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GRAPHICAL TECHNIQUES OF PRESENTATION OF HYDRO-CHEMICAL DATA IN SOME AREAS OF VILLUPURAM DISTRICT, TAMIL NADU, INDIA

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Abstract: **Groundwater is the major source for domestic and irrigation activities in urban regions. A study was carried out in the some areas of villupuram district in Tamil Nadu, to identify the factors that influencing the groundwater chemistry. Totally 20 samples were collected by representing the whole region in January 2017 and September 2017. The samples have been analyzed for major ions Ca, Mg, Na, K, Cl, HCO3, SO4 NO3 and pH, TDS. The Piper, schoeller, stiff and Durov diagram are useful for better understanding the evolution of hydro chemical parameters of groundwater that can be obtained by plotting the concentration of major cations and anions in percentage of meq/l, these diagram was created for comparing the results of water types. Majority of the samples were behaved in more or less same way except few samples.**

Keywords: **groundwater, chemical composition, Piper, schoeller, stiff and Durov diagram.**

1. INTRODUCTION

The quality of water is of vital concern for mankind since it is directly linked with human health, protection of the environment, plant growth and sustainable development [1]. Much of ill health which affects humanity, especially in the developing countries can be traced to lack of safe and whole some water supply [2]. Increasing population and its necessities have led to the deterioration of surface and sub surface water. Ground water is the major source of drinking and irrigation water in both urban and rural areas. The domestic sewage and industrial waste are the

leading causes of ground water pollution [3]. In most of the industrialized areas groundwater is the first victim of the local contamination as effluents are more often let into open abandoned wells, which is a type of point source contamination. The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region.[4].Quality of ground water is the resultant of all processes and reactions that act on the water from the moment it is condensed in the atmosphere to the time it is discharged by a well or a spring and varies from place to place and with the depth of the water table. Groundwater crisis is not the result of natural factors. It has been caused by hu man actions. The industrial effluents if not treated and properly controlled, can pollute and cause serious damage to the groundwater resources [5]. Increasing population growth and rising living standards in many countries necessitate higher quality water resources for various uses as agriculture, industry and drinking [6].

In this way groundwater resources have been considered as valuable reserves and infrastructure developing countries, also tried to understand the capabilities of these resources and their usage can be found [7]. Groundwater is almost globally important for human consumption as well as for the support of habitat and for maintaining the river's base-flow. It is usually of excellent quality. Being naturally filtered in their passage through the ground, they are usually clear, colorless, and free from microbial contamination and require minimal treatment [8].

Water quality with respect to path length and abundance of soluble ingredient can be very different in various regions [9].Surface water quality is a matter of serious concern today in developing countries, due to rapid population growth coupled with the rate of urbanization and economic development tends to impair the surface water resources and results in high variability for many water quality parameters. Anthropogenic influences (urban, industrial and agricultural activities, increasing exploitation of water resources) and natural processes (changes in precipitation, erosion, and weathering of crustal materials) degrade surface waters and impair their use for drinking, industrial, agricultural, recreation or other purposes [10]. Because lakes, reservoirs and rivers constitute the main inland water resources for domestic, industrial and irrigation purposes, it is imperative to prevent and control water pollution and to have reliable information on water quality. Anthropogenic influences and natural processes could each affect surface water quality. In view of the temporal variations in the hydrochemistry of surface waters, regular monitoring programmes are required for reliable estimates of the water quality [11]. The emerging global freshwater crisis in terms of water quality and quantity is already felt in India. The over drafting of groundwater in India due to the lack of surface waters during summer season has urged the need to undertake a detailed study on the quality and quantity of groundwater in different parts of India. Water quality gets modified along the course of movement of water through the hydrological cycle and through the operation of the following processes: evaporation, transpiration, selective uptake by vegetation, oxidation/reduction, cation exchange, dissociation of minerals, precipitation of secondary minerals, mixing of waters, leaching of fertilizers and manure, pollution and biological processes [12].

2. DESCRIPTION OF THE STUDY AREA

Study Area:

The study area lies between Latitude N $11^{0}56^{'}$ and Longitude E 79°29 $^{!}$ and is located in Northeast of TamilNadu in India, which is in the far southeast part of India , situated 160 km south of Chennai 160 km north of Trichy ,177 km east of Salem, 40 km west of Pondicherry it shares the seashore of the Bay of Bengal covering about 7217 Km^2 area (Fig.1). The area includes Villupuram, Vikkravandi, Tindivanam.

