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Groundwater Quality Assessment of Suruli Watershed,Vaigai River Basin Tamilnadu India

KEYWORDS: Suruli Watershed, Irrigation, USSL (U.S. Salinity Laboratory diagram)

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ABSTRACT *Present research work to understand the groundwater quality mapping through GIS technology. So, in this connection the field work was executed at Suruli watershed is located at Dheni District. The 55 groundwater samples were collected from open wells in the various locations in study area. The samples were analyzed for major Cations and Anions.The results were evaluated in detailed and compared with WHO water quality standards for drinking purposes. An overall assessment of the water samples indicated that all parameters are within the permissible limit except in some same locations.Piper trilinear diagram interpretations were made to know the chemical type of the groundwater. It reveals that the subsurface water is alkaline earth (Ca+Mg) exceeds alkalies (Na+K) type.The groundwater falls under good to permissible (Wilcox) zone. It shows that it is good for irrigation use as per the classifications of Wilcox diagram interpretation. The SAR values were plotted in the USSL Staff diagram and found most of the groundwater samples belongs to C3-S1 (41.82%) class indicating that the groundwater could be used for all types of crops on soils of medium to high permeability. However, the concentration of sodium was in significant amount showing 7.27% of sites under "Excellent to good" and the 41.82% sites under "Good to permissible" zones.*

INTRODUCTION

Safe drinking water is a human birthright. It must fall among the highest priorities for every nation on earth. It is vitally important that water is free of disease-causing germs and toxic chemicals and pollutants (Report of the Third World Academy of Sciences, 2002). There has been a tremendous increase in the demand for fresh water due to growth in population. The quality of groundwater varies from place to place with the depth of water table. Therefore, groundwater quality assessment studies, is equally important as its quantity. Water quality is determined by the solutes and gases dissolved in the water, as well as the matter suspended in and floating on the water. It is a consequence of the natural physical and chemical state of the groundwater as well as any alternations that may have occurred as a consequence of human activity.

Geochemical processes in groundwater involve the interaction of country rocks with water, leading to the development of secondary mineral phases. The principles governing the chemical characteristics of groundwater were well documented in many parts of the world (Garrels and Christ, 1965; Stumm and Morgan, 1970; Swaine and Schneider, 1971; Frappe et al., 1984; Herczeg, et al., 1991; Som and Bhattacharya, 1992; Pawar, 1993; Wicks and Herman, 1994; Kimblin, 1995; Raju, 1998). This paper investigates the possible chemical processes of groundwater rock interaction in hard rock terrain.

GIS has emerged as a powerful technology for instruction, for research, and for building the stature of programs (Openshaw 1991; Longley 2000; Sui and Morrill 2004; Baker and Case 2000). Saraf et al., (1994) have conducted GIS based study and interpretation of groundwater quality data. Durbude et al., (2002, 2007) mapped the ground water quality parameters in Ghataprabha command area in GIS environment.

In the present study, groundwater samples have been collected and analyzed for various parameters such as, EC, pH, TDS, Ca, Mg, HCO_3, Cl, Na and K etc., the analysed results were taken in to GIS environment. In GIS, spatial distribution maps were prepared for the above parameters. And multiple thematic maps overlay analyses were carried out to find the bat suitable zone with respect to all elements.

STUDY AREA

The Sureli Ar watershed of Vaigai basin location of whole Taluk of Uttamapalyam and a small part of Periyakulam Taluk, located in the western corner of Theni district of Tamil Nadu. It lies between 9°34' 11" N to 10°09'17'' N latitudes, and 77°10'5"' E to 77°36'5" E longitudes covering an area of 1577.92 Sq. km out of which plain area covers 1008.10 Sq. km and Hilly with Forest area covers 569.82 Sq. km (Fig.1).

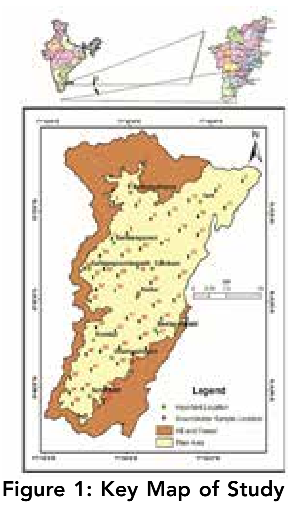

Figure 1: Key Map of Study Area

This is a linear valley located at the Catchment zone of the river Sureli Ar of Vaigai basin. Sureli Ar is located in the watershed situated amidst the hills that comprise the eastern arm of Western Ghats. The area around Sureli Ar is diversified by several ranges of hills, falls and rapids

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which impart to the region a picturesque appearance. The prominent mountain of the thesis area is the high wavy mountain and it is flanked on either side by hills. In the eastern portion, there is an intermountain valley called the Varshanad valley.

