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Quality Characterization of Groundwater in Parts of Govindaraopet Mandal, Warangal District, Telangana State, India

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Abstract: ***Govindaraopet Mandal is located in the northern parts of Warangal District,Telangana .28 water samples are collected at various locations covering different lithounits to understand the groundwater chemistry and their suitability for drinking and irrigation purposes. Study of groundwater chemistry in this area indicates that the waters are of Mixed Cationic and anionic Na dominating bicarbonate water, Mixed Cationic Mg dominating bicarbonate water, Mixed Cationic and anionic Ca dominating bicarbonate water, Mixed Cationic Ca dominating bicarbonate water, Mixed Cationic Na dominating bicarbonate water. Graphical treatment of chemical data reveals that, the area has basic water, whereas the chalvai & bollepally area are dominated by secondary alkaline water, and papayyapally and bussapur villages have strongly acidic water. Graphical representation further shows that most of the area has medium salinity–low sodium water useful for irrigation purposes. High salinity-low sodium and high salinity-medium sodium waters are present in some areas.***

Keywords: Groundwater, Chemical classification, Quality, Govindaraopet Mandal, Telangana.

1. Introduction

The study area is a contact zone of sandstones, and shales are forms a part of the sullavai basin area. Govindaraopet mandal the study area lies between latitudes 18°0'10" to 18°15'0" North and Longitudes 80°0'0" and 80°15'0" East with an areal extent of 98 sq. kms. Samples were collected from 28 wells used for domestic, agricultural and industrial purposes. Groundwater samples were collected from these wells during the month of December, 2013 and analyzed for all the major constituents. The samples were collected from the wells located in both phreatic and deeper fractured zones. (fig-1).

Evaluation of hvdrogeological parameters in hard rock terrains is quite difficult, unlike in soft rock areas. Since quality as important as quantity, the groundwater chemistry of the area was studied. The study includes determination of ionic concentrations, chemical classification (Sudersana Raju et al, 1990) and irrigation suitability. The chemical parameters analyzed were the major cations and anions. Major cations include Mg_2^+, Ca_2^+, K^+, Na^+, the major anions include SO_4^{2-}, NO_3^-, F^-, Cl^-, CO_3^-, HCO_3^- (Sakram. G *et al*, 2014).

A number of techniques and methods have been developed to interpret the data, Zaporozerc (1972) summarized the various methods of data representation and discussed about their possible use. In the present study, the method suggested by Hem (1975), the Piper trilinear diagram (Piper, 1953) and the Wilcox (1955) diagram are used for classifying the groundwater.

2. Geological Setup of the Area

The govindaraopet mandal is mostly covered by crystalline rocks or hard rocks. About 50 percent of study area comprises hard rocks i.e., kamthi formation. The central part comprises talchir formation, and a small pocket in northeast is covered by barren measures of lowergondwana series (fig-1, 3 & 4). Sanstone with numerous formation series. In the Govindaraopet study area, rocks of the Precambrian Sullavai Formation form the basement for the Lower Gondwana sequence. The stratigraphic succession is as fallows.

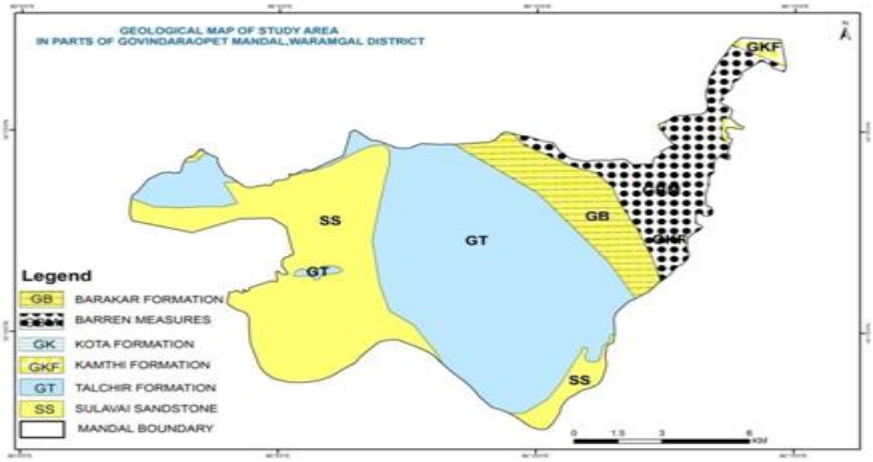


Figure 1: Map showing Geological map of the study area

Table 1: Stratigraphic Succession of the study area

Age	Group	Formation	Thickness(m)
Upper Permian	Lower Gondwana	Raniganj Formation (Upper Coal Measure)	More than 400
Middle Permian		Barren Measure (Middle Measure)	450-475
Lower Permian		Barakar Formation (Lower Coal Measure)	250-300
Permo-carboniferous		Talchir Formation	
----------Unconformity----------			
Precambrian		Sullavai Formation	

3. Literary Reviews

Kumar W and Saxena VK (1996), Study for the groundwater problem in Warangal district of Andhra Pradesh. Proc of Int. Sym. on Applied Geochemistry, 273-279.

Sakram. G *et al* (Jan-Feb, 2014) Qualitative assessment of groundwater in and around Macherla, Guntur District, Andhra Pradesh, India, International journal of advanced scientific and technical research, Issue 4, volume 1.

