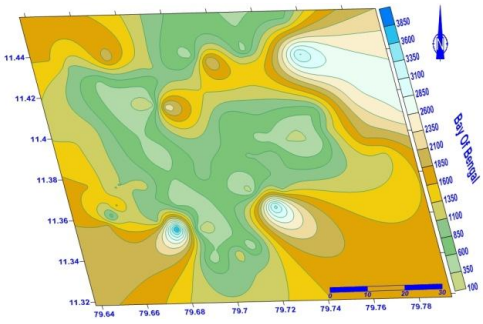

Fig.5. shows the TDS for 2nd Season

A.Mechanism of Weathering

The water science in the area of interest is directed by assorted procedures and components. Consequently, Gibbs plot is utilized for the examination zone to comprehend and separate with impacts from water- mix cooperation, vanishing and precipitation in water science [14]. Gibbs exhibited that the TDS noted on "Y" hub, and Na / (Na+Ca) and Cl / (Cl+HCO3) are noted on "X" pivot that could give data over the component that manages the science of H20. The compound information of groundwater tests is plotted with Gibbs Diagram (Fig. 6 and 7) for the region chosen. Most of the test samples recommend that the chemical weatherings are impacting the groundwater quality and few of the groundwater tests falling in the Precipitation zone amid the first and second period of the investigated region. Groundwater tests for clean and salinewater was separately dissipated along with enduring strength and precipitation predominance regions for both samples.

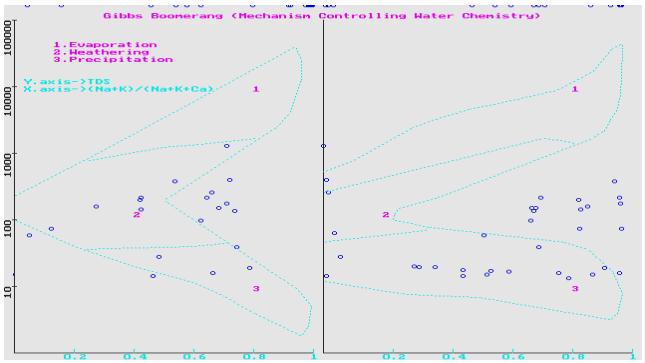

Fig.6. Gibb's Plot shows the TDS for 1st Season

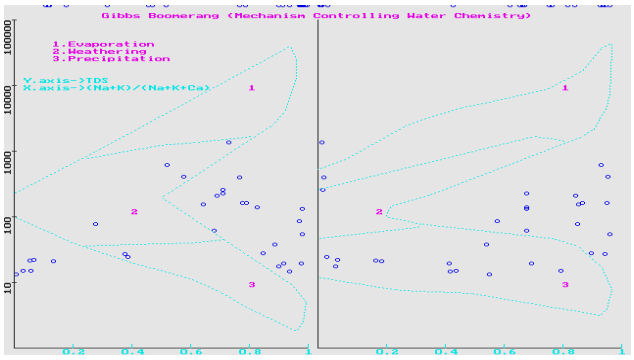

Fig.7. Gibb's Plot shows the TDS for 2nd Season

B. Piper Chart

Geochemical advancement in ground water could be comprehended with scheming the convergences of significant anions and cations in the flute player chart outline [15]. The anions and cations fields are joined to demonstrate a solitary point in a rectangular-formed area, from which deduction is drawn based on hydrogeochemical facies. The outcomes were plotted on Piper's chart (Fig. 8 and 9). In the primary season and second season, diagram (Fig. 8 & 9). In the first season and second season, many of the samples lies in alkaline earth (Ca+Mg) the vast majority of the examples fall in antacid earth (Ca+Mg) demonstrating water defiled with gypsum and furthermore showing static and disco-ordinate routines. In the two seasons, few examples fall in the (HCO3 + CO3). May the reasons are synthetic from enduring of rocks, and disintegration of little amounts of mineral issues is a direct result of the overall insolubility of the rock composition.

