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HYDROGEOLOGICAL STUDIES OF MARUDAIYARU -ARIYALUR WATERSHED, ARIYALUR DISTRICT, TAMILNADU.

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Abstract

The study area Marudaiyar – Ariyalur mini watershed of Ariyalur district which represents a part of coastal sedimentary plains and river basin is mainly composed of Cretaceous, Tertiary and Quaternary formation which includes calcareous sandstones, shell limestones and alluvium. The hydrogeochemical studies reveals that the pH values of all the samples of the study area are between 7-8 and within the range of utilization, EC and TDS also reveals that two third of the samples fall in Fresh water category both in pre and post monsoon seasons. However, one third falls in brackish water category. Based on the USSL classification, most of the samples of the study area during premonsoon and post monsoon seasons fall in C3S1 category and three samples falls in C2S1 category indicating high salinity and low sodium water type, which can be used for irrigation on almost all types of soil. Piper Trilinear diagram reveals that in the cation plot, most of the water samples falls in Calcium-Sodium facies type and only few samples fall in Calcium-Magnesium facies type, whereas in the anion plot it falls only in Chloride-Sulphate-Bicarbonate facies type. Regarding the condition of the drinking water nearly two third of the samples are within the limits. One third of the samples, which falls in the North Eastern and Eastern side of the study area, were having values above the limits.

Keywords: Cretaceous, Shell limestone, Tertiary formations, dendritic, calcareous, fossiliferous, aquifers.

