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GIS Applications for Groundwater Management on Different Taluks of Perambalur District, Tamil Nadu

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Abstract- Groundwater is a essential part of our human beings in various uses like drinking,domestic and Irrigation purposes. In my study area Perambalur district is one of the backward district in Tamilnadu. Groundwater condition also very drought conditions due to the low amount of rain, due to the reason ground water condition changed based on quality and quantity. Our study area located in north east and north west region of Perambalur district by using GIS techniques to discuss the spatial variations of groundwater condition. The study area covered with three taluks like Alathur, Kunnam and partially Perambalur taluk and it has a different lithological region like Archean, Gondwana and Cretaceous. For this study I have collected 70 borewell samples in each season. The water samples were analyzed different physico chemical parameter like Ca, Mg, Na, K, Cl,SO_4, PO_4,H_4SiO_4,Ec, pH, and TDS with a standard procedure. These parameter using standard techniques in the laboratory and compared with the standards. The groundwater quality information maps of the entire study area have been prepared using GIS spatial interpolation techniques for the all above parameters. The results obtained in the study and the spatial database established in GIS will be helpful for monitoring and managing ground water condition and pollution in the study area.

Keywords-*GIS, Physico-chemical analysis, Perambalur, Kunnam, Alathur, borewell.*

1. INTRODUCTION

Groundwater is the most important source of domestic, industrial and agricultural water supply in the world. Exploitation of surface waters has reduced, ensuring an increasing reliance on groundwater abstraction due to increasing pollution with the concomitant rise in the cost of water treatment. The quality of groundwater is constantly changing in response to daily, seasonal and climatic factors. Continuous monitoring of water quality parameters is highly crucial because changes in the quality of water has far reaching consequences in terms of its effects on man. Hence dependence on mining is increased; today man is depending on mined materials for industry, energy, agriculture, construction of buildings and for so many day-to-day requirements for our life. Remote sensing provides convenient solution for this problem. Further, voluminous data Gathered with the help of remote sensing techniques are better handled and utilized with the help of Geographical Information Systems (GIS). In this case study, GIS functionality were extensively utilized in the preparation of erosion and natural resources inventory and their analysis for assessing soil erosion and soil conservation planning. Scientific management of soil, water and vegetation resources on watershed basis is, very important to arrest erosion and rapid siltation in rivers, lakes and estuaries. It is, however, realized that due to financial and organizational constraints, it is not feasible to treat the entire watershed within a short time. Prioritization of watersheds on the basis of those sub-watersheds within a watershed which contribute maximum sediment yield obviously should determine our priority to evolve appropriate conservation management strategy so that maximum benefit can be derived out of any such money-time-effort making scheme.

The objective of this study was the investigation of the hydro geochemical evolution and the recharge processes of groundwater in the main basin subjected to increasing agricultural exploitation. The concentration of major and minor ions of groundwater are essential in understanding geochemical processes affecting water quality. The result of this study may contribute to the optimization of water resources management.

2. STUDY AREA

Perambalur district is a centrally located in district of Tamilnadu, spread over 3690.07 sq.kms, which was trifurcated from the erstwhile compositeTiruchirappalli district and was formed on 1 November 1995. The district is bounded by Cuddalore district in the North,Tiruchirappalli district in the South, Thanjavur in the East and Namakkal and Tiruchirappalli districts in the West.Perambalur District lies in the geographical co-ordinates of East longitude78°36' and 79°31'

and North latitude 10°51' and 10°31'.The district for administrative purpose has been divided into three Taluks(Perambalur, Kunnam, and Alathur).

