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Geographical Information System Approach on Groundwater Geochemistry of Western Region of Perambalur District, Tamilnadu

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Abstract-The groundwater investigation is to find the quality of water by using various Physico chemical parameters like pH, EC, TDS, Ca, Mg, Na, K, Cl, F. GIS technology has been acknowledged as a drawing tool for observing and analysing of all data set including Physico chemical parameters. Study area has been in hard rock region. The Nature of groundwater was discussed by temporal variation and geographical variation. Study area situated in central part of Tamilnadu, India. Study area lies between $11^0$06'11"N to $11^0$80'05"N in latitude and in longitude from $78^0$39'28"E to $79^0$39'19"E. The groundwater samples were collected from different location of our study area and also to find the coordinates points of the same location. It's obtained by using handheld GARMIN GPS receiver. The geochemical data were utilized the WATCLAST computer program (Chidambaram.S 2003). It's to be discussed in the various criteria like USSL, Hardness, Na%, Salinity, SAR % based on water quality. The above analytical methods to give the solution to our ground water quality.

Keywords-GIS, Physico-chemical analysis, graphical variation Temporal variation, GPS.

1. INTRODUCTION

Increased industrialization, urbanization and agricultural activities during the last few decades have deteriorated the surface water and groundwater quality of Tamilnadu, the southern most state of India. The hydrogeochemical processes help to get an insight into the contributions of rock-water interaction and anthropogenic influences on groundwater quality. These geochemical processes are responsible for the seasonal and spatial variations in groundwater chemistry (Manish kumar 2008; Kumar et al. 2006). Groundwater chemically evolves by interacting with aquifer minerals or internal mixing among different groundwater along flow-paths in the subsurface (Umesh kumar singh and AL Rmanathan 2008). Schuh et al.(1997) indicated that increase in solute concentrations in the groundwater were caused by spatially variable recharge, governed by micro topographic controls. GIS is computer-based tools that can be used to collect, store, integrate, modify and display geographical and spatial data. It is very useful for solving complex planning and management problems related to natural resources. Within India, several groundwater related studies have been conducted to determine potential sites for groundwater evaluation (Kamaraju et al.,1996; Krishnamurthy & Srinivas, 1995; A.Srivastava, Tripathi & Gokhale, 1997; P.K.Srivastava & Battacharya,2000) and groundwater quality mapping (Anbazhagan & Nair, 2004; Hong&Chon,1999) using remote sensing and GIS. The research described in this model delineated temporal and spatial variations in groundwater quality throughout the western part of Perambalur district. Our research focused on quantitative assessment of pollution within a shollow groundwater resource. Spatial distribution of pH, electrical conductivity (EC), total dissolved solids (TDS), chloride and total iron content of ground water samples collected from the residential region in western or study area. It has been studied for pre monsoon period of year 2015.

2. STUDY AREA WITH CLIMATE

Study area situated in central part of Tamilnadu, India. Study area lies between $11^0$06'11"N to $11^0$80'05"N in latitude and in longitude from $78^0$39'28"E to $79^0$39'19"E survey of India toposheet no 58 I/15(fig.1). The study area is one of the most backward District in Tamilnadu. Groundwater is the main problem for drinking, domestic and agriculture purposes. Because e we are having a low rainfall in this region. The climate

of the area is generally hot, semidry and tropical region. March to June is the hottest months and December to February is the coolest months of the year. The daily mean temperature ranges from 20 to 38 degrees Celsius. The daily mean relative humidity varies from 40 to 88 percent. The average annual rainfall in the Perambalur region is 52% in the northeast monsoon, 34% in the southwest monsoon and 14% in winter & summer weather condition.

