Interpretation of Ground Water Sample Analysis Around Etcherla in Srikakulam District, Andhra Pradesh, India

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Abstract

Water plays an important role in domestic and industrial usage. The quality of drinking water is a powerful environmental determinant of health. Assessment of water quality of drinking water supplies has always been paramount in the field of environmental quality management. Assurance of drinking water safety is a foundation for the prevention and control of water borne diseases. The suitability of drinking water has many requisite potable conditions. A systematic study has been carried out around Etcherla to assess the ground water quality data for 12 physicochemical parameters collected from 11 monitoring stations were analyzed. The fit models like surfer and Minitab was used to analyse data set. The results revealed highly variable hydrochemistry. The groundwater recorded a wide range in TDS. The major elements data were plotted on contors for working of hydro chemical facies.

Keywords: *Hydrochemical, dendogram, Etcherla, surfer*

I. INTRODUCTION

In many coastal towns or cities, groundwater seems to be the only source of fresh water to meet domestic, agricultural and industrial needs. Groundwater is an important water resource in both the urban and rural areas of srikakulam but in the rural, pipeborne water is also available. Basically rural dwellers rely on hand-dug wells for potable water supply as the streams usually dry up in dry season. These resources are under threat from pollution either from human life style manifested by the low level of hygiene practiced in the developing nations. But groundwater is under constant threat of saline water incursion, which seems to have become a worldwide concern. Environmental health involves all the factors, circumstances and conditions in the environment or surroundings of humans that can influence health and wellbeing. The neglect of rural areas in most developing countries in terms of basic infrastructures such as pipe-borne water and sanitation facilities, expose the villagers to a variety of health related problems such as water – borne diseases.

In this study, the levels of some physical and chemical water quality parameters in hand-dug wells located in the residential areas and in the vicinities of rural settlement near the coastal area of srikakulam district, Andhra Pradesh were assessed.

II. STUDY AREA

The study area lies between 18°10′ N and 18°22′ N latitudes and 83°70′E and 83°89′E longitudes (Figure 1) wide range of 70 kms in etcherla mandal, srikakulam district, Andhrapradesh. The northern and southern boundaries of the basin are defined by the Pddagadda and Mahendratanaya rivers which confluence into Bay of Bengal.