Chemical analysis of major ions for shallow bore wells

The groundwater quality analyses of total 28 groundwater samples collected from the study area **of 98sqkm (Figure 4.1)** were made for pH, EC, major ions concentrations during pre monsoon. All these samples were analyzed in the laboratory as per the standard procedures of American Public Health Association (Brown et al. 1974 and APHA 1985,1998). The detailed chemical analysis for major ions concentration for the above two seasons are presented in Tables 4.1&4.2 include WHO limits of the various elements, their minimum, maximum and average values as well as the standard deviations of the Samples. The objective of the water quality analysis is mainly to understand the influence of industrial effluent and Agricultural activities and surface water to the groundwater. Most of the groundwater samples located in Govindaraopet study area show medium concentration of TDS.

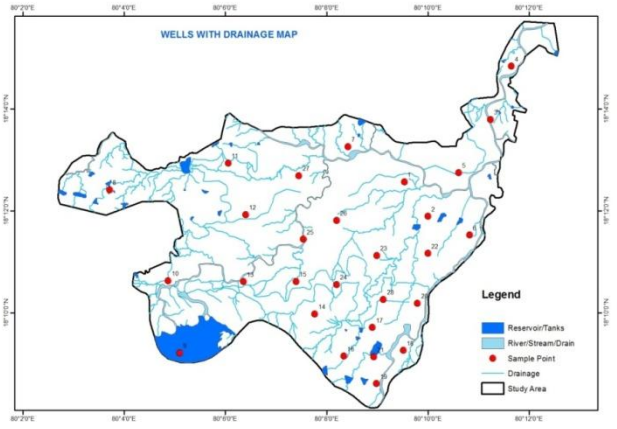


Figure 2: Map showing locations of the samples collected in Research area

Sample Collection and Analysis

Water samples were collected from 28 representative wells covering all the units in the study area. Laboratory analysis using standard methods of the American Public Health Association (APHA, 1998) include the determination of the ionic concentration of Na^+, K^+, Mg^{2+}, HCO_3^-, Cl^- and using the electrical neutrality method SO_4^{2-} is determined (Gopalakrishna et al, 2006) Data from field measurements and major ion analysis are presented in Table-4.1

Figure 3: Sandstone at the chalvai villege

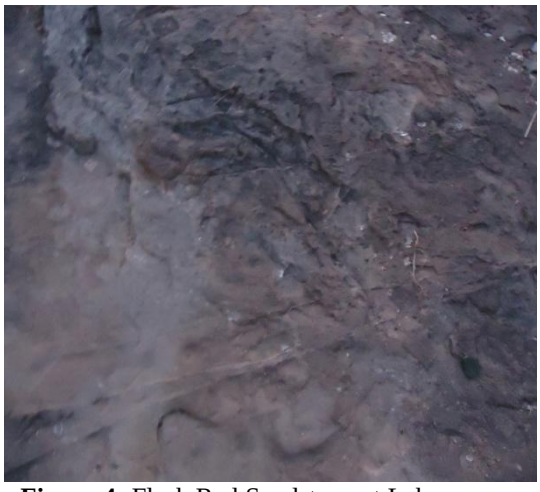


Figure 4: Flesh Red Sandstone at Laknavaram

4. Results and Discussions

Ionic Concentrations:

Sodium is the predominant cation, with a concentration range of 5.68-832.50 mg/l, and potassium occurs in minor concentration 3.69-120.60mg/l, Among alkaline earths, magnesium varies from 17.23-345.50 mg/l, and calcium from 3.58-107.70 mg/l. Bicarbonate is the predominant anion, with concentration varying between 61 and 1342 mg/l. Chloride is the principal anion among the strong acidic and varies from 12-1413mg/l. Nitrate is the predominant with concentration varying between 5.49 and 379.53mg/l. Fluoride is major concentration varying from 0.21 to 2.56 mg/l.

Table 2: Major ion chemistry of groundwater samples, pre monsoon (All the parameters are in mg/l except pH)

