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ASSESSMENT OF GROUNDWATER QUALITY IN VELLORE DISTRICT, TAMIL NADU, INDIA

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Abstract: **Vellore District is one of the most polluted in Tamil Nadu, India. The present study deals with the physio-chemical characteristics of ground water quality in Vellore district. Samples were collected from 24 locations within study area during month of May 2015. Sampling is done at each station in polythene bottles of one - liter capacity. The samples were analyzed various water quality parameters such as PH, Electrical conductivity (EC), Total dissolved solids (TDS), Total Hardness (TH), Calcium(Ca), Mgnesium(Mg), Sodium (Na), Potassium(K), Bicarbonate (HCO3), Chloride (Cl), Sulphate(SO4), Nitrate (NO3), and Fluoride (F), were determined using standard method. The methods used for estimation of various physio-chemical parameters of water were plotted in GIS (Geographical Information Systems).**

Keywords: **Water Quality, Physico-Chemical, Ground Water, Sampling, Location.**

1. INTRODUCTION

Water is an essential and vital component for our life support system. The rainfall is the major source for surface and groundwater resources and drought and floods are the extreme events of rainfall. The vagarious of monsoon and spatial variation in the hydro geological framework in the state make the water resources non-uniform in the state. Ground water is the major source of water supply for domestic, irrigation and industrial uses in TamilNadu due to the ever increasing demand to satisfy the needs of a growing population and near - total utilization of available surface water resources. Three fourths of the state is underlain by Achaean crystalline rocks, which form aquifers with limited groundwater prospects. The increasing extraction of ground water from these aquifers more than the recharge has caused over exploitation of groundwater resources in several parts of the state. This has resulted in decline of groundwater levels and piezometric heads, drying up of shallow wells and decrease in the yields of wells. In addition, pollution of groundwater resources by agricultural practices and industrialization also pose a serious constraint in several parts of the state for its sustainable development and management. Water due to great solvent power, is constantly threatened to get polluted easily. Pollution in broad sense refers to any change which causes misbalance in the natural quality of the environment brought about through physical, chemical or biological processes. These industrial pollutants degrade ecosystem many fold; pollute the water bodies or stream, damage aquatic ecosystem, damage the soil fertility and soil subsystem. The effluent contains various inorganic and organic substances in different concentration may affect the nature and quality of lake water. Over burden of the population pressure, unplanned urbanization enhances the infiltration of harmful compounds to the groundwater. Due to migration of population, it becomes necessary for the corporation to give clean drinking water for the entire population. The effluents of the leather industries falls heavily, usage of the chemical fertilizers for agriculture and small scale dying industries falls heavily on the quality of drinking water. The impact felt very much on the drinking water. Different activities of man have created adverse effects on all living organisms. Today the environment has become foul, contaminated, undesirable and therefore for the health of the living organisms including the man. Chemical manufacture and storage similarly present a threat through leakage. Pollution caused by fertilizers and pesticides used in

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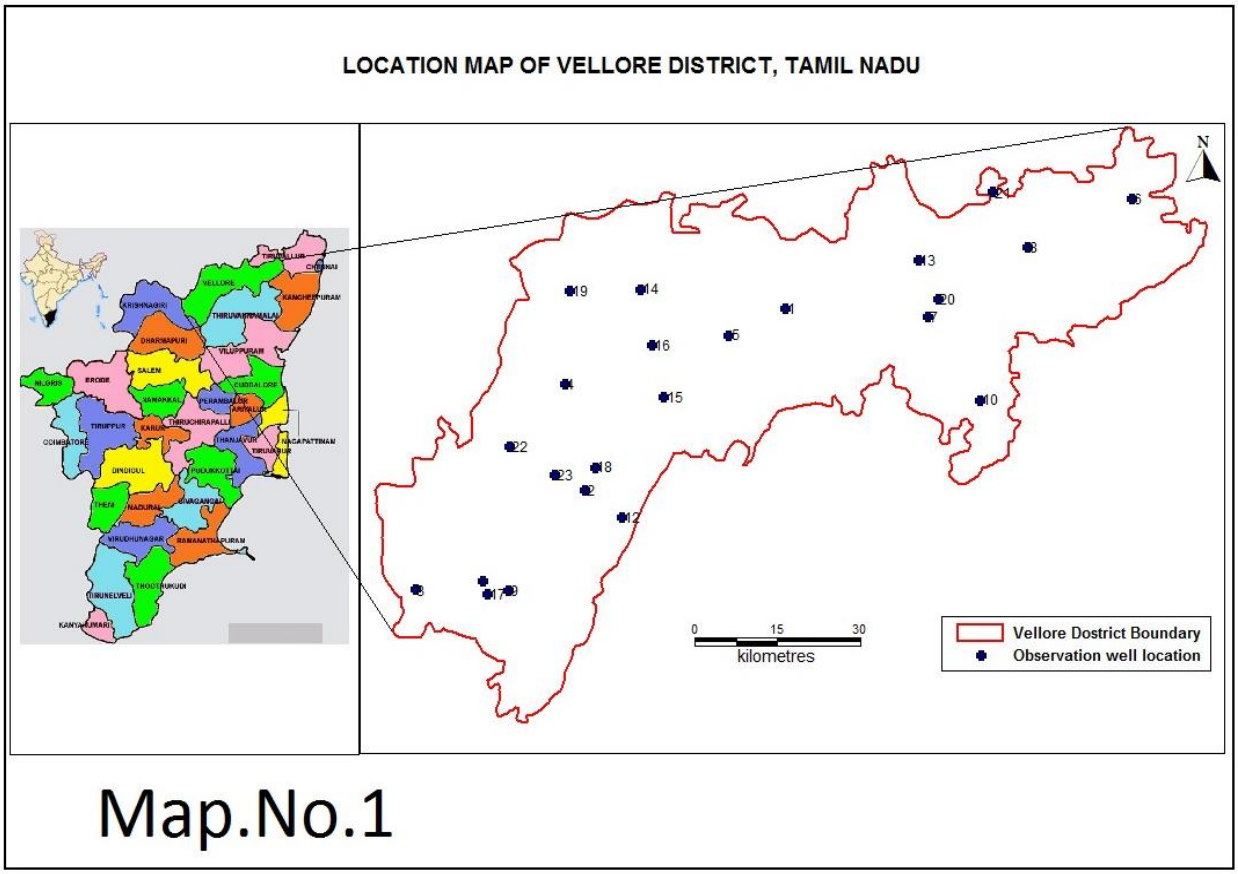
agriculture often dispersed over large area, is a great threat of fresh groundwater ecosystems. Health effects from contaminated groundwater depend on the specific pollutants in the water. Pollution from groundwater often causes diarrhea and stomach irritation, which can lead to cancer, reproductive abnormalities and other more severe health effects. So, the knowledge of extent of pollution and the status of water become essential in order to preserve the valuable sources of water for future generation. Hence the present work is explore the groundwater quality by carrying out analyzes various physio –chemical parameters of groundwater in Vellore district, Tamil Nadu, India.