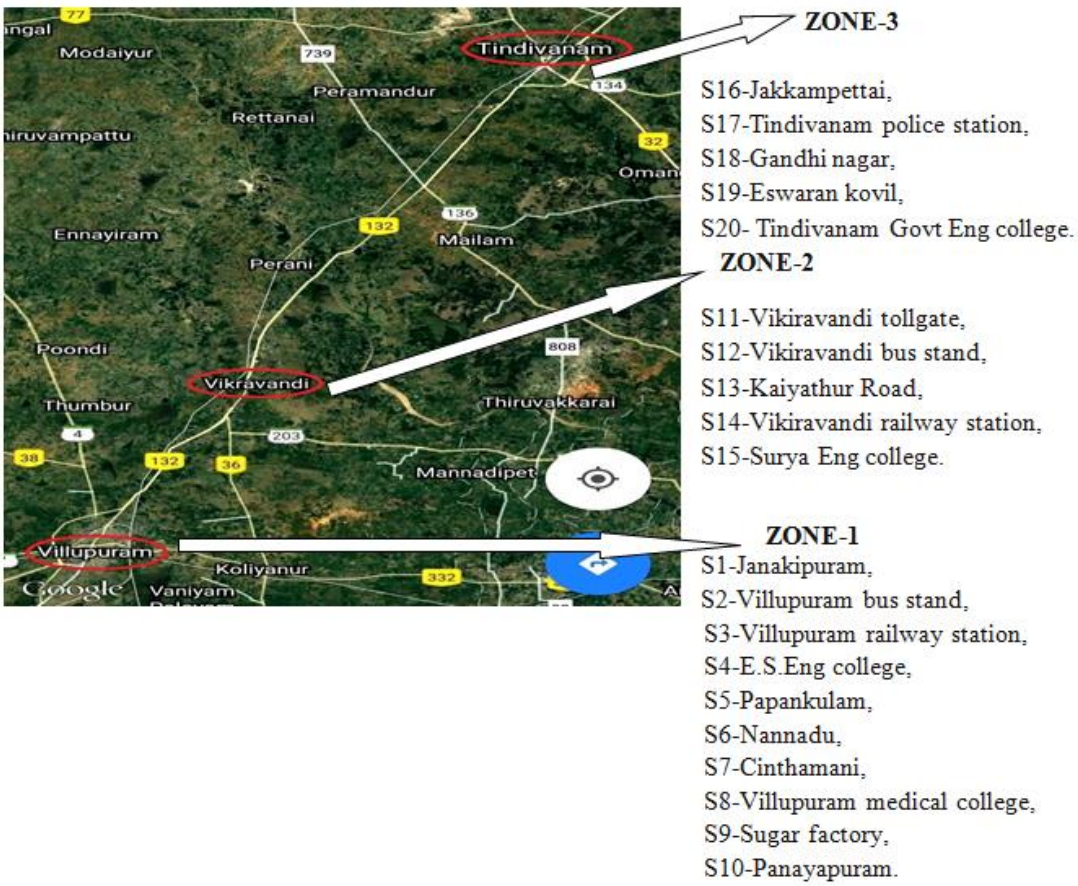

Figure 1: Study area map

Rainfall

Villupuram district receives rainfall from both southwest and northeast monsoons. The annual normal rainfall for the district is 1046.8 mm (41.2in). The driest month is march with 6 mm (0.24in) with an average of 222 mm (8.7in) per annum, the most precipitation falls in October.

Climate

The district enjoys a tropical climate. The highest temperatures are recorded during May and June. The mean daily minimum and maximum temperature are 24.6 to 32.0° C. The average annual temperature 28.4.^{0}c

Topography

The general geological formation of the district appears to be simple. The greater part of it is covered by the Metamorphic rocks belonging to Genesis family. There are also three great groups of sedimentary rocks belonging to different geological periods. The Kalrayan Hills in the north represents a continuous range of hills covered with some thorny forests and vegetation .Among the hills, the most beautiful part of the district lies, round about the Gingee Hills.[13]

3. MATERIALS AND METHODS

Collection of water samples

Groundwater samples were collected from 20 locations within the study area during month of Jan 2017& Sep 2017, Sampling is done at each station in polythene bottles of two-litre capacity. The samples were analyzed for various water quality parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Alkalinity, Total Hardness (TH), Chloride, Sulphate, Nitrate, Iron, Calcium and Magnesium Fluoride and Ammonia were determined using standard methods.[14] The method used for estimation of various Physico-chemical parameters are shown in Table-1. Reagents used for the present investigation were A.R. Grade and double distilled water was used for preparing various solutions. Methods used for estimation of various Physico-chemical parameters are shown in Table-1.

Table 1: Methods used for estimation of Physico - Chemical parameters

S. No	Parameter	Methods
1	P^H	P^H Meter
2	Electrical Conductivity	Conductivitymeter
3	Total Hardness	EDTA Titration
4	TDS	Filtration method
5	Alkalinity	Indicator method
6	Chloride	Argentometric method
7	Nitrate	Phenol disulphonic acid method
8	Sulphate	Nephelometry Method
9	Fluoride	SPADN spectrophotometric method
10	Calcium	EDTA titration
11	Magnesium	EDTA Titration
12	Iron	PHENANTHROLINE Spectrometry
13	Ammonia	Calorimetric method

4. RESULTS AND DISCUSSION

The graphic representations are used to discuss the water-rock interaction in the study area. Hydrogeological facies were worked out by developing Piper, Durov, stiff and Scholler diagrams using Aqua chem software.

4.1. Schoeller and Stiff Diagrams

Geochemistry of groundwater is discussed by means of its major ions. Stiff [15] diagram is a graphical representation of the different water ions. The average ionic composition analysis by stiff diagram . Schoeller [16] diagram is also used to present average chemical composition of villupuram district groundwater.

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The relative tendency of ions in mg/l shows Ca>Mg> Na and Cl > HCO3> SO4 in January 2017.