Well ID	PH	EC	TDS	F	Cl	Br	N	SO4	P	Na	K	Ca	Mg	Fe	St	HCO3
1	7.8	1250	800	0.83	205	0.65	19.35	49.64	0.23	86.54	32.18	5.04	55.29	1.89	0.51	427
2	7.5	1718	1100	1.36	234	0.21	72.47	127.90	ND	157.60	29.47	4.28	76.13	2.04	0.57	641
3	7.5	1250	800	0.68	146	ND	218.84	77.11	ND	39.30	34.14	41.56	63.44	1.80	0.38	336
4	7.5	2812	1800	0.98	601	1.28	202.32	134.45	ND	153.80	120.60	8.10	189.40	1.90	1.73	854
5	7.8	625	400	0.27	101	0.39	7.36	58.49	0.13	39.79	14.68	17.14	21.41	1.78	0.31	214
6	7.2	781	500	0.21	136	0.35	117.96	29.00	ND	33.53	12.58	15.92	37.49	1.71	0.23	122
7	7.6	1093	700	0.41	118	0.30	90.01	51.12	0.05	29.50	27.67	5.49	93.36	1.58	0.50	366
8	7.3	2187	1400	1.16	507	1.02	60.32	65.42	0.05	96.48	76.05	5.01	100.30	1.96	1.16	732
9	7.6	156	100	0.37	24	3.27	9.24	28.12	0.18	11.43	8.55	4.28	28.61	1.84	0.27	61
10	8	156	100	0.26	12	0.15	12.91	19.74	0.21	5.68	3.69	4.03	17.78	1.73	0.11	61
11	7.7	2343	1500	1.13	529	1.60	117.03	79.11	0.03	56.44	64.13	5.37	172.20	1.76	1.09	610
12	7.6	2031	1300	1.04	52	1.13	45.83	154.99	ND	152.70	41.08	4.88	55.30	1.77	0.92	549
13	8.1	781	500	0.65	137	0.32	5.49	70.51	ND	32.13	16.15	4.12	29.49	1.68	0.32	183
14	8.2	625	400	0.57	96	ND	11.99	75.01	ND	45.44	20.11	4.57	55.15	1.80	0.38	244
15	7.6	1250	800	0.59	229	ND	6.05	88.91	0.11	56.55	24.29	5.38	157.30	1.70	0.83	458
16	7.8	1562	1000	0.43	273	0.60	34.32	109.36	0.09	83.61	17.58	107.70	27.32	1.61	0.27	488
17	7.6	1093	700	0.89	88	0.35	10.75	26.06	0.07	29.91	30.81	8.30	51.59	1.64	0.40	732
18	7.1	4843	3100	0.40	1413	2.39	272.10	692.44	ND	832.50	101.30	8.10	345.50	1.59	1.31	671
19	7.7	1875	1200	0.47	288	0.76	43.45	57.48	0.06	138.60	41.69	5.33	39.35	1.52	0.84	854
20	7.4	2343	1500	0.66	450	1.13	75.52	95.25	0.11	134.50	44.46	4.55	57.81	1.45	0.87	854
21	7.6	3125	2000	0.63	679	1.27	379.53	159.83	0.06	94.51	56.24	4.53	163.10	1.34	0.58	671
22	7.8	3281	2100	2.56	922	1.25	41.52	118.15	0.08	373.00	33.50	4.04	16.24	1.37	0.37	763
23	8.2	1406	900	0.63	323	0.65	167.66	72.56	0.06	52.74	49.41	3.87	26.66	1.40	0.58	244
24	8	1718	1100	1.13	190	0.53	61.72	57.90	0.05	97.17	40.24	3.88	41.45	1.44	0.41	610
25	7.7	1250	800	0.85	180	0.44	26.37	49.23	0.12	59.09	18.45	4.88	30.83	1.34	0.28	580
26	7.5	4062	2600	1.78	840	1.38	184.86	174.43	0.32	405.20	34.47	5.10	17.23	1.24	0.42	1342
27	7.8	1093	700	0.57	111	0.38	56.42	43.99	0.06	76.41	14.44	3.58	27.29	1.23	0.37	488
28	7.8	2187	1400	0.59	603	1.13	70.29	185.61	0.04	82.08	51.37	10.32	65.22	1.30	0.70	366

DW = Dug well, **BW**=Bore well, **SW**=Surface water, Depth of the wells in m, EC in µS/cm, ions in mg/l and pH is evaluated at 25^0 C.

Table 3: Correlation Coefficient of chemical parameters for groundwater samples pre- monsoon

	PH	TDS	EC	Na	K	Ca	Mg	Cl	SO_4	HCO_3	NO_3	F	TH
PH	1												
TDS	-0.466	1.000											
EC	-0.466	1.000	1.000										
NA	-0.445	0.836	0.836	1.000									
K	-0.408	0.716	0.716	0.508	1.000								
CA	-0.011	-0.074	-0.074	-0.079	-0.147	1.000							
MG	-0.512	0.588	0.588	0.569	0.754	0.117	1.000						
CL	-0.416	0.935	0.935	0.856	0.690	0.076	0.633	1.000					
SO4	-0.436	0.746	0.746	0.897	0.579	0.004	0.756	0.793	1.000				
HCO3	-0.391	0.766	0.766	0.508	0.498	-0.097	0.227	0.579	0.282	1.000			
NO3	-0.400	0.643	0.643	0.431	0.598	-0.008	0.582	0.606	0.526	0.322	1.000		
F	-0.022	0.502	0.502	0.332	0.196	-0.203	-0.102	0.405	0.018	0.618	0.026	1.000	
TH	-0.517	0.579	0.579	0.559	0.733	0.053	0.985	0.624	0.761	0.212	0.584	-0.137	1.000