2. STUDY AREA

Vellore District which was carved out of the erstwhile North Arcot district during 1989 is located in the north-western part of Tamil Nadu and has a total geographical area of 5920.18 sq.kms. It lies between Latitude 12°15'23''-13°12'32'' and Longitude 78°24'16''-79°54'56'' and bounded by Chittur District of AndhraPradesh in the north and north-west. Thiruvallur district is the North East, Kancheepuram district in the south east, Thiruvannamalai district in the South and Dharmapuri district in the west and south west. The drainage of the study area is mainly Palar River and Ponnai River. The area is a chronic polluted area and one of the biggest exporting centres of tanned leather. Many small – scale tanneries are processing leather in the study area and discharging their effluents on the open land and surrounding water bodies. (Map No.1)



Map.No.1

2.1. RAINFALL:

Vellore district receives rainfall from both southwest and northeast monsoons. The annual normal rainfall (1901-80) for the district is 949.8 mm. the contribution of southwest monsoon ranges from 45 to 52 percent, whereas it ranges from 30-43 percent due to northeast monsoon.

2.2. CLIMATE:

The district enjoys a tropical climate. The highest temperatures are recorded during May and June. The mean daily minimum and maximum temperature are 18.2 to 36.8° C. The relative humidity ranges from 37 to 85 percent.

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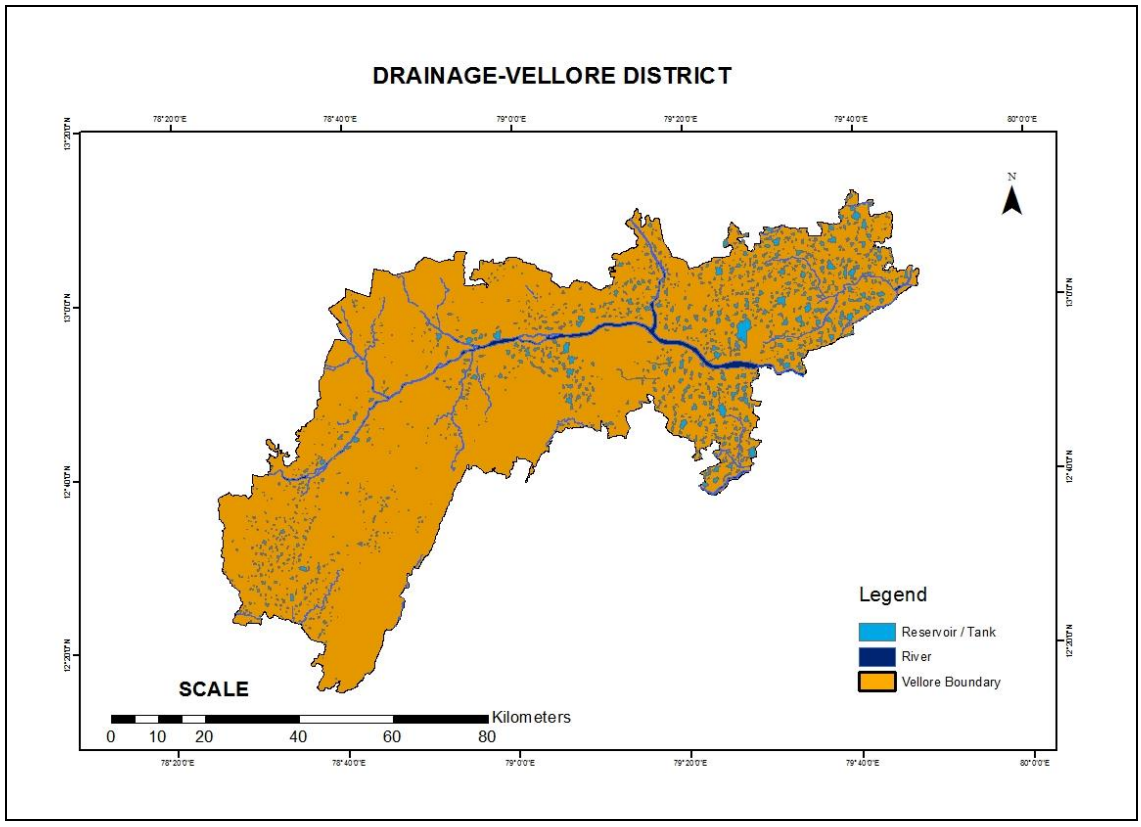
2.3. PHYSIOGRAPHY:

Physiographically, the Vellore district can be classified into two major divisions viz., (1) hilly terrain in the western and south western parts and (2) plain regions in the eastern part. The landscape in the hilly terrain is undulating to rugged, flanked by hill ranges belonging to Eastern Ghats. The major hill ranges in this district are those belonging to Javadi, Elagiri and Kalrayan hills. The eastern part of the district is a gently undulating plain dotted with isolated hillocks with sharply rising peaks, sloping toward east.

2.4. DRAINAGE:

Palar river is the major river drainage the district, flowing east through the district for a distance of about 295 km, it runs parallel to the hill ranges of the Eastern Ghats for a major part of its course. It has a vast flood plain in the lower reaches, but is dry for major part of the year.

