Indian Journal of Geo Marine Sciences
Vol. 46 (01), January 2017, pp. 196-202

Evaluation of the groundwater quality feasibility zones for Irrigation purpose in Salem district Tamilnadu India

Arulmozhi.S[1*] & Dr. Prince Arulraj.G[2]

[1]Department of Civil Engineering, Excel College of Technology, Coimbatore, Pin -637303, Tamil Nadu, India.
[2]Department of Civil Engineering, SNS College of Technology, Coimbatore, Pin- 641042, Tamil Nadu, India.

[*][E-mail: arul3345@gmail.com]

Received 13 May 2015 ; revised 19 May 2015

Groundwater samples from 26 bore wells were collected at various locations in Salem District during pre monsoon period (June to July 2013) and post monsoon period (December 2013 – January 2014) were analyzed for their physicochemical characteristics. Each parameter was compared with the standard permissible limits of the parameter as prescribed by the World Health Organization (WHO).

[**Key Words:** Underground; Groundwater quality; Physicochemical characteristics; Hydrochemical analysis; Salem district]

Introduction

Groundwater is one of the most precious natural resource of drinking water for the majority of the population. At present about one fifth of all the water used in the world is obtained from groundwater resources[1]

Groundwater is a valuable natural resource that is essential for human health, socio-economic development, and functioning of ecosystems[2]. Water logging and salinity in the case of agricultural use and environmental pollution of various limits occurs as a result of mining, industries and municipal use etc[3]. Transport of nutrients (primarily forms of nitrogen and phosphorus) to lakes and resulting accelerated eutrophication are serious concerns for planners and managers of lakes in urban and developing suburban areas of the country[4]. The multivariate statistical techniques such as cluster analysis, factor analysis, principal component analysis and discriminant analysis have widely been used as unbiased methods in analysis of water-quality data for drawing meaningful information[5].

The ionic concentrations were found to be higher than the permissible limits of WHO standards, due to leaching and surface run off of chemical fertilizers from agricultural lands[6]. Water quality assessment involves evaluation of the physical, chemical, and biological nature of water in relation to natural quality, human effects, and intended uses, particularly uses which may affect human health and the health of the aquatic system itself[7]. SAR is widely used to assess excessive sodium in irrigation water. It is calculated from the ratio of sodium to calcium and magnesium. The latter two ions are important since they tend to counter the effects of sodium. There are two different types of salt problems exist due to irrigation water. The first type is associated with the salinity and the second type is associated with the sodium. Soils may either be affected by salinity or by both salinity and sodium[8]. The impact of high concentrations of TDS in groundwater is used for drinking purpose with respect to medical norms were analyzed[9].

Excessive sodium content in water renders it unsuitable for soils containing exchangeable Ca and Mg ions. If the percentage of Na to (Ca + Mg + Na) is considerably above 50 in irrigation waters, soils containing exchangeable calcium and magnesium will take up sodium in exchange for calcium and magnesium causing de-flocculation and impairment of the tilth and permeability of soils[10]

Study Area

Salem District in Tamil Nadu is geographically situated between 11°14´ and12°53´ N and 77

°44´ and 78° 50´ E covering an area about 5245 Km^2. On the Northern side, it is bounded by Dharmapuri District; on the Western side, Erode District; on the Eastern side, Viluppuram District and on the Southern side, Namakkal and Tiruchirappalli Districts. Salem District consists of nine Taluks viz., Attur, Edappadi, Gangavalli, Mettur, Omalur, Salem, Sankari and Yercaud. Salem District experiences arid and semi-arid climate with an average annual minimum and maximum temperatures 19.7°C and 39.1°C respectively. The geographical formation of Salem District comprises hard rock types of granites, gneiss, charnockite, dunite, pyroxinite and quartzite. The minerals found in the District are magnesite, bauxite, quartz, felspar, limestone, soapstone, dunite, roughstone, granites. It receives rainfall in the South-west monsoon and North- east monsoon. Major industries in this District are steel and cottage industries. Paddy, Cholam, Cumbu, Ragi Redgram, Greengram, Blackgram, Horsegram, Turmeric, Sugarcane, Mango, Bannana, Tapiaco and Groundnut are the major food crops of this District. So, an attempt is made to study the water quality.The location of the study area is shown in the Figure 1