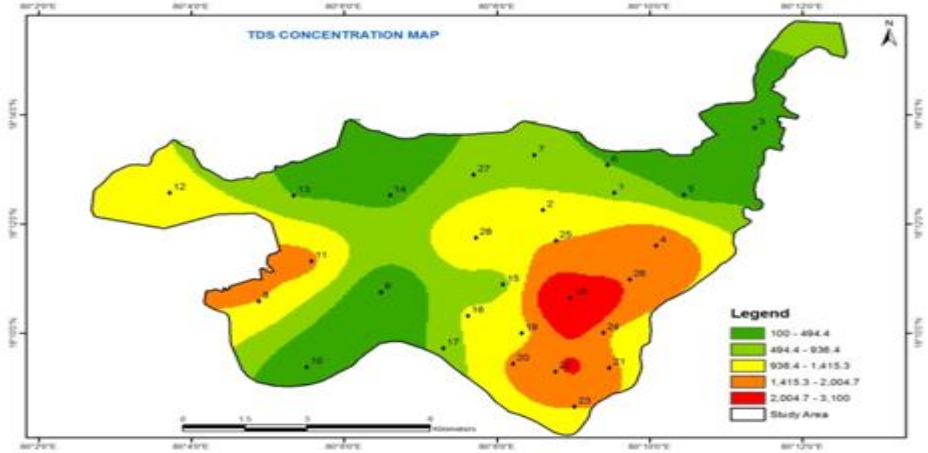


Figure 5: Variation of TDS concentrations during pre monsoon

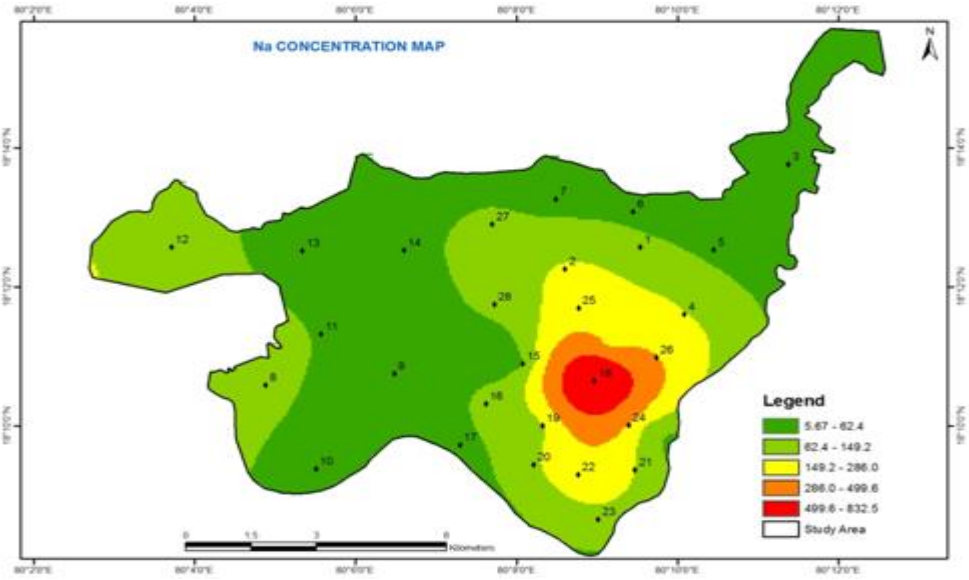


Figure 6: Variation of sodium concentration during pre monsoon

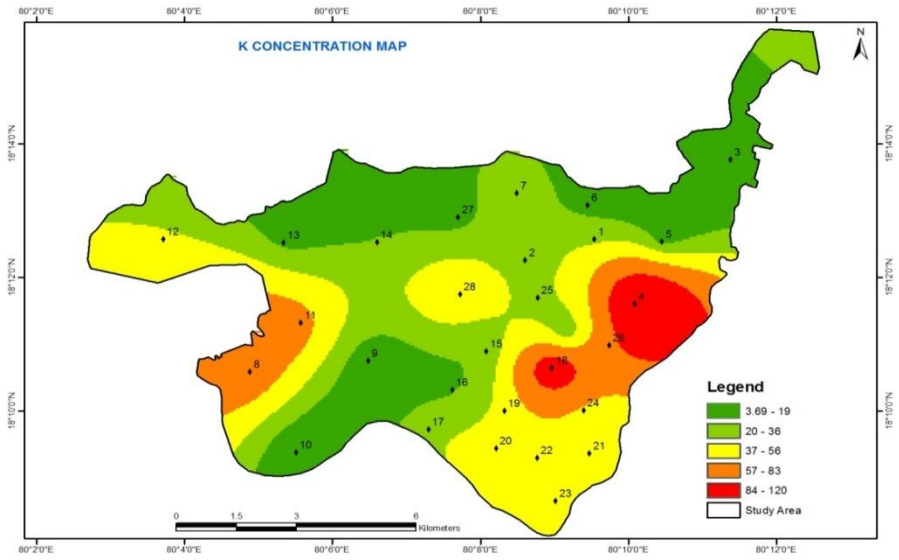


Figure 7: Variation of potassium concentration during pre monsoon