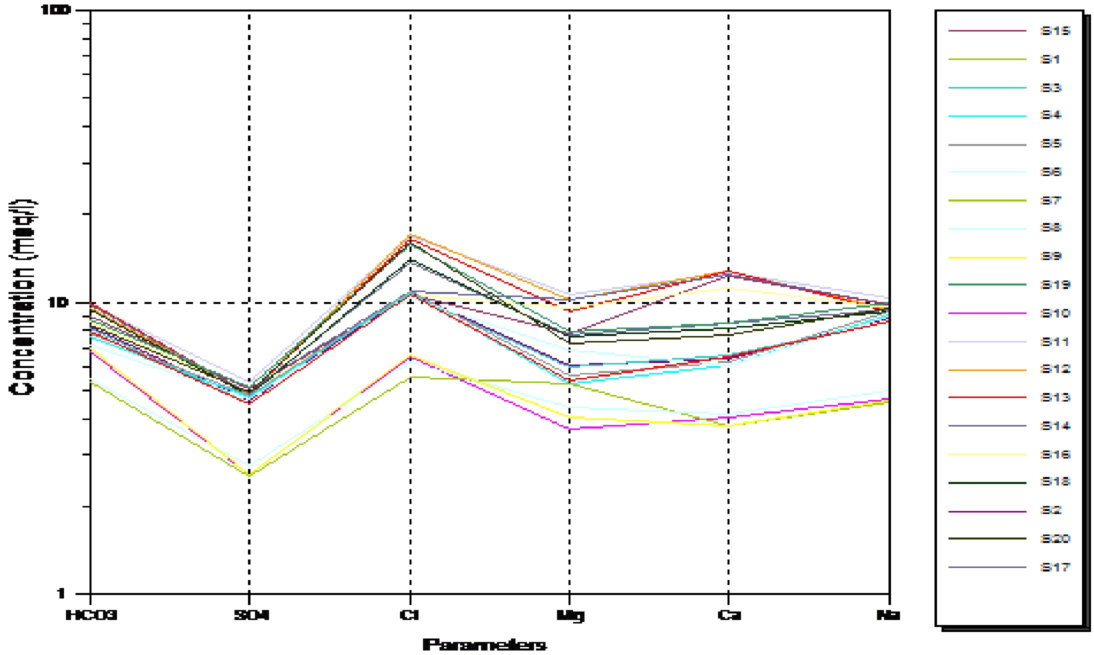

Fig 2: Schoeller diagram showing average composition of major cations and anions in mg/l and meq/l of the groundwater of villupuram. Collected during Jan 2017.

The relative tendency of ions in mg/l shows Ca>Mg> Na and Cl > HCO3> SO4 in September 2017.

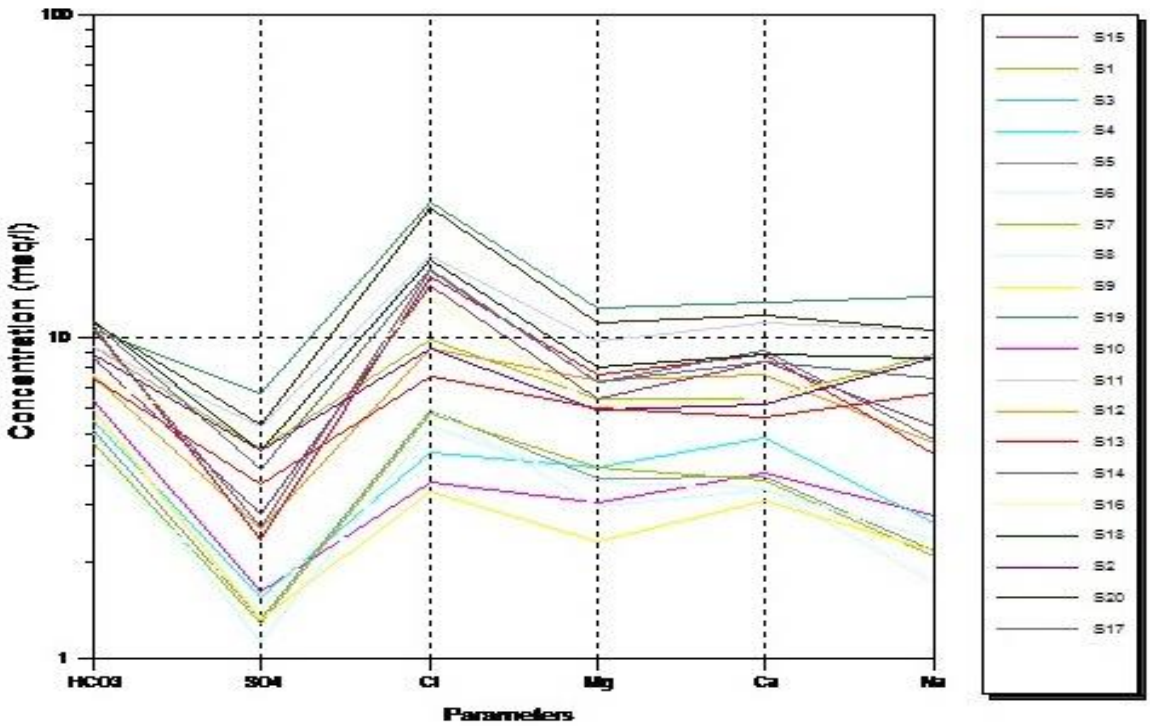

Fig 3: Schoeller diagram showing average composition of major cations anions in mg/l and meq/l of the groundwater of villupuram. Collected during Sep 2017.