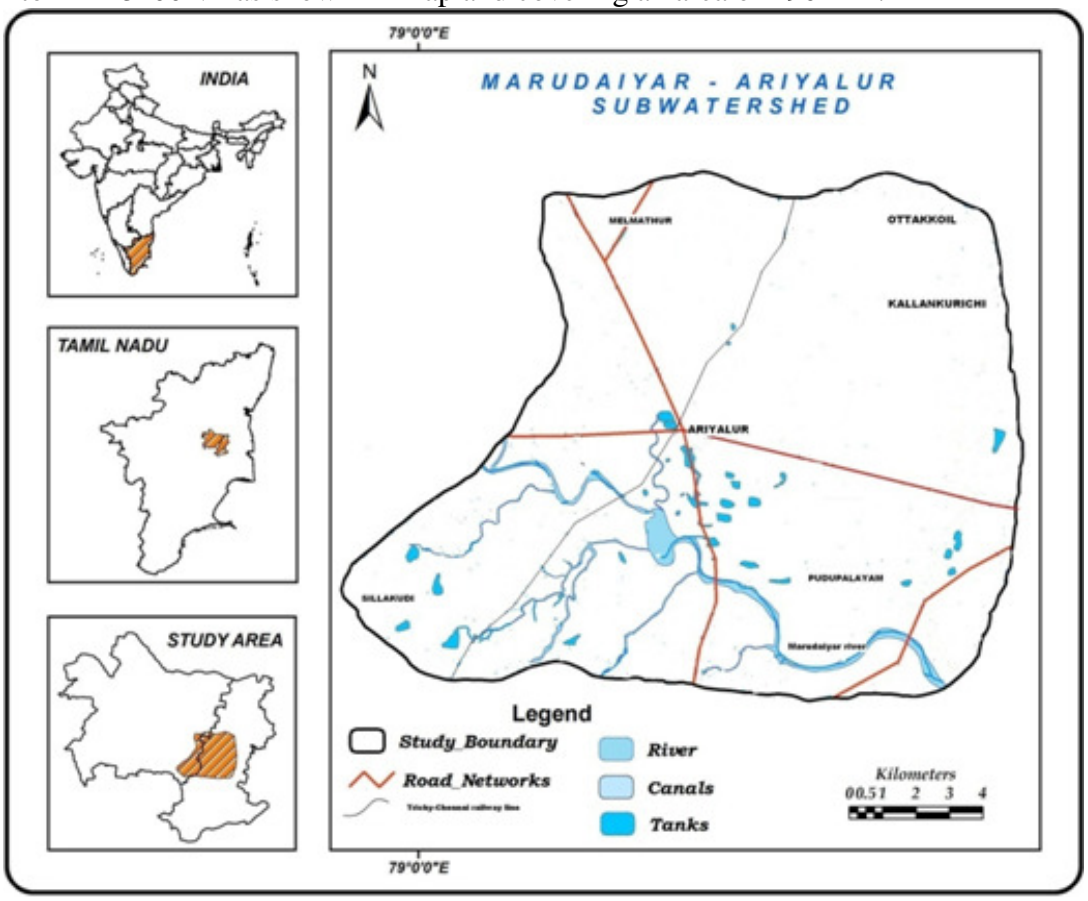
I. INTRODUCTION

Ground water is an important source of water supply throughout the world; its use in irrigation, industries, municipalities, and rural homes continues to increase. Excessive depletion of ground water without giving due attention to the geohydrology and geologic setup of the area may lead to be activation of many unwanted chemical process and which are harmful to human health and other uses. With these views Marudaiyar – Ariyalur mini watershed area of Ariyalur district was chosen for the study to know the ground water potential and quality of the groundwater. The area is mainly composed of Cretaceous, Tertiary and Quaternary formation which includes calcareous sandstones, shell limestones and alluvium The present aim is to understand the hydrogeology, hydrogeochemisty of groundwater in parts of Ariyalur taluk which forms the part of Marudaiyar (river) sub basinTo understand the features and phenomena which influence the groundwater potential and quality.

II. STUDY AREA

The study area forms a part of Ariyalur District of Tamilnadu, India. The geographical extent of Ariyalur taluk is 681.19 km. It is rich in limestone resources. The district lies between 10°54' and 11°30' of North latitude and 78°40' and 10°30' of East longitude. The study area falls in survey of India

Toposheet 58 M/3, M/6. within East longitudes 78°58 30"E to to 79° 09' 45 E" and North Latitudes 11° 03' 45" to 11° 13' 00N " as shown in Map and covering an area of 290 km².



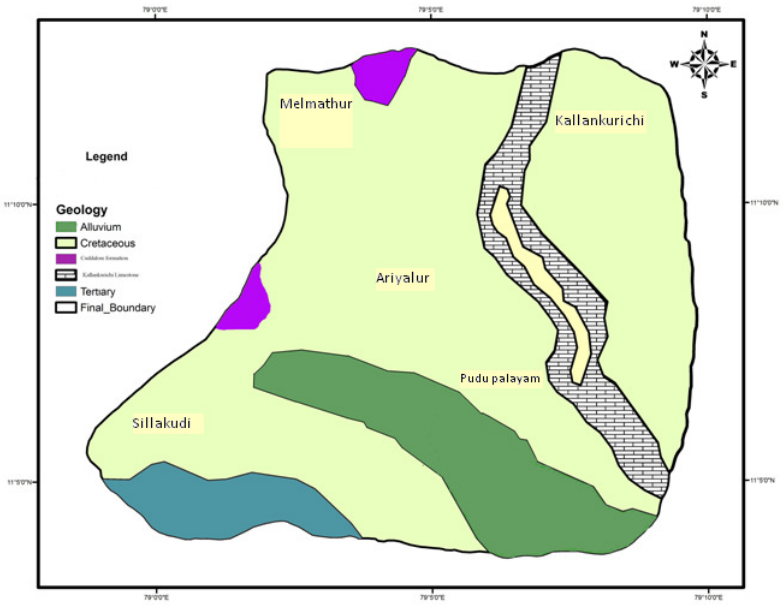
Map showing study area location

The study area represents a part of coastal sedimentary plains and river basin. Except for minor undulations in the middle, the major part of the area is plain with gentle southerly slope, the highest elevation being 80 m RL in the north & lowest of 50 m RL towards middle, where the river Marudaiyar flows with marked meandering. The average elevation is around 40-60 m. Geomorphologically the area is divided into alluvial plains, buried pediments, low land Cretaceous and lineaments.The drainage pattern of the study area is mostly controlled by the structural features. Radial and dentritic to sub dentritic patterns are recognized in this district among the different drainage patterns and associated features.