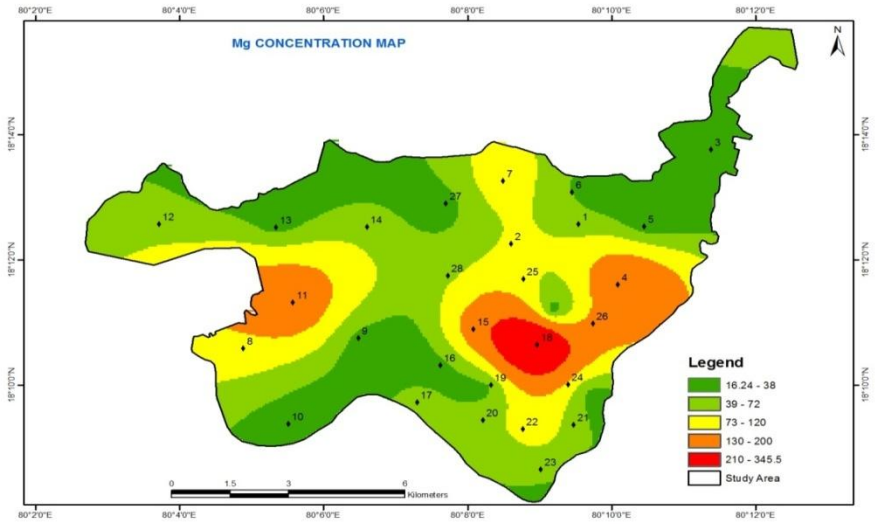


Figure 8: Variation of magnesium concentration during pre monsoon

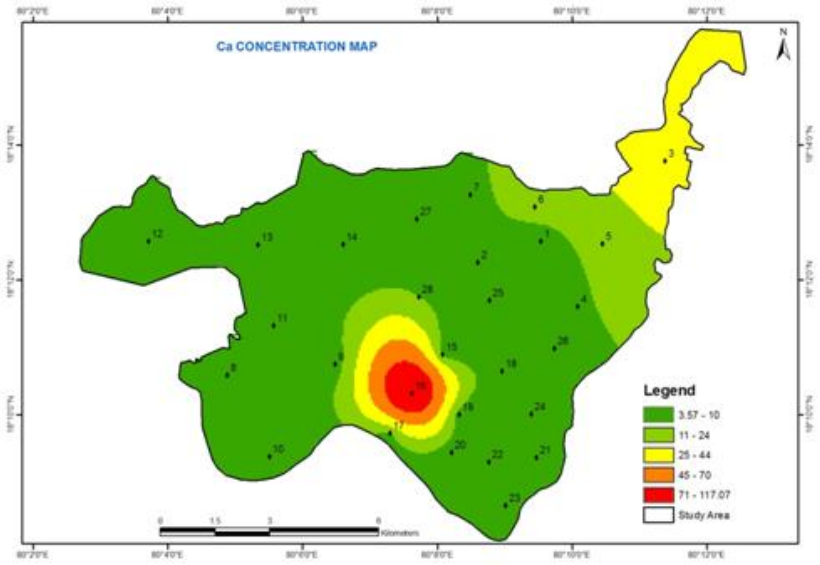


Figure 9: Variation of calcium concentration during pre monsoon

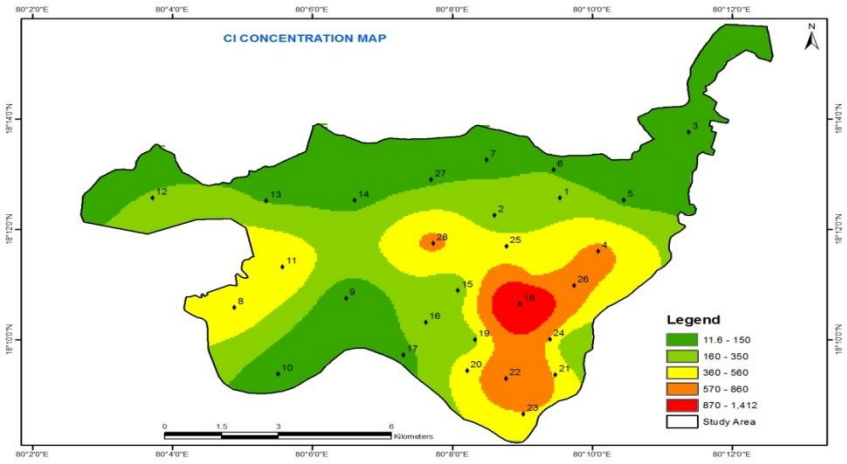


Figure 10: Variation of chloride concentration during pre monsoon