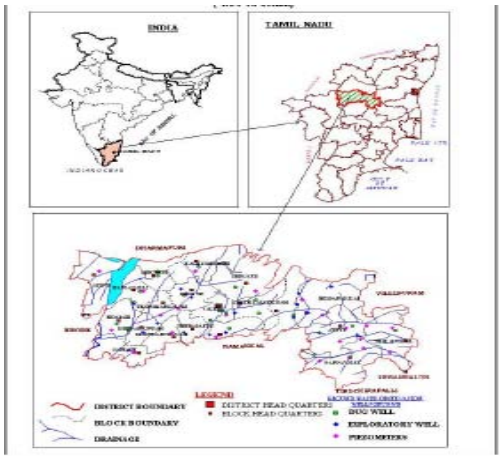

Figure 1 Study area

Materials and Methods

The water samples were collected from 26 sample locations covering almost all plain areas of the district leaving the areas which consists of structural hills. The sample locations are shown in Table 1.

The geographical location of each well was determined with a handheld GPS. Physical and chemical parameters were analyzed using the standard method suggested. EC and pH were analyzed as in situ using field kit. TDS was calculated from EC by an empirical formula TDS= 0.64*EC. Chloride, hardness, calcium, magnesium, carbonate and bicarbonate were determined by titration. Flame photometer was used to measure the sodium and potassium. Sulphate was determined by spectrophotometer. Analytical precision was maintained throughout the experiments.

A scheme for describing hydrochemical facies is presented[11] with tri-linear diagram. It is based on the method used[12]. This method is based on the dominance of certain cations and anions in solution. GW software package was used to plot the piper diagram. Water quality interpretation was done based on Sodium Adsorption Ratio (SAR), Soluble Sodium Percent (SSP) for irrigation purposes.

Results & Discussion

Quality of groundwater samples are estimated for both physical and chemical parameters based on IS 10500:1991. The water quality parameters of premonsoon and postmonsoon groundwater samples were presented in Table 2 and Table 3. It is found that the water quality parameters vary between the seasons.

SAR values of all the premonsoon groundwater samples are presented here in bar chart. SAR values of 6 samples of the study are in the range of 18 - 26, 20 samples are having more SAR values of > 26. Groundwater from 20 sample locations are very poor and they are not suitable for irrigation. Minimum value of SAR of the study area is found to be 27 at the sample S3 and the maximum value is 62 at the sample S14. SAR values of all the samples during premonsoon season are shown in Figure 2

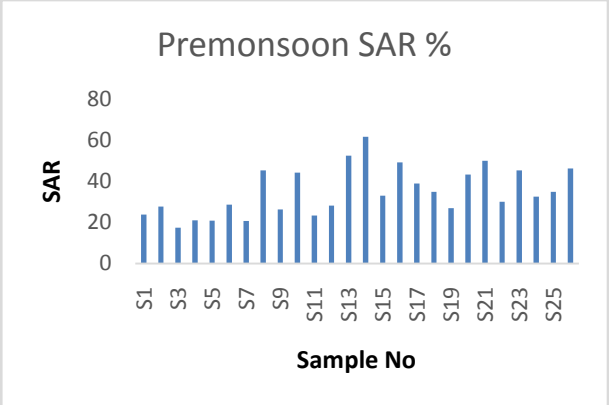

Figure 2 SAR for Premonsoon

SAR values of all the postmonsoon groundwater samples are presented here in bar chart. SAR values of 7 samples of the study are
in the range of 18 - 26, 19 samples are having more SAR values of > 26. Groundwaters from 19 sample locations are very poor and they are not suitable for irrigation. minimum value of SAR of the study area is found to be 22 at the sample S7 and the maximum value is 51 at the sample S5 and S25. SAR values of all the samples during postmonsoon season are shown in Figure 3.

