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Hydrogeochemical Characteristics of Groundwater in Kumbakonam Taluk, Thanjavur District, Tamil Nadu

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Abstract:-Kumbakonam is a well developed maritime district of Tamil Nadu. Groundwater has been the mainstay for domestic needs of more than 80% of population in the district. Dug wells with a density of around 150 per sq km are the major groundwater based structures along the surface level. Groundwater has been the principle source of water supply for the Kumbakonam town and along the urban area. The groundwater withdrawals need be regulated to avoid any possible seawater ingress. Characterization by factor analysis of hydrochemistry of Kumbakonam Taluk has been attempted in this paper. Factor analysis assumes that observed variables are products of linear combinations of some few underlying source variable known as factors. Factor analysis has not been a major tool in the study of groundwater geochemistry as has been demonstrated in several studies (Lawrence and Upchurce, 1983; Olobaniyi and Owoyemi, 2006; Aris et al. 2007; Gallardo and Marui, 2007; Ramesh Kumar and Riyazuddin, 2008). The present study was set to determine has factors that significantly control the chemistry of groundwater in the phreatic aquifers of Kumbakonam taluk.

Key words:-Hydro Geochemistry, Formula, SAR, RSC, Piper Diagram, Kumbakonam Taluk.

I. STUDY AREA

The Thanjavur District, Kumbakonam Taluk situated in the south eastern part of Tamil Nadu State. It's one of the economical backward Taluks out of the Eight Taluks in the Thanjavur District. The Taluk extents roughly between the segment of Cauvery and Arasalaru the non perennial rivers. Kumbakonam Taluk is Comprised of latitudinally from 10^{o} 55'00" to 11^{0}0'0" N and longitudinally from 79^{0}20'00" to 79^{0}30'00" E. The total geographical area of the taluk is 734.2 Sq.km

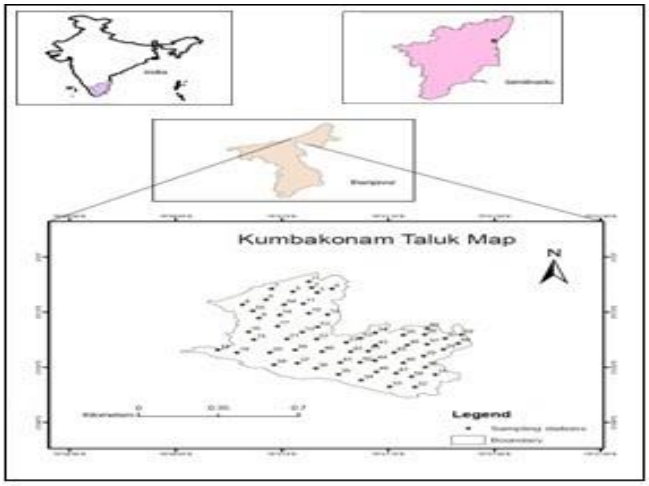

Figure.1 Location Map.

II. DRAINAGE

Kumbakonam Taluk are found to the sub-dedritic pattern. A drainage pattern in which the stream is oriented in a similar direction, but which lacks the regularity of the parallel pattern may be designated as sub-parallel. The streams may be sub-parallel due to slope control or due to alignment of some topographic features, as are usual in glacial region. (Fig.2)

III. GEOMORPHOLOGY

Geomorphology has diverse applications over a large of human activity like assessment of natural resources, land utilization planning, ecological conservation and applications in constructional planning. Geomorphology and prevailing climate has the mutual relationship (Davis 1986) and both reflect each other. Weathering, soil formation and ground water potential are the major environmental components of an area mainly depending upon the geomorphology of the respective region. The vivid understanding of geomorphology of an area is very essential to asses and managing natural resources especially the area like Kumbakonam being prone to drought.

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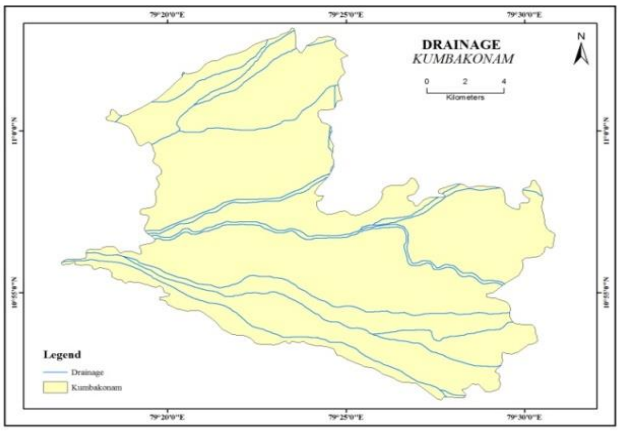

Figure.2 Drainage Map.

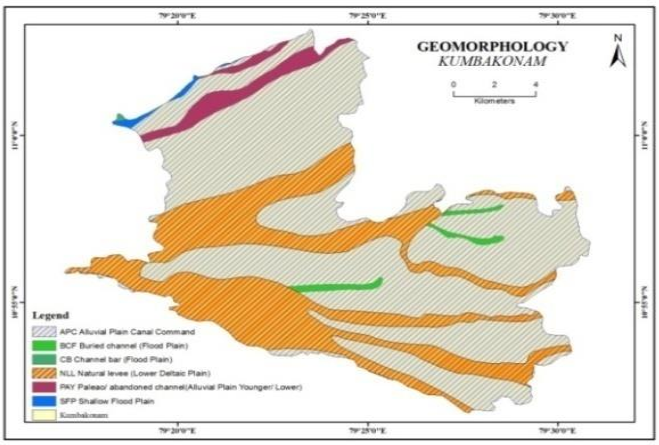

Figure. 3 Geomorphology Map

IV. HYDROGEOLOGY

The Tertiary formation of Thanjavur District is divided into four talukis viz. Kumbakonam, Thiruvidaimaruthur, Thiruvaiyaru and Pattukkottai taluks (CGWB, 1992). The maximum thickness of Tertiary sediments is reported in and around Kumbakonam taluk. The agricultural are poor aquifers (CGWB, 1992; CGWB, 2003). The Kumbaonam have been encountered at deeper levels in the dug and borewells of study area and the formation water is aquifer. The aquifers is extensively developed in and around Kumbakonam taluk.