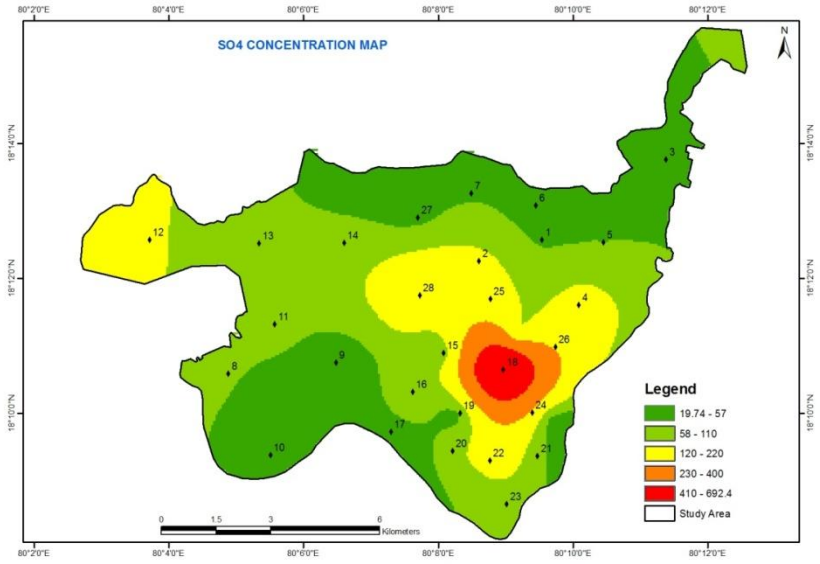


Figure 11: Variation of Sulfate concentration during pre monsoon

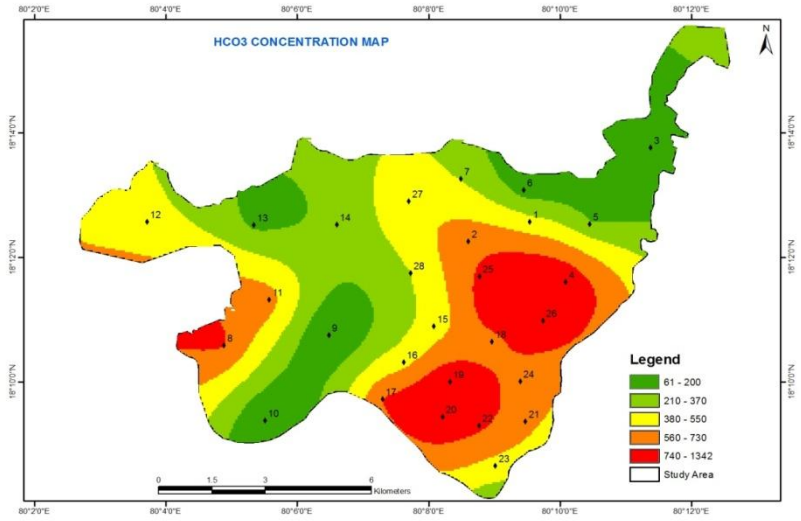


Figure 12: Variation of bicarbonate concentration during pre monsoon

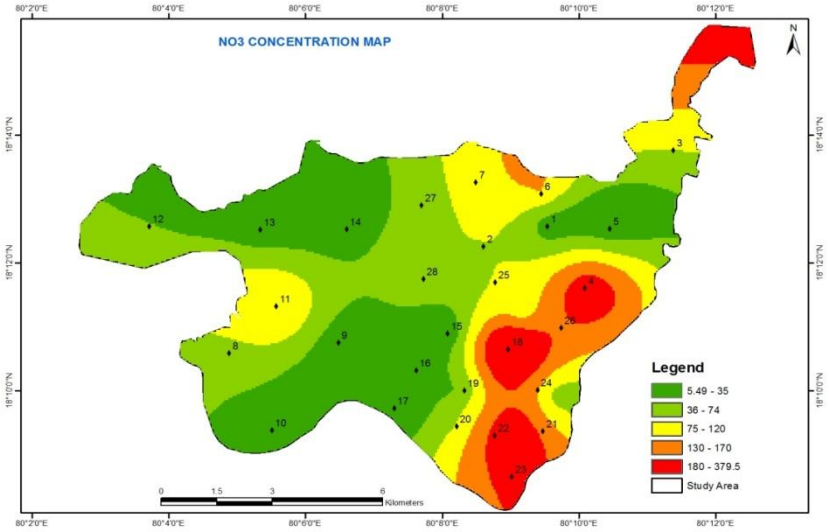


Figure 13: Variation of Nitrate concentration during pre monsoon