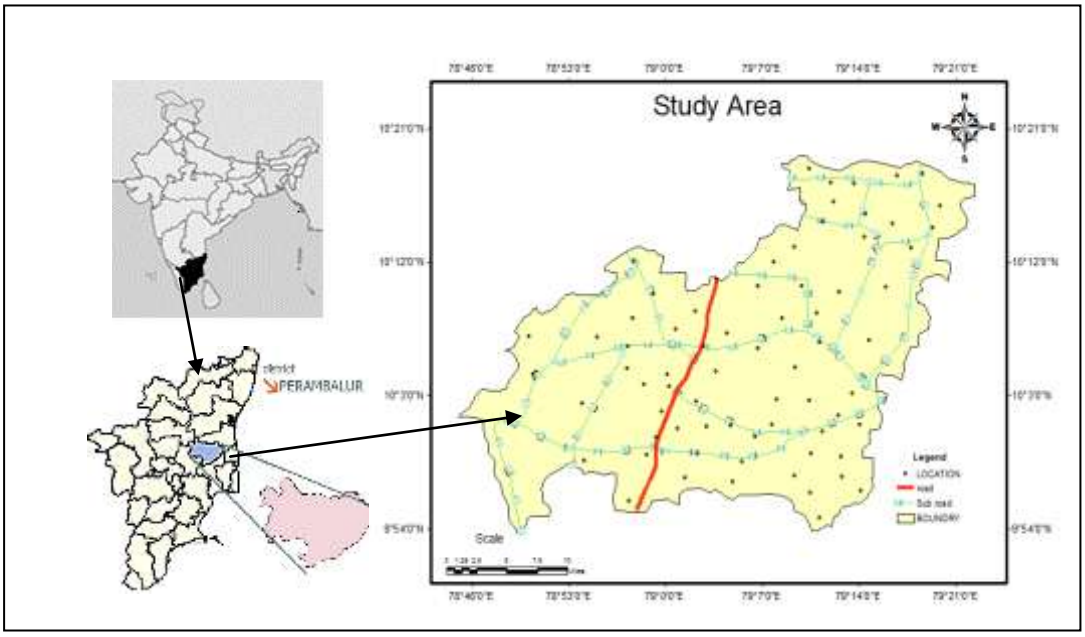

Fig.1. Map of the study area.

3. METHODOLOGY

Sampling of groundwater has been carried out in the Perambalur block during 2016. The sampling locations are shown in (Fig 1) and the sample location point to be point out in (Table. 1). The synoptic view of the methodology adopted for the present study is shown in the flow chart (Fig 2). The water samples were collected during postmonsoon to broadly cover the Water quality variation. A total of 70 water samples were collected from bore wells in the post monsoon season (January 2016). Water samples were collected in one litre clean polyethylene bottle to broadly cover Quality variation along with lithology. Electrical Conductivity and produncial Hydrogen were determined in the field using electrode. Then it was sealed and brought to laboratory for analysis and stored properly (4^0C) before analysis with standard (APHA 2003) procedure.

4. RESULT AND DISCUSSION

Chemical constituents present in water during postmonsoon season are presented in Table 2.Water in the study area is generally had not more alkaline in nature, with pH ranging from 6.12 – 6.72 average 6.49. In postmonsoon season it is relatively suitable for drinking purpose.

The describe the quality parameter like USSL, Na%, SAR are present in the given (table.3) and the comparison of our drinking water quality for WHO (2006) and ISI (1995), BIS(IS:10500) also present table.4.The generally SAR, Na%, Total Na concentration and EC described that suitability of ground water for irrigation purpose (Table.3). Sodium percentage is calculated against major cations and expressed in terms of SAR. Na is an important cation which is in excess deteriorates the soil structure and reduces crop yield. Total salt concentration and probable sodium hazard of the irrigation water are the two major constituents for determining SAR. Salinity hazard is based on EC measurements. If water used for irrigation is high in Na^+ and low in Ca^{2+} the ion exchange complex may become saturated with Na^+ which destroys the soil structure, due to the dispersion of clay particles and reduces the plant growth. Excess salinity reduces the osmotic activity of plants. The plotting of SAR values in USSL classification indicates that all the samples have low SAR value. Out of 70 samples, 4 sample lies in C2-S1field, 1 samples inC2-S2field, 2 samples in C3-S4 field and one sample lies in C4-S4 field. 3 samples in C4-S2.5 samples in C4-S1. 13 samples falls in C3-S2. Remaining samples were falls in C3-S1.The C3-S1field in USSL diagram is considered as good water category for irrigation use (Vijayakumar V,et.al 2014).

Temporal Variation

During study years 2016 we were collected water samples for the postmonsoon

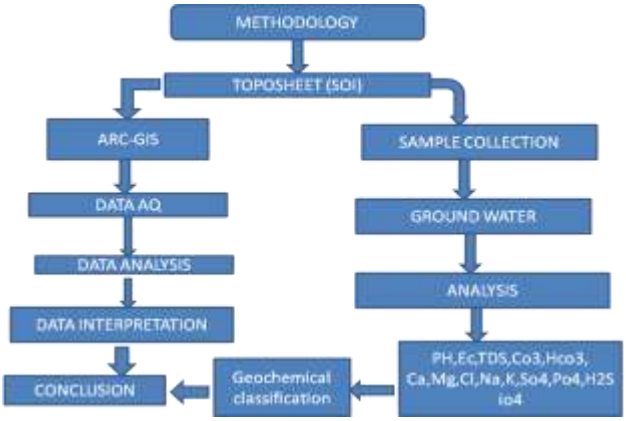

Fig.2. Flow chart of methodology

season. This allowed us to analyze temporal variations in groundwater quality parameters. Our samples were taken from fifteen selected bore wells within the Perambalur region. We compared the characteristics of samples collected during the postmonsoon season with the WHO standards to determine whether the concentration of various constituents was changing due to evaporation and precipitation.