Drainage

After a reconnaissance survey, the watershed was delineated on the basis of drainage line, land slope, and outlet point. Cauvery is the major river flowing in the region and the composite district has a canal system covering just 47 km stretch and ayacut of 11,610 ha. This is the major source of water drainage in the study area. The drainage pattern of the study area is shown in the drainage map (Fig.2).The drainage patterns and associated features recognized in this area as follows, 1.Dentritic and Subdentritic, 2.Radial.The dentritic (or) subdentritic patterns are characterized by irregular branching of tributary streams in many

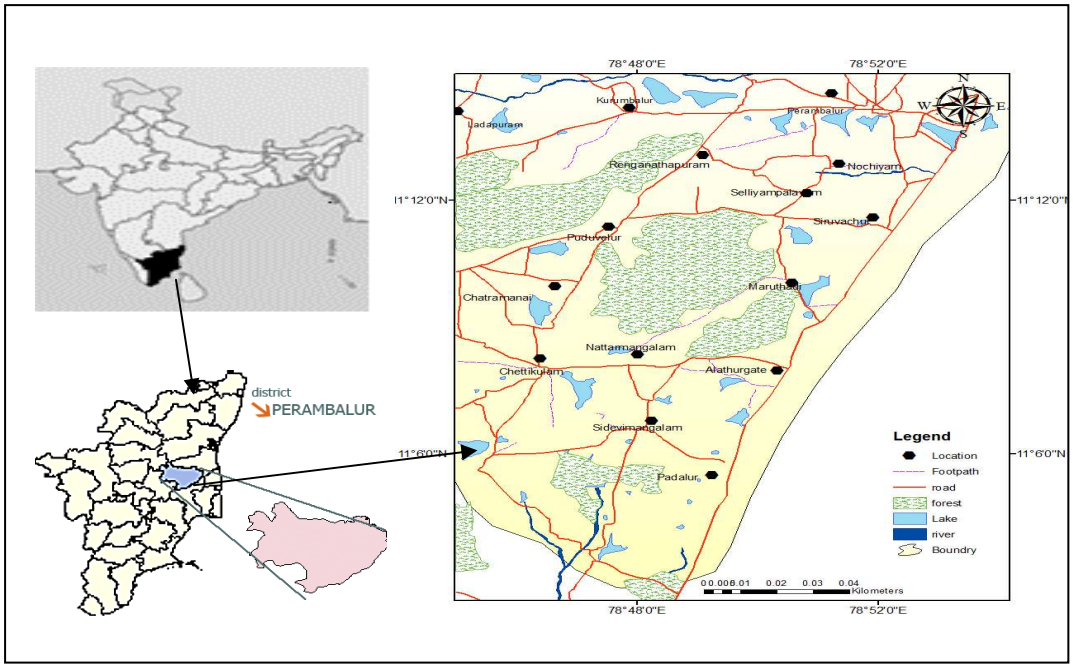

Fig.1.Map of the study area.