III. GEOLOGY

The study area forms a part of Ariyalur formation which includes Ariyalur, Sillakudi, Ottakoil, Kallankurichi and Kallamedu villages. The Ariyalur district is geologically made up of Cretaceous, Tertiary and Quarternary formations which includes calcareous sandstone, shell limestone and alluvium. The sequence of Cretaceous beds commence with Trichinopoly group and closes with Niniyur stage. These beds consist of shale, clay, limestone, argillaceous limestone and shell limestone.

Ariyalur group of rocks in Trichinopoly area overlies the Uttathur group with an unconformity marked by ferruginous bands add evidences of erosion, by Sillakudi formation (Campanian to Maestrichitian) followed by Kallankurichi formation (Maestrichtian) with an unconformity marked by conglomerate and this is overlain by Kallamedu sandstone (Maestrichtian) directly without any unconformity.



Stratigraphic setup of the study area is as follows (after Sastry *et al*. 1968; Chandrasekaran and Ramkumar, 1995).

Group	Age	Formation	Gross lithology	Thickness
		Kallamedu Formation	Sandstone	100 m
	Maestrichtian	Ottakoil Formation	Sandstone	60 m
Ariyalur		Kallankurichchi Formation	Limestone	40 m
Group		----------Unconformity----------		
	Campanian	Sillakkudi Formation	Sandstone	400 m
		----------Unconformity----------		
		Trichinopoly Group		

Sillakudi formation

The Sillakkudi Formation at the base of the Ariyalur Group overlies the Trichinopoly Group unconformably. This formation comprises of unfossiliferous calcareous sandstone, fossilifereous calcareous gritty sandstone, interbedded with claystone and arenaceous limestone with sandy clay (Madhavarju, 1996). Major part of this Sillakkudi Formation consists of sandstone.

The lower Sillakkudi member rests over the Garudamangalam formation with an unconformity and occupies very large areal extent. This member comprise, lower calcareous fine to medium grained sandstones and an upper soft, friable sandstone which is unfossiliferous, whereas the calcareous sandstone is fine to medium grained is fossiliferous. This member is well exposed in a stream section near Sillakudi village and exposures present in Kilapaluvur and Melmathur. The thickness of the member is 210 m. (Armstrong Altrin 2010,2011)

Kallankurichi formation

The Kallankurichchi Formation unconformably overlies this Sillakkudi Formation. Guha and Senthilnathan, 1990 has stated that the Kallankurichchi Formation is a prominent carbonate horizon of the Ariyalur Group and is exposed as isolated outcrops. The Kallankurichi formation comprises fossiliferous calcareous conglomeratic sandstone, fossiliferous calcareous sandstone interbeded with claystone, sandy fossiliferous limestone, fossiliferous limestone and marl. Based on these characteristics

and according to the classification of Fritz and Moore (1988), these are classified as quartz sandy to gravely conglomerates, typical of coastal regions.