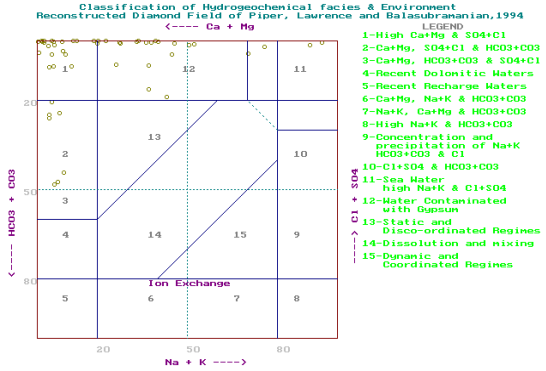

Fig.8. Piper chart shows the TDS for 1st Season

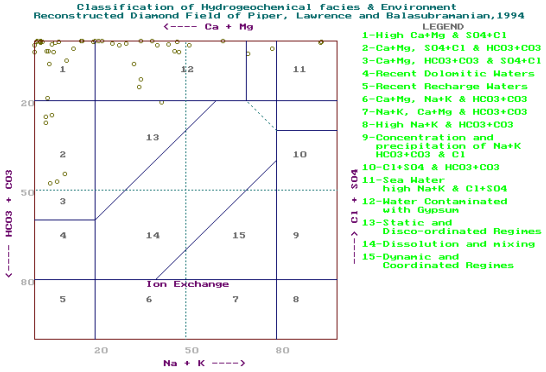

Fig.9. Piper chart shows the TDS for 2nd Season

C. Seawater Intrusion

The coastal aquifers were high danger of high contact with water with sea water intrusion had greater influence. The plenitude of Na^+, Cl^-, and SO_4^-over different particles in the ground water at a couple of areas shows the conceivable ocean water interruption here. These particles expanding the EC and complete broke up solids (Table 1). The absolute cations versus chloride show the sea water impact too (Fig. 8) through tests that were plotted along with trend line of sea water. The upward deviation from the blending line is by all accounts brought about by other substance responses giving cations starved of with shifting focus of chloride. In the second season, 3 tests fall underneath the ocean water shoreline and with first season, 8 tests were beneath ocean water blending line. Due to the impact, all things considered, the sciences of these examples are exceedingly influenced by cation exchange.

D. Analysis of irrigation water samples

In imperative to selecting for reasonableness of groundwater for horticulture reason, different techniques were broke down. The job of sodium for the characterization of groundwater in water system remained underlined on account of the way that sodium responds in addition with dirt and as result stopping up of units happens, in this manner lessening the penetrability [16], [17]. Level of sodium (Na) is an essential cation which in abundance falls apart the dirt formation and decreases crop yield [18].

Na percentage is determined to utilize the recipe given in equation 1:

Na percentage = ((Na+K) / (Ca+Mg+Na+K))*100 --- (1)

Where, the value of ions are expressed in milliequivalents per litre.

In Wilcox outline [19] the water is arranged dependent on the Na% as for different cations that are available. Information on first and second season groundwater tests of the territory are strategized in the Wilcox outline are appeared in Fig. 10. In the investigation territory, 32% and 28% of tests fall in superb classification, 24% and 26% of tests fall in great kind, 12% and 10% examples fall in allowable sort, 18% and 20% of tests fall in doubtable and 14% and 12% of tests fall in unacceptable sort. The majority of the examples fall in the exceptionally great classification of the study area.

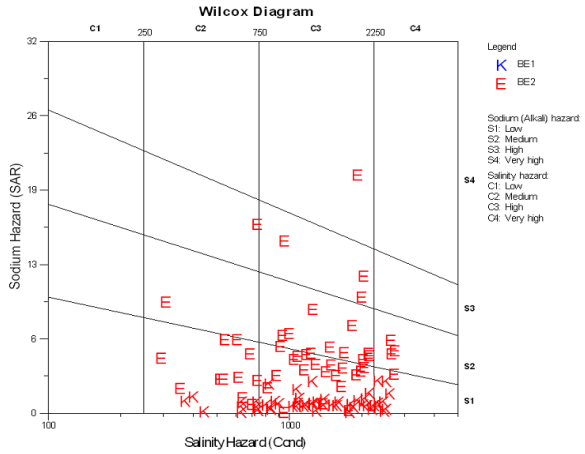

Fig.10. Classification of Water based on Wilcox diagram

E. USSL diagram

The groundwater with salinity and SAR are additionally decides the usefulness for horticultural determinations [20]. Saltiness begins in ground water due to enduring of rocks and draining of particles through topsoil, anthropogenic source alongside slight impacts on the atmosphere. The dimension of Na and HCO_3 in ground water system influences penetrability of the dirt and waste of the territory. Whenever SAR (antacid peril) and explicit conductance (Salinity danger) is plotted in USSL graph, a grouping of water for water system reason can be resolved. In the arrangement (Fig. 11 and 12) demonstrates dominant part of tests fall in C1S1 zone amid the first season and showing low saltiness and low sodium risk, useful for plants having moderate salt resistance soils. Significant portrayals of the first season are additionally noted in C1S1, C1S2 and C2S1 zones demonstrate medium to low salinity waters. In the second season, many of the test samples were drop in C1S1 which indicating low salinity and low sodium exposure and few samples lay in C2S1 and C3S1 indicating prominent salinity hazard and low sodium vulnerability.