Table 1 Details of the sample locations

Sample Location No	Sample ID	Name of the location	Longitude	Latitude
1	S1	Minampalli	77°25'54"	10°37'59"
2	S2	Siruvachur	78°45'20"	11°38'20"
3	S3	Attur	78°36'20"	11°35'55"
4	S4	Rajapalayam	78°48'48"	11°25'48"
5	S5	Kadampur	11°30'12"	78°35'58"
6	S6	Chinnakrishnapuram	78°30'30"	11°35'35"
7	S7	Kattur	78°16'00"	11°42'00"
8	S8	Sukkampatti	78°16'01"	11°43'04"
9	S9	Sendarapatti	78°31'20"	11°27'10"
10	S10	Ayothiyapattinam	78°14'02"	11°40'23"
11	S11	Nirmullikuttai	78°21'25"	11°42'35"
12	S12	Thalaivasal	78°45'30"	11°35'00"
13	S13	Ramanaickenpalayam	78°33'35"	11°37'41"
14	S14	Malliakarai	78°30'00"	11°34'20"
15	S15	Ettapur	78°28'30"	11°39'55"
16	S16	Sathapadi	78°41'50"	11°32'10"
17	S17	Pulluthikuttai	78°25'40"	11°46'15"
18	S18	Paithur	78°34'42"	11°32'19"
19	S19	Thumbal	78°31'05"	11°46'05"
20	S20	Illupanatham	78°45'29"	11°30'39"
21	S21	Panaimadal	78°28'55"	11°43'30"
22	S22	Pappanaickenpatti	78°34'08"	11°46'38"
23	S23	Mannarpalayam	78°23'56"	11°36'27"
24	S24	Karipatti	78°17'15"	11°39'55"
25	S25	Sokkanur Agraharam	78°43'20"	11°28'18"
26	S26	Singipuram	78°24'57"	11°38'00"

Table 2: Water quality Parameters of Premonsoon season

S. No.	Sample No	Location	Appearance	Odour	Turbidity	EC	TDS	pH	TA	TH	Ca	Mg	Na	K	NO3	Cl	F	SO4	PO4
1	S1	Minampalli	Colourless	None	0	1320	924	7.6	204	248	56	26	152	28	19	112	0.6	257	0
2	S2	Siruvachur	Colourless	None	0	1642	1149	7.4	268	312	71	33	200	40	18	196	0.6	291	0
3	S3	Attur	Slighty Brownish	Slightly obj.odour	0	791	554	7.7	176	184	42	19	97	20	10	64	1.2	140	0
4	S4	Rajapalayam	Colourless	None	0	1228	860	7.5	260	304	69	32	150	30	14	76	1.2	220	0
5	S5	Kadampur	Colourless	None	0	1025	718	8	184	200	45	21	120	40	14	100	0.8	183	0
6	S6	Chinnakrishnapuram	Colourless	None	0	1885	1320	7.3	236	368	75	43	220	70	26	216	0.4	337	0
7	S7	Kattur	Colourless	None	0	1064	745	7.5	184	212	50	21	124	40	15	104	0.6	190	0
8	S8	Sukkampatti	Colourless	None	0	4140	2898	7.3	492	880	210	85	550	120	57	476	1.2	640	0
9	S9	Sendarapatti	Colourless	None	0	1824	1277	7.4	216	340	83	32	200	60	25	180	1	326	0.6
10	S10	Ayothiyapattinam	Colourless	None	0	3870	2709	7.9	384	652	147	68	460	140	47	672	0.6	590	0.5
11	S11	Nirmullikuttai	Colourless	None	0	1245	872	7.4	120	212	51	20	140	52	15	220	1	223	0