Groundwater development is through shallow dug wells tapping the sandy zones. The elevation of land surface along the study area is between 0.65 m to 5 m above msl. The depth to water lavel is less (mbgl) and with respect to reduce level in varies from 1 m to 3 metre aove msl. In the southern part, the water table near the sea is between 0.25 m above msl in the northern part. As per Ghyben-Herzberg relation (Todd, 1980) the salt-water interface near the sea should hence be around 10 m below the surface in the north and between 10 and 20 m below surface in the south.

V. HYDROGEOCHEMISTRY

The groundwater development in Kumbakonam is substantial. Some of the dug wells tapping the phreatic aquifers show salinity. The intra-coastal canals which permit intrusion of the sea water by tidal action and the prawn culture farms along the have made the phreatic aquifer system more complex.

Sl. No	Location	EC	pH	Ca	Mg	Na	K	HCO3	Cl	SO4	TDS
1	Aharathur	0.52	7.25	85	45	56	0.08	182	79	39	333
2	Annalakraharam	0.56	7.12	82	46	52	0.05	186	85	38	358
3	Athiyur	0.51	7.06	89	45	56	0.06	189	86	34	326
4	Devanancheri	0.54	7.13	85	48	51	0.02	182	82	35	346
5	Kadichambadi	0.53	7.42	86	43	53	0.04	185	74	36	339
6	Keelapalaiyar	0.82	7.45	165	102	58	0.08	258	148	62	525
7	Kothangudi	0.86	7.56	158	105	53	0.06	253	146	68	550
8	Maharajapuram	0.84	7.48	164	103	56	0.12	248	142	63	538
9	Nagakugi	0.83	7.62	160	102	59	0.13	263	140	65	531
10	Perumandi	0.85	7.54	167	105	64	0.11	248	148	64	544
11	Sakkottai	0.62	7.34	165	82	75	0.08	43	89	58	397
12	Sundaraperumalkoil	0.59	7.38	162	84	74	0.07	238	87	53	378
13	Thippirajapuram	0.63	7.39	167	86	73	0.06	225	8	52	403
14	Thiruvalansuzhi	0.62	7.34	169	87	70	0.04	241	86	59	397
15	Umamaheshwarapuram	0.64	7.32	172	84	72	0.02	236	80	52	410
16	Valayapettai	0.89	7.85	212	105	136	0.08	360	158	59	570
17	Ammachatram	0.82	7.79	213	102	135	0.09	358	168	58	525
18	Ariyapadaiyur	0.86	7.8	223	103	132	0.11	349	159	53	550
19	Baburajapuram	0.84	7.75	224	104	134	0.12	342	160	56	538

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20	Eraharam	0.8	7.72	216	108	120	0.1	362	164	54	512
21	Kallapuliyur	0.68	7.78	125	56	112	0.02	186	112	59	435
22	Koranattukaruppur	0.64	7.74	123	54	114	0.05	185	118	63	410
23	Kovilacheri	0.62	7.85	124	58	115	0.06	187	123	65	397
24	Manambadi	0.65	7.84	120	56	112	0.05	183	124	68	416
25	Neerathanallur	0.63	7.79	128	53	110	0.03	182	125	61	403
26	Patteeswaram	0.48	7.56	85	48	69	0.1	128	75	62	307
27	Senganoor	0.45	7.54	86	46	63	0.13	126	74	63	288
28	Thenampadugai	0.43	7.46	82	4	64	0.08	125	78	65	275
29	Thirunallur	0.45	7.5	84	47	67	0.09	120	79	68	288
30	Udaiyalur	0.42	7.52	80	49	62	0.08	134	72	69	267
31	Uthamathani	0.76	7.63	128	75	89	0.11	245	110	58	487
32	Vilanthakandam	0.78	7.64	125	76	87	0.08	241	113	52	499
33	Anaikudi	0.75	7.69	123	78	82	0.12	263	115	54	480
34	Asoor	0.72	7.62	127	74	83	0.14	254	118	53	461
35	Cholanmaligai	0.74	7.65	126	73	84	0.11	248	116	57	474
36	Innambur	0.96	7.69	168	78	125	0.15	312	156	75	614
37	Kallur	0.98	7.1	167	79	123	0.14	321	158	78	627
38	Korukkai	0.94	7.12	164	75	125	0.13	315	162	74	602
39	Kumarangudi	0.92	7.32	171	71	124	0.15	324	163	72	589
40	Maruthanallur	0.9	7.5	163	76	154	0.12	316	157	73	576
41	Palavankattalai	0.57	7.89	125	63	79	0.11	182	85	58	365
42	Puthur	0.59	7.84	124	65	75	0.05	189	87	52	378
43	Seshambadi	0.58	7.8	123	68	78	0.06	184	82	54	371
44	Thillaiyambur	0.54	7.87	120	64	88	0.08	187	86	56	346
45	Thiruppurambiyam	0.53	7.81	128	68	81	0.07	192	80	53	339
46	Ullur	0.68	7.36	116	56	74	0.05	186	102	54	465
47	Valapuram	0.71	7.32	112	58	85	0.03	185	106	52	454
48	Cholapuram	0.73	7.42	105	52	84	0.03	182	105	58	467
49	Swamimalai	0.69	7.39	108	50	82	0.05	180	112	59	442
50	Thirunageshwaram	0.72	7.42	110	54	79	0.08	189	108	52	461
51	Dharasuram	0.45	7.22	85	52	74	0.08	115	86	50	288
52	Alamankurichi	0.41	7.25	80	51	72	0.07	118	82	48	262
53	Chettimandapam	0.45	7.24	84	56	76	0.08	123	84	46	288
54	Thandathottam	0.42	7.23	86	50	71	0.06	120	79	43	269
55	Nachiarkovil	0.46	7.21	84	51	73	0.1	121	80	48	294
56	Thirucherai	0.51	7.62	82	46	59	0.05	125	57	57	326
57	Nagarasampettai	0.52	7.61	84	45	52	0.04	123	59	59	333
58	Visalur	0.57	7.51	86	42	54	0.05	120	53	53	365
59	Krishnapuram	0.53	7.62	80	41	57	0.11	124	51	51	339
60	Malaiyappanallur	0.57	7.68	87	43	53	0.07	120	54	54	365