MATERIALS AND METHODS

Fifty five water samples are collected in May 2014 (Pre-monsoon) from different open wells which are almost uniformly distributed over the study area. Before a well water sample is taken, the well should be pumped for some time so that the sample will represent the Groundwater from which the well is field. All bottles should be rinsed with the water to be sampled before the sample for analysis is collected. If water samples are collected in glass bottles, sufficient air space may be provided, but if polythene bottles are used they may be provided, but if polythene bottles are used they may be completely filled. The locations of groundwater sampling stations are shown in the Fig. 1. pH and electrical conductance were measured within a few hours of collection by using Elico pH meter and conductivity meter. Ca and Mg were determined titrimetrically using standard EDTA, and chloride was determined by silver nitrate titration (Volgel, 1968). Carbonate and bicarbonate were estimated with standard sulphuric acid and sulphate was determined gravimetrically by precipitating $BaSO_4$ from $BaCl_2$. Na and K by Elico flame photometer (APHA, 1996). The for determination of suitability for irrigation use SAR, %Na and PI were calculated and plotted on USSL diagram (Richards, 1954), Wilcox diagram (1955) and Doneen diagram (1948) respectively.

The base map was prepared using toposheet nos. 58 F/8, 58 G/1, 2, 5 and 6. on 1:50,000 scale. Their attributes are added and analyzed in ArcGIS software. Spatial analysis tools were used for the preparation of interpolation map. The maps were interpolated by using inverse distance methods to generate the spatial distribution map.

RESULTS AND DISCUSSION

The hydro-chemical analysis data of groundwater samples for the pre-monsoon season are presented in Table 1. The pre-monsoon pH values are in the range of 6.9 to 8.95 indicating an alkaline nature. As per the (WHO, 1997) standards, 45 samples fall within the recommended limit (6.5 to 8.5) for human consumption. The conductivity value of the samples varies from 572 to 9340 μScm^{-1}. The TDS value varies from 199 to 1678 mg/l during the pre-monsoon season. Number of samples showed normal values of Conductivity (18 samples) and TDS (45 samples) falling within thepermissible limits (WHO, 1997). The alkalinity value varies from 7.82 to 281.92 mg/l during the pre-monsoon season 2014. The presence of carbonates, bicarbonates and hydroxides are the most common source of alkalinity in natural water. Bicarbonates represent the major form since they are formed in considerable amounts from the action of carbonates upon the basic materials in the soil.

The sodium concentration in the groundwater from study area varies between 1.38 to 316.02 mg/l. It can be observed from the table.1 that sodium concentrations in the groundwater from some of the wells in pre-monsoon season are very high and unsuitable for some of the drinking applications (WHO, 1997). Calcium, magnesium and total hardness in the groundwater are inter-related. Most of the samples showed normal values of calcium, magnesium and total hardness well within permissible limits(WHO, 1997) and thus the groundwater is not much hard. The chloride contents range from 10.99 to 843.95 mg/l. 43.64% of samples falls within thepermissible limit for drinking purpose (WHO, 1997).

Groundwater Quality Spatial Analysis for Drinking Use

It is an analytical technique associated with the study of location specific geographic phenomena together with their spatial dimensions and their associated attributes (like table analysis, classification, polygon classification and weight classification).

The calcium, magnesium, sodium, potassium, chloride, EC, TDS and pH thematic maps as described above have been converted into raster form considering 30m as cell size to get considerable accuracy. These were then reclassified and assigned suitable weightages for the spatial distribution maps and results are given below.

Data and Maps Analysis for Drinking

Each thematic map such as calcium (Fig.2), magnesium (Fig.3), sodium (Fig.4), potassium (Fig.5), chloride (Fig.6), sulphate (Fig.7), bi-carbonate (Fig. 8), pH (Fig.9) and TDS (Fig.9) provides certain clues on for the quality of groundwater. Spatial distribution map with respect to WHO standard 1997, these maps shows that small portion of the study area fall in permissible category except sulphate concentration. Most of the study area fell in desirable limit and rest of the very small portion is poor category. Detailed spatial information of individual element are given in the above said maps.

Sodium Adsorption Ratio

The sodium or alkali hazard in groundwater for irrigation is determined by the absolute and relative concentration of cations and is expressed in terms of Sodium Adsorption Ratio (SAR). There is a significant relationship between SAR values of irrigation water and the extent to which sodium is absorbed by the soil. If groundwater used for irrigation is high in sodium and low in calcium, the cation-exchange complex may become saturated with sodium.