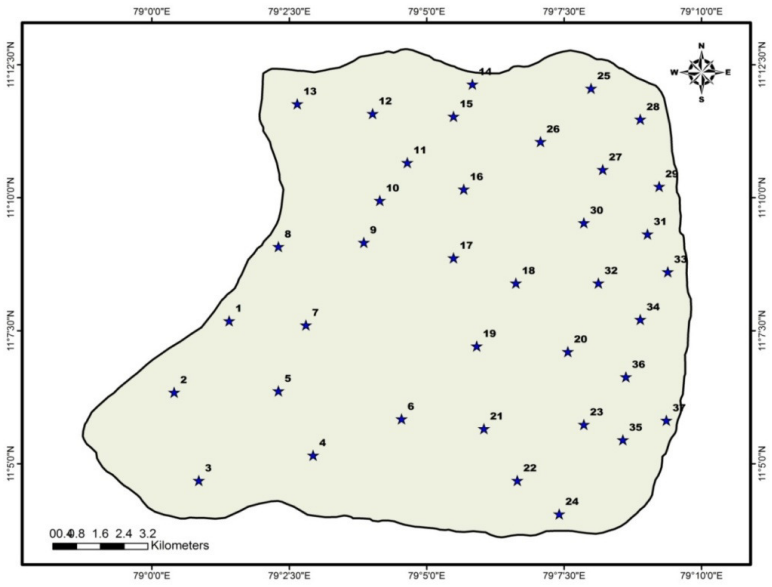
Ottakoil and Kallamedu formation

Kallankurichi limestone member is conformably overlain by a sequence of fossiliferous calcareous sandstone interbeded with claystone were observed in Ottakoil area. The Kallamedu member comprises fine to coarse, whitish to light green, micaceous, argillaceous, soft sandstone with thin bands of hard calcareous sandstone. The sandstone is unfossiliferous and fine grained. It is well exposed in the stream section near Ottakovil and Kallamedu.

IV. HYDROGEOLOGY

The water level fluctuations reflect the change in ground water storage. For this purpose, the water level data (source: TWAD) observed from the various wells in the study area during pre-monsoon shows that the water level is 5.95 bgl. In the post-monsoon, the water level is 4.44bgl. The fluctuation of seasonal groundwater level is 1.51 bgl. This region is having good rainfall; mean annual rainfall for the years taken shows for the area is 829 mm. which shows an average amount of rainfall during Northeast monsoon followed by Southwest monsoon and the minimum rainfall was noted in winter. To understand the geochemical quality of groundwater the water samples were collected at 45m to 50 m depth bore holes drilled by Tamilnadu Water and Drainage Board (TWAD) from 37 locations during pre monsoon (Jan) and Post monsoon (May).

In India, the geochemical studies on ground water has been undertaken from 1970 onwards all over the country (Handa,1986; Krupanidhi, 1986; Balasubramanian, 1986; Ramanathan *et al*., 1996, Ramkumar *et al*.,2010, Chidambaram *et al*., 2010, Vasudevan *et al*., 2010, Srinivasamoorthy *et al*., 2003, 2005). Hydrogeochemical quality of groundwater in coastal towns was studied by Venkatramanan *et al*., (2009). The uses of groundwater were categorized based upon the chemistry of water. Studies on groundwater for agriculture were discussed by Doneen (1948), Eaton (1950) and USSL (1954). Similar studies were carried out by Sondhi and Ramprakash (2000) and Puranik and Abbi (2000). The impacts of mining and other anthropogenic activities have also done by different authors Krishnappa and Shinde (1980) and Anandhan (2005). Water quality effects due to industrial effluents were studied by Rajaram and Ashutosh Das (2008). The impact of filling an abandoned open cast mine on groundwater quality was studied by Prasad and Mondal(2008).



The pH values of all the samples are between 7-8 and within the range of utilization. The seasonal fluctuations in the EC values are like that the more variations were observed during the post monsoon season. Based on the USSL classification (1954), most of the samples during premonsoon and post monsoon seasons fall in C3S1 category and three samples falls in C2S1 category indicating high salinity and low sodium water type, which can be used for irrigation on almost all types of soil(Richards, 1954; Todd, 1980; Balasubramanian, 1986; Sastri and Lawrence, 1988). The evolution of water and the relationship between rock types and the water composition can be analyzed by trilinear diagram(Piper, 1954). For the aquifer in all seasons, the plot reveals that water samples fall in the cation plot, most of the water samples falls in Calcium-Sodium facies type and only few samples fall in Calcium-Magnesium facies type, whereas in the anion plot it falls only in Chloride-Sulphate-Bicarbonate facies type. This indicates that there is no systematic variation even though there is some variation in the actual concentration of major ions between the aquifers (Karanth, 1987; Chidambaram *et.al*., 2010; Pandian and Sankar, 2007; Reddy and Kumar, 2010; Anitha Mary *et.al*., 2012; Venkatraman *et.al*., 2014).. Further, it indicates that the considerable part of water in the deeper aquifer is derived from the shallow aquifers.