Table.1 Geochemical Characteristics of Kumbakonam Taluk, Thanjavur District (ppm value)

Sl. No	Location	RSC	SAR	NCH	MR	Na%	TH	KI	CAI-I	CAI-II	GIBBS-I	GIBBS-II
1	Aharathur	-4.96	6.95	247.98	46.60	23.48	397.11	0.31	1.13	42.95	912.62	28.69
2	Annalakraharam	-4.83	6.5	241.33	48.04	22.32	393.74	0.29	1.45	28.07	1005.56	27.43
3	Athiyur	-5.04	6.84	252.22	45.45	23.03	407.09	0.30	1.42	31.54	920.26	24.34
4	Devanancheri	-5.21	6.25	260.31	48.20	21.31	409.44	0.27	1.35	55.73	1007.69	28.26
5	Kadichambadi	-4.80	6.6	239.79	45.18	22.75	391.38	0.29	0.98	33.85	970.04	31.74
6	Keelapalaiyar	-12.39	5.02	619.68	50.47	13.18	831.08	0.15	3.57	16.67	2237.75	14.97
7	Kothangudi	-12.37	4.62	618.65	52.27	12.25	825.95	0.14	3.56	15.05	2430.55	16.17

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8	Maharajapuram	-12.59	4.85	629.49	50.86	12.77	832.70	0.15	3.40	23.72	2344.01	16.65
9	Nagakugi	-12.06	5.15	603.11	51.23	13.56	818.61	0.16	3.30	21.18	2181.56	16.29
10	Perumandi	-12.90	5.49	645.20	50.89	14.10	848.41	0.16	3.51	35.02	2171.52	15.82
11	Sakkottai	-14.27	6.75	713.61	45.03	17.89	748.85	0.22	1.21	25.34	1398.78	49.21
12	Sundaraperumalkoil	-11.09	6.67	554.57	46.08	17.68	749.59	0.21	1.14	20.2	1327.21	24.25
13	Thippirajapuram	-11.72	6.49	585.92	45.91	17.09	770.29	0.21	-13.85	24.77	1460.59	456.51
14	Thiruvalansuzhi	-11.64	6.19	581.91	45.90	16.34	779.39	0.20	1.17	21.76	1496.67	25.68
15	Umamaheshwarapuram	-11.62	6.36	581.16	44.59	16.81	774.54	0.20	0.87	25.22	1533.93	29.68
16	Valayapettai	-13.31	10.8	665.70	44.94	23.54	960.69	0.31	3.13	14.52	1589.42	12.35
17	Ammachatram	-13.15	10.76	657.50	44.11	23.59	950.85	0.31	3.50	6.99	1475.31	10.45
18	Ariyapadaiyur	-13.88	10.34	693.94	43.22	22.66	979.91	0.29	3.20	20.36	1615.89	12.02
19	Baburajapuram	-14.13	10.46	706.28	43.35	22.81	986.51	0.30	3.22	21.95	1569.64	11.79
20	Eraharam	-13.73	9.43	686.38	45.18	20.98	983.00	0.27	3.50	11.48	1569.21	10.49
21	Kallapuliyur	-7.79	11.77	389.73	42.47	30.99	542.14	0.45	1.62	32.07	992.14	22.19
22	Koranattukaruppur	-7.55	12.12	377.34	41.98	31.91	528.93	0.47	1.84	29.71	917.58	19.37
23	Kovilacheri	-7.89	12.06	394.64	43.53	31.34	547.87	0.46	2.03	31.11	888.15	17.52
24	Manambadi	-7.59	11.94	379.71	43.47	31.50	529.66	0.46	2.10	32.58	927.41	18.31
25	Neerathanallur	-7.76	11.56	388.16	40.56	30.80	537.29	0.45	2.17	32.63	941.12	17.57
26	Patteeswaram	-6.09	8.46	304.56	48.20	26.83	409.44	0.37	0.70	40.97	740.68	34.45
27	Senganoor	-6.01	7.75	300.47	46.85	25.35	403.72	0.34	0.77	40.28	738.66	33.24
28	Thenampadugai	-2.37	9.76	118.61	7.44	38.65	221.04	0.63	0.93	44.22	679.09	29.43
29	Thirunallur	-6.09	8.28	304.51	47.97	26.57	402.84	0.36	0.92	44.74	702.08	30.82
30	Udaiyalur	-5.83	7.72	291.28	50.23	25.17	401.08	0.34	0.70	40.74	662.10	31.11
31	Uthamathani	-8.54	8.83	427.00	49.13	23.57	627.75	0.31	1.85	31.55	1290.27	22.06
32	Vilanthakandam	-8.54	8.68	426.90	50.05	23.26	624.38	0.30	2.00	31.69	1321.41	21.94
33	Anaikudi	-8.24	8.18	412.11	51.10	22.14	627.61	0.28	2.14	30.51	1305.64	19.60
34	Asoor	-8.26	8.28	413.01	48.99	22.53	621.14	0.29	2.24	30.22	1269.77	18.50
35	Cholanmaligai	-8.23	8.42	411.32	48.84	22.92	614.54	0.30	2.15	30.77	1289.39	19.75
36	Innambur	-9.68	11.27	484.23	43.35	26.88	739.89	0.37	3.16	24.66	1560.44	14.67
37	Kallur	-9.57	11.09	478.47	43.81	26.52	741.50	0.36	3.25	23.74	1603.38	14.48
38	Korukkai	-9.19	11.43	459.46	42.98	27.48	717.57	0.38	3.38	24.77	1507.93	13.54
39	Kumarangudi	-9.06	11.27	453.10	40.63	27.29	718.59	0.38	3.42	20.83	1520.56	12.93
40	Maruthanallur	-9.21	14.09	460.26	43.45	31.77	719.19	0.47	2.91	22.01	1275.39	13.54
41	Palavankattalai	-8.44	8.15	421.79	45.37	23.14	570.92	0.30	0.96	27.75	1027.29	28.30

