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RESEARCH ARTICLE

WATER QUALITY STUDIES USING REMOTE SENSING & GIS TECHNOLOGY IN VAIPPAR RIVER, TAMIL NADU

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ABSTRACT

Hydro geochemical studies are of great importance in hydro geological investigation of ground water. Ground water samples from several wells in parts of Virthnagar District have been collected and chemically analyzed. The suitability of ground water for domestic industrial and irrigation demands have been discussed in this paper in terms of Handa's classification, chloroalkalinity indices, potential soil salinity, permeability index, sodium adsorption rations, PH, EC, TDS, Major Iron concentration and by the mechanism controlling the ground water chemistry. The data were used to complete chemical parameters as no-corbonate hardness, sodium absorportion ratio, percentage of sodium residual sodium carbonate, magnesium ratio, corrosivity ratio, choro alkaline indices and permeability index found to be based on evaluation of the chemical parameters quality of water is fit for drinking, industrial and agricultural users, except in a few isolated locations. According to Gibb's diagram most of the samples falls under rock dominance. Wilcox's diagram indicates that less than 60 percent of samples fall in excellent to good and good to permissible types. According to the USSL classification of water quality of the samples belong to CS-S1,C5-S2,C5-S3 and C5-S4 classes water are also found in the area are which not suitable for irrigation.

INTRODUCTION

Rapid growth of population, expansion of irrigation and increasing trend of industrialization have contributed towards rising demand for ground water in the vaippar river basin of tamilnadu. This paper analyses various chemical parameters of groundwater in this basin to find out its usability for domestic, industrial and agriculture purposes. The investigated area figure -1 is located between Latitudes $9^0$0'05" and $9^0$30'54"N and Longititudes $77^0$17'44" to $78^0$9'58"E. It covers an area of about 4900square kilometers. Toposheet No. 58 G/5, 6, 7, 8, 10, 11, 12, 15, 16, 58 k/3, 4, 8. The area is a hard rock terrain of peninsular India, mainly composed of Precambrian formation like granite rocks, charnockites ultra basic to alkaline intrusive bodies, generally underlain by the Archeans and over which the recent alluvium is deposited. The average rainfall in the region is 1000 to 1300 mm.

MATERIALS AND METHODS

Ground water samples were collected in new polyethylene containers to avoid contamination. PH was measured using a portable PH meter and EC was determined using conductivity meter. Other chemical constituents. Na^+, K^+, Ca^{++}, Ma^{++}, $SO4^2$, C1-, $CO3^{2-}$, HCO^{3-} were determined by the standard methods (American Public Health Association, 1971). Concentrations of various constituents are expressed in epm units. Ground water is areplenishable source which as certain inherent advantages over surface water. The wide distribution, negligible evaporation loss, low risk of population are a few advantages. The presence of certain chemical substances and their concentration in ground water is a function of initial composition of water, the type of surrounding rocks with which the water is in contact, the water contact, the water temperature, the volume of water in movement and its velocity. Hence the study the various aspects of an aquifer, quality and suitability of water for domestic, irrigation and industrial purposes (Fig 1).

RESULTS AND DISCUSSION

Table 1 shows the representative chemical analyses of 60ground water samples collected from three district. Earlier publications of Hydro geochemical communications [Kelly (1940), Eaton (1950), Shah *et al* (1958)] considered the status of quality of waters based on different premises and using their methods, it has been observed that a sample water classified as suitable for particular use may not reach the same classification tag of another worker because of the differences in the parameters chosen for classification. It is observed that by considering the entire chemistry, rather than individual ionic or grouped characters in pairs, the results obtained are better. [Hem (1959) Handa (1964a, 65)].

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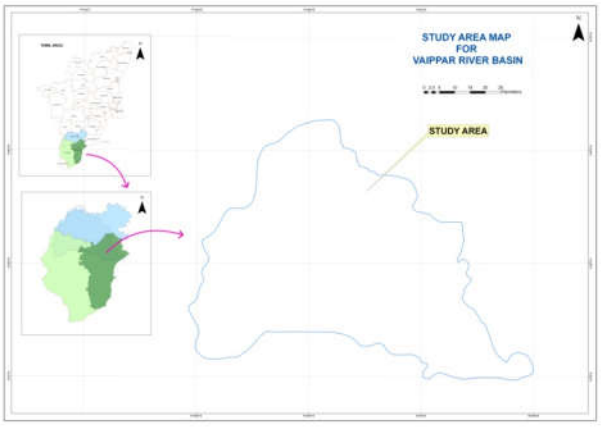


Fig. 1. Site Area

Sodium concentration in ground water is important since increase of sodium concentration in waters effect deterioration of the soil properties reducing permeability (Kelly (1951) and Tijani(1994)). The process leading to the cation exchange reactions in soil may be studied from sodium absorption ratio (U.S. Salinity Laboratory, 1954). Sodium absorbed on clay surface as substitute for calcium and magnesium may damage the soil structure making it compact and impervious, SAR is expressed as where the concentration are expressed in equilent per million (epm).