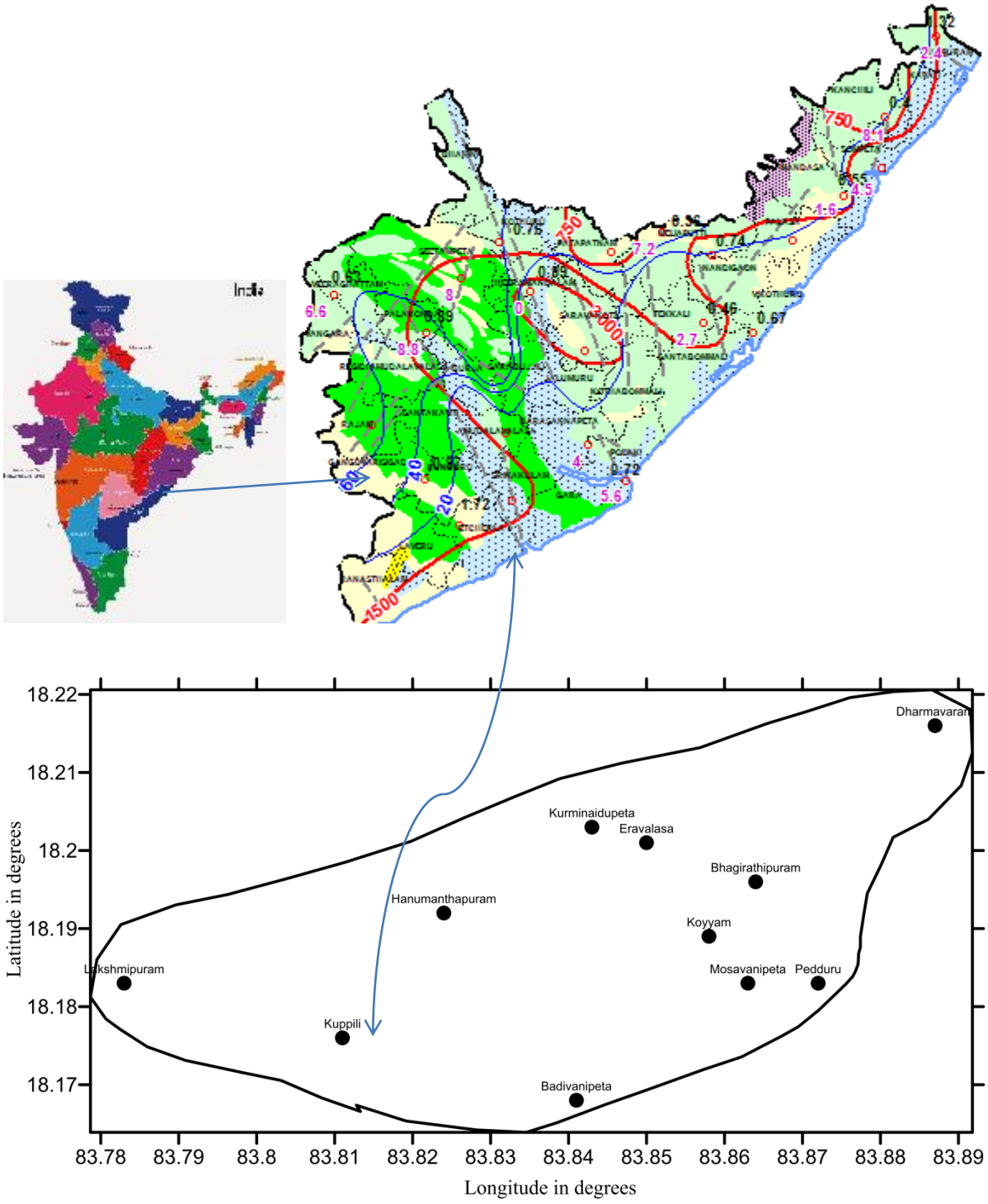


Figure 1: shows the map of the study area

III. MATERIALS AND METHODOLOGY

Groundwater samples were collected after well inventory survey from 11 representative wells during october 2014 (Figure 1). The samples were collected after 10 min of pumping and stored in Polyethylene bottles at 25°C. Immediately after sampling, pH and electrical conductivity were measured in the field by using systranic water analyser instrument. Total dissolved solids (TDS) were calculated from EC multiplied by 0.64 (Brown, Skougstand, & Fishman, 1970). Nitrate (NO_3) and ortho-phosphate (PO_4) by spectrophotometer, sulphate (SO_4) analysed using Nephelometer, sodium (Na) and potassium (K) studied by flame photometer, bicarbonate (HCO_3), calcium (Ca), and Total hardness (TH) were determined by volumetric methods. High purity analyticalreagents were used throughout the study,

and chemical standards (Merck, Germany) for each element were prepared separately.

IV. RESULTS AND DISCUSSION

A. Ground Water Quality

1. Electrical Conductance

Electrical conductance (EC) is the conductance of one centimetre cube of the substances and is represented in micromhos/cm at 25ºc. The presence of ions in solution increases conductivity of water. The EC of water samples from the study area varies between 640 to 4100 micromhos/cm.

2. Total Dissolved Solids (TDS)

TDS is defined as the residue of filtered water sample after evaporation. The bulk TDS include bicarbonates, sulphates and chloride of calcium, magnesium, sodium, potassium, silica, potassium chloride, nitrate and boron. According to Hem (1959) [6] TDS was calculated using the relationship given below TDS (in mg/L) = 0.64 * EC (in micromhos/cm).Analysis of water samples of the study area revealed that the presence of TDS varies between .409 to 2624 mg/L except dharmavaram sample exceeds the limit due to brackish water. Subsequently, Table 2 describes about four classes of water were proposed based on the procedures adopted from Carroll (1962) which confirms majority of samples belongs to fresh water category.