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42	Puthur	-8.44	7.72	421.78	46.35	22.05	576.65	0.28	1.12	27.49	1094.99	27.76
43	Seshambadi	-8.71	7.98	435.72	47.67	22.44	586.49	0.29	0.85	27.22	1042.15	30.11
44	Thillaiyambur	-8.19	9.17	409.33	46.78	25.39	562.56	0.34	0.85	30.23	887.22	25.99
45	Thiruppurambiyam	-8.83	8.18	441.64	46.68	22.73	598.97	0.29	0.69	30.05	953.52	27.81
46	Ullur	-7.35	7.98	367.28	44.31	23.65	519.68	0.31	1.76	35.91	1301.25	27.29
47	Valapuram	-7.33	9.22	366.34	46.05	26.30	517.93	0.36	1.75	35.63	1140.43	25.22
48	Cholapuram	-6.53	9.48	326.66	44.94	27.74	475.79	0.38	1.73	37.87	1136.83	26.53
49	Swamimalai	-6.55	9.23	327.56	43.28	27.29	475.05	0.38	2.03	38.64	1109.89	22.91
50	Thirunageshwaram	-6.83	8.72	341.62	44.72	25.71	496.49	0.35	1.92	36.05	1197.27	24.64
51	Dharasuram	-6.63	8.94	331.66	50.20	27.43	425.89	0.38	1.10	40.56	667.43	27.55
52	Alamankurichi	-6.25	8.9	312.62	51.23	27.67	409.30	0.38	0.96	37.5	595.92	26.68
53	Chettimandapam	-6.78	9.08	339.06	52.35	27.32	439.84	0.38	0.97	36.84	653.11	27.73
54	Thandathottam	-6.44	8.61	321.83	48.93	26.88	420.16	0.37	0.84	39.01	642.77	28.79
55	Nachiarkovil	-6.40	8.89	320.14	50.01	27.47	419.28	0.38	0.85	43.62	681.96	30.74
56	Thirucherai	-5.83	7.38	291.31	48.04	24.58	393.74	0.33	0.01	35.43	845.75	55.47
57	Nagarasampettai	-5.88	6.47	293.83	46.89	22.28	394.61	0.29	0.30	34.38	950.10	54.39
58	Visalur	-5.78	6.75	288.94	44.59	23.27	387.27	0.30	-0.08	35.82	1031.79	70.55
59	Krishnapuram	-5.33	7.33	266.58	45.79	25.20	368.19	0.34	-0.29	40.3	884.45	67.92
60	Malaiyappanallur	-5.91	6.57	295.55	44.89	22.65	393.88	0.29	0.01	39.58	1052.11	68.69

Table.2 Geochemical Characteristics of Kumbakonam Taluk, Thanjavur District (formula value)

Water Quality parameters	Units	Average	Minimum	Maximum
Ec	µS/cm	0.7	0.41	0.98
pH	Mg/l	7.5	7.06	7.89
Ca	Mg/l	128	80	224
Mg	Mg/l	67	4	108
Na	Mg/l	83	51	154
K	Mg/l	0.1	0.02	0.15
HCO3	Mg/l	207	43	362
Cl	Mg/l	105	8	168
SO4	Mg/l	57	34	78
TDS	Mg/l	420	262	624

Table 3: Statistical Measure Such As Minimum, Maximum, Median.