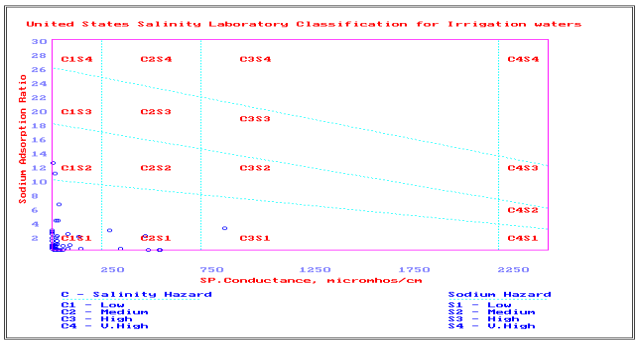

Fig.11. Water Classification based on USSL diagram for 1st Season

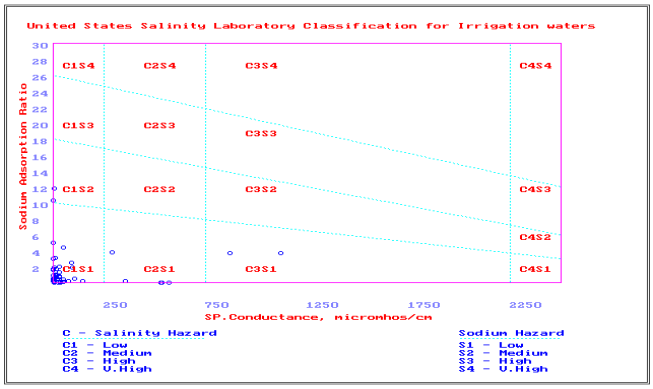

Fig.12. Water Classification based on USSL diagram for 2nd Season

F. Doneen Diagram

Penetrability file is additionally an important factor which impacts the nature of water system, in connection to the soil for advancement in cultivation. In view of porousness record, [21] the groundwater is characterized as class I, II and III to discover appropriateness of groundwater for water system purposes. In basic development (Fig. 13 and 14) the greater part of the examples independent of seasons fall in class I demonstrating water is useful for water system purposes. Certain examples were noted in the first season which fall in class II. It might be moderate for water system purposes. The same thing occurs for the second season and one example falls in class III.

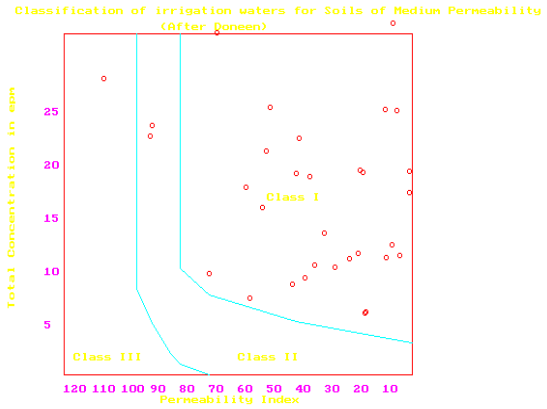

Fig.13. Water Classification based on Doneen diagram for 1st Season

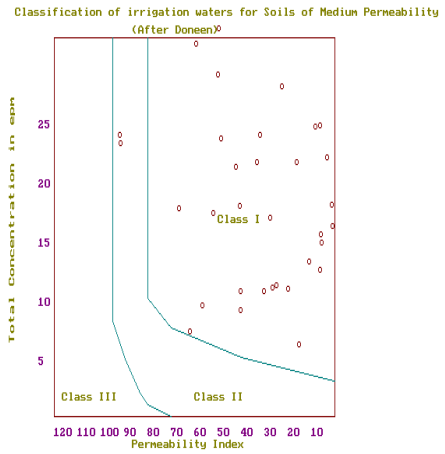

Fig.14. Water Classification based on Doneen diagram for 2nd Season

V. CONCLUSION

This investigation result demonstrates that the hydrogeochemistry of the samples fall in alkaline earth (Ca + Mg) showing water tainted with gypsum and furthermore demonstrating static and disco-ordinate routines. In the two seasons, few samples fall in the (HCO3 + CO3). Hydrogeochemistry of the shallow aquifer moved towards basic with sulfate and bicarbonate. Particle trade process in the shallow aquifer was discovered base exchange type in both the seasons. As indicated by Gibbs' outline plot substance enduring of shake framing minerals in the second season and synthetic enduring alongside vanishing in first season were the real main thrust controlling hydrogeochemistry of shallow aquifer. In water system water alongside US Salinity Laboratory's, Wilcox's and Doneen outlines recommended that most of the groundwater tests were useful for water system amid both first and second seasons. It comprehended that the groundwater was basic in nature, and ionic quality additionally high. The complete disintegrated solids content likewise high in the investigation tests. There was no wide variety between the examples of the primary season and the second season in the examination zone. The groundwater at a couple of areas shows that the conceivable ocean water interruption here amid the second season. It obviously shows that the atmosphere assumes a noteworthy job in changing the nature of the groundwater

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AUTHORS PROFILE

Dr. B. Kumaravel, Ph.D., is an Assistant Professor in the department of Civil Engineering, Annamalai University. His area specialization is water resources engineering & management and Air pollution dispersion modeling. He has published 10 papers in international journals and 11 papers in the proceedings of National seminar and Conferences. He has 18 years in teaching experience and 10 years in the field of construction works.

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