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}} \quad ...... (3)$$

(All ions in epm)

A simple method of evaluating the high sodium in water is the Sodium Adsorption Ratio. (SAR). Calculation of SAR value for a given groundwater provides a useful index of the sodium hazard of that water for soils and crops. A low SAR of 2 to 10 indicates little danger from sodium; medium hazards is between 10 to 18 high hazards is between 18 to 26 and very high hazards is above 26. The lower the ionic strength of solution, the greater sodium hazards for a given SAR. The value of SAR in the groundwater samples of the study area ranges from 0.302 to 8.068 during pre-monsoon (Table 1). Majority of the samples in the study area fall under the category of low sodium hazards.

Pipers Trilinear Diagram

The Piper (1944) Trilinear Diagram is most useful to understand the chemical relationships among groundwater. The chemical quality data of the investigated area are used in Pipers Trilinear Diagram for graphical analysis (Fig. 11). It reveals that mostly of the groundwater samples fall in alkaline earth exceeds alkalies nature. The lithological composition of the aquifer's matrix is dominated by calcareous sandstone and clay layers, organized in the groundwater chemical evolution where the water–rock interaction processes are considered important in the definition of their calcium-bicarbonate type visible in a Piper diagram in which dispersion in the cation (calcium and magnesium)

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content of the groundwater samples is shown. This could be associated either to lithological heterogeneities or whichever with human activities.

Doneen's Permeability Index:

The soil permeability is affected by long term use of irrigation water. It is influenced by sodium, calcium, magnesium and bicarbonate contents of soil. Doneen (1964) has evolved a criterion for assessing the suitability of water for irrigation based on Permeability Index (PI):

PI =

$$\frac{Na+\sqrt{HCO_3}}{Ca+Mg+Na}\times 100 \text{.......... ....} (1)$$

Na,Ca Etc. values in epm

The majority of the samples fall under class-I (Fig.12) under sampling programs as per Doneen's classification (Table 2), which indicates that groundwater is good for irrigation.

Wilcox Diagram

Wilcox (1955) used sodium % and specific conductance in evaluating the suitability of groundwater to irrigation. Sodium-percentage determines the ratio of sodium to total cations viz., sodium, potassium, calcium and magnesium. All concentration values are expressed in equivalents per million. The results (Table 3) show that the groundwater near the upstream is good for irrigation and the contamination are found to be high near the downstream (Fig.13). This may be due to the effluents from the industries as well as the domestic sewages directed into the river.

USSL Diagram

U.S. Salinity Laboratory diagram (1954) interpretation is given in the Fig.14. The two most significant parameters of sodium and salinity hazards indicate usability for agricultural purposes. USSL classification of groundwater in the study area is given in Table 4. Thirty sites (41.82 %) samples occur within C_3–S_1 category. This category is predominant in the study area and accordingly it is suitable for irrigations purposes.

TABLE-1

CHEMIC AL COMPOSITION OF GROUNDWATER (Ionic concentrations are expressed in mg/L and EC in μScm^{-1})