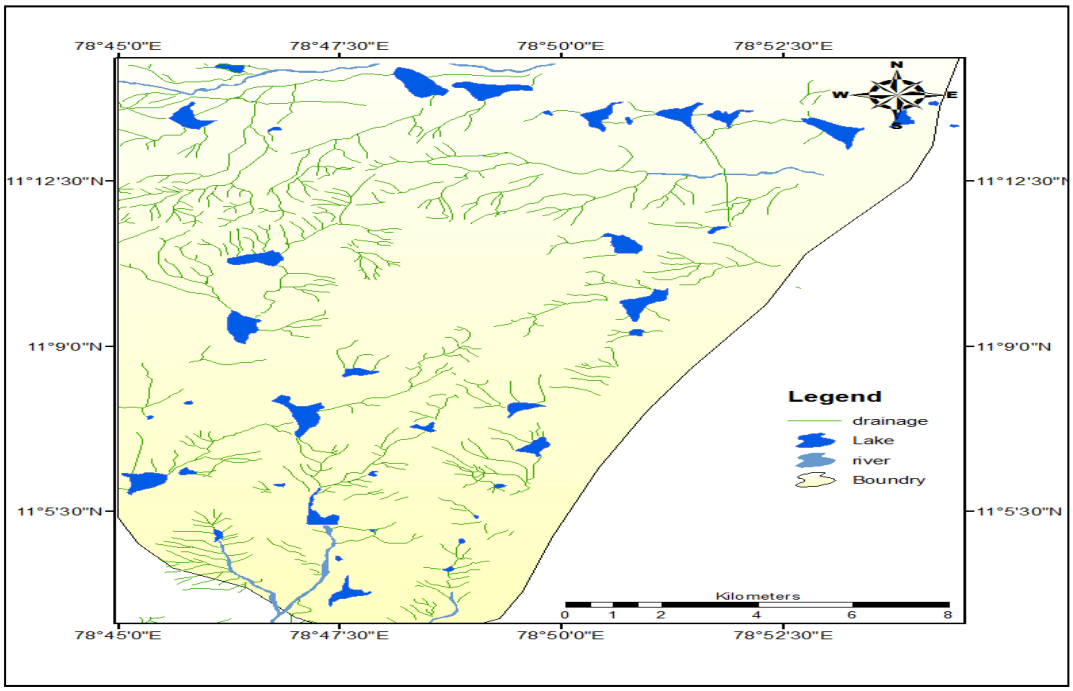

Fig.2. Drainage map of the study area

directions and at most in all angle, although considerably less than at right angle. They are mostly found in the hard rock zones of the study area. Radial patterns seen in the Upland area (north western) where there are pronounced slope which lead to regular spacing of Parallel or near parallel streams forming radial patterns.

3. METHODOLOGY

Sampling of groundwater has been carried out in the Perambalur block during 2015. 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 4). The water samples were collected during premonsoon to broadly cover the Water quality variation. A total of 15 water samples were collected from bore wells in the premonsoon season (December 2015). 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.

Table 4.1.Ground water sample location with Geographic co-ordinates

Location .No	Location Name	Latitude	Longitude
1	Ladapuram	11˚14'05"	78˚45'13"
2	Kurumbalur	11˚14'05"	78˚48'14"
3.	Perambalur	11˚13'12"	78˚52'9"
4.	Nochiyam	11˚13'06"	78˚51'8"
5.	Selliyampalayam	11˚33'05"	79˚39'19"
6.	Siruvachur	11˚60'04"	78˚52'15"
7.	Marudhati	11˚54'13"	78˚39'28"
8.	Alattur Gate	11˚08'09"	78˚50'9"
9.	Padalur	11˚06'16"	78˚49'04"
10.	Sidevimangalam	11˚06'11"	78˚47'14"
11.	Chettikulam	11˚08'05"	78˚42'14"
12.	Nattarmangalam	11˚08'16"	78˚48'12"
13.	Chattramanai	11˚10'02"	78˚47'16"
14.	Pudhu velur	11˚10'13"	78˚46'17"
15.	Renganathapuram	11˚12'09"	78˚48'08"