3. Calcium

Calcium is a major constituent of igneous rocks. The range of calcium content in ground water is largely dependent on the solubility of calcium carbonate, sulphide and rarely chloride. The calcium content of the water samples were estimated by EDTA titration method. The maximum acceptable limit of calcium for domestic use is 75mg/L. The range of calcium varies from 64 to 164.2 mg/L. All samples are within range of permissible limit.

4. Magnesium

Magnesium is an important constituent of basalt. It's solubility in water is around five times that of calcium. Calcium and Magnesium together cause the hardness of water. EDTA titration was used to determine the magnesium concentration in the samples. The range of magnesium varies from 14.58 to 75.57 mg/L.

5. Sodium

Sodium is an important constituent for determining the quality of irrigation water. Most sodium salts are readily soluble in water, but take no active part in chemical reactions. Sodium has wide variations in its concentration in ground water. The sodium content of the samples was determined by a flame photometer. Sodium content in the water samples varies between 126.3 to 623mg/L. Majority of collected water samples shows exceed limit range because of the wells are near to the sea.

6. Potassium

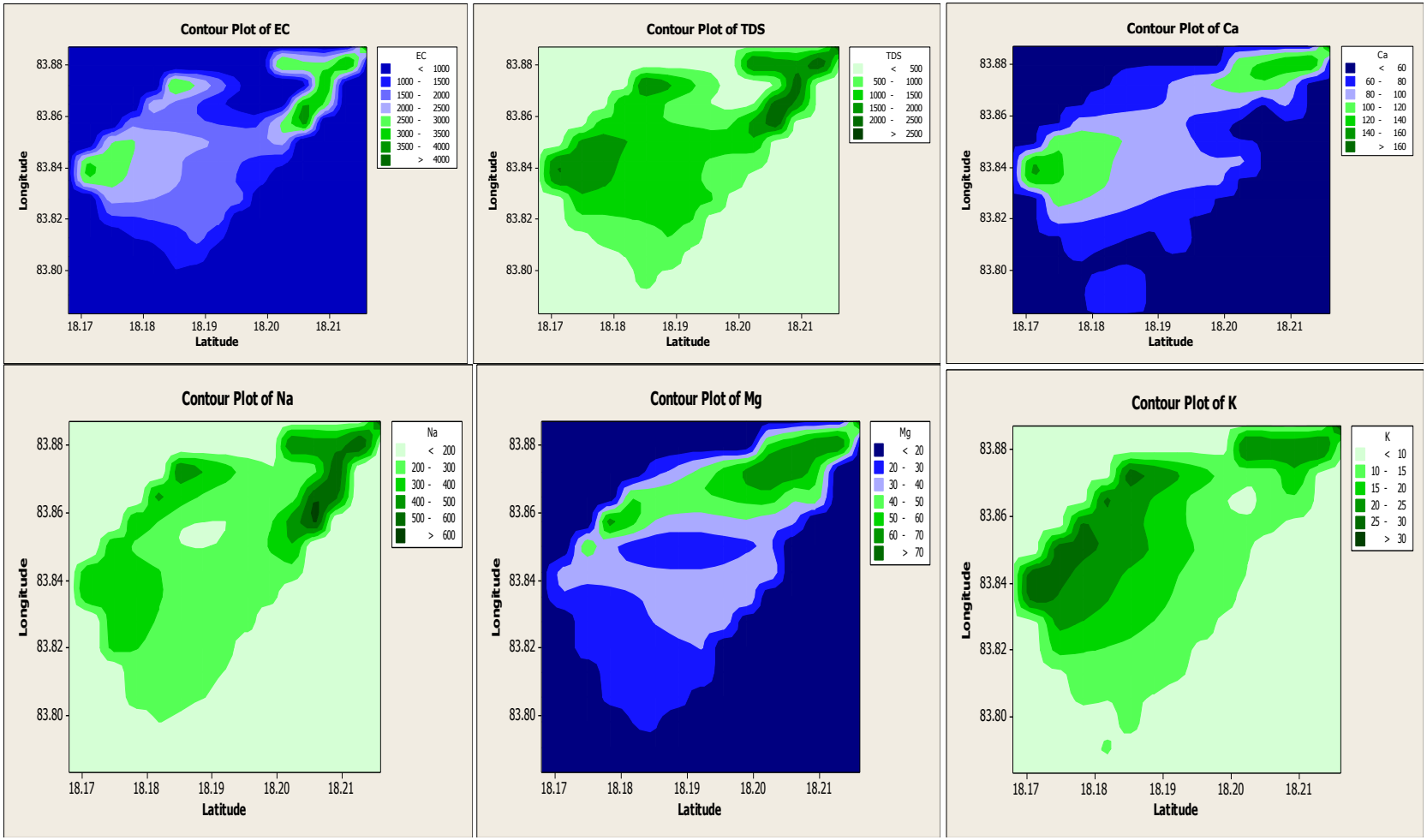
Although potassium is nearly as abundant as sodium in igneous rocks, its concentration in ground water is comparatively very less as compared to sodium. This is due to the fact that the potassium minerals are resistant to decomposition by weathering. The potassium concentration in the water was determined with the help of Flame photometer. Analysis of water samples in the study area indicates that potassium value varies between 9.4 to 30.6 mg/L. Half of the water samples lies in the potassium acceptable limit.