Ponnaiyar, Cheyyar, Pambar, and Malattar are some of the major tributaries of Palar draining the district. Almost all the streams are ephemeral in nature and are mostly structurally controlled. (Map No.2)



Map No.2

2.5. GEOLOGY:

Geologically, the district is covered by crystalline rocks of Archaean age comprising of charnokites, granites, genesis, quarter sites etc. Alluvium occurring in the district is of fluviatile origin and restricted to the course of rivers and major systems. The alluvium consists of gravel, fine, coarse sand clay. Groundwater occurs under water table conditions in the weathered and jointed rocks of the crystalline basement. Water levels range between 2 to 29 m in crystalline rocks and 2 to 8 m cartulary deposits depending on topography. (Map No.3) The groundwater extraction points are mostly in the form of open dug – wells of diameters ranging between 6 m to 10 m, these wells vary in yields. There are several groundwater extraction points in the river Palar bed in the form of infiltration wells and galleries and water from these structures is supplied to the major regions located along the river course including a few industries too. In some of the areas bore wells supply water for drinking and industrial use. The Palar River and tributaries are seasonal rivers. Water flows only during the rainy seasons while throughout the year there is barely any flow, the district, therefore, relies mostly on rain water and ground water.

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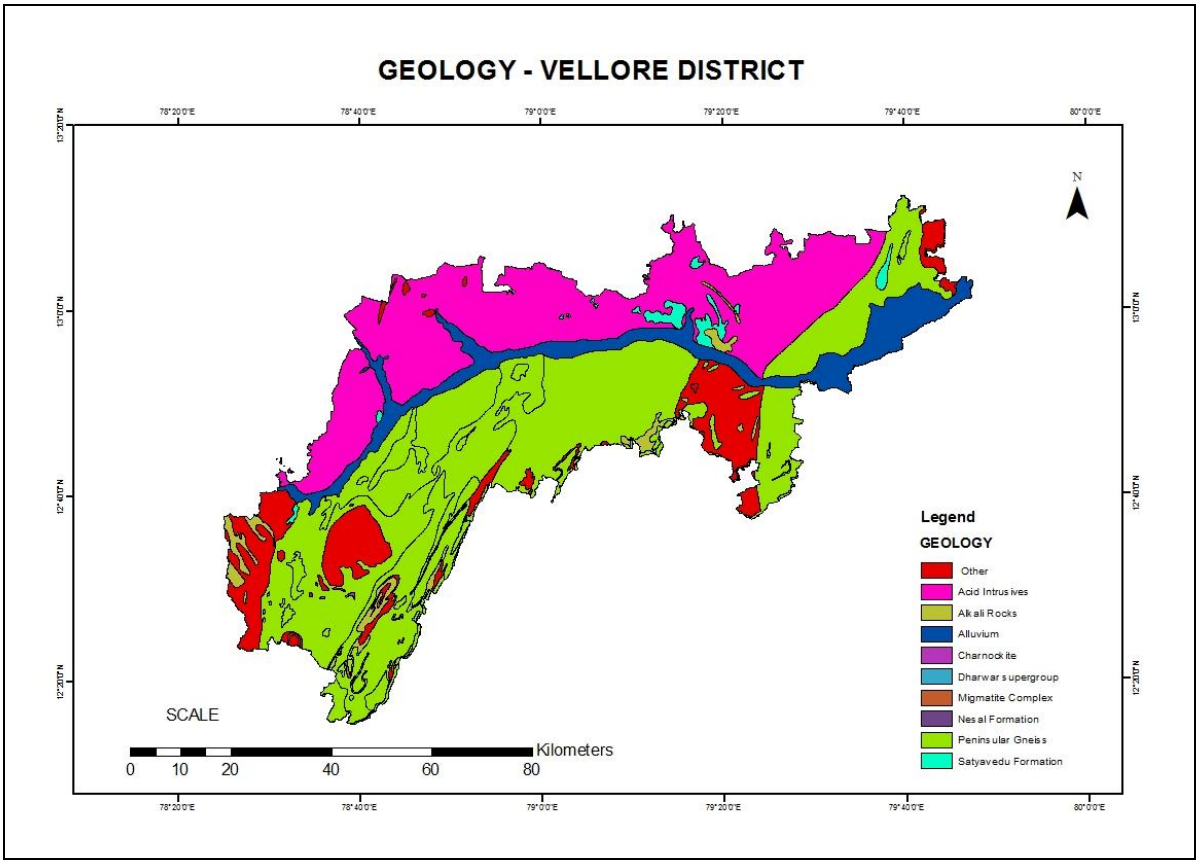

Map No.3

3. MATERIALS AND METHODS

Groundwater samples were collected from 24 locations within study area during month of May 2015.Sampling is done at each station in polythene bottles of one - liter capacity. The samples were analyzed various water quality parameters such as PH, Electrical conductivity (EC), Total dissolved solids (TDS), Total Hardness (TH), Chloride(Cl), Sulphate (SO4), Nitrate (NO3), Calcium(Ca) and Mgnesium (Mg), Bicarbonate (HCO3) were determined using standard method. The methods used for estimation of various physio-chemical parameters of water were plotted in GIS (Geographical Information Systems).

4. RESULT AND DISCUSSION

Result and analysis are presented in Table-1 and Table-2 compared with the permissible drinking water standards specified by WHO standard specification as per 2011, and the number of samples exceeding the limits parameter wise and their values are given.

Table 1: Physio-Chemical parameter of ground water during month of May 2015

SAMPLE NO	PH	EC	TH	TDS	Ca	Mg	Na	K	HCO3	Cl	SO4	NO3	F
S1	7.5	4700	1015	3055	344	38	568	121	780	1030	210	116	1.01
S2	8.0	1700	460	1105	32	92	520	9	486	320	96	66	0.99
S3	7.4	4000	1065	2600	124	184	439	14	388	1072	122	179	0.41
S4	7.3	6300	1050	4095	340	49	931	3	451	1789	278	6	0.28
S5	7.7	2100	700	1365	192	54	190	3	396	270	298	9	0.18
S6	7.7	950	345	618	100	23	116	3	439	185	10	5	0.50
S7	7.7	1560	330	1014	84	29	273	15	671	298	22	7	0.43
S8	7.6	870	330	566	72	36	89	5	342	163	12	42	0.58