Chemical Relationship

The piper (1944) Triliner Diagram (PTD) is most useful to understand chemical relationships among waters. The chemical quality data of the investigated area are used in

Table 1. Representative chemical analysis of ground water samples

S.No	Name	Ec	pH	Ca	Mg	N a	K	HCO_3	Cl	SO4	NO_3	F	Fe	$CaCO_3$	TDS
1	Chokkampatti	3390	7.73	256	125	280	8	1160	888	131	10	0.1	1.2	260	2373
2	Kunnur	974	8.1	45	21	120	4	200	204	62	1	0.2	0.53	164	682
3	Sundrapandian	3000	8.08	96	43	480	10	420	584	182	8	1.1	0	352	2061
4	Vathirairuppur	1605	7.87	69	40	192	4	340	252	84	6	1	0	408	1103
5	Srivilliputhur	1919	7.58	112	53	220	8	500	512	17	2	0.1	0.13	192	1343
6	Rajapalayam	1876	7.83	120	53	160	4	520	352	105	7	0.2	0	280	1313
7	Chathirampatti	2560	7.63	104	48	360	12	460	532	101	6	0.2	0	328	1759
8	Alakkulam	2630	7.89	64	62	380	16	420	424	223	8	1	0	380	1807
9	Kandiyapuram	1217	7.9	40	34	160	4	240	164	80	3	1	0.13	312	852
10	Sevalpatti	2170	7.52	45	103	240	8	540	256	371	6	0.4	0	320	1519
11	Sankarankovil	2240	7.66	58	23	360	16	240	416	63	4	0	0.67	360	1539
12	Puliyankudi	2220	7.78	91	56	280	8	460	392	92	8	0.2	1.47	440	1525
13	Chinthamani	904	8.15	64	13	97	2	216	108	90	1	0.2	0	244	633
14	vasudevanallur	836	7.75	56	24	90	2	240	124	18	0	0.5	0	216	585
15	mullikulam	3470	7.92	78	65	560	20	468	824	95	4	0.4	0	296	2384
16	Vadamalapuram	469	7.4	48	10	40	0	160	76	8	10	0.4	0	132	322
17	Ramalingapuram	2050	7.9	93	21	300	8	320	356	136	3	0.2	0	480	1435
18	panaiyur	4070	7.87	112	82	640	30	620	1096	87	13	1.4	0	452	2849
19	Meenatchipuram	285	7.57	24	5	32	0	80	28	9	6	0.2	0.13	96	196
20	Sivagiri	1680	7.53	58	57	190	4	380	292	77	5	0.1	0	300	1154
21	Devipattinam	1295	8.05	35	41	160	4	260	180	60	4	1.5	0.13	376	907
22	Chokkonathanpudur	559	8.16	48	10	60	0	160	84	14	0	0	0	126	391
23	mettupatti	908	7.59	45	38	90	2	272	112	21	8	1	0.13	260	624
24	Nallamangalam	1549	7.58	72	86	120	4	540	212	32	4	0.4	0	444	1064
25	Chettiarpatti	1598	7.47	88	48	160	4	420	324	36	7	0.2	0	308	1119
26	Cholapuram	4550	7.63	80	149	650	20	820	1132	173	12	0.3	0	284	3185
27	Manalur	2520	7.59	72	182	140	4	940	532	42	3	0.2	0.4	348	1731
28	Kuruvigulam	535	8.05	48	12	40	0	172	72	6	1	0	0	180	368
29	Kalugumalai	1897	7.79	72	43	260	12	360	328	66	5	0.6	0	348	1328
30	Pazhankottai	1669	7.64	88	24	220	8	320	252	83	7	0.2	1.2	356	1168
31	Gururajakulam	3010	7.81	80	43	480	20	80	188	738	8	1.4	0	356	2068
32	Kovilpatti	5050	7.46	248	154	520	30	248	1284	211	2	0.2	0.27	288	3469
33	Kadalai	3000	7.4	160	67	320	12	680	560	196	3	0.1	0	384	2100
34	Ettaiyapuram	1037	7.88	86	10	120	2	256	104	18	9	1	0	344	726
35	Nalathiputhur	1053	7.86	56	24	130	4	240	144	36	6	0.1	0	248	723
36	Eliyarasanendal	5540	7.28	160	389	380	12	2020	1080	814	8	0	0	144	3806
37	Chidhambara nanthapuram	1540	8.22	48	43	190	6	300	216	125	10	0.1	0	268	1078
38	Mulliseval	3400	8.11	80	80	480	30	532	616	425	7	1.5	0.4	368	2380
39	Ealairumpannai	1122	8.16	37	43	120	4	272	156	23	3	1	0	284	771
40	O.Mettupatti	3250	7.9	112	43	470	20	460	648	334	3	1.4	0	260	2233
41	Sathur	7470	7.95	80	70	1400	40	492	1216	1009	10	1.2	0	648	5229
42	Sulakkarai	739	8.08	48	17	68	2	192	120	30	9	0.1	0	144	517
43	Virudunagar	1890	8	45	4	350	20	128	268	93	4	0	0.27	380	1298
44	Vellur	16930	7.65	400	655	2200	40	3730	2924	3314	11	1.5	0	404	11631
45	Pandalkudi	3600	7.92	93	64	560	20	500	720	279	4	1.5	0	340	2520
46	Melapatti	803	7.76	56	24	70	2	240	40	26	6	0.1	0	336	562
47	Vembur	1467	7.64	112	48	120	4	480	320	39	1	1.5	0	216	1008
48	Mettlepatti	1082	7.67	64	8	140	2	192	40	29	7	1.5	0	440	743
49	Puthur	6000	7.62	112	91	980	20	660	1696	226	3	0.2	0.67	336	4200
50	Nagalapuram	2350	7.91	99	42	360	8	424	508	217	8	0.2	0	172	1645
51	Karisulkulam	4490	7.56	128	211	420	10	1200	732	588	5	1.4	0.13	400	3085
52	Vilathikulam	1227	8.71	8	5	260	4	40	44	36	4	0.6	0	516	843
53	Vadamalai samuthiram	2120	7.82	40	24	360	8	200	332	142	5	0.2	0.93	352	1484
54	Kulathur	2540	7.51	48	82	340	8	460	432	121	4	0	0	464	1778
55	Uppathur	709	7.92	40	12	82	2	148	32	27	1	0.6	0	292	487
56	Sarivai kundapuram	7060	8.01	208	178	910	20	1260	2232	18	0	0	0	220	4850
57	Kilavaippar	7320	7.72	192	168	1200	20	1180	1832	565	1	0.1	0	248	5124
58	Vaippar	5470	7.68	160	101	920	40	820	1324	362	0	0	0	220	3829