Table 1. Analytical Data for the Water Samples

S.No	Sample ID	Longitude	Latitude	Type of well	pH	EC	TDS	Salinity	NO_3^-	Mg^{2+}	Ca^{2+}	TH	Cl^-	HCO_3^-	Na^+	K^+	SO_4^{2-}
1	Koyyam	83.858	18.189	Bore well	7.3	1523	974.72	0.73104	19.56	36.87	85.69	360.52	396	156	202.2	18.4	72.6
2	Badivanipeta	83.841	18.168	Bore well	8.1	3162	2023.68	1.51776	26.12	31.06	148.24	486.23	1080	282	384.2	30.6	236.4
3	Dharmavaram	83.887	18.216	Open well	7.9	4100	2624	1.968	33.26	75.57	164	711	1710	496	623	30.2	376.2
4	Kurminaidupeta	83.843	18.203	Open well	6.9	1123	718.72	0.53904	35.91	35.52	82.1	346.24	348	142	264.4	9.6	104
5	Lakshmipuram	83.783	18.183	Bore well	7.4	640	409.6	0.3072	13.81	14.58	64.21	215.32	176	114	126.3	9.4	84.2
6	Eravalasa	83.85	18.201	Bore well	7.1	1995	1276.8	0.9576	69.52	30.08	64.2	280.4	590	231	348.6	10.6	42.8
7	Bhagirathipuram	83.864	18.196	Bore well	7.4	780	499.2	0.3744	30.18	50.10	84	412	354	146	211	12.6	52.6
8	Pedduru	83.872	18.183	Open well	8.5	3300	2112	1.584	13.29	22.18	59.6	236.2	1280	249	486.2	28.4	246.42
9	Mosavanipeta	83.863	18.183	Open well	7.8	1910	1222.4	0.9168	29.6	49.07	74.23	384.26	810	261	356.2	23.6	196.5
10	Kuppili	83.811	18.176	Open well	7.6	810	518.4	0.3888	14.56	22.86	70.2	264.5	301	362	286.9	12.5	132.6
11	Hanumanthapuram	83.824	18.192	open well	7.5	1680	1075.2	0.8064	17.53	31.18	70.52	300.2	284	196	246.6	12.4	104.2

Table 2. Water Quality Classification Based on TDS Content by Carroll (1962)

TDS in mg/L	Water Quality
0 -1000	Fresh water
1000 – 10, 000	Brackish water
10, 000- 100, 000	Salty water
> 100, 000	Brine