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In the study area, total concentration of Electrical Conductivity (EC) of water samples from different locations in the Thanjavur district could indirectly indicate the level of mineralisation in the phreatic zone. Based on these observations water samples from 60 representative wells were collected and analysed for the Regional Laboratory of Central Ground Water Board, Tamil Nadu. Representative groundwater samples collected from 32 dug wells season period (April 2004) were chemically analysed for Ca,Mg, Na, K^+, Cl, SO^{--}, HCO_3^-, CO_3^{--}, NO_3^- and F^- apart from determination of, pH, EC, total dissolved solids (TDS) and temperature. The chemical data is given in Table 1. All the major ions in 95% of the samples are well within the standards specified for drinking and other purpose (BIS, 1991). Parameter like Na;Cl in some of the samples is characteristic of sea water mixing. Factor analyses is applied to determine the factors that control the chemistry of groundwater in the phreatic aquifers of Kumbakonam taluk. The electrical conductivity of water is an index of mineralization (Hem, 1991).

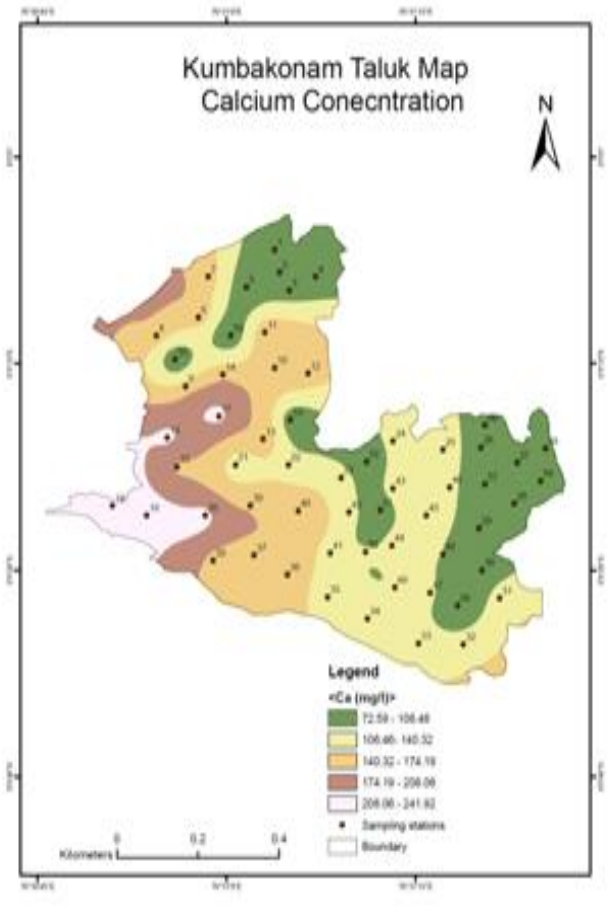

Figure.4 Map Showing Electrical Conductivity of Kumbakonam Taluk Map

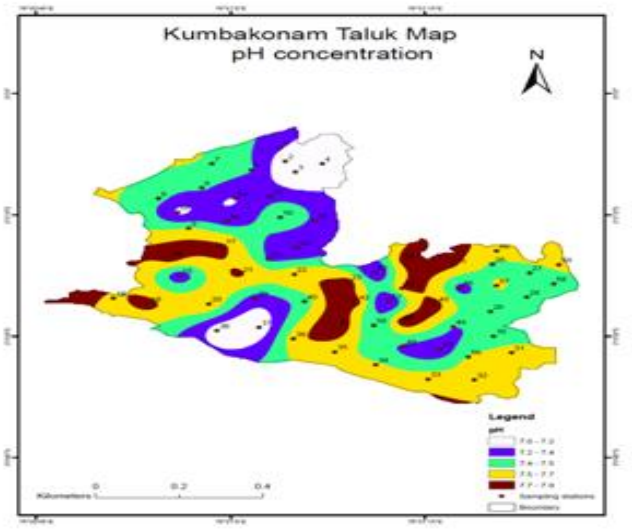

Figure.5 Map Showing pH Concentration of Kumbakonam Taluk Map.

VI. CALCIUM

In the study area, Calcium concentration ranges from 80 to 224 ppm in the groundwater samples. The samples are 96 percentage of the sample within the permissible limit and few sample fall more than the permissible limit. Figure Shows Calcium in the Kumbakonam Taluk could be seen from this figure the maximum concentration are seen in the area of North-West parts of the study area whereas minimum concentration are seen in the area of all position