Sample Location	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl	pH	EC*	TDS	TH	K. Ratio	RSC*	SAR*	Na%	Mg - Hazards
Kulasekarapattinam	117.23	82.69	52.90	19.55	3.2	1.5	43.23	333.32	8.30	600	770	162.23	0.18	-7.95	0.91	15.38	53.75
Teni	100.00	43.29	97.52	46.92	3.86	0.03	73.97	97.87	7.90	1241	529	100.90	0.50	-4.66	2.05	33.15	41.64
Bodinayakanur	53.91	51.80	174.34	35.19	5.27	0.13	79.73	165.95	7.90	1494	687	57.81	1.09	-1.55	4.07	52.17	61.29
Vayalpatti	81.16	39.52	81.65	11.73	2.6	2.45	9.61	195.03	8.35	3670	558	154.66	0.49	-2.25	1.86	32.72	44.52
Thrichendur	51.10	71.71	64.40	50.83	2.15	0.35	16.81	251.77	8.45	2160	531	61.60	0.33	-5.95	1.36	24.89	69.82
Kodungipatti	115.03	49.73	217.12	46.53	5.97	0.03	73.01	374.46	8.10	1918	1009	115.93	0.96	-3.83	4.26	48.99	41.61
Kodungipatti (B)	58.12	30.40	104.65	35.19	4.2	0.9	7.20	198.58	8.00	1883	552	85.12	0.84	-0.30	2.77	45.73	46.30
Odaipatti	23.85	38.79	71.99	30.50	1.62	0.03	36.98	10.99	7.90	720	232	24.75	0.71	-2.73	2.12	41.68	72.83
T.Mattupatti	82.16	48.03	55.20	14.08	6.95	0.09	40.83	78.01	7.95	1604	515	84.86	0.30	-1.01	1.20	22.97	49.07
Silamalai	105.81	111.75	81.88	29.72	4.19	0	81.65	336.87	6.90	1760	843	105.81	0.25	-10.28	1.32	19.74	63.51
Silamarathupati	81.16	50.46	159.85	46.92	5.8	1.05	45.63	216.31	8.10	2980	758	112.66	0.85	-1.35	3.43	45.87	50.61
Perumalgoundan-patti	103.21	78.43	143.75	43.01	3.25	2.15	40.83	450.34	8.25	3550	978	167.71	0.54	-6.20	2.60	35.01	55.60
Uppukottai	75.15	27.97	102.35	7.82	2.9	1.65	38.42	179.07	8.90	2900	559	124.65	0.74	-1.50	2.56	42.38	38.02
Dombucheri	61.12	31.01	88.55	13.29	2.95	0.2	50.43	182.62	8.90	2900	508	67.12	0.69	-2.45	2.30	40.74	45.54
Erranampatti	51.10	117.34	270.25	8.99	4.6	2.6	74.45	578.00	8.10	6860	1307	129.10	0.96	-5.00	4.76	49.06	79.10
Virapandi	79.16	31.62	142.60	19.94	2.8	0.4	33.62	274.82	7.90	1353	658	91.16	0.95	-3.35	3.43	48.63	39.69
Meenashipuram	75.15	63.48	119.83	53.18	3.91	0.003	79.73	256.73	8.10	2380	712	75.24	0.58	-5.06	2.46	36.74	58.19
Pannaipuram	36.07	26.75	67.85	1.96	3.4	0.7	9.61	92.20	8.30	1410	355	57.07	0.74	0.10	2.09	42.45	55.00
Sankarapuram	60.12	36.72	64.40	33.63	2.05	0.07	55.23	166.31	8.00	8664	446	62.22	0.47	-3.90	1.61	31.75	50.17
Ammapatti	86.17	43.78	94.30	60.61	2.45	1.1	36.02	147.16	8.00	2420	514	119.17	0.52	-4.35	2.06	34.17	45.57
Upparpatti	23.05	35.87	69.00	44.97	1.9	0.35	14.41	109.93	8.00	1400	320	33.55	0.73	-1.85	2.10	42.25	71.95
Maligaipuram	112.22	60.80	127.65	48.88	1.95	0.4	16.81	361.69	8.35	3560	749	124.22	0.52	-8.25	2.41	34.37	47.17
Rajandrapuram	79.16	66.27	44.85	48.88	2.4	2.1	38.42	99.29	8.80	1590	463	142.16	0.21	-4.90	0.90	17.18	57.98
Seelayampatti	122.85	111.75	81.88	61.78	3.79	0.34	97.50	288.64	7.80	1667	826	133.05	0.23	-11.19	1.29	18.86	59.99
Pachanayackanpatti	163.33	107.62	103.50	97.75	1.25	0.2	57.64	579.77	8.20	4490	1055	169.33	0.26	-15.55	1.54	20.93	52.06
Tevaram	37.07	30.40	37.95	50.83	2.55	0.3	12.01	56.74	8.70	1240	259	46.07	0.38	-1.50	1.12	27.50	57.47
Pallavaiyanpatti	208.42	100.32	269.10	41.06	3.55	2.45	76.85	843.95	7.85	7160	1678	281.92	0.63	-12.65	3.83	38.55	44.24
Vayalpatti	47.09	50.46	50.60	84.07	2.8	1.75	144.09	755.30	8.45	1780	1184	99.59	0.34	-1.95	1.22	25.29	63.85
Puttur	10.02	21.28	37.95	7.04	0.8	0.25	26.42	86.88	8.60	572	214	17.52	0.73	-1.20	1.56	42.31	77.78
Venkatachalapuram	41.88	16.66	211.60	28.54	6.17	0.06	41.79	223.04	7.90	1209	721	43.68	2.66	2.77	6.99	72.67	39.60
Kottur	95.19	100.32	309.35	67.25	3.8	0.7	43.23	684.38	8.25	5380	1367	116.19	1.03	-8.50	5.28	50.85	63.46
Chinnamanur	47.09	39.52	163.30	13.69	2.7	1.15	52.83	285.45	8.35	2280	703	81.59	1.27	-1.75	4.24	55.91	58.04
Ambasamudram	166.33	86.34	103.50	29.33	2.95	0.45	16.81	547.86	8.00	4040	1023	179.83	0.29	-12.00	1.62	22.61	46.10
Kombai	61.12	21.28	42.55	2.35	2.65	0.25	12.01	122.34	8.95	1200	346	68.62	0.39	-1.90	1.19	27.82	36.46
Uttamapalayam	198.20	140.20	66.70	49.27	2.45	0.05	24.98	639.70	7.90	2365	1145	199.70	0.14	-18.92	0.89	11.92	53.83
Hunumanthanpatti	79.16	51.68	113.85	2.35	3.85	0.8	36.02	276.59	7.90	2820	696	103.16	0.60	-3.55	2.44	37.64	51.83
Chinnaokelapuram	57.11	23.10	42.55	7.04	1.55	0.8	21.61	131.20	8.40	1300	346	81.11	0.39	-2.40	1.20	28.03	40.00
Markkayankottai	64.13	26.14	94.30	1.56	2.45	0.6	9.61	221.63	8.30	2280	507	82.13	0.77	-2.30	2.51	43.39	40.19
Erasanayakannur	81.16	36.60	211.60	55.52	3.91	0.03	34.58	462.04	7.80	840	944	82.06	1.30	-3.12	4.90	56.58	42.63
Ehuvapatti	97.19	64.45	177.10	56.70	3.75	2.5	31.22	336.87	8.10	3380	894	172.19	0.76	-3.90	3.42	43.14	52.22
Anaipatti	122.24	72.96	62.10	19.55	2.9	3.8	67.24	255.31	8.40	2950	781	236.24	0.22	-5.40	1.10	18.24	49.59
Kamayagoundan-patti	109.22	88.16	103.50	76.25	1.3	0.6	36.02	446.80	8.35	3430	841	127.22	0.35	-10.80	1.79	26.16	57.09
Ansipatti	17.03	104.58	128.80	25.42	4.4	1.65	38.42	267.72	8.20	3030	738	66.53	0.59	-3.40	2.58	37.21	91.01
Devathanapatti	69.14	49.73	148.35	77.81	3.88	0.02	62.44	241.13	7.80	1385	687	69.74	0.86	-3.64	3.32	46.10	54.24
Pudupatti	139.28	92.42	117.30	3.13	6	0.35	64.84	421.97	8.65	3190	1026	149.78	0.35	-8.20	1.89	25.95	52.23