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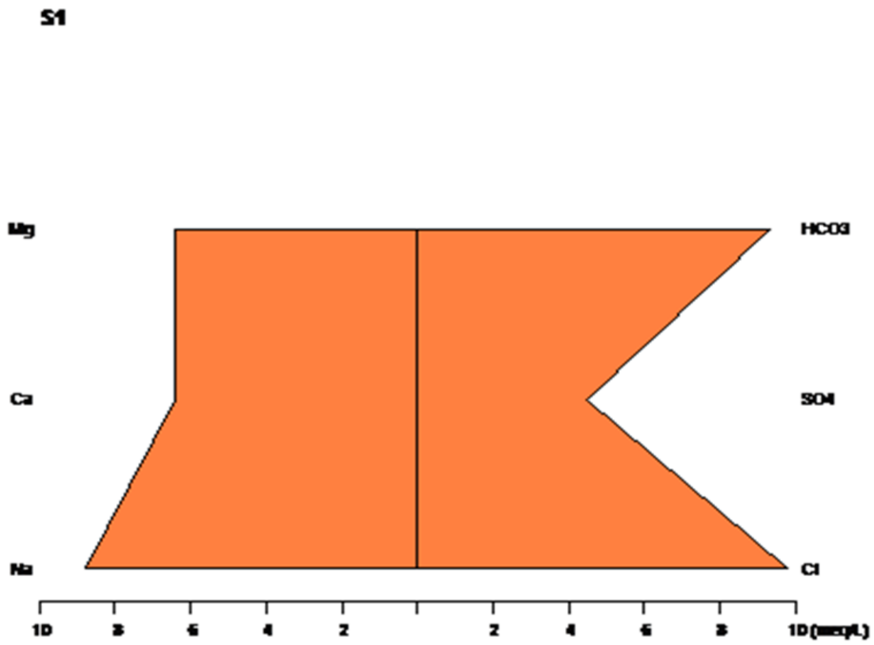

Figure 4: Stiff diagram showing average composition of major cations and anions in mg/l and meq/l of the groundwater of villupuram ,Collected during Jan 2017

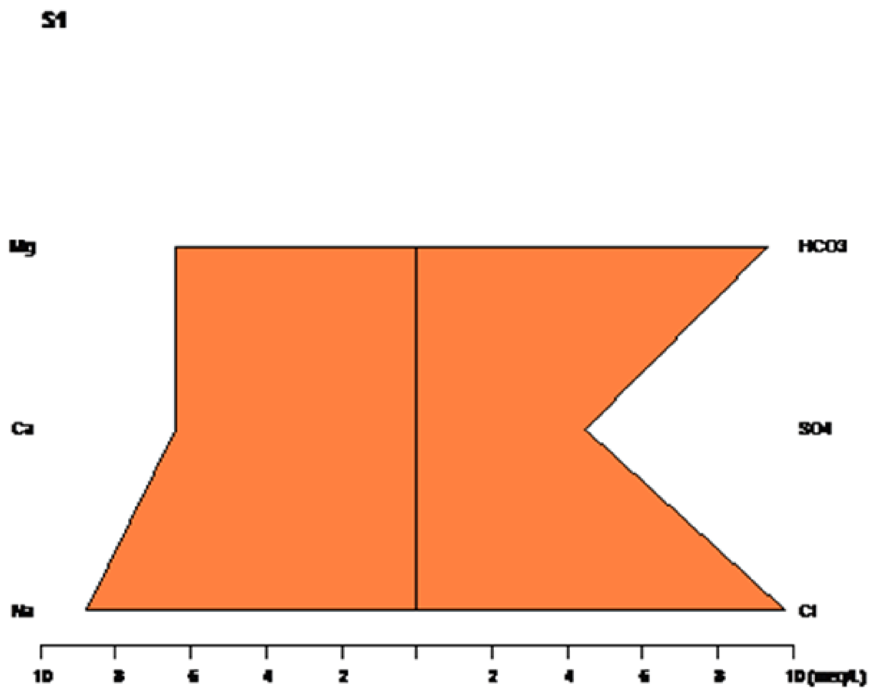

Figure 5: Stiff diagram showing average composition of major cations and anions in mg/l and meq/l of the groundwater of villupuram ,Collected during Sep 2017

4.2. Trilinear Diagram (Piper Diagram)

These diagrams reveal the analogies, dissimilarities and different types of waters in the study area, which are identified and listed in the concept of hydrochemical facies was developed in order to understand and identify the water composition in different classes. The Aquachem software was used for plotting the piper diagram [17].

Classification diagram for anion and cation facies in the form of major-ion percentages.

A- Calcium type

B- NO Dominant type

C- Magnesium type

D- Sodium and potassium type

E- Bicarbonate type

F- Sulphate type

G- Chloride type

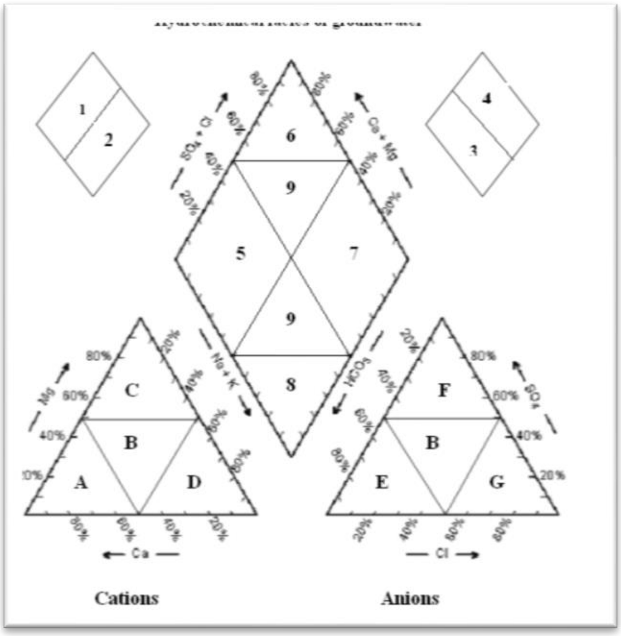

Figure 6: Classification of Hydrochemical facies.