Our study of temporal variations in water quality considered a number of agriculture derived ions, such as Nitrate, Phosphate, and Potassium. We also looked at other parameters, including Total Dissolved Solids (TDS), pH, Electrical conductivity, and Turbidity.Fig 4. (a) to (g) ,show the temporal variation in concentrations of Sodium & Pottasium, Sulphate & Phosphate and Nitrate & Silicate respectively, for the selected bore wells. As the graphs make clear, these substances showed higher concentrations in the northwest region than

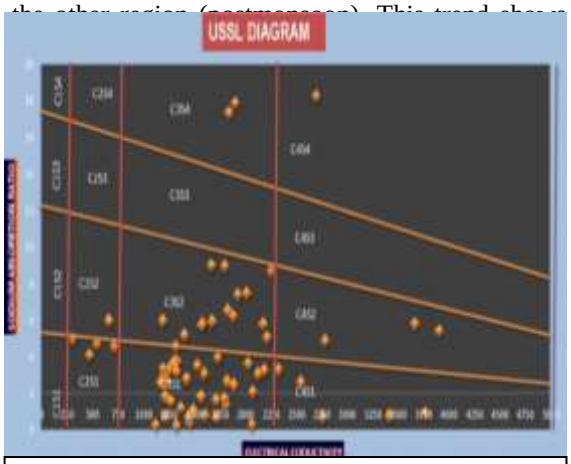

Fig.3. USSL diagram for ground water samples

Spatial Analysis

The chemical quantity have been analysed for different quality parameters over the entire study area of the Perambalur region. The profiles of spatial variations for each resource are discussed below in terms of their relation with each other and their change in concentration over space. The distance between observation points were calculated by exported sampling points map in shape format in to Arc view and interpolated by the kriging analysis option.By the application of GIS (Arc view) software, the spatial distribution of parameters has presented. The figure 5. depict amount of spatial variation in all parameters. It is obviously noticed that most of the parameters have higher concentration at the north western part as the result of shallow part of the water body which receives higher amount of sediment input and effluent water from Perambalur region activities that can be trap most of ions on the particles.

Spatial Distribution

The EC values show regular trend over the entire areas excess for those shallow locations. The EC values range from 317 to 6100µs/cm near. The Perambalur,Alambadi, Aranarai, Irur, Pimmur Vijayagobalapuram, , and Labbai kudikadu area has higher value of EC(3200-6000µs/cm).The spatial distribution based on Electrical Conductivity concentration and pH concentration value of ground water samples were highly found in Kunnam and Perambalur region and also Ca concentration value of groundwater samples were highly found in Alathur region and some of the location in Kunnam block. Because in these region has lot of ponds and mines. Based on this observed clues the spatial data has been reclassified as favourable and unfavourable zones with respects to rock water interaction of water has been shown in the fig. 6(Srinivasan.S et.al 2014).There are no common features in Plankton but most of them are alkaline side but in that area generally the calcium content is not high. The spatial distribution based on Sodium concentration values were highly found in Kunnam region and also concentration of Pottasium value was highly found. The spatial distribution based on Manganese concentration of groundwater samples were equally found most of the locations.Alathur regions that is Padalur, and Naranamangalam due to the effluents from stone quarries are mixed with groundwater. Cl concentration was high in Kurumbalur and Nattarmangalam and Na concentration was highly found in Perambalur which are lies on the northern part of Perambalur district. The high concentration of Dissolved Solids, high Ca, high HCO_3 and high EC Concentration contamination Caused by results of evaporation within the study area.