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Cumbum	57.92	125.49	316.02	60.61	8.36	0.12	159.46	411.34	8.10	2330	1324	61.52	1.04	-4.73	5.35	50.98	78.12
Kamayangoundan-patti	49.10	12.77	46.00	3.91	2.55	0.7	38.42	47.87	8.80	1150	291	70.10	0.57	-0.25	1.51	36.36	30.00
Kamayangoundan-patti	64.13	37.09	113.85	10.17	2.6	0.8	14.41	195.03	8.25	2220	526	88.13	0.79	-2.85	2.80	44.20	48.80
Surulipatti	27.05	15.81	47.15	33.24	1.1	0.8	2.40	69.15	7.85	1420	218	51.05	0.77	-0.75	1.78	43.62	49.06
Narayanadevanpatti	53.11	30.40	87.40	13.29	1.2	2.35	21.61	175.53	8.45	9340	474	123.61	0.74	-1.60	2.37	42.46	48.54
Surulipatti	7.82	3.53	1.38	59.43	0.24	0	2.88	175.88	8.00	770	199	7.82	0.09	-0.44	0.10	8.11	42.65
Melagudalur	24.05	17.02	50.60	7.82	1	1.5	19.21	67.37	8.95	1620	253	69.05	0.85	-0.10	1.93	45.83	53.85
Kamayangoundan-patti	44.09	15.20	64.40	1.96	3.1	0.45	12.01	88.65	8.50	1800	331	57.59	0.81	0.10	2.13	44.80	36.23
Surulipatti	43.09	52.90	88.55	21.51	3.25	0.6	9.61	203.90	8.45	1500	513	61.09	0.59	-2.65	2.14	37.20	66.92
Gudalur	68.14	43.17	148.35	44.97	6.65	1.35	24.02	179.07	8.00	2660	702	108.64	0.93	1.05	3.46	48.13	51.08

EC* – Electrical conductivity, RSC* – Residual Sodium Carbonate, SAR* – Sodium Adsorption, Ratio, TH* - Total Hardness

TABLE-2
CLASSIFICATION OF IRRIGATION GROUNDWATER BASED ON DONEEN (1964)

Sl. No.	Category of Irrigation Water	Sample Numbers (Locations samples)	Total No. of Locations	Percentage (%)
1	Class - I	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17, 18,19,20,22,23,24,25, 27,28,31,32,33,34, 35,36,37,38,39,40,41,42,43,44,45,46,48,50, 54,55.	45	81.82
2	Class - II	2,21,26,29,30, 47,49,51,52,53.	10	18.18
3	Class - III	-	-	-

TABLE-3
CLASSIFICATION OF GROUNDWATER FOR IRRIGATION BASED ON WILCOX DIAGRAM INTERPRETATION (1955)

Sl. No.	Category of Irrigation Water	Pre Monsoon (Locations samples)	Total No. of Locations	Percentage %
1	Excellent to Good	1,8,29,51.	4	7.27
2	Good to Permissible	2,3,6,7,9,10,17,19,21,23,24,26,28,30,34,37,39,44,47, 49,52,53,54.	23	41.82
3	Permissible to Doubtful	-	0	0.00
4	Doubtful to Unsuitable	5,11,13,14,18,20,32,35,36,38,41,43,46,48,55.	15	27.27
5	Unsuitable	4,12,15,16,22,25,27,31,33,40,42,45,50.	13	23.64