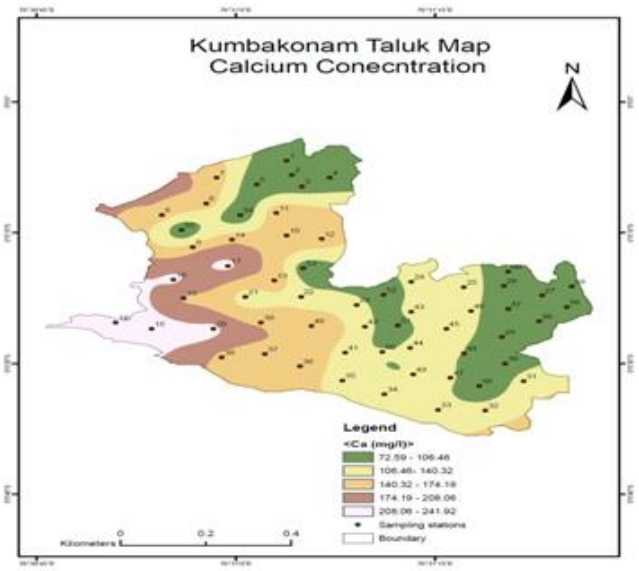

Figure. 6 Map Showing Calcium Concentration of Kumbakonam Taluk Map

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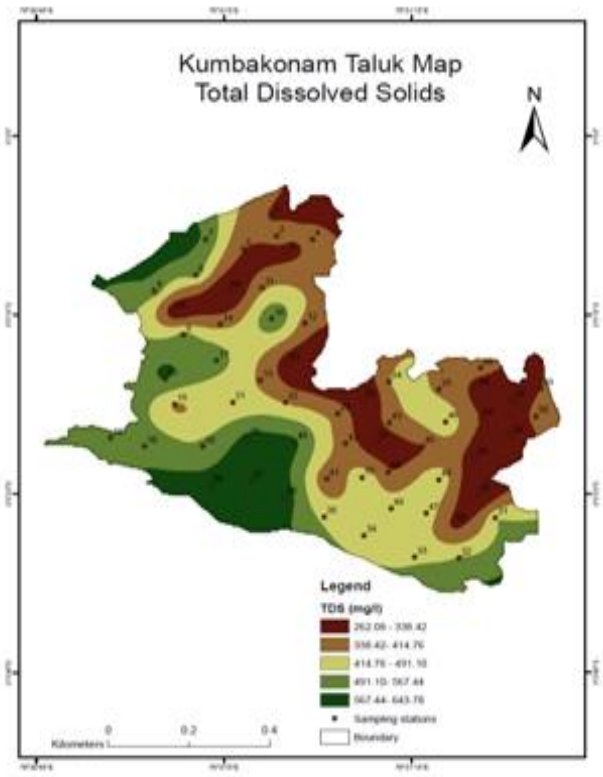

Figure. 7 Map Showing TDS Concentration of Kumbakonam Taluk Map

VII. SODIUM

In the study area, Sodium concentration ranges from 34 to 78 ppm in the groundwater samples. The samples are 84 percentage of the sample within the permissible limit and few sample fall more than the permissible limit. Sodium concentration in the Kumbakonam Taluk could be seen from this figure the maximum concentration are seen in the area of South-West parts of the study area whereas minimum concentration are seen in the area of North-East position of study area.

VIII. SODIUM ADSORPTION RATIO (ALKALI HAZARD)

Excess sodium in water creates harmful effects of changing soil characteristics and reducing soil permeability (Kelley, 1951). Hence, the development of sodium concentration has the same importance and is desirable for irrigation. Irrigated water tends to enter into cation exchange reactions in soil and it could be pointed out by sodium adsorption ratio (U.S. Salinity Laboratory, Op.cit). Sodium substituting adsorbed calcium and magnesium is a danger. irrigation water divide according to SAR along (Richards, Op. cit) is given below. Low sodium water (S_1) could be used for irrigation on nearly all soils with minor harm for the evaluation of dangerous level of exchangeable sodium. Sodium sensitive crops, such as stone-fruit trees may increase injurious concentration of sodium.

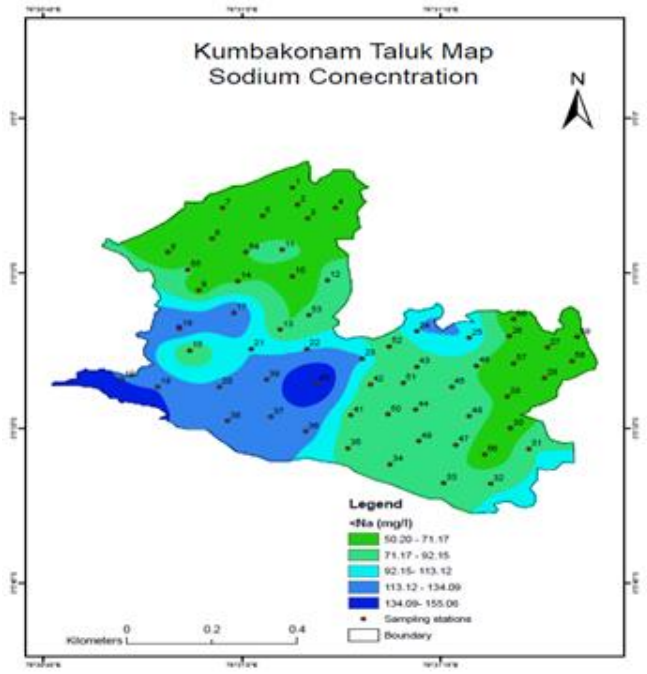

Figure. 8 Map Showing Sodium Concentration of Kumbakonam Taluk Map

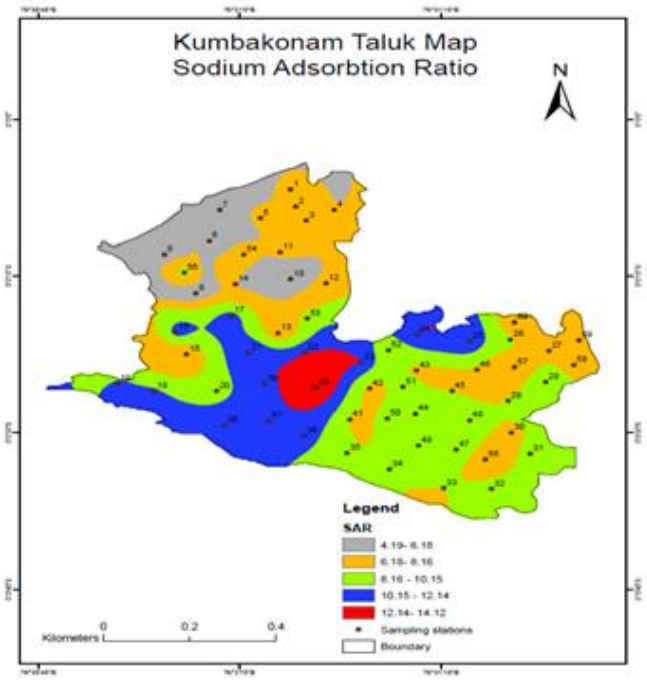

Figure. 9 Map Showing SAR Concentration of Kumbakonam Taluk Map

IX. VALUE OF HYDROGEN ION CONCENTRATION

In the study area, the hydrogen ion concentration (pH) in samples ranges from 7.06-7.89 with an average around 7.52 and in the season samples from 5.4 to 8.8 with an average