12	S12	Thalaivasal	Colourless	None	0	3070	2149	7.3	296	692	147	78	300	40	40	392	0.8	549	0
13	S13	Ramanaickenpalayam	Colourless	None	0	1939	1357	7.3	176	216	46	24	310	120	22	284	0.8	347	0
14	S14	Malliakarai	Colourless	None	0	2790	1953	7.4	252	312	66	36	440	40	32	360	1.4	499	0
15	S15	Ettapur	Colourless	None	0	956	669	7.6	112	116	22	14	140	16	12	108	1.4	171	0
16	S16	Sathapadi	Colourless	None	0	3300	2310	7.6	412	448	94	51	420	120	40	352	1.2	590	0
17	S17	Pulluthikuttai	Colourless	None	1	1712	1198	7.9	216	232	51	25	240	28	21	176	1.2	306	0
18	S18	Paithur	Colourless	None	0	1472	1030	7.4	168	240	54	25	220	12	17	240	1.2	263	0.4
19	S19	Thumbal	Colourless	None	0	1054	738	7.3	124	136	30	14	126	74	13	176	1.2	188	0
20	S20	Illupanatham	Colourless	None	0	1856	1299	7.3	228	236	54	24	270	20	24	220	0.4	332	0
21	S21	Panaimadal	Colourless	None	0	1440	1008	7.4	120	148	34	15	250	40	18	248	0.6	257	0.6
22	S22	Pappanaickenpatti	Colourless	None	1	884	619	7.2	84	96	22	10	120	46	12	164	1	148	0
23	S23	Mannarpalayam	Colourless	None	0	1930	1351	7.4	232	260	64	24	300	16	20	224	0.8	345	0
24	S24	Karipatti	Colourless	None	0	1382	967	7.6	168	184	58	10	190	36	14	164	0.4	247	0
25	S25	Sokkanur Agraharam	Colourless	None	0	1515	1061	7.5	184	204	42	24	200	50	15	180	1.2	271	0
26	S26	Singipuram	Colourless	None	1	3830	2681	7.5	456	716	152	81	500	160	35	456	0.6	685	0

Table 3: Water quality Parameters of Postmonsoon season

S. No.	Sample No	Location	Appearance	Odour	Turbidity	EC	TDS	pH	TA	TH	Ca	Mg	Na	K	NO3	Cl	F	SO4	PO4
1	S1	Minampalli	Colourless	None	0	1191	834	7.81	92	168	46	12	198	20	10	162	0	270	0
2	S2	Siruvachur	Colourless	None	0	1504	1053	7.02	176	232	58	21	260	22	14	212	0.2	276	0
3	S3	Attur	Colourless	None	0	1890	1323	7.33	272	308	72	31	240	60	24	192	1	372	0
4	S4	Rajapalayam	Colourless	None	0	3460	2422	7.32	372	644	146	67	370	90	19	480	0.2	620	0
5	S5	Kadampur	Colourless	None	0	3700	2590	7.62	428	576	126	62	490	60	36	532	0	680	0
6	S6	Chinnakrishnapuram	Colourless	None	0	1003	702	8.02	140	176	40	18	124	18	9	136	0.2	177	0
7	S7	Kattur	Colourless	None	0	710	497	8.13	92	100	34	4	96	20	8	96	0.2	86	0
8	S8	Sukkampatti	Colourless	None	0	1375	963	7.32	144	200	50	18	192	20	8	186	1.2	240	0
9	S9	Sendarapatti	Colourless	None	0	1814	1270	7.32	128	252	67	20	290	30	21	252	0.6	354	0
10	S10	Ayothiyapattinam	Colourless	None	0	1564	1095	7.58	168	292	69	29	184	20	10	216	0	280	0
11	S11	Nirmullikuttai	Colourless	None	0	1771	1240	7.29	136	248	62	22	290	30	19	236	0.4	346	0
12	S12	Thalaivasal	Colourless	None	0	1936	1355	7.82	304	312	74	31	280	30	26	200	0.6	389	0
13	S13	Ramanaickenpalayam	Colourless	None	0	1751	1226	8.01	240	252	59	25	240	40	17	268	0.8	298	0
14	S14	Malliakarai	Colourless	None	0	1290	903	7.79	124	256	62	24	148	16	6	168	0.8	234	0
15	S15	Ettapur	Colourless	None	0	3100	2170	8.15	432	452	101	48	420	60	28	420	0.6	597	0
16	S16	Sathapadi	Colourless	None	0	3050	2135	7.18	340	460	102	49	420	46	25	432	0	559	0
17	S17	Pulluthikuttai	Colourless	None	0	1007	705	8.22	140	152	42	12	130	32	12	132	1	179	0
18	S18	Paithur	Colourless	None	0	3170	2219	7.92	468	516	115	55	430	60	41	376	0.8	635	0
19	S19	Thumbal	Colourless	None	0	1492	1044	7.94	216	244	61	22	188	28	14	204	0.2	255	0
20	S20	Illupanatham	Colourless	None	0	2880	2016	7.12	448	460	115	41	400	46	40	360	0.2	480	0
21	S21	Panaimadal	Colourless	None	0	1015	711	8.15	140	176	43	16	124	18	12	136	0.2	179	0
22	S22	Pappanaickenpatti	Colourless	None	0	1093	765	7.83	152	200	51	17	138	20	10	148	0.4	192	1.2
23	S23	Mannarpalayam	Colourless	None	0	3320	2324	7.56	452	500	114	52	420	70	40	532	0.4	551	0