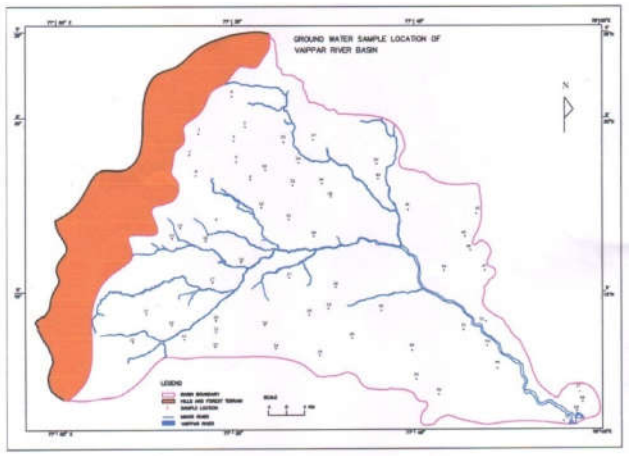


Fig : 2 WATER SAMPLE MAP

Table 2. Classification based on USSL diagram

S.No.	Category	No of samples
1	C1 – S1	21
2	C2 – S1	5,19,30,35,36,39
3	C3 – S1	2,3,4,9,13,16,17,25,31,32,34,37,38,41,42,43,45,46,48
4	C4 – S1	8,10,14,20,26,28,40,50,51,52,54
5	C5 – S1	1,15,18,27,56,57
6	C3 – S2	6,7,11,22,23,24,29
7	C4 – S2	33,44,58
8	C5 – S2	47,59
9	C4 – S3	12
10	C5 – S3	49,60

Table 2 Depicts the Classified of Groundwater 10 figure shown preparing figure 3.