S9	7.5	1380	425	897	48	74	187	1	695	156	28	45	0.40
S10	7.6	1080	290	702	42	45	94	5	305	185	24	8	0.06
S11	7.6	1080	290	650	42	45	94	5	305	142	24	16	0.64
S12	7.3	1030	410	670	108	34	84	14	476	178	27	9	0.53
S13	7.4	1790	465	1164	108	47	262	8	732	341	16	20	0.20
S14	7.7	1810	380	1177	52	61	286	4	403	291	176	4	0.19
S15	7.5	1990	635	1294	92	98	230	7	464	426	125	7	0.18
S16	7.7	640	185	416	40	21	78	10	378	36	10	8	0.29
S17	7.7	1480	375	962	52	60	196	6	437	227	46	112	0.25
S18	7.7	960	310	624	40	51	78	2	362	92	58	5	0.27
S19	7.4	2100	485	1365	84	67	254	13	610	376	18	13	0.19
S20	7.4	6000	1400	3900	128	263	955	8	500	1783	478	70	0.18
S21	8.2	270	90	176	30	4	34	2	73	55	10	14	0.08
S22	7.6	2300	520	1495	64	88	341	34	547	497	176	52	1.12
S23	7.7	2100	575	1365	68	98	288	32	617	362	128	99	1.56
S24	7.5	4400	1000	2860	140	158	550	55	678	1107	98	13	1.18

Table 2: Results of water analyzed in comparison with WHO standards

Parameters	Permissible limit as Per, WHO 2011	Concentration Minimum	Observed Maximum	No of samples exceeding permissible limit	Percentage %
pH	7.0-8.5	7.3	8.2	24(Permissible limit)	100
EC	1000	270	6300	19	79.1
TH	300	90	1400	20	83.3
TDS	1000	175	4095	14	58.3
Ca	75	30	344	11	45.8
Mg	50	4	263	13	54.1
Na	200	34	955	13	54.1
K	100	1	121	1	4.1
HCO3	200	73	780	23	95.8
Cl	250	36	1789	15	62.5
SO4	200	10	478	4	16.6
NO3	45	4	179	7	29.1
F	1.5	0.06	1.56	1	4.1

All parameters are expressed in mg/l except pH and EC in µS/cm.

4.1. pH

The purpose of finding the pH value is to determine whether is acidic or alkaline in nature. The pH value of the samples varies in the range of 7.3 to 8.2. The maximum value of pH was obtained at the samples (Sholingar-S21), and the minimum value of the pH was obtained at the samples (Ambur-S4 &Kavalur-S12). The permissible amount of the pH value in the groundwater is 7.0 to 8.5. the samples (Abdullapuram-S1 to Vengalapuram-S24) the pH value is less than the permissible limit it showed that they are of acidic in nature and twenty four samples within permissible limit, if they pH value lies beyond the limit it affects the mucous membrane of the cells. (Fig No.1 and Map No.4)

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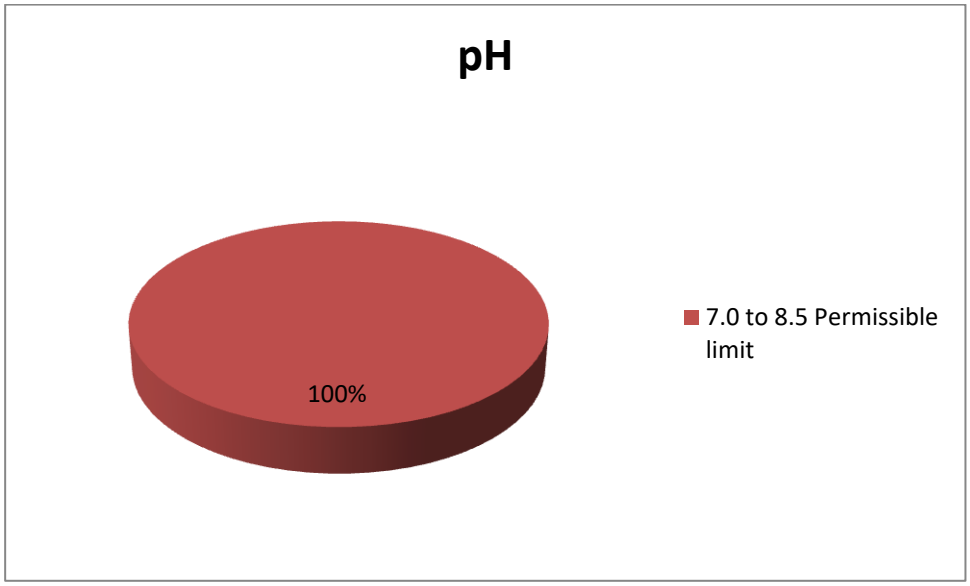