Contour Plot of EC
EC
< 1000
1000 - 1500
1500 - 2000
2000 - 2500
2500 - 3000
3000 - 3500
3500 - 4000
> 4000
Contour Plot of TDS
TDS
< 500
500 - 1000
1000 - 1500
1500 - 2000
2000 - 2500
> 2500
Contour Plot of Ca
Ca
< 60
60 - 80
80 - 100
100 - 120
120 - 140
140 - 160
> 160
Contour Plot of Na
Na
< 200
200 - 300
300 - 400
400 - 500
500 - 600
> 600
Contour Plot of Mg
Mg
< 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
> 70
Contour Plot of K
K
< 10
10 - 15
15 - 20
20 - 25
25 - 30
> 30
Longitude
83.88
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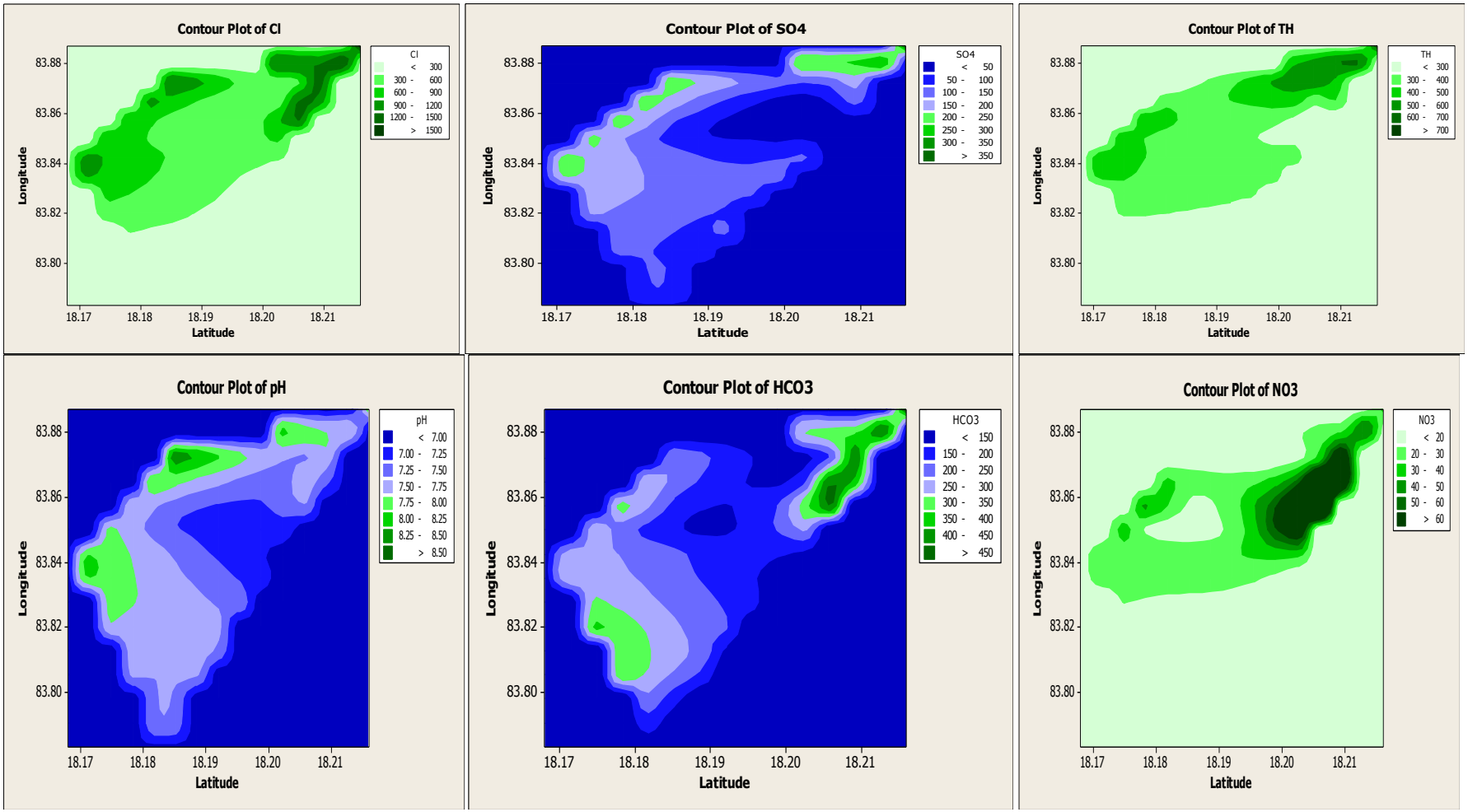