Table.1. Physico chemical parameter of the Perambalur district water samples. All values are in mg/L except EC(µs/cm)&pH

S. NO	LOCATION	**Ca**	**Mg**	**Na**	**K**	**Cl**	**HCO_3**	**SO_4**	**NO_3**	**H_2SiO_4**	**PO_4**	**PH**	**EC (µs/cm)**	**TDS (ppm)**
1	MGR NAGAR	118	52.8	46	0	212	923	1.8	0.05	16	0.04	7.28	1230	874
2	ELAMBALUR	56	30.8	6.8	10.6	14.98	464.9	0.9	0.03	9	0	7.12	1466	1040
3	KONERIPALAYAM	47	18.8	94	6	212.7	854.2	1.8	0.03	14	0.06	7.43	1593	1130
4	ESANAI	118	27	18.4	14.3	68.4	602	1.8	0.04	9	0	7.55	1621	1150
5	LADAPURAM	69	50.2	378	3	1117.2	1334	5.8	0.19	14	0.06	7.33	1853	1290
6	KURUMBALUR	38	21.6	40.2	10.5	11.8	394.1	1.4	0.04	11	0	7.27	1247	861
7	CHATTRAMANAI	42	34.6	108	3	340.2	878.9	1.9	0.04	11	0.04	7.52	1897	1360
8	CHETTIKULAM	40	22.4	40.8	11.1	12.4	396.2	1.4	0.04	11	0	7.3	1228	867
9	VIJAYAGOPALAPURAM	28	41.4	304	2	702.3	1246.4	3.6	0.04	10	0.1	7.54	2710	1930
10	SIRUVACHUR	48	26	11.4	11.6	29.29	358.8	1.2	0.03	9	0	7.32	1453	1010
11	AYILUR	42	48.2	62	1.2	268.9	678	1.4	0.01	9	0.05	7.46	1272	899
12	KALPADI	36	28.8	16.7	12	16.35	353.6	1.6	0.04	8	0	7.34	1504	1070
13	KAVULPALAYAM	80	56.6	208	78	712	1124.4	5.2	0.08	12	0.2	7.49	1814	1280
14	DURAIMANGALAM	46	22.8	19.3	12	15.76	328.2	2.1	0.02	22	0	7.28	1381	961
15	PERAMBALUR	88	50.4	118	4	531.75	353.8	1.5	0.074	14	0.086	6.62	2230	1590
16	AALAMBADI	88	84	126	2	1382.55	439.2	1.9	0.101	12	0.104	6.04	5230	3680
17	ARANARAI	64	36	108	0	833.07	378.2	4	0.179	10	0.086	6.4	3920	2780
18	PUDHUNADUVALUR	64	31.2	88	0	319.05	305	1.9	0.021	14	0.244	6.37	1329	900
19	NOCHIYAM	44	62.4	67	2	496.3	475.8	1.6	0.202	12	0.095	6.58	2340	1660
20	SELLIYAMPALAYAM	32	12	54	0	177.25	183	1.8	0.005	10	0.135	6.58	483	343
21	AALATHUR	68	7.2	103	1	177.25	256.2	2.7	0.215	15	0.115	6.33	674	479
22	IRUR	124	21.6	114	0	1896.57	317.2	2.5	0.019	12	0.129	6.28	6100	320
23	PADALUR	32	21.6	72	1	177.25	219.6	1.4	0.0117	10	0.028	6.58	317	225
24	THERANI	56	57.6	63	0	319.05	317.2	10.8	0.093	14	0.069	6.64	1216	864