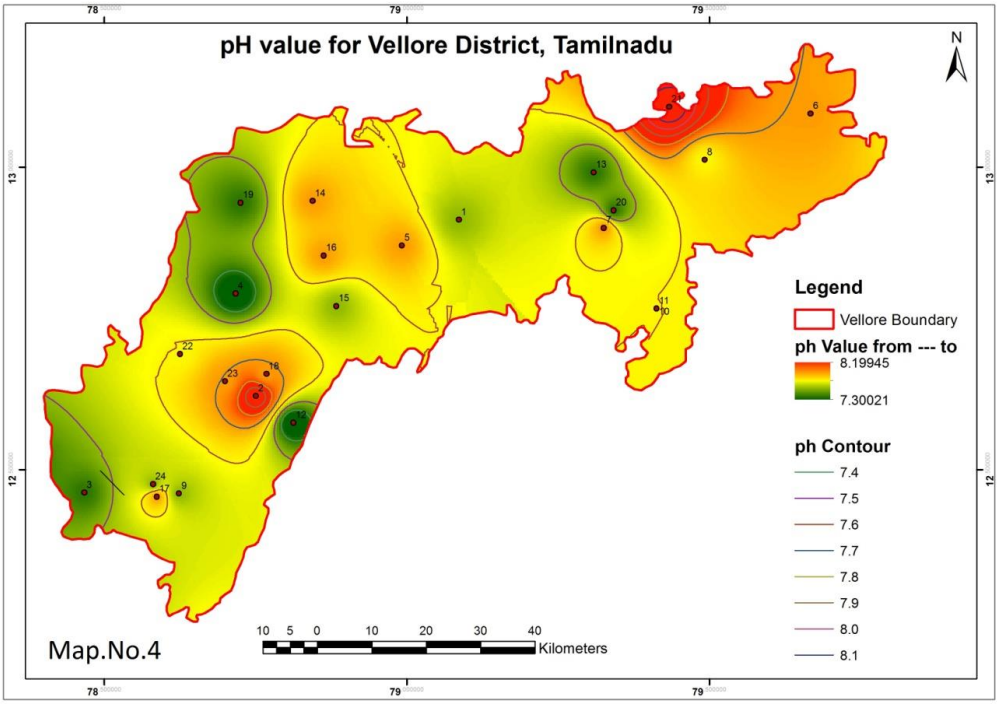

4.2. Electrical conductivity (EC):

The electrical conductance value of all the samples varies in the (Table -3& Fig.2) range of 270 to 6300 µS/cm. The Maximum electrical conductivity value of (6300 µS/cm) was found in the sample (Ambur-S4) and the minimum value of 270 µS/cm) was found in the sample (Sholingar-S21). The electrical conductance is a good indication of total dissolved solids which is a measure of salinity that affects the taste of portable water. The electrical conductivity is also influenced by ionic mobility, ionic valence and temperature. (Map.No.5)

Table 3: Classification of ground water based on Electrical conductivity

Electrical conductivity µS/cm	No.of. samples	Percentage %	Description
<500	1	4.1%	Excellent
500-1000	4	17%	Good
1000-3000	14	58.3%	Doubtful
>3000	5	21%	Unsuitble

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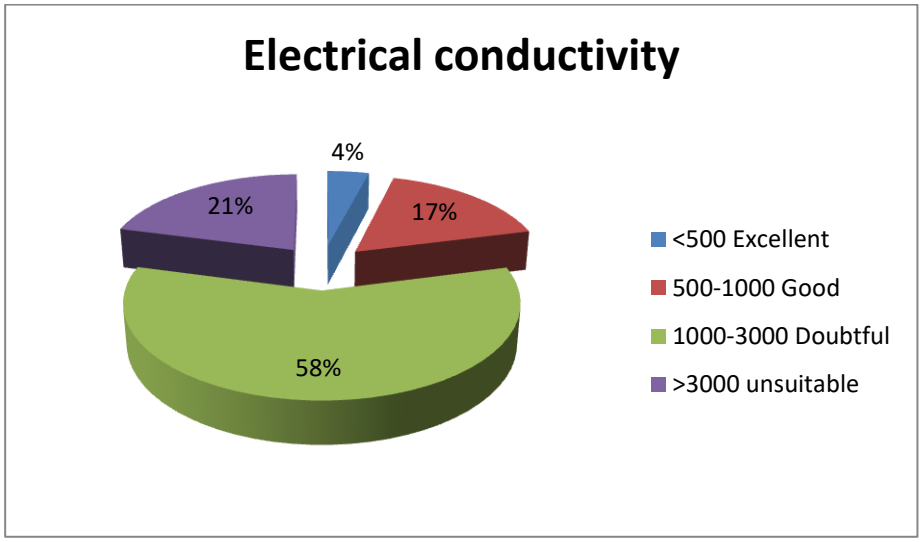

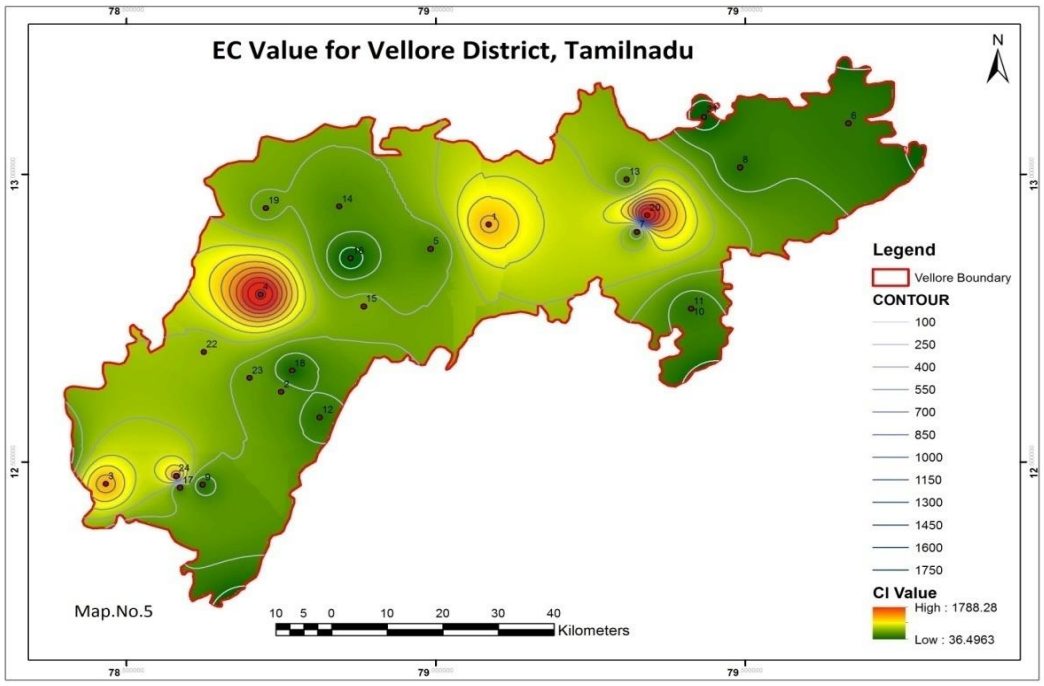

4.3 Total Hardness (TH):

The classification of groundwater (Table - 4 & Fig-3) based on total hardness (TH) shows that a majority of samples fall in the hard water category & very hard water category. Hard and very hard water might lead to pre-natal mortality, a cardio-vascular disease etc. and is unsatisfactory for domestic purpose and hence water softening processes for removal of hardness are needed. TH of the ground water was calculated using the formula given below.