Characteristics of corresponding subdivisions of diamond-shaped fields

1. Alkaline earths exceed alkali metals.
2. Alkali metals exceed alkaline earths.
3. Weak acidic anions exceed strong acidic anions.
4. Strong acidic anions exceed weak acidic anions.
5. Mg-HCO_3 type
6. Ca-Cl type
7. Na-Cl type
8. Na-HCO_3 type
9. Mixed type (NO cation-anion exceed 50%

In January 2017 all the samples (100%) are occupy middle upper side of the diamond shape. This group indicates mixed water (chloride-calcium and chloride magnesium water type).

Within the Cation triangle (left side diagram), all of the samples (100%) fall B in which represents no dominant ion type water.

Within the Anion triangle (right side diagram) **B** represents no dominant ion type water with the coverage of 100% area.

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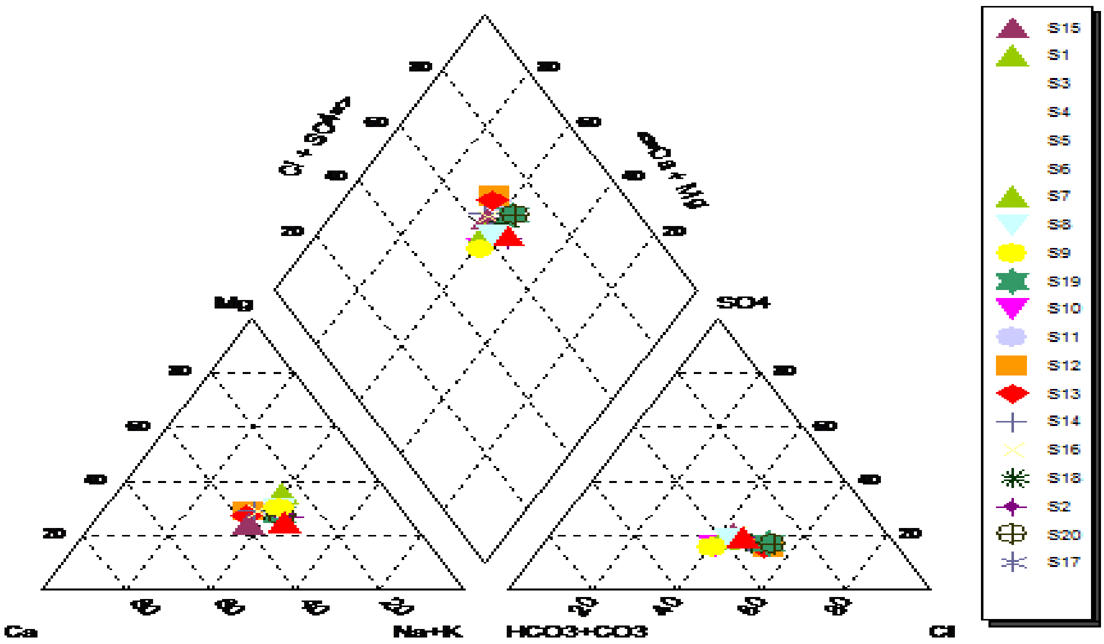

Figure 7: piper diagram for Jan 2017

In September 2017, Most of the samples (80%) are occupy middle upper side of the diamond shape. This group indicates mixed water (chloride-calcium and chloride magnesium water type). 20% of samples occupy the left side corner of the diamond shape, where these samples belong to Mg-HCO_3water type).

Within the Cation triangle (left side diagram), all of the samples (100%) falls B represents no dominant ion type water.

Within the Anion triangle (right side diagram) **B** represents no dominant ion type water with the coverage of 70% area. Anion triangle **G** represents the Cl (20%) ion type water Anion triangle **F** represents the HCO_3 ion (10%) type water.