Premonsoon

l.no	pH	EC	TDS	TH	SAR	Ca	Mg	Na	K	Cl	HCo3	So4	No3
1	7.9	1347	862	627	2	215	22	91	3	63	415	34	19
2	7.6	1388	888	664	1	230	22	85	2	33	483	19	14
3	7.6	1369	876	678	1	232	24	80	2	36	462	22	18
4	7.4	1077	689	610	0	205	24	13	2	54	336	34	21
5	7.6	1028	658	606	0	210	20	12	2	64	310	24	16
6	7.8	1166	746	645	0	219	24	15	2	61	370	33	22
7	7.7	1106	708	633	0	216	23	14	3	72	333	28	19
8	7.6	1058	677	608	0	204	24	12	3	56	323	34	22
9	7.7	1263	808	620	1	209	24	68	3	88	362	28	26
10	7.7	1357	868	696	1	236	26	68	3	72	417	22	24
11	7.9	1350	864	695	1	239	24	76	1	38	454	14	18
12	7.8	1460	934	711	1	242	26	68	3	86	445	36	28
13	8.0	1353	866	636	2	217	23	92	3	62	418	33	18
14	7.8	1829	1171	1105	0	371	44	20	2	29	641	47	18
15	7.7	1227	785	593	1	198	24	68	1	96	363	16	19
16	7.5	1324	847	721	1	246	26	54	1	46	430	21	23
17	7.8	1366	874	667	1	231	22	86	2	32	468	19	14
18	7.8	1362	871	683	1	231	26	80	1	32	473	16	12
19	7.9	1354	867	634	2	218	22	93	3	63	416	34	18
20	7.8	1349	864	635	2	215	24	94	3	65	413	31	19
21	7.7	1057	677	604	0	204	23	11	3	54	325	35	22
22	7.7	1082	693	609	0	208	22	12	2	54	340	34	21
23	7.2	466	298	69	5	8	12	89	5	30	127	14	13
24	7.4	455	292	56	5	6	10	84	6	34	115	21	16
25	7.8	2110	1351	1327	0	473	36	16	1	24	738	50	13
26	7.6	2258	1445	1430	0	488	52	5	1	24	803	50	22
27	7.5	2009	1286	1247	0	421	48	6	1	25	713	51	22
28	7.7	1998	1278	1191	0	422	34	28	1	24	688	47	36
29	7.4	1206	772	601	1	208	20	64	1	84	329	42	24
30	7.4	1969	1260	1182	0	392	50	18	1	29	661	80	30
31	7.8	1818	1164	1055	0	393	18	33	2	23	623	47	25
32	7.6	1869	1196	1119	0	416	20	18	4	28	631	52	28
33	7.8	1890	1210	1110	0	419	16	32	2	23	648	47	24
34	7.9	2181	1396	1311	0	447	48	30	4	27	762	48	30
35	7.3	458	293	536	0	5	9	93	5	33	112	22	14
36	7.9	2342	1499	1432	0	495	48	31	4	27	818	47	29
37	7.6	2099	1344	1275	0	432	48	16	1	29	705	82	30