24	S24	Karipatti	Colourless	None	0	2840	1988	7.46	264	576	126	62	310	35	12	360	0	560	0
25	S25	Sokkanur Agraharam	Colourless	None	0	3990	2793	7.45	488	640	146	66	520	60	46	576	0	787	0
26	S26	Singipuram	Colourless	None	0	1046	732	8.37	168	192	51	15	134	18	12	128	0.6	184	0

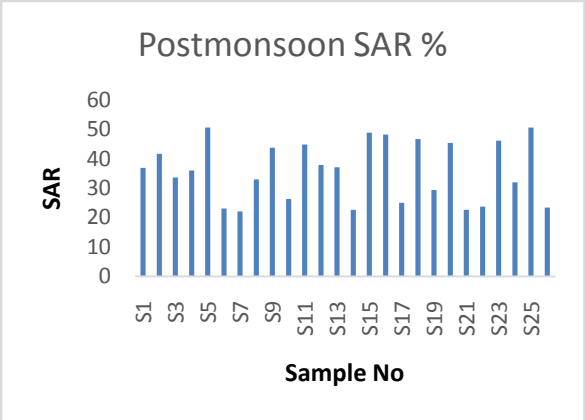

Figure 3 SAR for Postmonsoon

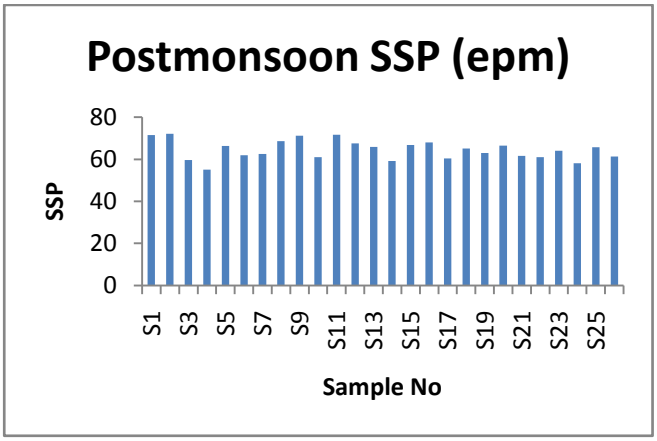

Figure 5 SSP for Post monsoon

SSP values of all the premonsoon groundwater samples are presented here in bar chart. SSP values of the premonsoon samples show that 12 samples of the study area contain SSP values above the permissible limit. SSP values of all premonsoon samples are shown in Figure 4. Minimum value of SSP is 52 epm in the sample S19 and the maximum value is 76 epm in the sample S14.

SSP values of all the postmonsoon groundwater samples are presented here in bar chart. SSP values of the postmonsoon samples show that 22 samples of the study area contain SSP values above the permissible limit. SSP values of all postmonsoon samples are shown in Figure 5. Minimum value of SSP is 55 epm in the sample S4 and the maximum value is 72 epm in the sample S1, S2, S11.

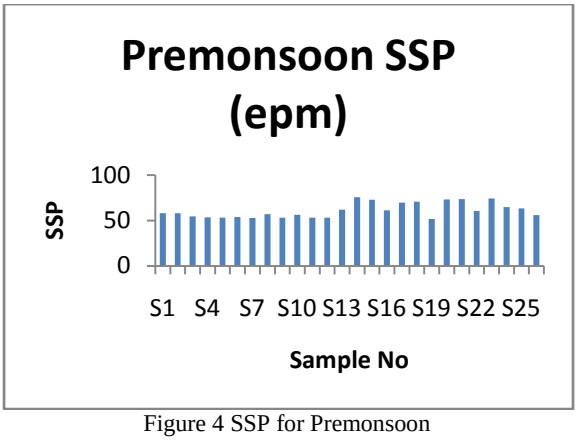

Figure 4 SSP for Premonsoon

The ESP values of all the premonsoon and postmonsoon groundwater samples are presented here in bar chart. ESP values of the premonsoon samples show that 1 sample of the study area contain ESP value above the permissible limit. The remaining 25 samples contain ESP values within the desirable limit. The minimum value of ESP of the study area is 8 epm at the sample S52 and the maximum value is 55 epm at the sample S14. ESP values of all samples are shown in Figure 6 and 84 % of the samples have the risk sodium accumulations due to ESP and the remaining 16% of the samples have no risk of sodium due to increase in ESP during premonsoon season.