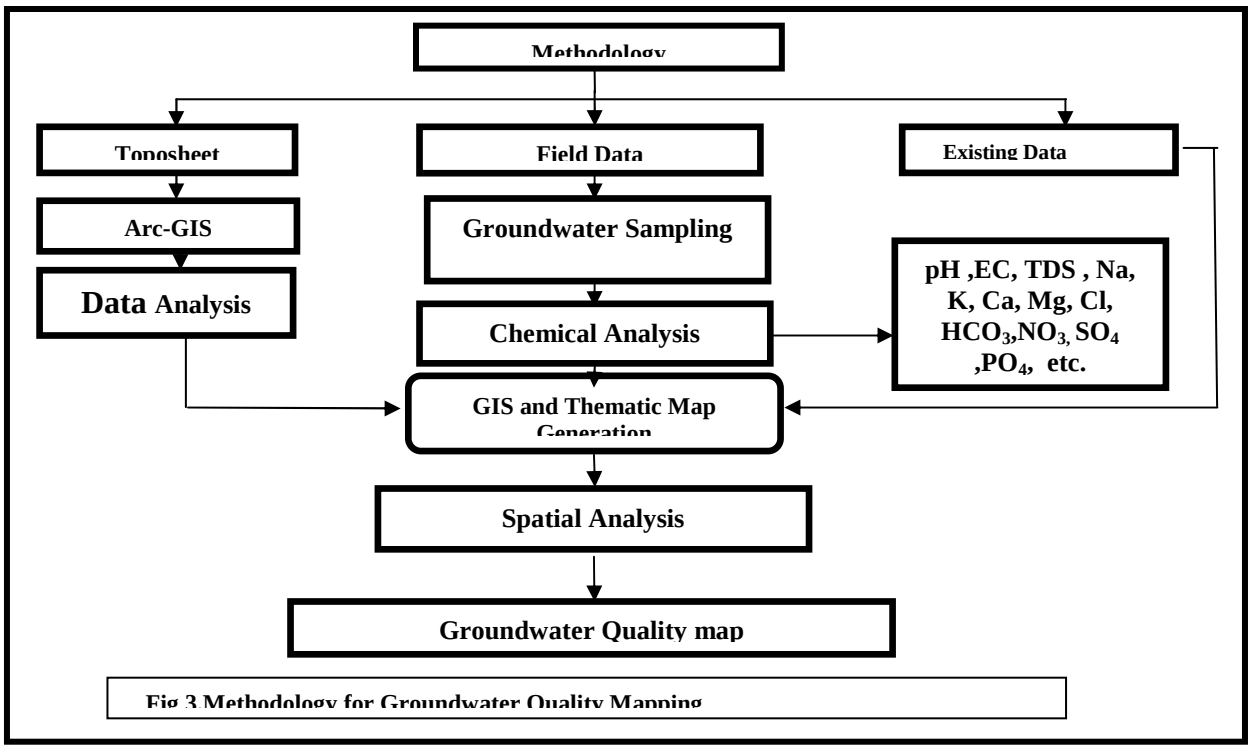

Fig 3 Methodology for Groundwater Quality Mapping

4. RESULT AND DISCUSSION

Chemical constituents present in water during premonsoon 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 premonsoon 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 15 samples, 4 sample lies in C3-S1field, 8 samples inC3-S2field, 2 samples in C3-S3 field and one sample lies in C3-S4 field. 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 2015 we were collected water samples for the premonsoon 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 premonsoon 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

the other region (premonsoon). This trend shows the influence of precipitation and leaching on groundwater.

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 1077 to 2200µs/cm near. The Kurumbalur area has higher value of EC(2200µs/cm).The spatial distribution based on Electrical Conductivity concentration and Alkalinity concentration value of ground water samples were highly found in Pudhuvelur region and also total hardness concentration value of groundwater samples were highly found in Nattarmangalam and Padalur region. Because in these region has lot of ponds. 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 the calcium content is not high. The spatial distribution based on Sodium concentration values were highly found in Chattramanai region. In east and west region, the concentration of Pottasium value was highly found. The spatial distribution based on Manganese concentration of groundwater samples were highly found in only two regions that is Siruvachur and Nattarmangalam 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. 2.Physico chemical parameters of groundwater samples of Perambalur district. All values are in mg/L except EC(µs/cm)&pH