Post monsoon

l.no	pH	EC	TDS	TH	SAR	Ca	Mg	Na	K	Cl	HCO_3	SO_4	NO_3
1	7.8	1457	932	692	2	238	24	96	4	60	445	43	22
2	7.7	1398	895	692	1	236	25	87	3	39	460	25	20
3	7.7	1395	893	701	1	238	26	82	3	42	452	28	22
4	7.4	1007	644	588	0	201	21	19	3	65	285	31	19
5	7.6	1086	695	627	0	215	22	18	4	78	318	26	14
6	7.8	1138	729	636	0	212	26	20	3	68	351	30	19
7	7.8	1251	801	700	0	228	32	22	5	94	372	32	16
8	7.7	1004	643	581	0	200	20	18	4	67	285	30	19
9	7.5	1183	757	591	1	204	20	64	2	64	359	20	24
10	7.6	1294	828	664	1	230	22	64	2	78	386	26	20
11	7.8	1312	840	681	1	230	26	68	2	44	438	16	16
12	7.9	1320	845	675	1	236	21	54	1	80	404	30	19
13	8	1469	940	702	2	240	25	98	4	61	448	42	22
14	7.9	1908	1221	1163	0	387	48	27	1	30	655	52	22
15	7.8	1310	838	621	1	206	26	74	2	98	387	22	24
16	7.6	1352	865	699	1	234	28	62	2	67	418	26	28
17	7.8	1413	904	692	1	238	24	88	3	40	466	26	19
18	7.9	1482	948	759	1	258	28	86	2	43	496	22	13
19	7.9	1482	948	703	2	239	26	98	4	60	457	42	22
20	7.9	1467	939	695	2	234	27	98	4	61	454	40	21
21	7.7	1053	674	584	0	201	20	17	4	66	315	31	20
22	7.8	1008	645	585	0	203	19	17	3	64	290	30	19
23	7.2	458	293	75	5	7	14	90	5	40	107	18	12
24	7.4	478	306	67	5	7	12	92	4	37	109	25	20
25	7.9	2260	1446	1426	0	506	40	22	3	25	781	56	15
26	7.7	2301	1472	1417	0	476	56	13	2	26	819	55	26
27	7.6	1981	1268	1233	0	405	54	14	2	27	684	54	28
28	7.8	2077	1329	1238	0	434	38	33	1	24	707	50	43
29	7.5	1231	788	599	1	204	22	68	2	88	332	46	26
30	7.5	2062	1320	1238	0	401	58	24	2	30	690	84	32
31	7.9	1890	1209	1090	0	401	22	35	3	24	653	50	23
32	7.7	1936	1239	1154	0	423	24	24	3	30	656	58	22
33	7.8	1968	1259	1149	0	428	20	35	2	24	679	50	22
34	7.8	2228	1426	1306	0	451	44	40	5	28	766	52	40
35	7.4	466	298	547	0	6	11	85	4	36	110	26	20
36	7.9	2354	1507	1439	0	501	46	32	5	21	812	51	39
37	7.7	2199	1407	1331	0	441	56	25	2	30	736	86	32