ESP values of the postmonsoon samples show that 1 sample of the study area contain ESP value above the permissible limit. The remaining 25 samples contain ESP values within the desirable limit. Minimum value of ESP of the study area is 8 epm at the sample S8 and the maximum value is 55 epm at the sample S22. ESP values of all samples are shown in Figure 7 and 85 % of the samples have the risk sodium accumulations due to ESP and the remaining 15% of the samples have no risk of sodium due to increase in ESP during postmonsoon season.

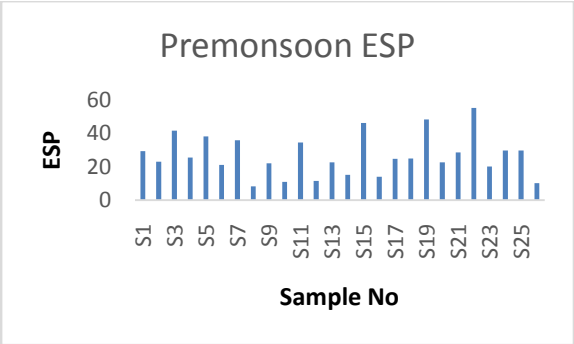

Figure 6 ESP for Premonsoon

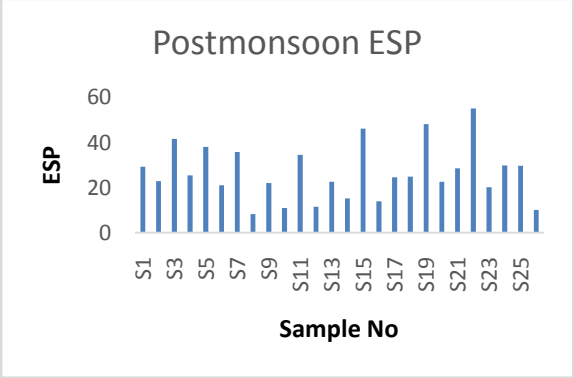

Figure 7 ESP for Post monsoon

Hydrochemical facies

Hydrochemical facies, cation and anion types of both the premonsoon and post monsoon seasons were analyzed and presented in Figure 8 and 9. The results observed from hydrochemical facies show that there is no specific cation – anion pair found in water samples of the study area. Facies of primary alkalinity exists in all the water sample from the location is generally considered as alkaline in nature.

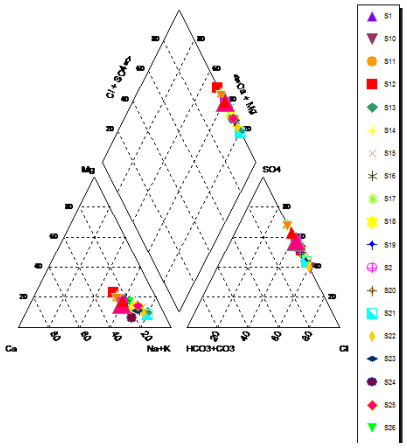

Figure 8 Hydrochemical facies of Premonsoon season

Sodium and potassium type cation is present in all the 26 samples during the premonsoon and postmonsoon season. This shows that the concentration of these cation exceed by 50% than other cations.

Bicarbonate type anion is present in all the 26 samples during the premonsoon and postmonsoon season. This shows that the concentration of these anion exceed by 50% than other anions.