LOCATION NAME	pH	EC	TDS	CO3	HCO3	Cl	SO4	PO4	NO3	H2SiO4	Ca	Mg	Na	K
LADAPURAM	6.49	1840	1310	0	414.8	478.57	1	0.035	0.011	10	52	48	130	1
KURUMBALUR	6.29	2200	1560	0	341.6	584.92	2.6	0.035	0.011	10	56	57.6	69	1
PERAMBALUR	6.64	2030	1440	24	292.8	443.12	1.6	0.045	0.07	15	56	16.8	127	1
NOCHIYAM	6.62	1342	950	0	305	319.05	1.8	0.067	0.35	14	76	21.6	73	0
SELLIYAMPALAYAM	6.12	1312	929	0	280.6	301.2	1	0.042	0.034	18	96	38.4	86	2
SIRUVACHUR	6.54	2090	1480	24	305	496.3	1.8	0.049	0.043	12	64	96.0	52	1
MARUDHATI	6.62	1436	1020	0	231.8	354.5	1.4	0.051	0.056	16	106	31.2	64	2
ALATHUR GATE	6.65	1208	857	0	268.4	265.87	1.2	0.073	0.042	18	48	26.4	57	0
PADALUR	6.29	1283	912	0	207.4	265.87	1.6	0.039	0.019	12	120	36.0	38	1
SIDEVIMANGALAM	6.69	1203	855	0	207.4	265.87	1.8	0.061	0.025	18	60	28.8	112	0
CHETTIKULAM	6.19	1745	1240	0	292.8	389.95	2	0.056	0.068	18	44	16.8	61	2
NATTARMANGALAM	6.64	1611	1140	0	207.4	443.12	1.2	0.037	0.38	12	60	96.0	76	0
CHATHRAMANAI	6.33	1724	1220	0	207.4	354.5	1.6	0.063	0.073	16	84	52.8	37	2
PUDHU VELUR	6.72	1077	763	0	305	301.2	2.2	0.64	0.052	16	76	40.8	72	0
RENGANATHAPURAM	6.51	1864	1320	0	280.6	602.6	1.8	0.038	0.047	16	100	36.0	49	1
MAXIMUM	6.72	2200	1560	24	414.8	602.6	2.6	0.64	0.38	18	120	96.0	130	2
MINIMUM	6.12	1077	763	0	207.4	265.87	1	0.035	0.011	10	44	16.8	37	0
AVERAGE	6.49	1597.68	1133.07	3.2	276.53	391.10	1.64	0.088	0.085	14.73	73.2	42.88	73.53	0.93

Table 3. USSL, Hardness, Na%, Salinity, SAR % based on water quality

Classification of water sample based on USSL Diagram Sawyer and Mc Carty Hardness based on water quality

Zone	Water class	No of GW sample
C3S1	Very Good	4 (6,9,13,15)
C3S2	Good	8 (2,4,5,7,8,11,12,14)
C3S3	Moderate	2 (1,10)
C3S4	Bad	1 (3)

Sawyer and Mc Carty Hardness based on water quality

Range	Water Class	No of GW sample
<75	Soft	2 (3,8)
75-150	Slightly soft	10 (1,2,4,5,7,10,11,13,14,15)
150-300	Moder soft	3 (6,9,12)
>300	Very hard	

Classification of water sample based on Na%

Range	Water Class	No of GW sample
<20	Excellent	
20-40	Good	9 (2,5,6,7,9,12,13,14,15)
40-60	Permissible	5 (1,4,8,10,11)
60-80	Doubtfull	1 (3)
>80	Unsuitable	

Classification of water sample based on salinity

Salinity Hazard Class	EC(µs/cm)	Water class	No of GW sample
C1	100-250	Excellent	
C2	250-750	Good	
C3	750-2250	Doubtfull	15(1 to 15)
C4	>2250	Unsuitable	

Table.4 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	6.12-6.72	6.5-8.5	---	6.5-8.5	6.5-8.5
EC	1077-2200	1400	(1,2,3,6,7,11,12,13,15)	---	---
TDS	763-1560	1000	(1,2,3,6,7,11,12,13,15)	1500	2000
CO_3	0-24	0	---	---	---
HCO_3	207.4-414.8	0	---	---	---
Cl	265.87-602.6	250	(1 to 15)	1000	1000
SO_4	1-2.6	400	---	400	400
PO_4	0.035-.64	0	---	---	---
NO_3	0.011-0.38	0	---	45	100
H_2SiO_4	10.0-18.0	0	---	---	---
Ca	44-120	500	---	200	200
Mg	16.8-98	0	---	100	---
Na	37-130	200	---	---	---
K	0-2.0	0	---	---	---