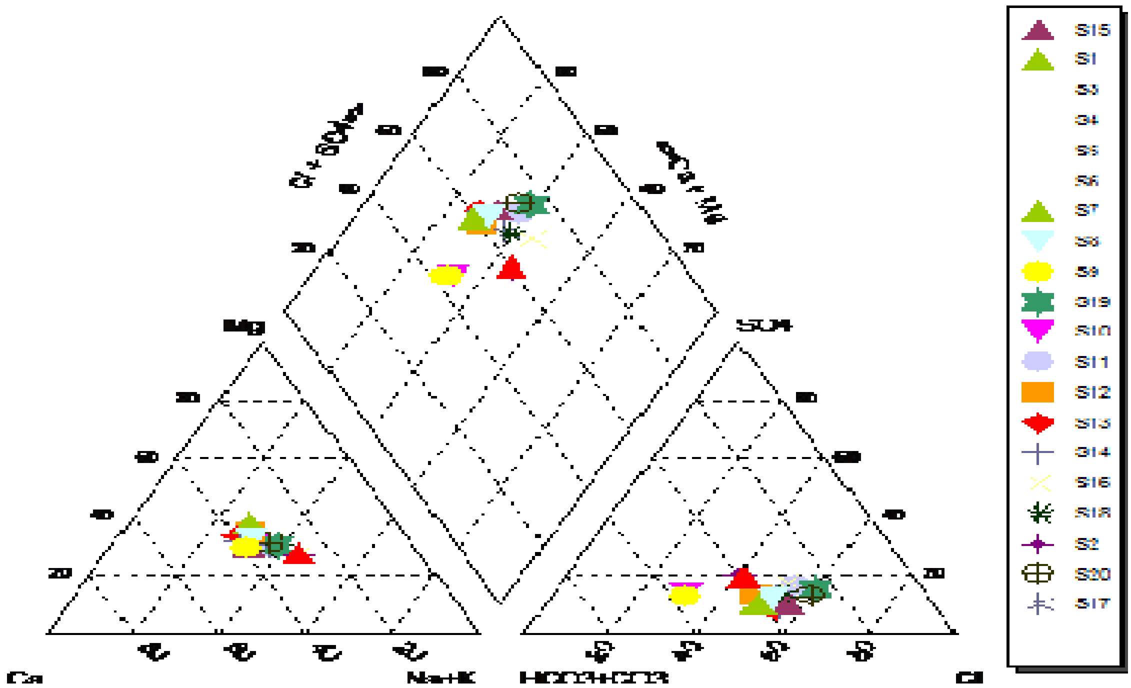

Figure 8: piper diagram for Sep 2017

4.3. Durov diagram

Durov, [18] introduced another diagram which provides more information on the hydro chemical facies by helping to identify the water types and it can display some possible geochemical processes that could help in understanding quality of groundwater and its evaluation. The diagram is a composite plot consisting of 2 ternary diagrams where the cations of interest are plotted against the anions of interest; sides form a binary plot of total cation vs. total anion concentrations; expanded version includes electrical conductivity (µS/cm) and pH data added to the sides of the binary plot to allow further comparisons.

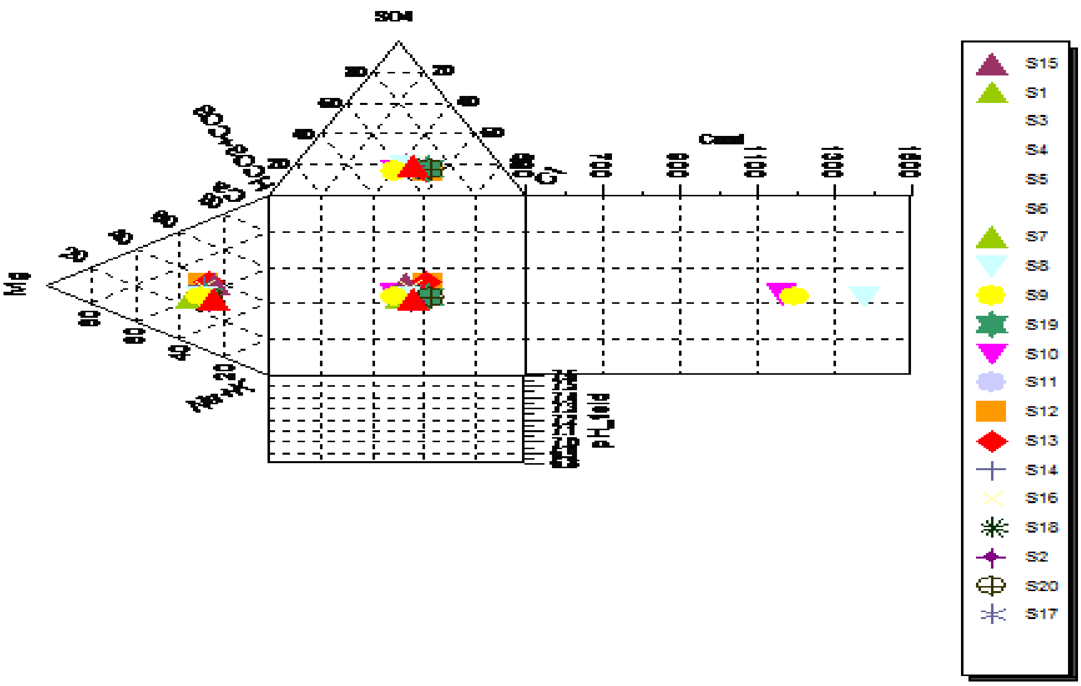

Figure 9: The Durov Diagram for the major cations and anions was plotted for ground water colleted during Jan 2017