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7.4 indicating alkaline nature. As for ISI (1983) standards 99 percentages of the samples in the within the recommended limits (6.5 to 8.5) and suitable for human consumption. Except one sample was not desirable limit that is Melacauvery village.

X. RESIDUAL SODIUM CARBONATE (RSC)

Residual sodium carbonate is defined as the water having excess of carbonate and bicarbonate concentration over the alkaline earths chiefly calcium and magnesium, as the water in the soil becomes highly concentrated with sodium. It causes this reaction, the relative position of sodium in the water is increased in the form of sodium carbonate. The Residual sodium carbonate
(RSC) = $(CO_3 + HCO_3) – (Ca + Mg)$

(where all the ionic concentration are expressed in epm)
Residual sodium carbonate of Kumbakonam Taluk. It can be classified into positive and negative zones and most of the Positive zones are found to be most of the study area except a few locations where negative zones also exists.

RSC (epm)	Water category	No. of samples	Percentage of samples
< 1.25	Safe	37	74
1.25-2.5	Marginally	10	20
> 2.50	Unsuitable	3	6

Table 4 Residual Sodium Carbonate in Groundwater in the Kumbakonam Taluk

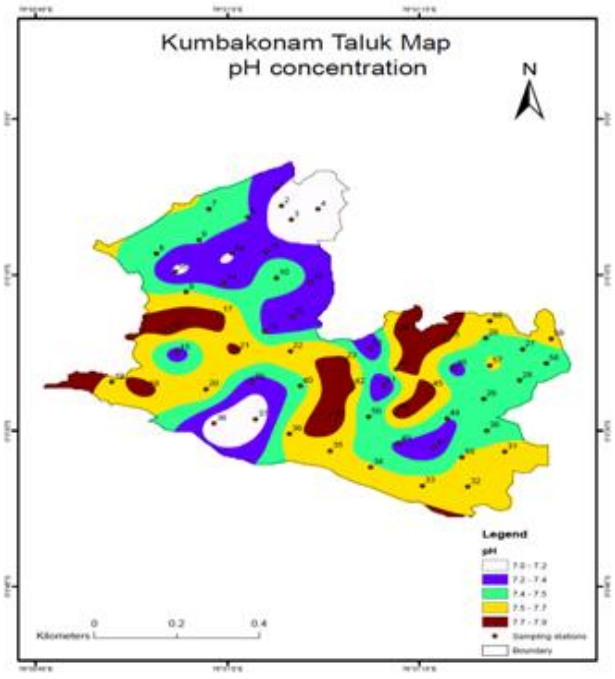

Figure.10 Map Showing pH Concentration of Kumbakonam Taluk Map

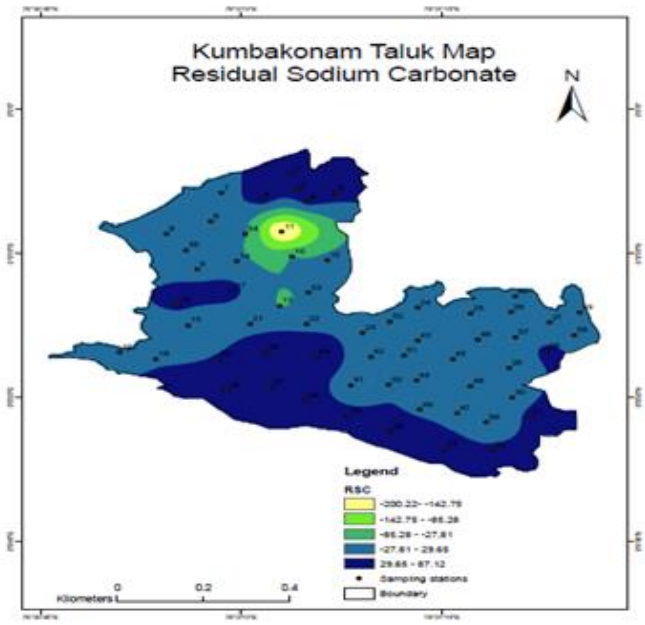

Figure.11 Map Showing RSC Concentration of Kumbakonam Taluk Map

XI. THE PIPER DIAGRAM

The data plot in the Piper diagram show 50% of the samples in the central part of the diamond field, there by indicating non domination of any of the cation or anion pairs. About 50% of the samples are in the field of permanent hardness and the remaining in the temporary hardness field. The hydro-geochemical observations are not supporting direct seawater ingress though the groundwater samples have a marine signature. Alternative of the diamond field was suggested and he has recommended a rectangular field and it was applied for splitting the triangles (Piper, 1944).

In this study, hydrochemical zonation has been made by plotting the percentage of ionic concentrations of the Piper's trilinear diagram for graphical analysis. Distribution of groundwater samples in different subdivisions of the diamond shaped field of the Piper diagram reveals that the water samples fall in the areas of 1, 2, 3, 4, 5, 6.