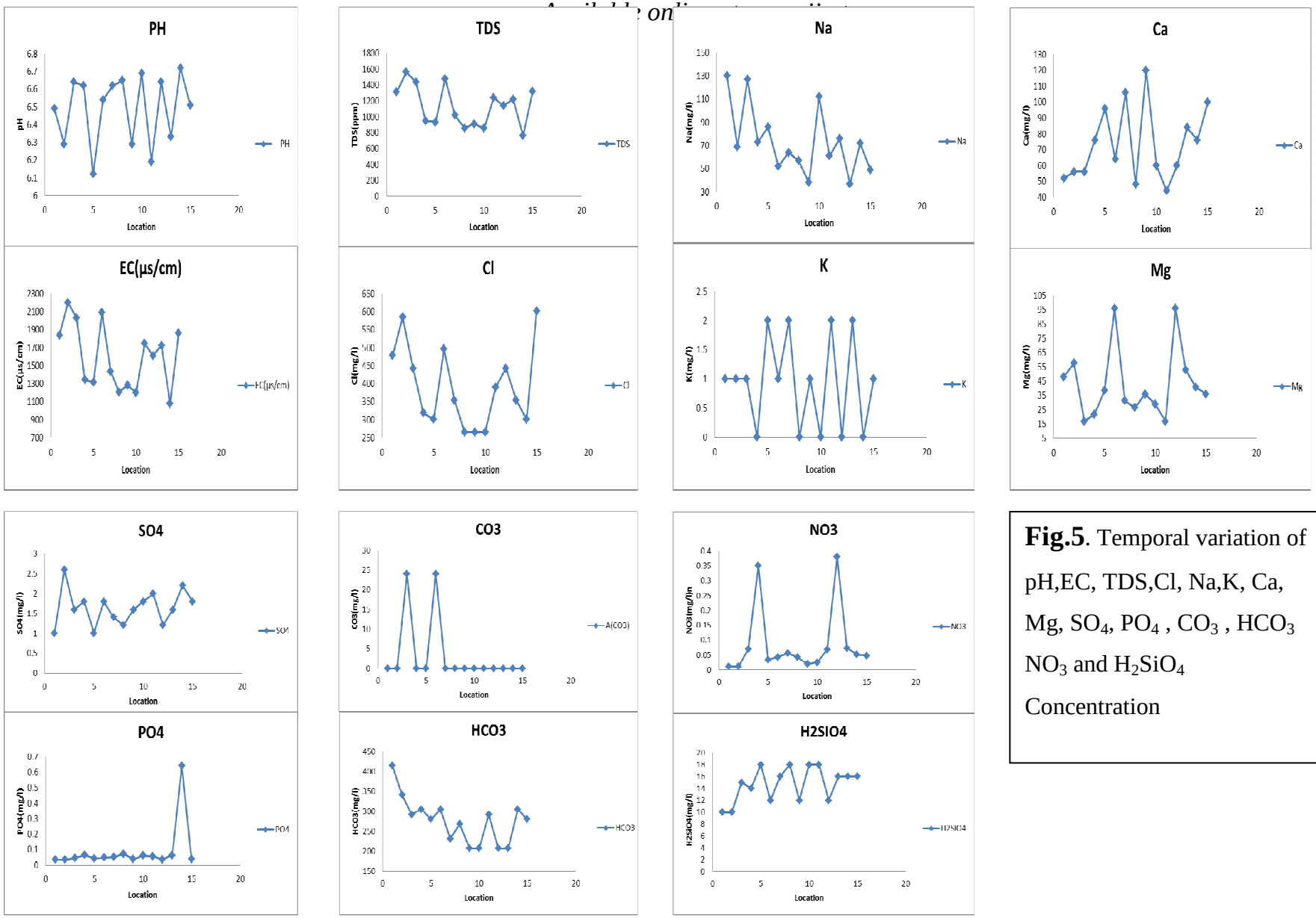

Fig.5. Temporal variation of pH,EC, TDS,Cl, Na,K, Ca, Mg, SO_4, PO_4 , CO_3 , HCO_3 NO_3 and H_2SiO_4 Concentration