Figure 4: shows the distribution concentration of physicochemical parameters

7. Chloride

Chloride ion is a predominant natural form of chlorine and is extremely soluble in water. The major sources of chloride in natural water are sedimentary rocks particularly evaporates. Igneous rocks contribute only a fraction of total chloride. Other sources are industrial and domestic wastewater. The limit for domestic purposes is fixed at 250mg dm^{-3} [10]. The chloride content in the samples was determined by using 0.1N AgNO3 solution. In the present study chloride ion content in all the ground water samples ranged from 176 to 1710 mg/L. Among 11 collected water samples, pedduru, mosavanipeta and badivanipet a shown high content of chloride due to effect of cashew industries more.

8. Sulphate

The sulphate content in the atmosphere precipitation is only about 2mg/L, but a wide range in sulphate content in ground water is made possible through reduction, precipitation, solution and concentration. The primary mineral sources of sulphate ions include evaporate minerals such as calcium, gypsum and sulphates of magnesium and Sodium. The sulphate concentrations in the water samples were determined by Nephelo meter and results revealed that all analysed samples in permissible limit. The sulphate content in the samples varies between 42.8 to 376 mg/L.

9. Total Hardness TH

Hardness is often referred to as the soap consuming property of water. Hardness may be divided into two types, carbonate and non-carbonate. Carbonate hardness includes portions of calcium and magnesium, and certain amount of bicarbonates. Total hardness is defined as TH= (2.497 Ca + 4.11 Mg); where Ca and Mg are expressed in mg/L [11]. Total hardness of the study area varies between 215.32 to 486.23mg/L. Classification of water was done based on hardness given by Sawyer (1960) [12] and is listed in Table **3** suggested that all water samples in the category of hard.

Table 3. Water Classes Based on Hardness by Sawyer (1960)

Hardness as CaCO3	Water Class
0 -75	Soft
75- 100	Moderately hard
150 – 3000	Hard
> 3000	Very hard

10. Hydrogen Ion Concentration (pH)

The pH of a solution is defined as the negative logarithmic of the ion concentration and is normally expressed in moles per liter at a given temperature. pH of a solution can affect the toxicity of other elements and has very pronounced effect on many chemical reactions which are important to industry, irrigation and domestic water treatment. The pH value was determined in the field using a pH paper and the values vary between 7.1 to 8.5

11 . Correlation analysis

Pearson correlation (r) matrix was used to determine the relationship between variables. The classification was based on Guildford's rule (Guildford, 1973) of thumb for interpreting the Pearson product moment correlation

Table 3: Guildford's rule of thumb for interpreting correlation coefficient.

r value	Interpretation
0.0 to 0.29	Negligible or little correlation (N)
0.3 to 0.49	Low correlation (weak) (W)
0.5 to 0.69	Moderate correlation (M)
0.7 to 0.89	High correlation (Strong) (S)
0.9 to 1	Very high correlation (Perfect) (p)

The correlation matrix (Table 3), describes the interrelationship between variables and the results for 12 hydro chemical parameters which show that the very high positive correlation (p) exist between EC-(Na, Cl) and TH-Ca. High positive correlation (S) exist between EC-K, K-(Na,HCO_3,SO_4),Na-SO_4 and HCO_3-(Cl,SO_4).