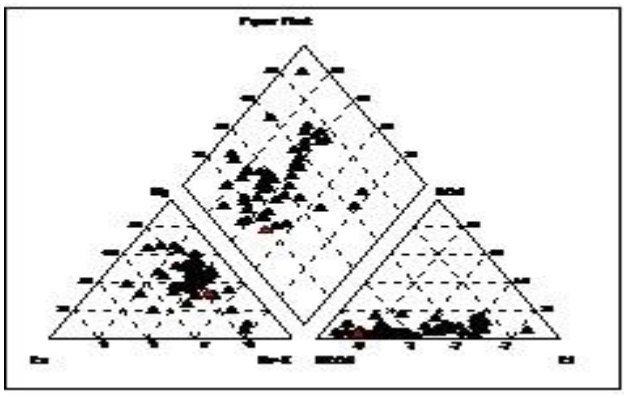

Fig 12 Piper Diagram

Even the surface water bodies, when brackish in nature, have not shown any impact on fresh groundwater in the sea. The tidal regulators mainly influence the quality of water in the canals and backwaters. The theory sounds that once the groundwater levels goes down and the tidal regulators are open, the quality of water deteriorates in the wells adjoining the back water bodies. Such wells regain better quality of water once the situation reverses during monsoon season.

XII. RESULT AND DISCUSSION

The chemical data were statistically computed using correlation coefficient to indicate the sufficiency of one variable to predict the other (Nie et al. 1975: Davis, 1986). Factor analysis has been applied to the chemical analysis data of 60 groundwater samples that were collected from dug wells extract the principal factor from the source of variation in the hydrochemistry. Correlations among 12 hydrochemical parameters are statiscally examined. Varimax rotation was used to define the factor scores and percentage of variance in the hydrochemistry (Kaiser, 1958). A high correlation coefficient means a good relationship between two variables, and a correlation coefficient around zero means no relationship. Positive values of indicate a positive ralationship while negative values indicate an inverse relationship. The correlation coefficient matrix of analyzed ions is shown in Table 2. The correlation coefficient matrix was calculated using linear regression analysis. From the analysis, three different correlation types can be identified namely: (i) highly competitive relationship between ions with the same charge but different valence number , such as Cl^- with SO_4^{--}(r= 0.656; $p < 0.01$), (ii) a strong chemical association between ions of opposite charge, but with equal valence number such as Cl^- with Na^+ (r= 0.707; $p < 0.01$) and (iii) a noncompetitive correlation between ions of the same type of charge and equal valence number such as K^+ groundwater and the major components of seawater (Na^+, Cl^- and SO_4^{--}) showed significance correlation (EC- Na^+, r= 0.784; EC- Cl^-, r = 0.963; and EC - SO_4^{--} , r = 0.657 with; $p < 0.01$); an indication of seawater influence on the groundwater quality. The variation of these relationships may indicate the complexity of the hydrochemical components of groundwater (Ariz et al. 2007; Gallardo and Marui, 2007) EC is the major variable showing 0.945 of the variables contributed by all factors. The relation between F1 score and EC of groundwater in different locations is shown in Fig.4. the figure shows a strong correlation between these two variables. Sampling (Neerathanallur) exhibits the highest F1 score followed by location numbers (Cholanmaligai) and (Kovilacheri). All these stations have high chloride content with maximum shown at location 10. Neerathanallur station, located near to the sea, shows highest F1 score indicating a strong saline signature. The other two stations are close to the back waters (Fig.1). but the F1 score does not show high loading of Na^+. The concentration of Na^+ and Cl^- in seawater is afr greater than that of continental water. But in the study area the ratio is small. Hence no evidence of direct sea water ingress due to pumping. Here the saline signature is attributable to the effect of marine aerosol. The relationship between EC and Cl^- of groundwater is shown in fig.5. Figure 5 has revealed mixing of sea water is prominent in three locations namely Neerathanallur, Cholanmaligai and Kovilacheri. Factor 2, which explains 21.253% of the total variance, includes Mg, Ca^+, HCO_3^- (Table 1). Factor 3, which explains 10.305% of the total variance with high loading on pH, CO_3^{--}, K^+. This factor reflects the signatures of natural water recharge and water-soil/rock interaction. There is also strong correlation between F3 score and pH (Fig.6). pH and CO_3 is showing very good correlation indicating the dissolution is rise in pH and reduction in HCO_3^- concentration in water samples (Freeze and Cherry, 1979).

XIII. CONCLUSION

Hydro-geochemical investigation Kumbakonam Taluk, Thanjavur district, Tamil Nadu, a very careful planning of ground water investigation and utilization in this water sample becomes a necessity. The candidates has investigated the study area and presents his observations under the heading The study area encompasses Kumbakonam Taluk total geographical extent of Area (409.79 sq.km) in the study area, the hydrogeology enjoys tropical climate and it receives rainfall mostly from north east monsoon between October and December. In the study area, the predominant soil series are 1.Red Sandy 2.Browon Calcareous 3.Red Loamy soil. The cashew plantation and scrub eucalyptus are the main trees found as natural vegetation in the study area. The study area is covered by Charnokite, Gneiss, Granite rock, Quartzite and Shaly Sand stone. Using survey of India toposheet of the year 1973, in the scale of 1: 50,000, a base map was prepared to represent the drainage map of the study area. In the geochemistry identified and delineated for geochemical parameters the 50 locations and various geochemical characteristics and their features are observed.

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