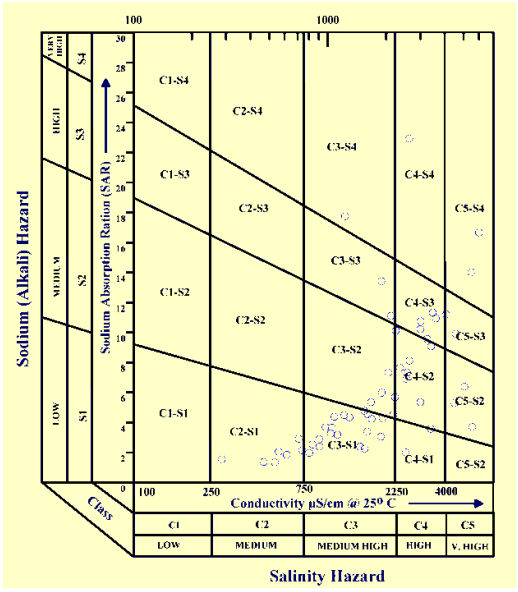


Fig. 3. Ussl Classification Of Vaippar River Basin

Pipers Trilinear Diagram for graphical analysis. The ground water samples fall in various segments of the diamond shaped field of the piper diagram and their characterstics may be studied from Alkalies exceed alkaline earths in the southern and southeastern parts, whereas weak acids (CO_3 + HCO_3) exceed strong southern, northern and northeastern parts of the study area. Non-carbonate alkali types of water are found in the northeastern and in a few isolated pockets of the study area Figure 5.

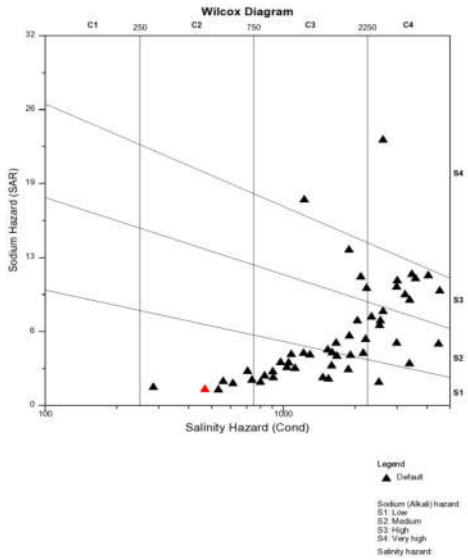
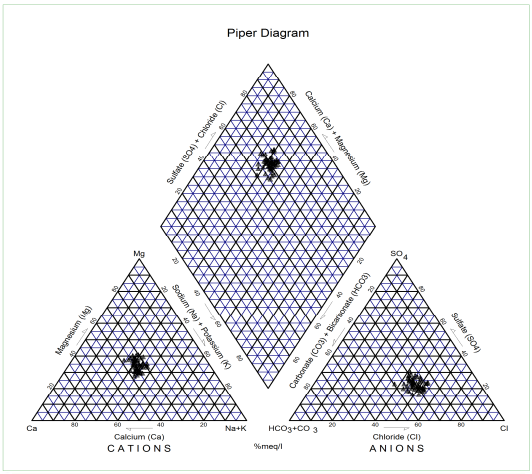


Fig. 4. Sources the Classification of Ground water based on SAR



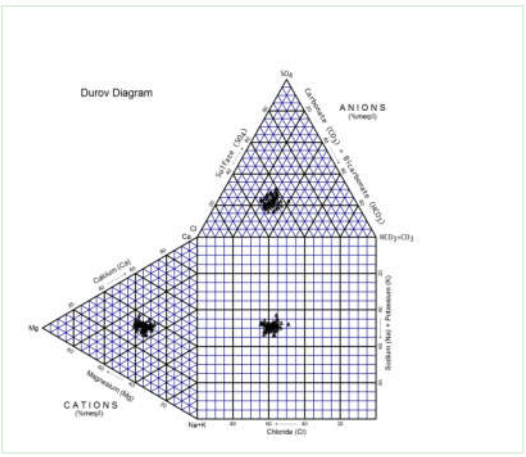


Fig. 6. Chemical Relationship

Ground Water Type

Scholler (1965a, 67) has pointed first and the foremost water in which CO3> C1 or SO4 as type 1 water, as the concentration increases the above relation changes to CO3 or SO4 > as Type II water, still at a higher concentration the