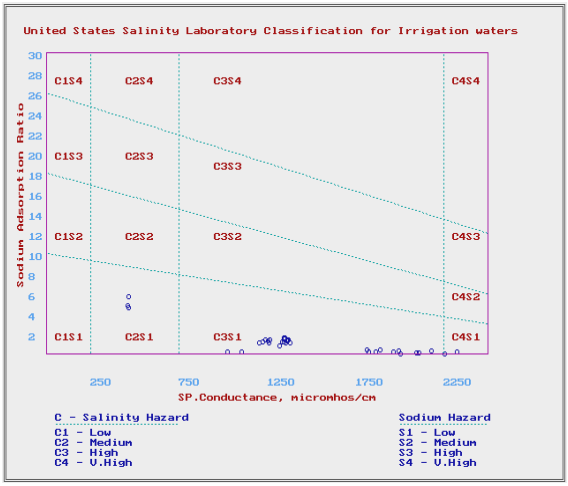


Fig. showing salinity / sodium hazard during pre monsoon

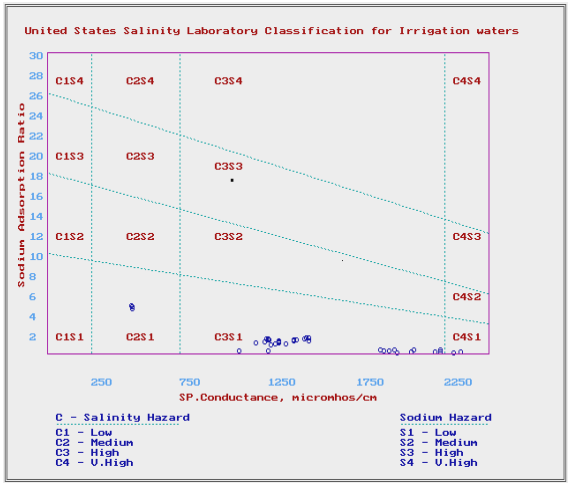
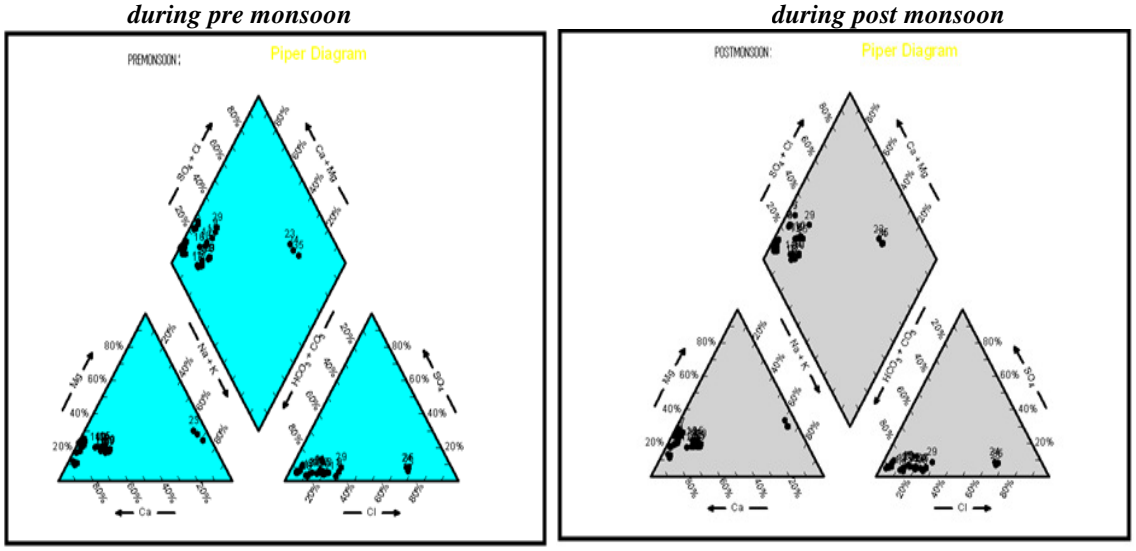


Fig. showing salinity / sodium hazard during post monsoon



Piper plot exhibiting chemical facies of groundwater samples

V. CONCLUSION

The groundwater of the study area in general is colorless and odorless. Analytical data shows that most of the groundwater of the region is suitable for irrigation and domestic purpose with few abnormal concentrations exceeding the maximum permissible limit. Regarding the condition of the drinking water nearly two third of the samples are within the limits. The water from the south and south eastern area which belongs to alluvium formation are suitable for drinking purpose. The hydrogeochemical studies of EC and TDS also reveals that two third of the samples fall in Fresh water category both in pre and post monsoon seasons. One third of the samples, which falls in the North Eastern and Eastern side of the study area, were having values above the limits. Twelve numbers of samples falls in brackish water category. This is due to the successive action of weathering and dissolution process based on the lithology of the area which includes limestone and shale.

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