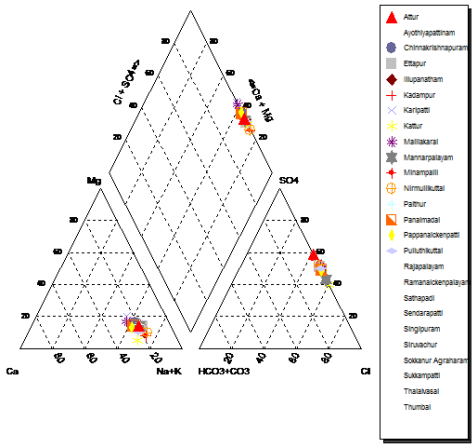

Figure 9 Hydrochemical facies of Postmonsoon season

There is no significant change in the hydro-chemical facies in the groundwater samples during the study period of premonsoon and postmonsoon seasons. Premonsoon season of the study period was June - July 2013. Postmonsoon season of the study period was December – January 2014. Predominant hydrochemical facies of both the season was of the type of Primary hardness and Primary salinity. Other hydro chemical facies present during premonsoon and postmonsoon season was of the type “Primary alkalinity”. This is represented by 98% of the total samples. The predominant hydrochemical facies of this season was found to be “Primary Hardness”.

Conclusion

Suitability of groundwater for drinking purpose when verified with IS:10500 exhibit that the groundwater can be utilised for drinking purpose. From the Table 2 and 3, it is clear the groundwater contains more amount of TDS, Total Hardness and Sulphate. Hence the groundwater samples need treatment to remove

the Hardness. Suitability of groundwater for irrigation purpose reveals based on the SAR, SSP and ESP. SAR of groundwater is found more for 20 and 19 samples during the premonsoon and postmonsoon seasons. SSP values is also found more for 12 and 22 samples during the premonsoon and postmonsoon seasons. Hence the ware is not suitable for irrigation purposes. ESP values of both the premonsoon and postmonsoon is found more for only 1 sample. Hence there is no risk of sodium interference in both the seasons. Hydrochemical facies indicate that primary salinity is more in premonsoon and postmonsoon samples. The hydrochemical facies of type primary hardness and primary alkalinity is found same in premonsoon season and postmonsoon. From the above two aspects, it can be stated that the groundwater may contains any soluble rocks and the rock dominance in the groundwater chemistry in the study area.

Acknowledgement

The authors express their gratitude to the reviewers of the manuscript; their suggestions have improved the manuscript substantially.

References

1. Raghunath, H.M., “Ground Water”, 3rd Edition, New Age International (P) Ltd, Publishers, New Delhi, 2007.
2. Zektser IS Groundwater and the environment: Applications for the global community, Boca Raton: Lewis.2000. p. 175.
3. Choubisa, S.L., Sompuria, K., Choubisa, D.K., Pandya, H., Bhatt,s.k. and Parmar, L. Fluoride content in domestic water sources of Dungarpur district of Rajasthan, Indian Jour, Environ. Health.,1995. v.37, pp.154 – 160.
4. USGS Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin.(Resources Investigations Report 02–4130)Impact of chemical fertilizers on water quality in selected agricultural areas of Mysore district, Karnataka, India, 2002.
5. Singh K. , Malik A. , Sinha S. , “Water quality assessment and apportionment of pollution sources of Gomti river (India) using multivariate statistical techniques- a case study”. Analytica Chimica Acta 2005., 538,355–374
6. Divya, Impact of chemical fertilizers on water quality in selected agricultural areas of Mysore district, Karnataka, India. International Journal of Environmental Sciences 2012,.Volume 2, No 3,
7. UNESCO/WHO/UNEP Water Quality Assessments—a guide to use of biota, sediments and water in environmental monitoring, 2nd edn. In: Chapman D (ed) Chapman & Hall Publishers. 1996., ISBN 0419215905(HB) 0419 216006(PB).
8. Fipps, G. “Irrigation Water Quality Standards and Salinity Management Strategies”, The Texas A&M University System, 1914.
9. Kavitha Batheja, Sinha, A.K., Gita Seth and Jaipal Garg, “Physico- Chemical Characteristics of Groundwater at Churu Tehsil, Rajasthan, India”, Journal of Environmental Science & Engg., 2007., Vol.49, No.3, pp.203-206,
10. Karnath, K.R. “Groundwater Assessment Development and Management”. Tata McGraw-Hill, New Delhi, 1999
11. Walton, W.C. “Groundwater resources evaluation”. McGraw-Hill, New York, 1970.
12. Piper, A.M. “A Graphic Procedure in the geochemical interpretation of Water Analysis”. USG Groundwater Publications, 1984., Vol.150, pp.313-322.