TABLE-4
GROUNDWATER CLASSIFICATION BASED ON USSL DIAGRAM INTERPRETATION (1954)

Sl. No.	Category	Pre Monsoon (Locations samples)	Total No. of Locations	Percentage %
	C1S1	51.	1	1.82
1	C2-S1	1,8,29.	3	5.45
2	C3-S1	2,3,5,6,7,9,10,16,18,21,23,24,26,28, 34,37,39,44,47,49,52,53,54.	23	41.82
	C3S2	30.	1	1.82
3	C4-S1	4,11,12,13,14,15,17,19,20,22,25,33, 35,36,38,40,41,42,43,45,48,50,55.	23	41.82
5	C4-S2	27,31,32,46.	4	7.27

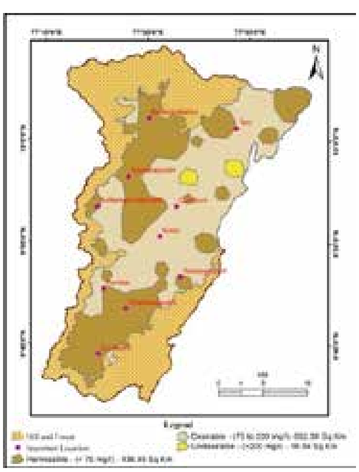

Figure 2: Calcium Spatial Distribution Map

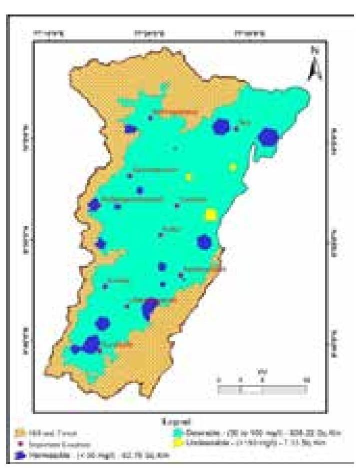

Figure3: Magnesium Spatial Distribution Map

Volume : 6 | Issue : 2 | FEBRUARY 2016 | ISSN - 2249-555X

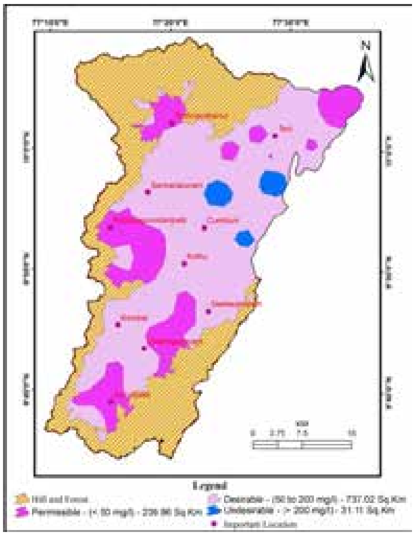

Figure 4: Sodium Spatial Distribution Map

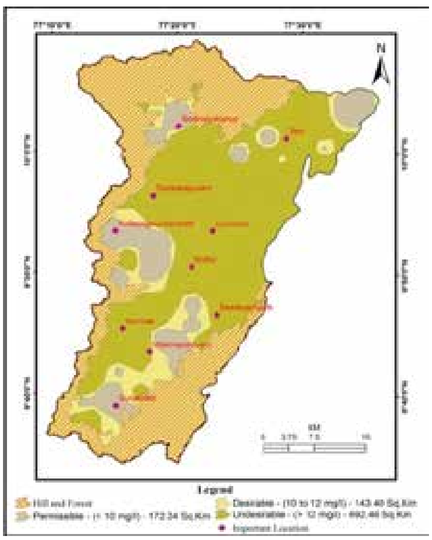

Figure 5: Potassium Spatial Distribution Map

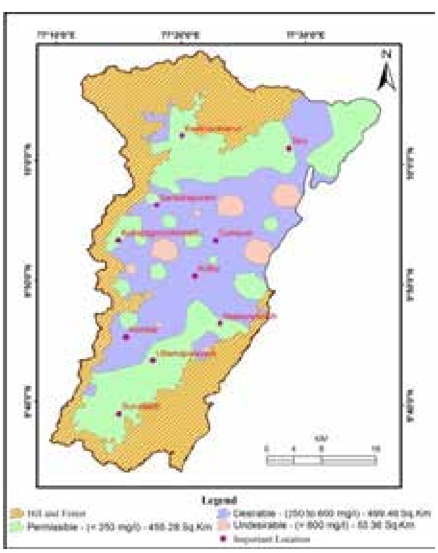

Figure 6: Chloride Spatial Distribution Map

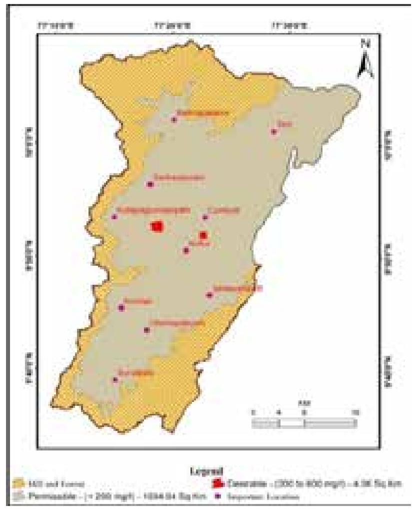

Figure 7: Sulphate Spatial Distribution Map

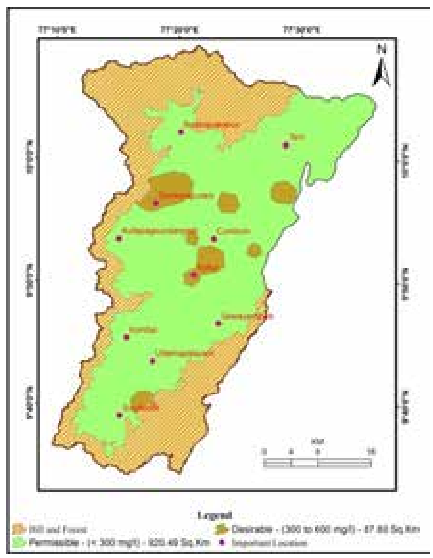

Figure 8: Bi-carbonate Spatial Distribution Map