A moderate correlation (M) exists between EC-(Ca, HCO_3, TH,), Ca-(Cl, , HCO_3,Na,K), K-(Ca, TH, HCO_3),and SO_4-(TH, Mg). It can also be an indication of weathering of calcite mineral,.

Table4: correlation factor analysis of collected samples

	pH	*EC*	*TDS*	*Salinity*	*NO_3*	*Mg*	*Ca*	*TH*	*Cl*	*HCO_3*	*Na*	*K*	*SO_4*
pH	1.00												
EC	0.69	1.00											
TDS	0.69	1.00	1.00										
Salinity	0.69	1.00	1.00	1.00									
NO3	-0.44	0.12	0.12	0.12	1.00								
Mg	0.06	0.45	0.45	0.45	0.27	1.00							
Ca	0.30	0.66	0.66	0.66	0.07	0.65	1.00						
TH	0.21	0.62	0.62	0.62	0.18	0.89	0.92	1.00					
Cl	0.72	0.96	0.96	0.96	0.10	0.55	0.67	0.67	1.00				
HCO3	0.50	0.68	0.68	0.68	0.06	0.53	0.62	0.64	0.74	1.00			
Na	0.63	0.92	0.92	0.92	0.20	0.55	0.58	0.62	0.95	0.83	1.00		
K	0.84	0.88	0.88	0.88	-0.17	0.42	0.65	0.60	0.90	0.61	0.78	1.00	
SO4	0.75	0.86	0.86	0.86	-0.18	0.51	0.70	0.67	0.92	0.80	0.88	0.87	1.00

Dendrogram figure shows output of the Q-mode cluster analysis. Three clusters, first cluster contain EC, TDS, Salinity, Sodium, Chlorine Sulphate and potassium ,Second cluster explain the calcium, magnesium relation with bicarbonate the third one contained nitrate but it is not correlated with any of the remaining clusters.