TH (as CaCO3) mg/l = (Ca 2+ +Mg2+) mg/l x50. The hardness values range from 90 mg/l to 1400 mg/l. The maximum total hardness value (1400 mg/l) was found in the samples (Ranipet-S20) and the minimum value of (90 mg/l) was found in the sample (Sholingar-S21). (Map.No.6)

Table 4: Classification of ground water based on Hardness range

Total Hardness mg/L	No.of. Samples	Percentage	Description
0-75	-	-	Soft
75-150	1	4.1%	Moderately hard
150-300	3	12.5%	Hard
>300	20	83.3%	Very hard

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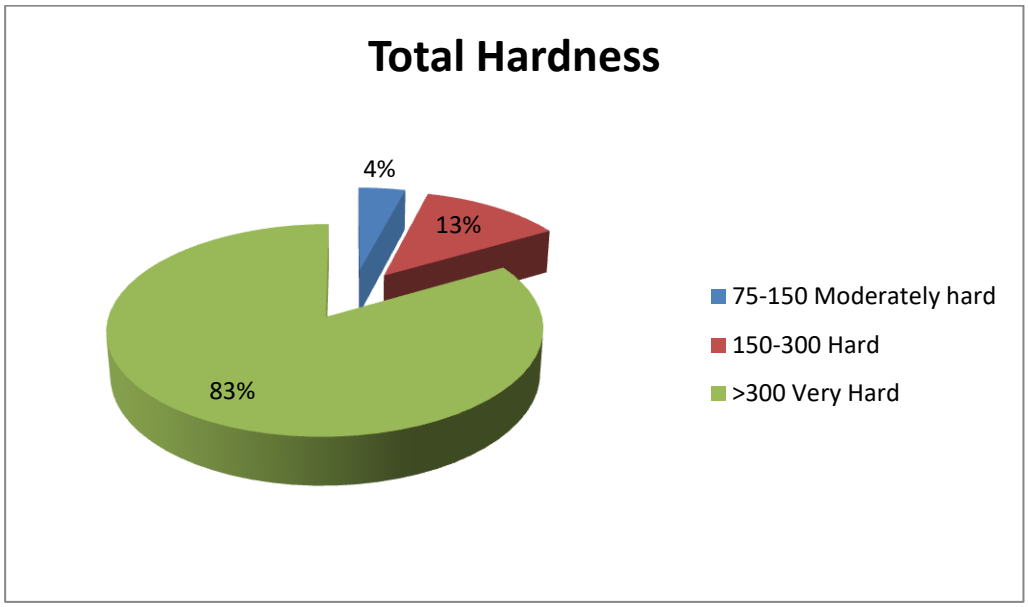

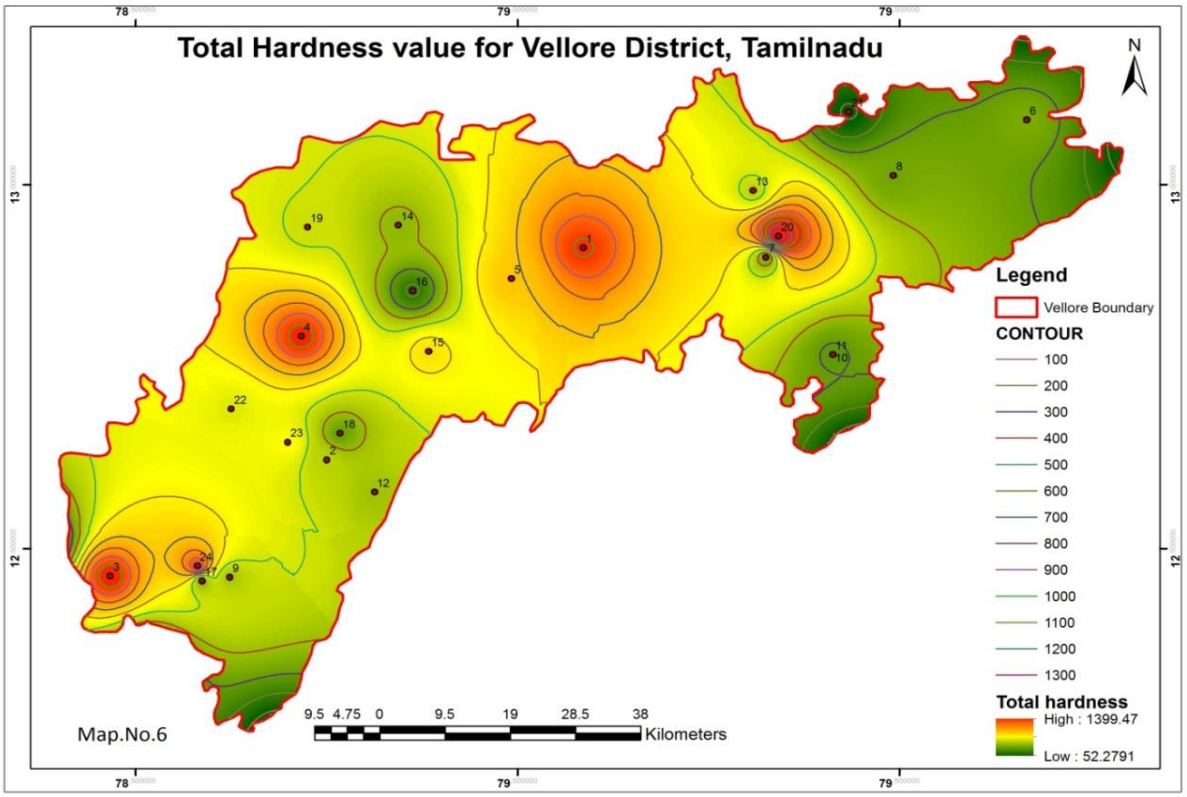

4.4 Total Dissolved Solids (TDS):

To ascertain the suitability of groundwater for any purpose, it is essential to classify the ground water depending up on their hydro chemical properties based on their TDS values. Which are presented in (Table-5&Fig.No.4) most of the groundwater samples are within the maximum permissible limit for drinking as per the WHO international standard, except 10 samples in study area. Most of the samples in the study area shown above 1000 mg/l of TDS indicating low content of soluble salts in groundwater which can be used for drinking without any risk. The TDS values range from 175 mg/l to 4095 mg/l. the maximum TDS value of 4095 mg/l) was found in the sample (Ambur-S4) and the minimum value of (175 mg/l) was found in the sample (Sholingar-S21). (Map.No.7)