25	KARAI	36	45.6	46	2	230.42	231.8	1.2	0.076	12	0.058	6.84	1183	840
26	NARANAMANGALAM	84	38.4	58	0	514.02	317.2	1.2	0.71	15	0.035	6.2	1836	1300
27	KOLAKKANATHAM	56	72	55	5	514.02	305	1.9	0.045	12	0.103	6.1	1900	1350
28	AYINAPURAM	48	14.4	74	2	159.52	183	1.8	0.081	10	0.064	6.22	555	394
29	KULATHUR	84	40.8	68	2	655.82	244	1.2	0.66	18	0.89	6.17	2140	1520
30	PIMMUR	140	84	76	1	1418	256.2	1.8	0.047	14	0.116	6.21	5500	3900
31	SILLAKUDI	64	33.6	117	0	443.12	256.2	1.7	0.102	12	0.136	6.72	1690	1200
32	ATTUR	60	28.8	108	0	389.95	378.2	10	0.125	12	0.108	6.27	1587	1130
33	NOCHIKULAM	52	48	130	1	478.57	414.8	1	0.011	10	0.035	6.49	1840	1310
34	BUJANGARAYANALLUR	56	57.6	69	1	584.92	341.6	2.6	0.011	10	0.035	6.29	2200	1560
35	GUDALUR	56	16.8	127	1	443.12	292.8	1.6	0.07	15	0.045	6.64	2030	1440
36	KUTTUR	76	21.6	73	0	319.05	305	1.8	0.35	14	0.067	6.62	1342	950
37	ALAGIRIPALAYAM	96	38.4	86	2	301.2	280.6	1	0.034	18	0.042	6.12	1312	929
38	TONDAPADI	64	96	52	1	496.3	305	1.8	0.043	12	0.049	6.54	2090	1480
39	MELAMATHUR	106	31.2	64	2	354.5	231.8	1.4	0.056	16	0.051	6.62	1436	1020
40	ADANUR	48	26.4	57	0	265.87	268.4	1.2	0.042	18	0.073	6.65	1208	857
41	KOTTARAI	120	36	38	1	265.87	207.4	1.6	0.019	12	0.039	6.29	1283	912
42	SATHANUR	60	28.8	112	0	265.87	207.4	1.8	0.025	18	0.061	6.69	1203	855
43	SIRUGANPUR	44	16.8	61	2	389.95	292.8	2	0.068	18	0.056	6.19	1745	1240
44	KUDIKADU	60	96	76	0	443.12	207.4	1.2	0.38	12	0.037	6.64	1611	1140
45	VARUGUPADI	84	52.8	37	2	354.5	207.4	1.6	0.073	16	0.063	6.33	1724	1220
46	OGALUR	65	43.2	28	12	247.05	843.6	0.4	0.035	14	0.08	6.68	1824	1290
47	VADAKKALUR	72	18.8	13	23	163.52	764.4	0.8	0.006	16	0.09	7.31	1733	1230
48	ATTIYUR	63	21.4	16	24	172.5	689.2	0.06	0.045	15	0.08	7.7	3780	2670
49	AGARAMSIGUR	78	32.4	14	12	169.8	735.4	0.08	0.037	14	0.028	7.48	2770	1960
50	KEEZHA PERAMBALUR	78	38.6	76	132	321.05	982.2	2	0.18	16	0.17	7.36	1313	933
51	VAYALAPADI	68	49.6	387	3	1116.8	1332	5.6	0.19	14	0.055	7.05	1912	1350

52	KILAMATHUR	58	52.6	102	4	348.2	913	2.2	0.063	16	0.039	7.69	2800	1990
53	OLAIPADI	92	50.8	76	38	426.4	846.8	2	0.4	15	0.056	7.44	1339	949
54	NANNAI	34	5.8	57	118	98.63	918	1.6	0.045	18	0.09	7.46	726	516
55	PERUMATTUR	42	32.2	62	123	124.6	826	1.8	0.034	16	0.08	7.4	2040	1440
56	SIRUMATTUR	83	27	121	12	356.5	816.3	2.8	0.096	14	0.07	7.49	2190	1560
57	KEEZHAPULIYUR	52	21.2	126	87	268.9	923	3.6	0.106	13	0.08	7.18	1941	1380
58	ELUMUR	68	28.4	176	4	393	876.2	3.1	0.057	16	0.046	7.2	1685	1190
59	PARAVAI	46	18.8	93	6	212.7	853.8	1.8	0.027	13	0.06	7.29	3680	2590
60	ASOOR	64	23.6	96	2	252.15	721.8	1.9	0.06	12	0.04	7.92	1418	1000
61	SITHALI	14	5.2	76	0	108.25	623.2	1.8	0.07	8	0.068	7.15	2270	1600
62	PERALI	132	37.4	67	0	373.2	742.6	0.9	0.01	16	0.035	7.21	2560	1820
63	ODIYAM	124	42.4	43	2	231	816	1.2	0.038	14	0.042	7.56	1810	1290
64	KUNNAM	118	52.8	46	0	212	923	1.8	0.045	16	0.037	7.42	1578	1120
65	KULAPADI	62	32.8	4.8	12.8	16.8	623	1.8	0.04	12	0.01	7.59	1132	795
66	KATTUR	72	36.4	5.2	28	18.9	462.8	1.8	0.04	12	0	7.05	2080	1470
67	PUDUVETTAKUDI	44	34.2	62	124	126.8	832	1.8	0.04	16	0.08	7.4	1542	1090
68	VARAGUR	72	63.4	5.1	11.6	18.9	578	1.6	0.04	9	0	7.68	1340	956
69	PENNAGONAM	127	26	16.9	12.2	72.62	516	2.8	0.04	10	0.01	7.22	1228	870
70	LABBAIKUDIKKADU	130	24	18.3	11.8	141.8	488	3	0.03	9	0	7.3	3430	2420

Table.2 Comparison of chemical composition of water with WHO(2006) and ISI(1995), BIS (IS:10500) in mg/L (Except EC and pH),EC in µs/cm.