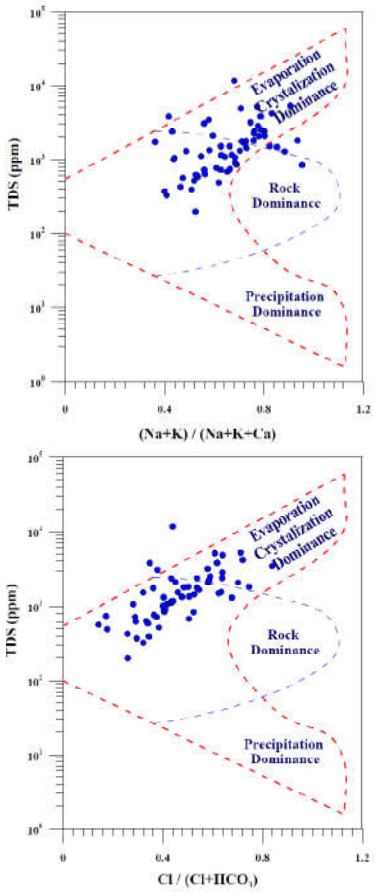


Fig. 7. Mechanisms controlling the chemistry of ground water

water may change to C1>SO4>CO3 as Type III water and C1>SO4>CO3 and Na > Mg > Ca as Type IV water, Using the abovesaid method, the water from the study area has been classified into different types.

Mechanisms controlling the chemistry of ground water

Mechanisms that control the chemical composition of the major dissolved salts of waters have discussed earlier by Conway (1942), Gorham (1961), Gibbs (1970), Ramesan *et al* (1973), Machenzie *et al* (1965, 66) and Sillen (1967). Fig 3 represents the mechanism responsible for the control of surface water chemistry of the globe. Gibbs (1970). The TDS is plotted with respect to the ration of (Na + K)/(Na + K + Ca) and C1/(C1 + HCO3). In this, the total enveloping curves for the chemistry of surface water of globe after Gibbs have demarcated by a continuous line. Density of distribution of points of ground water chemistry was maximum in the central portion [enclosed by dashed line, Viswanathaiah, *et al* (1978)]. This specific area dominants or cluster of points indicate the interaction between rock chemistry of the study area and the perlocating. waters in the subsurface. Further it has been clearly shown that the presence of some minerals having exchange capacity in the rock obliterated the chemistry of water. Ground water samples about 88% and 76% of the ground water samples fall within C2 – S1, C3 – S1, C3 – S1 and C4 – S2 Categories in both seasons. Nearly fifty eight percent and thirty eight percent of samples occur within C3 – S1 category in this category is predominant are suitable for irrigation purposes. It is found to be southern south western, western parts and a few isolated pockets of entire basin Fig. 7.

It was also found that the ground waters of all the three taluks exhibit Type III water except sample 1 which shows Type II nature. Doneen (1962) evolved a criteria based on the salinity, permeability of irrigation waters which is said to be an improvement over the U.S. soil salinity diagram. The potential soil salinity (P.S) is given by the concentration of C1 plus half(1/2) SO4 ion is listed in Table 2. The values indicate that except in two cases, water samples 5 and 11 showing High – very salinity, others are low to medium salinity range. Sodium assorption ratio (SAR) and Residual sodium carbonate (RSC) values of the ground water also describe that the waters are excellent for irrigation purposes. Total dissolved solids (TDS) of the waters vary from 326 ppm to 2904 ppm, which indicates that the ground water is fairly suitable for domestic purposes and most suitable for irrigation and industrial purposes. Other constituents are present within the permissible limit of domestic, industrial and irrigation demands. Total dissolved solids a result of dissolution of minerals from the overlying layers and weathered zones by water percolation. The overall all characteristics of ground water in the investigated area, where majority of the minerals are high due to the rock water interaction, are also controlled by the contamination from extraneous sources. In general south western, eastern, north western and southern parts of the study area found to have good quality of ground water, where as moderate quality is identified in the area of south eastern and central parts of the vaippar river basin.

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