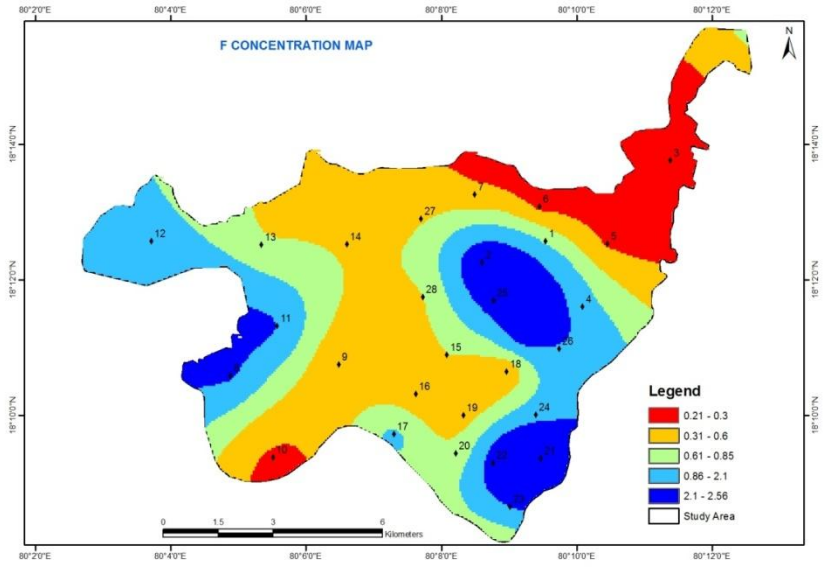


Figure 14: Variation of Fluoride concentrations during pre monsoon

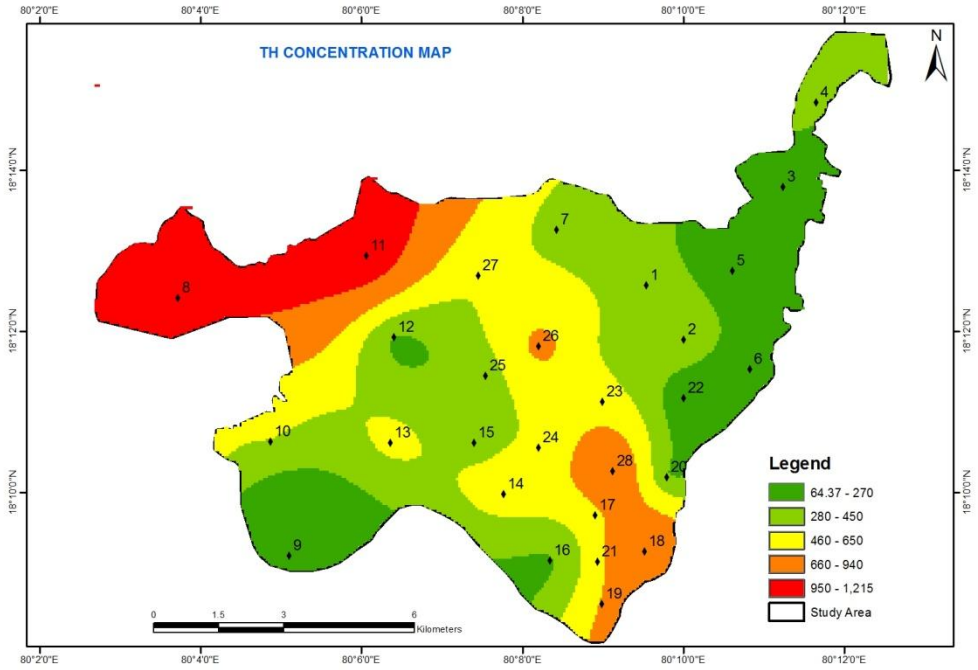


Figure 15: Variation of total hardness concentration during pre monsoon

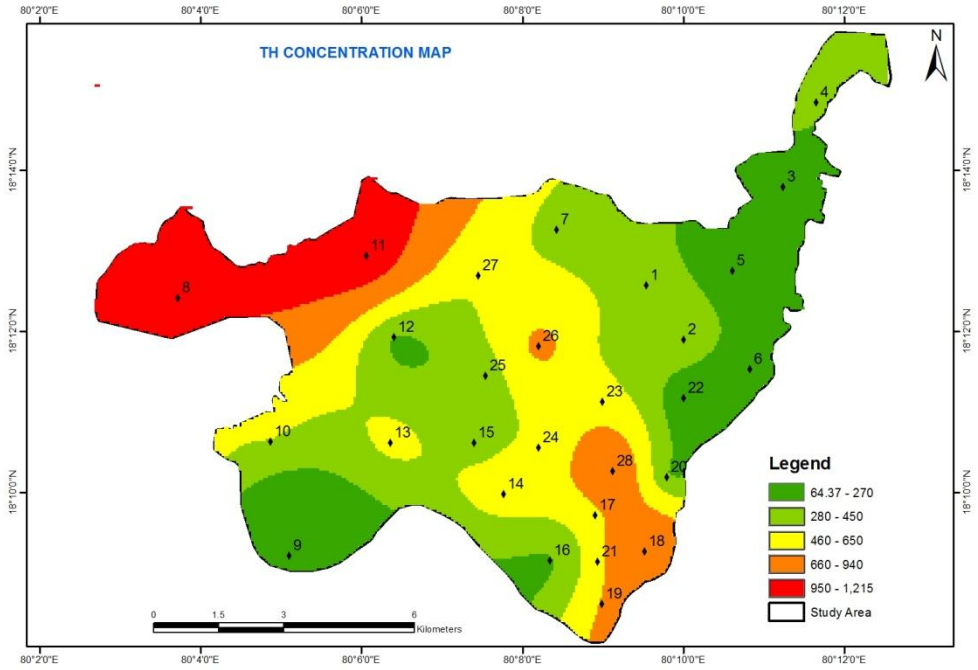
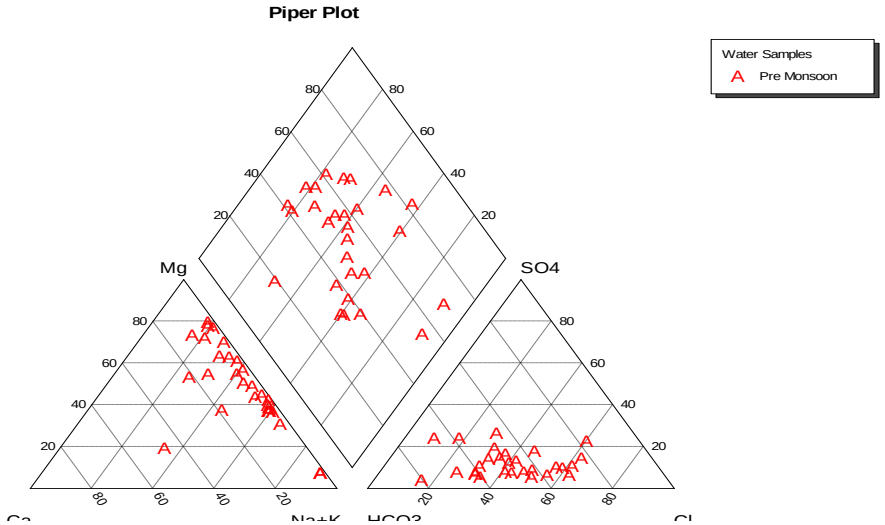