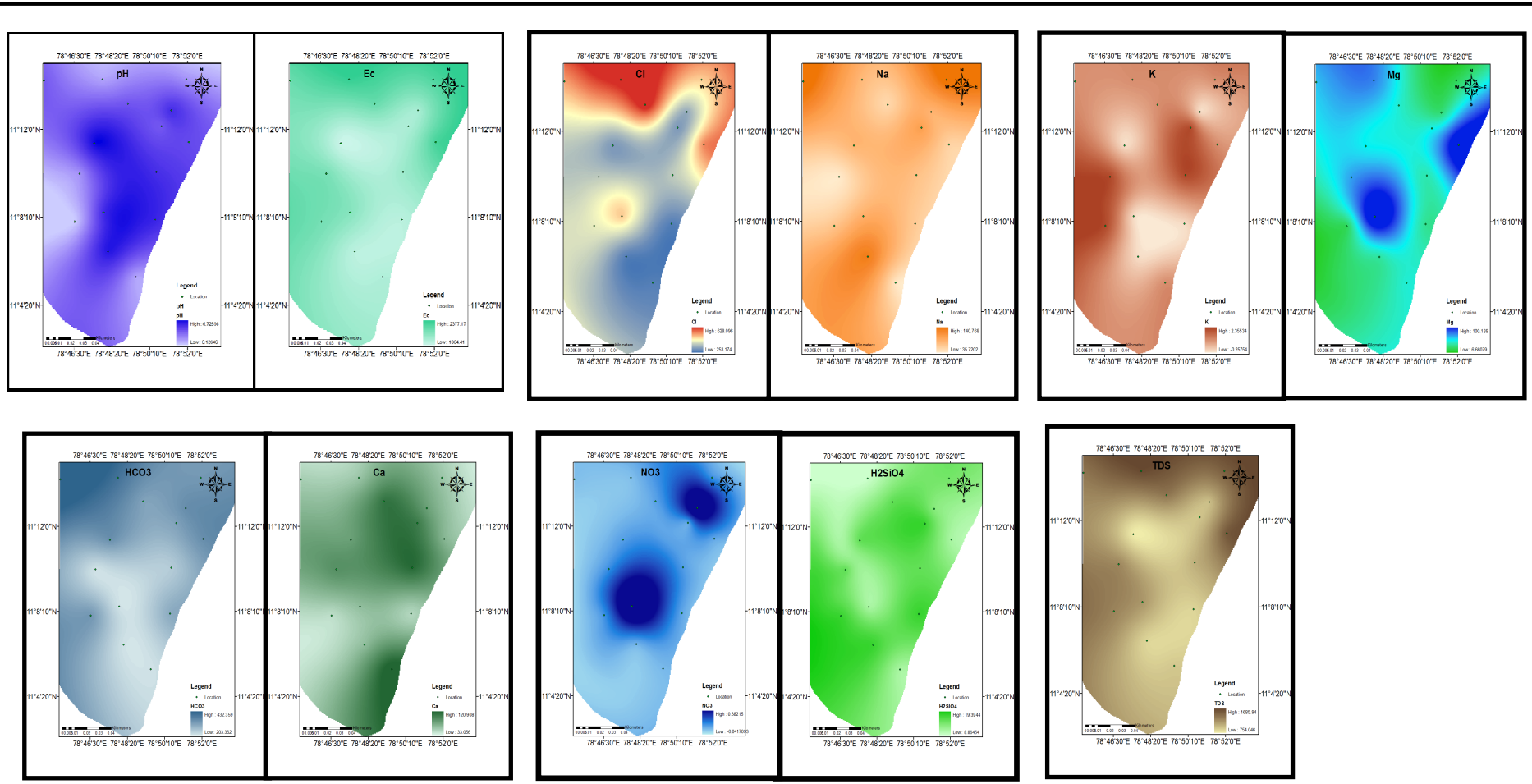

Fig .6.Spatial Distribution of physico chemical parameter of groundwater samples in western part of Perambalur region pH, EC, Cl, Na, K, Mg, HCO_3, Ca, NO_3 H_2SiO_4 and TDS concentration**.**

5. CONCLUSION

The issue of demand management has been given due importance in order to achieve higher levels of water use efficiencies. Ground water and is threatened by several factors related to its negligence. In the study discussed here, we analyzed groundwater quality parameters within the Perambalur watershed, noting spatial and temporal variations. We performed chemical analysis on groundwater samples taken from various locations within the catchment at different times. 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 premonsoon 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 drinking water quality map, the groundwater found in almost 80 percent of the Perambalur basin is desirable for drinking purposes. The irrigation water quality map shows that groundwater in over 60 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.

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