Parameters	**Ground Water**	**WHO(2006)**	**Highest desirable**	**ISI(1995)**	**BIS(IS:10500)**
pH	6.04-7.92	6.5-8.5	---	6.5-8.5	6.5-8.5
EC	317-6100	1400	(except 6,8,11,14,18,20,21,23,24,25,29,36,37,40-42,50,53,54,65,68,69)	---	---
TDS	225-3900	1000	(1,2,3,6,7,11,12,13,15)	1500	2000
CO_3	0-24	0	---	---	---
HCO_3	183-1334.	0	---	---	---
Cl	11.8-1896.57	250	(5,7,13,15,16,17,18,19,22,24,27,29-46,50-53,56-58,62,64)	1000	1000
SO_4	0.06-10.8	400	---	400	400
PO_4	0-0.89	0	---	---	---
NO_3	0.005-0.71	0	---	45	100
H_2SiO_4	8-22	0	---	---	---
Ca	14-140	500	---	200	200
Mg	5.2-96	0	---	100	---
Na	4.8-387	200	(5,9,11,51)	---	---
K	0-132	0	---	---	---

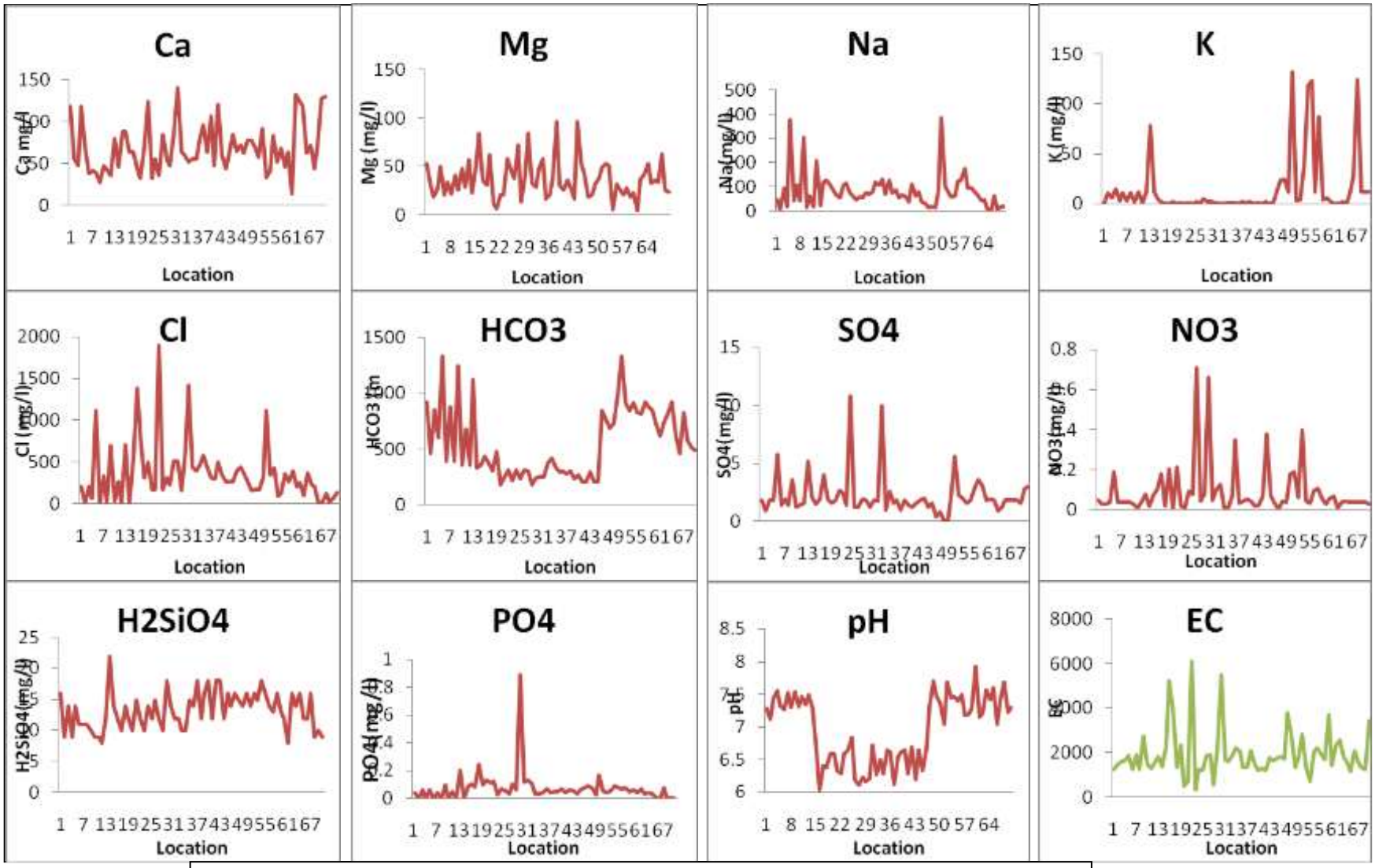

Fig.4. Temporal Variation in ground water samples

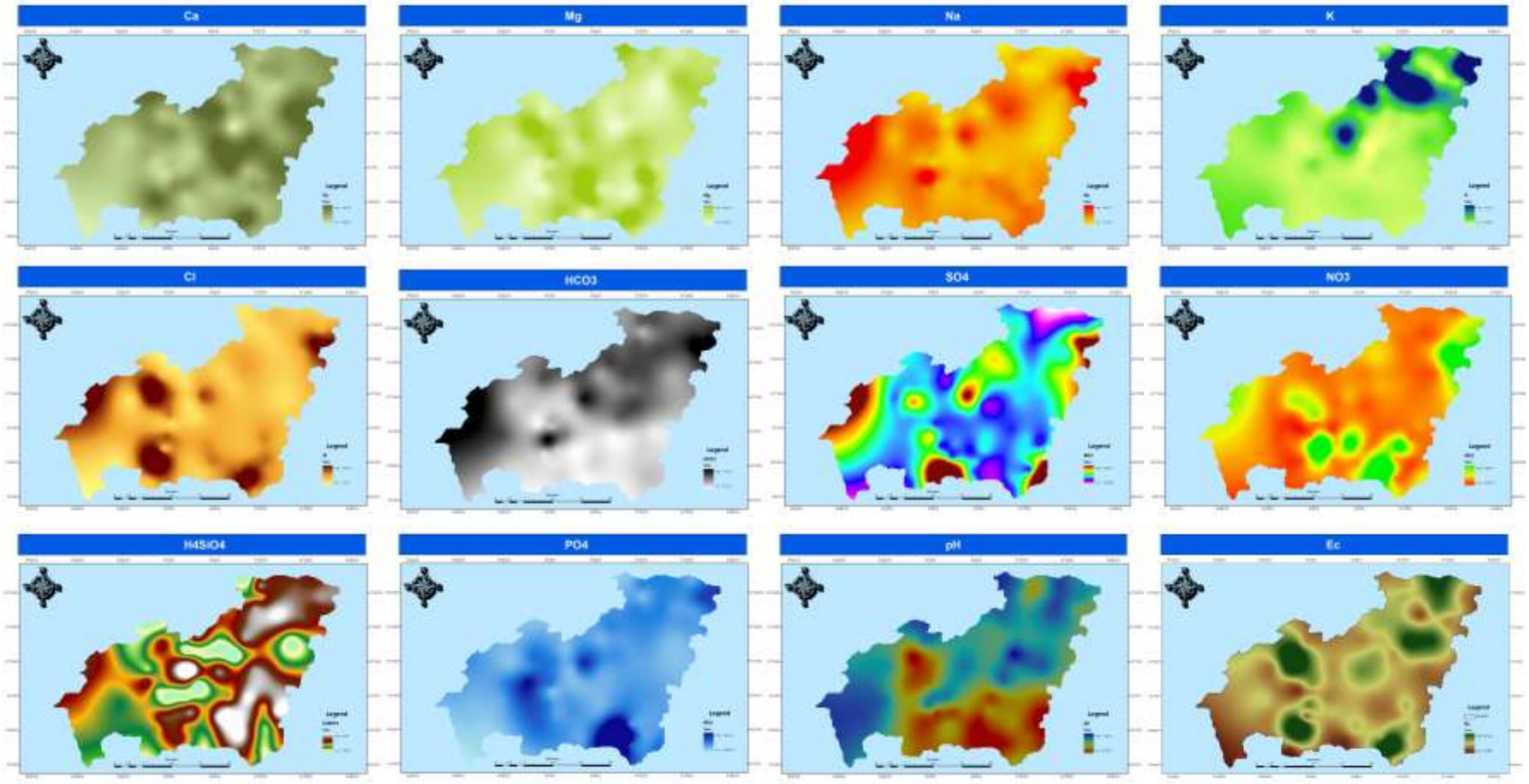

Fig.5. Spatial Distribution of ground water samples

5. CONCLUSION

The increasing need for water, puts a high strain on the available water resource, automatically leads to the conservation of water and water resources. In regions of scanty rainfall, every drop of water has to be stored. The meteorological study point out the higher amount of rainfall is during Postmonsoon. The temperature of the region is higher in the summer. The study draws out the following conclusions.We noted that major water quality parameters (such as turbidity, pH, salinity, and dissolved oxygen) and measures of agriculture-derived ion (such as potassium, phosphorus, and nitrogen) reflected higher pollutant concentrations during the postmonsoon season, which highlights the effect of precipitation on groundwater quality. Hydrochemical analysis data revealed that the region has high concentrations of chlorine and Electrical Conductivity. From our hydrochemical analysis results, it can also be inferred that excess concentrations of chloride and TDS, as well as the presence of water hardness, make the groundwater at some locations undesirable for drinking.