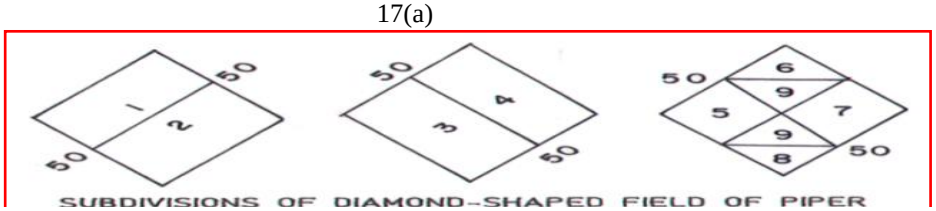
Figure 16: Variation of total hardness concentration during pre monsoon

Chemical Relationships

The trilinear diagrams of Piper are very useful in bringing out chemical relationship among groundwaters in more definite terms than other possible plotting methods (Walton, 1970). Chemical data of the area are subjected to graphical treatment by plotting them in a Piper trilinear diagram (1953). Distribution of the groundwater samples in deferent subdivisions of the diamond-shaped field of the Piper diagram shown in Fig-5a and Fig-5b. Piper plot of water samples showed clusters of samples tend close to sodium, potassium & magnesium, bicarbonate and chloride in diamond facies showing water rich in chloride and bicarbonate.



17(a)



17(b)

Figure-17(a), 17(b): Chemical data of water plotted in Piper trilinear diagram

Irrigation Suitability:

Groundwater quality for irrigation is generally expressed by class of relative suitability, taking sodium content and electrical conductivity into consideration. Electrical conductivity and sodium adsorption ratio should be considered in determining the suitability of water quality for irrigation.

The distribution of the data from the govindaraopet mandal area in the Wilcox (1955) diagram classification (fig-17 (a,b) shows that most of the area has medium salinity–low sodium water is useful for irrigation purposes. papayyapally and bussapur villages have high salinity–low sodium water. Chalvai has high salinity–medium sodium water (Kumar and Saxena VK, 1996) indicating a need for adequate drainage to overcome salinity problem for irrigational purposes.

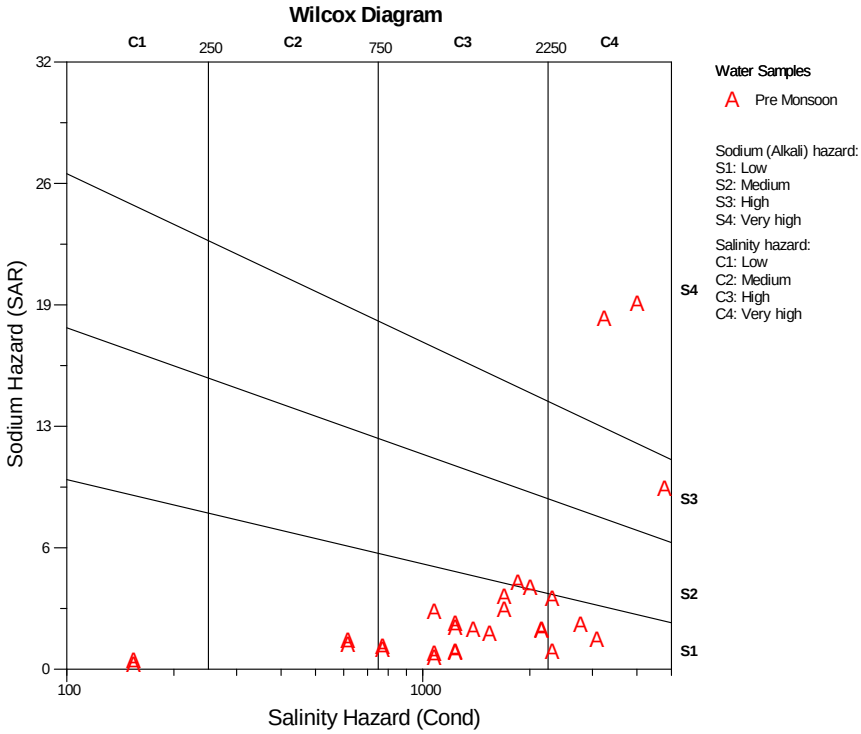


Figure 18: Chemical data of water plotted in Wilcox diagram

5. Conclusions

The govindaraopet mandal area is a hard rock terrain consisting sandstone and shales and their contact zones. The study of the chemical characteristics of the water shows that the area is dominate in Mixed Cationic Ca dominating bicarbonate water, Mixed Cationic and anionic Ca dominating bicarbonate type of water.

The piper trilinear diagram reveals that, the area has basic water and two villages have strongly acidic water. The entire area is devoid of primary alkalinity and secondary salinity water but primary salinity water occurs in Bharampur village. And fluoride is high i.e. concentration of 2.56 mg/l at the amruthanda village, and 2 samples have above permissible limits. High concentration of Nitrate -379 mg/l at lakshmipuram village and 16 samples have above permissible limits, this is because farmers are using more fertilizers in agricultural activities. Water sample collected at papayyapally village shows high concentration of TDS - 3100 mg/l, and 24 samples have above permissible limits. A long intake of this water may lead to chronic diseases, proper attention is required to purify the water particularly for drinking purposes. While most of the water available in this area is suitable for irrigation, some pockets have high salinity–medium sodium and high salinity-low sodium water which needs better drainage to overcome the salinity problem.

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