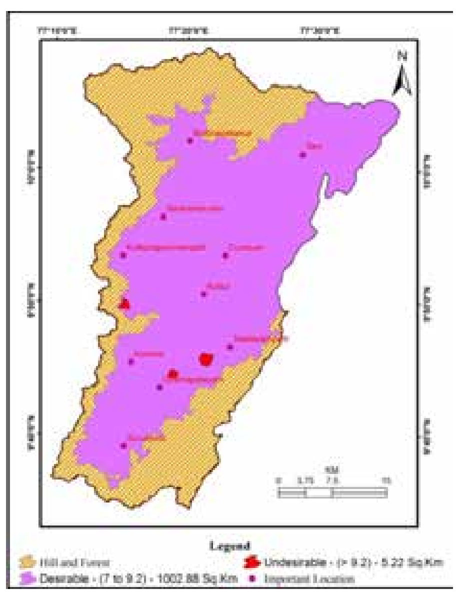

Figure 9: pH Spatial Distribution Map

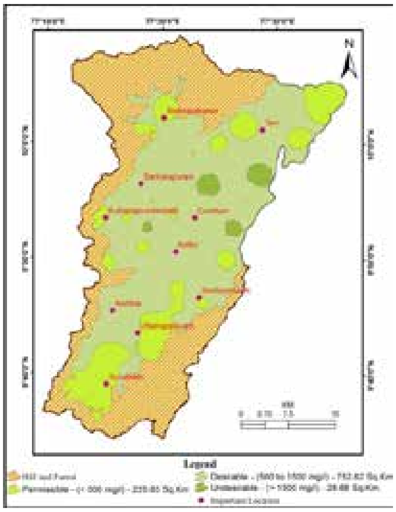

Figure 10: TDS Spatial Distribution Map

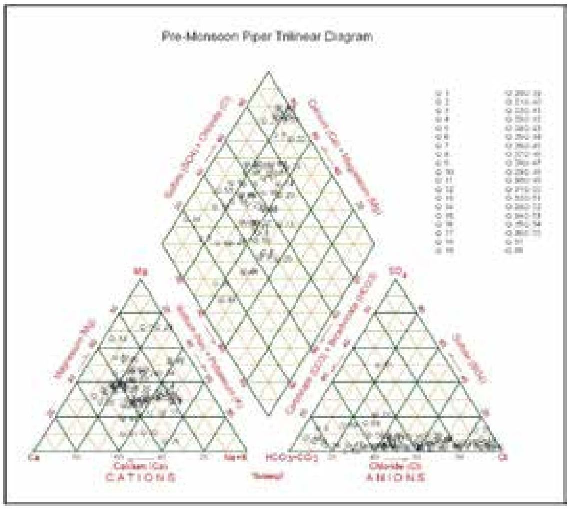

Figure 11: Pre-Monsoon Piper Trilinear Diagram

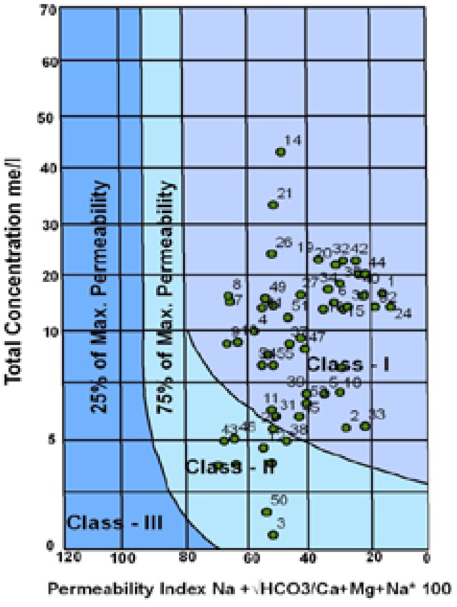

Figure 12: Pre-Monsoon Doneen's Diagram

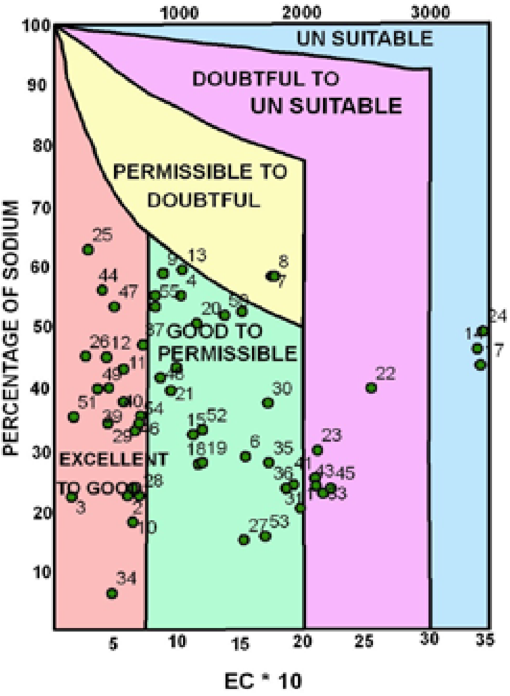

Figure 13: Pre-Monsoon Wilcox Diagram

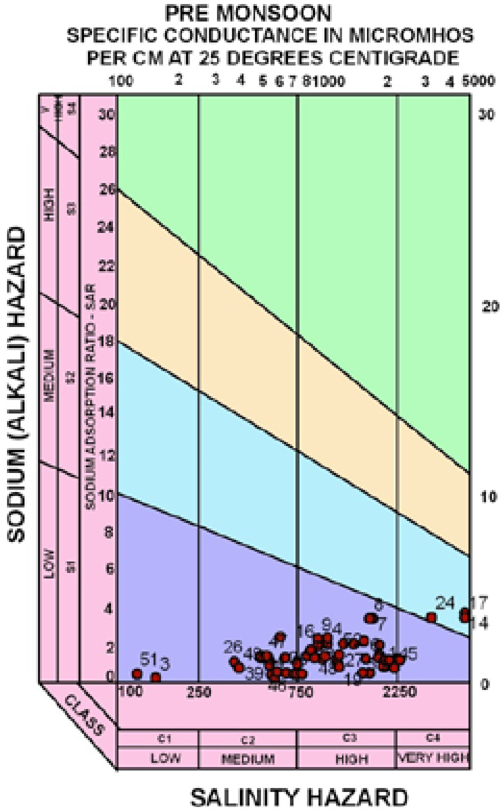

Figure 14: Pre-Monsoon USSL Diagram

CONCLUSIONS

In this study, the assessment of groundwater quality for drinking purposes has been evaluated on the basis of WHO 1997 standards, were used to prepare the individual parameter spatial distribution map. Spatial distribution map with respect to WHO standard 1997, these maps shows that

Volume : 6 | Issue : 2 | FEBRUARY 2016 | ISSN - 2249-555X

small portion of the study area fall in permissible category except sulphate concentration. Most of the study area fell in desirable limit and rest of the very small portion is poor category. Detailed spatial information of individual element are given in the above said maps.

In this study, the assessment of groundwater for irrigation has been evaluated on the basis of various guidelines. Piper trilinear diagram interpretations were made to know the chemical type of the groundwater. It reveals that the subsurface water is alkaline earth (Ca+Mg) exceeds alkalies (Na+K) type. The groundwater fall under class-I for 81.82% as per the classification of Donnen's Permeability Index, and could be treated as good for irrigation. The Wilcox classification has shown 23.64% of groundwater under "Unsuitable" zone. According to U.S. Salinity diagram, the 41.82% of groundwater samples belong to C_3–S_1 (High Salinity – Low SAR) under the present investigations, and this type of groundwater should be used for soils of medium to high permeability. In the present study, it is evident that high salinity of groundwater persists at majority of sites. Hence, for high to very high salinity of waters, soil must be permeable with adequate drainage facilities for satisfactory crop growth.

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