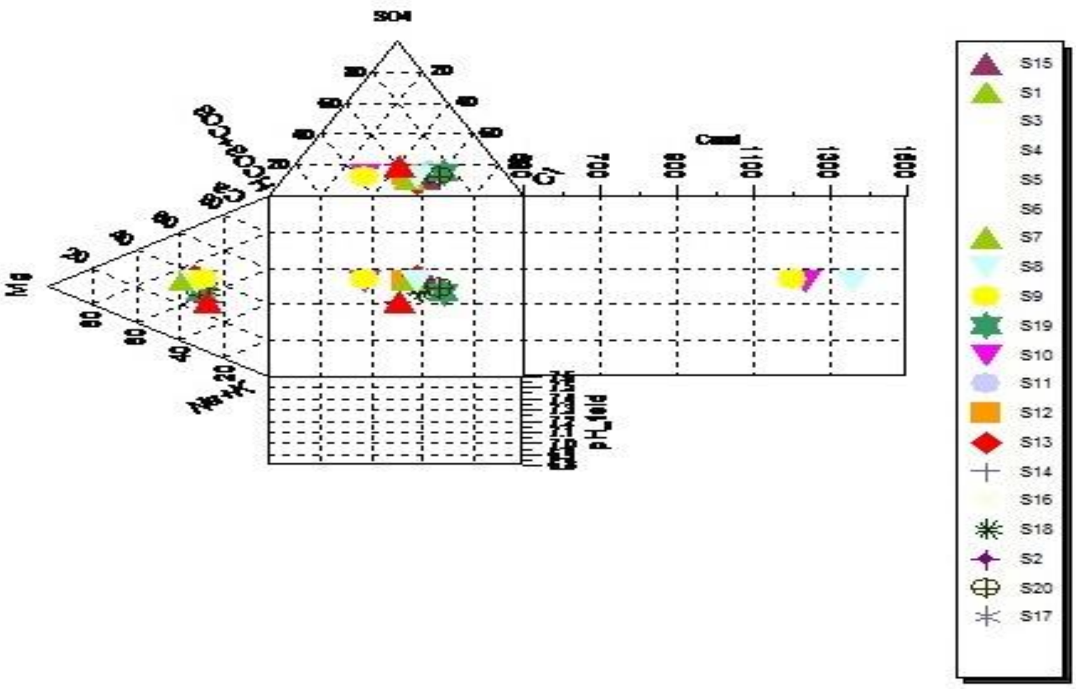

Figure 10: The Durov Diagram for the major cations and anions was plotted for ground water collected during Sep 2017

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Table 2: Physico-chemical parameter of ground water collected during the month of January 2017

Sample	P^H	EC	TDS	TH	Alkalinity	Cl	NO_3	SO_4	F	PO4	Na	K	Ca	Mg	Mn	Fe	NH_3
S1	7.4	2480	1732	580	482	378	34	215	0.3	1.2	198	52	131	66	0	0	0.82
S2	7.3	2520	1780	570	503	382	36	221	0.4	1.4	204	60	128	74	0	0.1	0.79
S3	7.5	2510	1750	540	498	376	41	216	0.4	1.3	199	59	132	73	0	0.1	0.86
S4	7.6	2670	1696	521	465	381	26	226	0.8	0.9	209	50	122	64	0	0	0.68
S5	7.2	2690	1696	512	476	386	24	231	0.7	1	214	54	125	68	0	0	0.84
S6	7.2	2680	1694	521	435	367	22	223	0.8	1.4	206	69	122	83	0	0	0.6
S7	7.2	1645	1124	315	324	198	36	122	0.6	1.6	105	50	76	64	0	0	0.5
S8	7.1	1375	1160	312	336	222	42	132	0.5	1.7	115	39	83	53	0	0	0.45
S9	6.8	1196	1276	289	427	234	37	123	0.2	1.4	106	35	76	49	0	0	0.6
S10	6.9	1159	1297	285	413	231	43	124	0.3	1.1	107	31	81	45	0	0	0.54
S11	7	4100	2963	1145	602	602	91	256	0.4	1.7	239	115	254	129	0.2	0.5	2.2
S12	7.1	3930	2830	1112	587	611	86	234	0.3	1.8	217	110	256	124	0.1	0.4	2.4
S13	7.3	4150	2939	1078	607	587	84	232	0.2	1.9	215	99	258	113	0.1	0.5	2.3
S14	7.5	3840	2796	1034	543	387	75	242	0.9	1.8	225	111	249	125	0	0.1	0.1
S15	7.4	4050	2882	1124	546	375	72	243	1.1	1.6	226	81	248	95	0	0.1	0.2
S16	7.2	3860	2794	1167	524	379	73	236	0.8	1.1	219	102	225	116	0	0.2	0.1
S17	7.3	2780	1990	856	598	487	121	235	0.3	0.9	218	80	170	94	0	0	0.45
S18	7.2	2790	1997	734	579	495	124	231	0.2	1.2	214	79	163	93	0	0	0.51
S19	7.4	2796	1990	879	534	562	113	246	0.1	0.8	229	82	169	96	0	0	0.52
S20	7.5	2789	1982	823	512	567	116	237	0.2	0.7	220	74	156	88	0	0	0.56

Table 3: Physico-chemical parameter of ground water collected during the month of September 2017.