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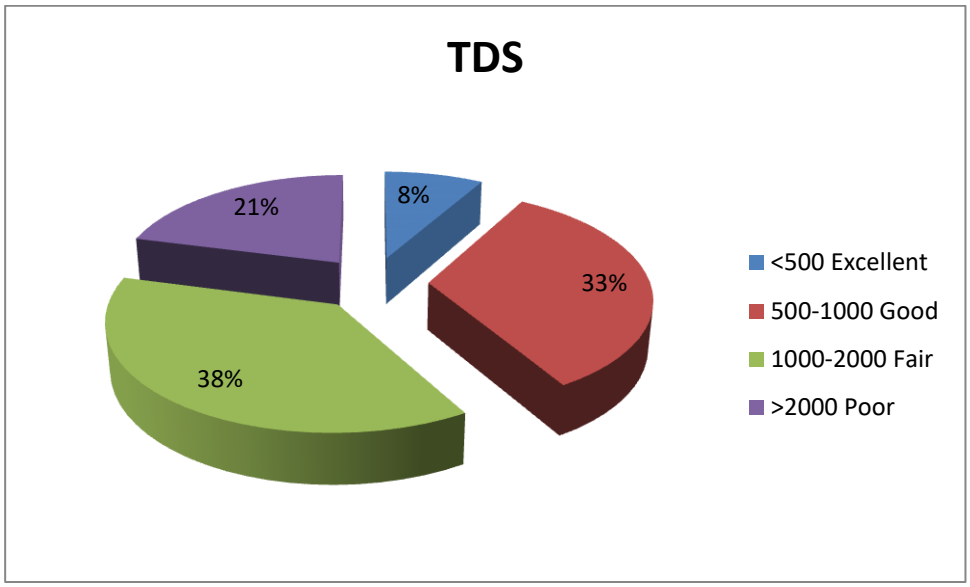
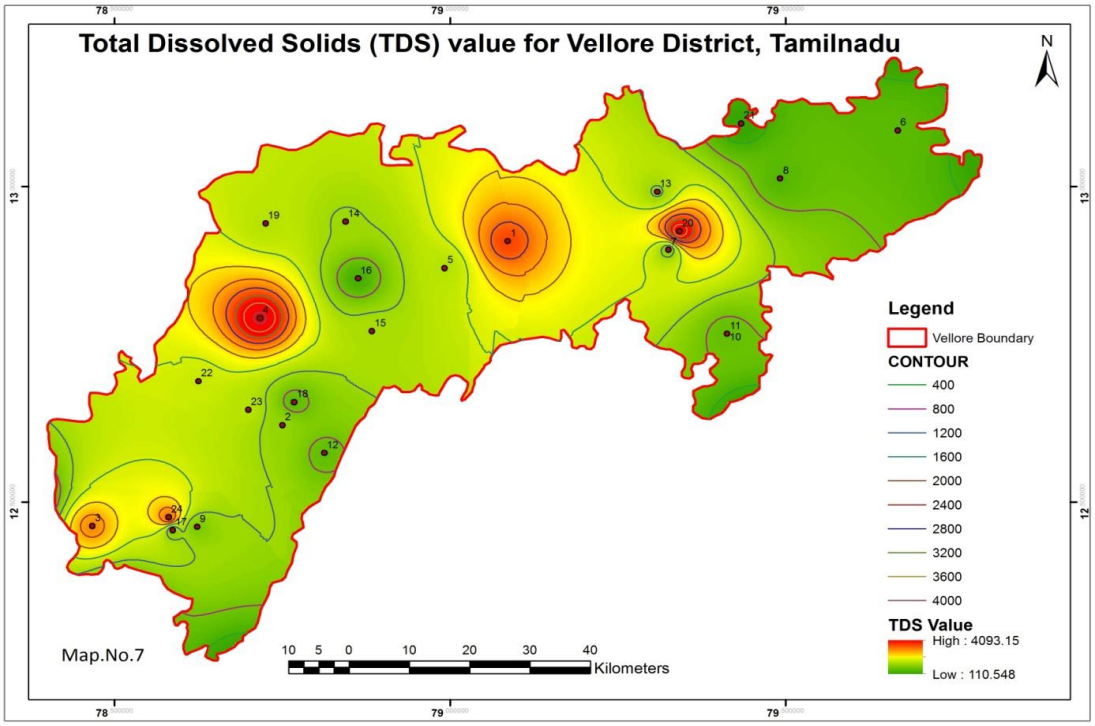
Table 5: Classification of grund water based on TDS Classes

TDS mg/L	No. of. Samples	Percentage %	Description	
<500	2	8.3%	Non-saline	Excellent
500-1000	8	33.3%	Non-saline	Good
1000-2000	9	37.5%	Slightly saline	Fair
>2000	5	21%	Moderately saline	Poor





4.5 Calcium (Ca):

Calcium is an essential nutrition element for human being and aids in maintaining the structure of plant cells and soils. The value of calcium of all the samples varies in the range of 30 to 344 mg/l. The maximum value of the calcium was obtained at the sample (Abdullapuram-S1), and the minimum value of the calcium was obtained at the sample (Sholingar-S21). (Fig.No.5& Map.No.8)

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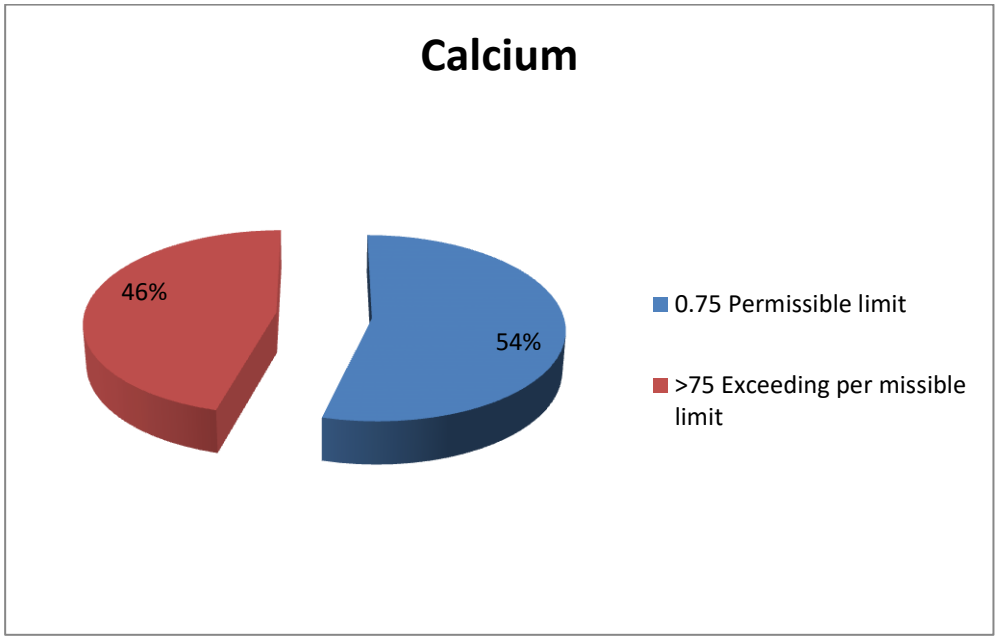