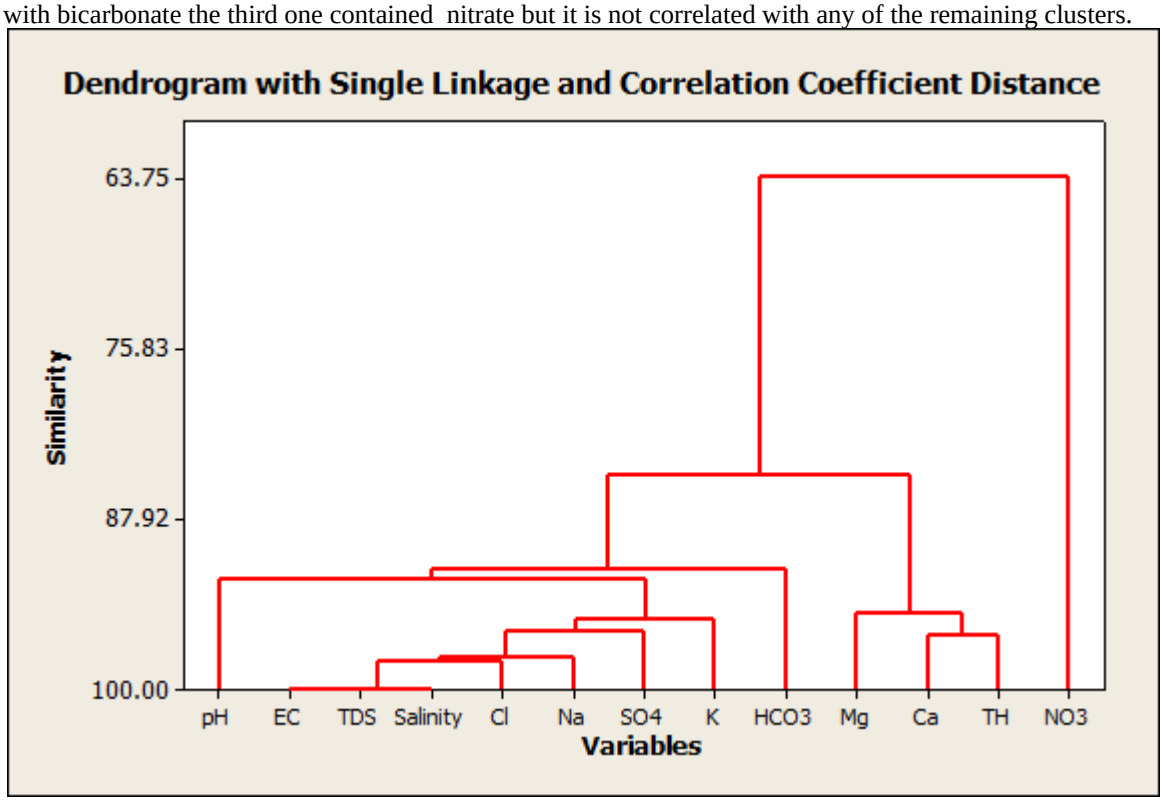

Fig. 5. Dendogram for 21 variables from cluster analysis in R-mode

Table 6: Principal Component Factor Analysis of the Correlation Matrix

Variable	Factor1	Factor2	Factor3	Factor4	Communality
NO3	-0.086	0.842	0.501	0.142	0.987
Mg	-0.730	0.486	-0.290	-0.112	0.865
Ca	-0.836	0.159	-0.369	0.135	0.878
TH	-0.866	0.340	-0.366	0.024	0.999
Cl	-0.935	-0.144	0.248	0.164	0.984

HCO3	-0.840	-0.054	0.165	-0.471	0.957
Na	-0.908	-0.063	0.388	-0.049	0.981
K	-0.851	-0.368	0.042	0.310	0.958
SO4	-0.925	-0.329	0.038	-0.044	0.967
Variance	5.9699	1.3577	0.8479	0.4006	8.5761
% Var	0.663	0.151	0.094	0.045	0.953

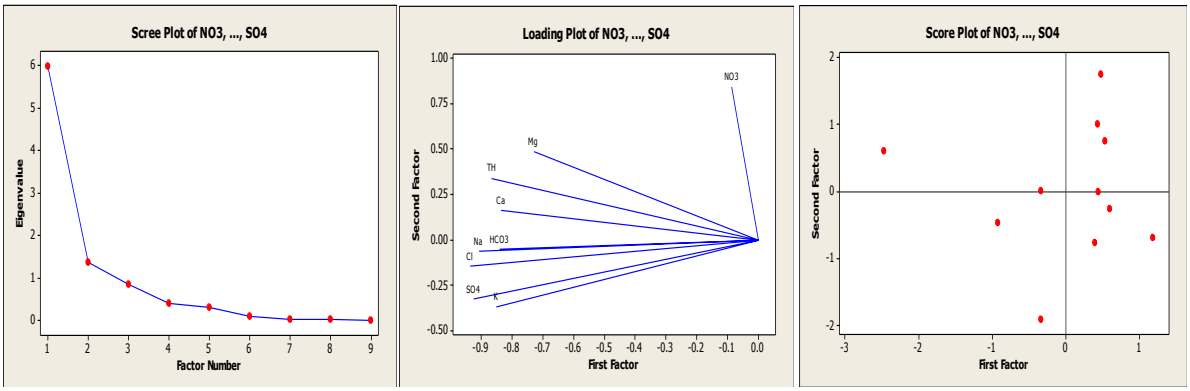

Figure 6: shows the factorial analysis of ground water samples

V. CONCLUSION

During last decades Pressure on groundwater was increased continuously with population and water demands. In the present study, 11 ground water samples were collected from around Etcherla in srikakulam District of Andhra pradesh. Groundwater major ions of the coastal aquifers indicate that the groundwater quality is safe in the central part, but it is not safe for consumption/irrigation purposes towards the coastal line. for groundwater samples indicates that most of the samples pH is alkaline and EC of most of groundwater samples lies in the range of drinking water with comparisons of data (WHO 2011) standards for drinking water indicate that the groundwater in the most of study area are suitable for drinking purposes except some few places.

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