Sample	P^H	EC	TDS	TH	Alkalinity	Cl	NO_3	SO_4	F	PO4	Na	K	Ca	Mg	Mn	Fe	NH_3
S1	7.7	2565	1870	623	567	346	43	216	0.3	0.8	202	61	128	78	0	0	0.16
S2	7.8	2500	1750	610	540	325	40	213	0.2	0.93	199	55	124	72	0	0	0.19
S3	7.5	2345	1657	534	456	267	32	168	0.1	0.8	154	56	113	73	0	0	0.11
S4	7.7	1942	1367	435	334	156	27	75	0.1	0.5	61	31	98	48	0	0	0.1
S5	7.6	1423	996	368	312	210	20	64	0.2	0	50	27	74	44	0	0	0
S6	7.7	1554	926	258	304	187	16	54	0.1	0	40	26	68	43	0	0	0
S7	7.8	1645	932	312	287	206	24	62	0.2	0.1	48	31	72	48	0	0	0.12
S8	7.6	1357	856	289	256	213	18	68	0.1	0	54	19	67	36	0	0	0.11
S9	7.7	1198	839	272	360	118	15	64	0.2	0	50	11	62	28	0	0	0
S10	7.5	1234	934	311	387	126	26	78	0.2	0.1	64	20	76	37	0	0	0
S11	7	4150	2912	1090	565	635	87	254	0.4	0.26	240	87	223	118	0.5	0.1	1.95
S12	7.3	2100	1470	750	460	325	55	122	0.2	0.13	108	72	152	89	0	0	0.28
S13	7.6	3450	2234	1124	657	546	78	113	0.4	0.22	99	76	178	93	0.4	0.1	0.18
S14	7.8	3546	2345	1134	643	567	87	124	0.5	0.21	110	71	182	88	0.4	0.1	0.19
S15	7.6	2980	1995	768	523	512	73	135	0.4	0.12	121	61	167	78	0.3	0.1	0.12
S16	7.2	2800	1960	630	464	475	65	213	0.2	0.93	199	57	128	74	0	0	0.28
S17	7.3	3534	2456	877	678	580	84	186	0.4	0.67	172	71	168	88	0.1	0.1	0.16
S18	7.1	3680	2564	932	680	612	98	213	0.3	0.62	199	81	176	98	0	0	0.11
S19	7	4700	3290	1260	640	930	75	319	0.4	0.29	305	98	256	149	0	0	0.37
S20	7.6	3945	2680	1124	678	887	86	256	0.5	0.15	242	86	235	135	0.1	0	0.25

5. CONCLUSION

Many researchers have studied the groundwater quality, and each of them has used different methods for research. Nevertheless, studies in which different methods are used to assess water quality, can provide more comprehensive view of the future management of groundwater. In this study, groundwater quality was assessed in some areas of villupuram district by uses of Piper, schoeller, stiff and Durov diagrams water type and its components can be easily realized. Results, showed the concentrations of major cations and anions as Ca >Mg> Na & Cl > HCO3> SO4. the prominent types of water are chloride-calcium and chloride magnesium type. In general, higher concentration of ions in the groundwater occurs due to weathering of silicate rocks and also from human activities, besides the evaporation which leads to the high concentration of ions there by increasing the chemical budget of groundwater.

REFERENCES

[1] Arain M B, Kazi T G, Jamali M K, Jalbani N, Afridi H I,Shah A, (2008) Total dissolved and bio available elements in water and sediment samples and their accumulation in Oreochromismossambicus of polluted Manchar Lake.Chemosphere, 70(10): 1845--1856.

[2] Shyamala, R., Shanthi, M. and Lalitha, P. (2008).Physiochemical analysis of bore well water samples of Telungupalayam area in Coimbatore District, Tamilnadu, India. E-Journal of Chemistry, 5(4), 924-929.

[3] Garg V K, Chaudhary A, Dahiya S D, (1999) Indian J.Environ Prot, 19 (4): 267.

[4] Gupta D P, Saharan S J P, (2009) Physiochemical analysis of ground water of selected area of Kaithal city (Haryana)India.Researcher, 1(2): 1--5.

[5] Olayinka K O, (2004) Studies on industrial pollution in Nigeria: The effect of textile effluents on the quality of ground water in some parts of Lagos. Nigerian Journal of Health and Biomedical Sciences, 3: 44--50.

[6] Rahmani A (2010). Study of groundwater quality changes trend(case study: Qaemshahr – Joybar, Mazandaranprovince). MS Thesis, Natural Resources Faculty of Sari.69-93.

[7] Mohamadi M, MohamadiGhale Ney M, Ebrahimi K (2011). Temporal and spatial variation of groundwater quality in Qazvin. Journal of Iran Water Researc, 5(8): 41-52.

[8] Babiker S, Mohamed MAA, Hiyama T (2007). Assessing groundwater quality using GIS. Water resource Manage. Springer science + Business Media B.V.21:699-715.

[9] Mahdavi M (2011). Applied Hydrology. in: Tehran University 9th ed. Tehran, Iran.

[10] Nouri J, Karbassi AR, Mirkia S (2008) Environmental management ofcoastal regions in the Caspian Sea. Int J Environ SciTechnol5(1):43–52

[11] Singh KP, Malik A, Mohan D, Sinha S (2004) Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India): a case study. Water Res38(18):3980–3992

[12] Appelo CA, Postma D (1999) Geochemistry, groundwater and pollution. Balkema, Rotterdam

[13] Tamilnadu water supply and Drainage board

[14] APHA, (2005) Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WPCF. Washington D.C.

[15] Stiff, H.A., Jr., (1951). The interpretation of chemical water analysis by means of patterns: Journal of Petroleum Technology, v. 3. no. 10, p. 15-17.

[16] Scholler,H, Geo chemistry of ground water ,In ground water studies –An international guide for research and practice, UNESCO, Pris ,pp1-18

[17] Ramamoorthy.p ,Rammohan.v , (2014) Assessment of ground water quality in varahanadhi sub basin in Tamilnadu, India, India, international journal of water research, *2(1):10-15.*

[18] Piper, A.M. (1944) “A graphic procedure in the geochemical interpretation of water analysis”, American Geophysical Union Transactions, Vol.25, pp.914-923 .

[19] Durov, S. A. (1948) Natural waters and graphical representation of their composition. Dokl.Akad.Nauk. USSR 59,87-90.