The GIS techniques used in this study demonstrated their capability in groundwater quality mapping. The maps we were able to create offered a pictorial representation of groundwater quality throughout the Perambalur basin, and allowed us to delineate clearly whether the groundwater found within specified locations was suitable or unsuitable for purposes of drinking and irrigation. As indicated on our spatially integrated pH map, the groundwater found in almost 70 percent of the Perambalur basin is permissible for drinking purposes. The irrigation water quality map shows that groundwater in over 65 percent of the area is doubt full for irrigation purposes, with salinity (as measured by electrical conductivity) of more than permissible limits of 1400 µs/cm. If they are to be used for agricultural purposes, these zones require special care and utilization of an alternative "salt tolerance" cropping pattern. However, this study has made clear that GIS-based methodology can be used successfully for groundwater quality mapping even in small catchments.

REFERENCES

[1]Anbazhagan S, Nair A M., "Geographic information system and groundwater quality mapping in Panvel Basin, Maharashtra," India. Environ Geol 45(6):753– 761, 2005.

[2]APHA (Americans Public Health Association), "Standard Methods for Examination of Water and Wastewater," 20th Edition, APHA, Washington DC,1998.

[3]BIS, (1991). Indian standard drinking water - specification (First Revision) IS-10500:1991. New Delhi,

[4]Chidambaram.S.,(2003) WATCLAST computer programme for hydrogeochemical studies. Recent trends in hydrogeochemist, Capital Publishing Company, New Delhi, pg. no 203-207

[5]Hong. I .A, Chon .HT. "Assessment of groundwater contamination using geographic information systems. Environ Geochemical Heal 21(3):273–289, 1999.

[6]ISI (Indian Standard Specification for drinking water) (1995). New Delhi, IS 10500.

[7]Kamaraju, M.V.V., Bhattacharya, A., Reddy, G.S., Rao, G.C., Murthy, G.S. and Rao, T.C.M., 1995. Groundwater potential evaluation of West Godavari District, Andhra Pradesh State, India – AGIS approach. Ground Water 34(2):318–325

[8]Krishnamurthy, J., Srinivas, G., (1995), Role of geological and geomorphological factors in groundwater exploration: A study using IRS-LISS-II data. International Journal of Remote Sensing, vol.,16, pp. 2595- 2618.

[9]Kumar, M., Bhatt, G., Duffy, C.J., 2010. An object-oriented shared data model for GIS and distributed hydrologic models. Int. J. Geogr. Inform. Sci. 24 (7), 1061e1079.

[10]Schuh WM, Klinkebiel DL, Gardner JC, Meyar RF. 1997. Tracer and nitrate movements to groundwater in the Norruem Great Plains. Journal of Environmental Quality,**26**:1335–1347.

[11]Srinivasan. S, S.,Vasudevan*.S., Balamurugan, P., Selvaganapathi, R., Pruthiviraj, T and Vijayakumar, V., GIS Based Assessment Of Hydrogeochemical Characteristics And Its Inferences In Displaying Hydrocarbon Microseepage In Nagapatinam Subbasin,Cauvery Basin (ONLAND), India. International Journal of Recent Scientific Research 2014,Vol. 5, Issue, 1, pp.252-260.

[12]Srivasthava, P.K. and Bhattacharya, A.K ., 2000. Delineation of groundwater potential zones in a hard rock terrain of Baragarh District, Orrissa using IRS data. J. Indian Soc. Remote sensing 28(2&3): 129-140.

[13]Vijayakumar V, Suganya C, Suganya S, Sivasri M(2014) A GIS Approach on Ground Water and Surface Water Investigation of in and around Wellingdon Lake, Tittakudi, Cuddalore District, Tamilnadu, International Journal of Advanced Research,Vol. 19 (2), 2014: 207-212.

[14]WHO (World Health Organization), "Guidelines for Drinking Water Quality," 3rd Edition,WHO, Geneva, 2006.