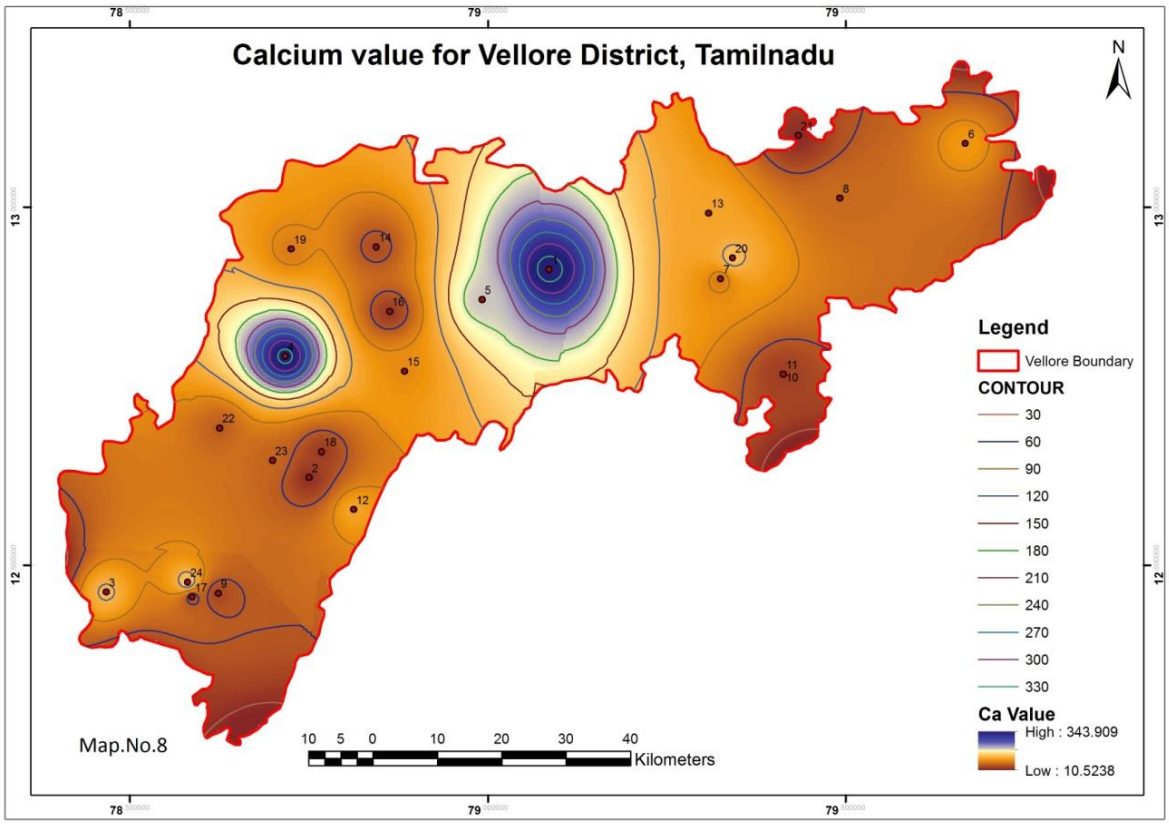

4.6 Magnesium (Mg):

The magnesium value of all the samples varies in the range of 4 to 263 mg/l. the maximum value of magnesium was obtained at the sample (Ranipet-S20), and the sample minimum value of the magnesium was obtained at the sample (Sholingar-S21). The permissible limit of the magnesium value in the groundwater is 50 mg/l according to the WHO standards. Magnesium generally occurs in lesser concentration than calcium because of dissolution of magnesium rich mineral is slow process and calcium is more abundant in earth crust. (Fig.No.7 & Map.No.9)

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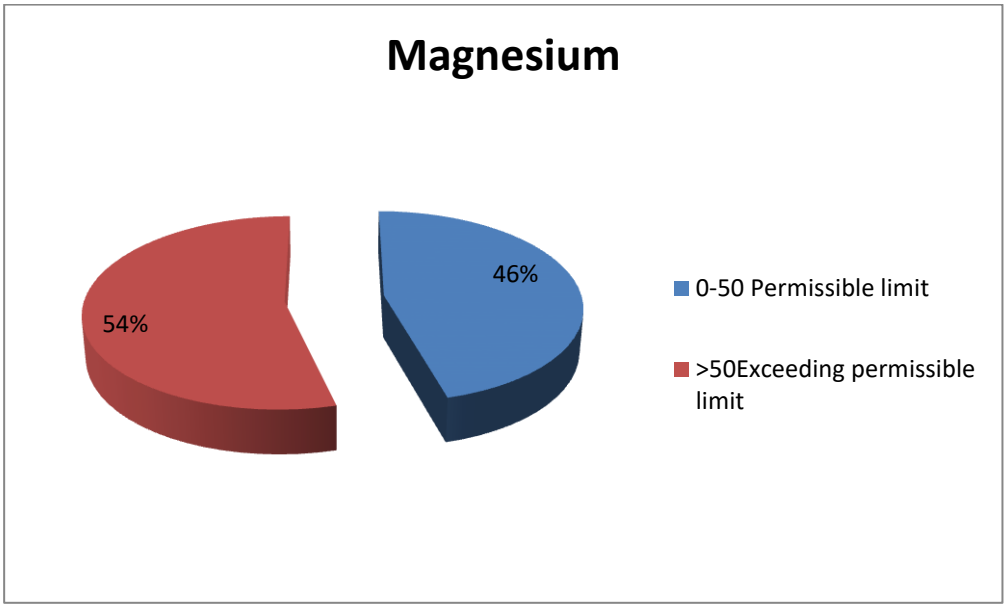

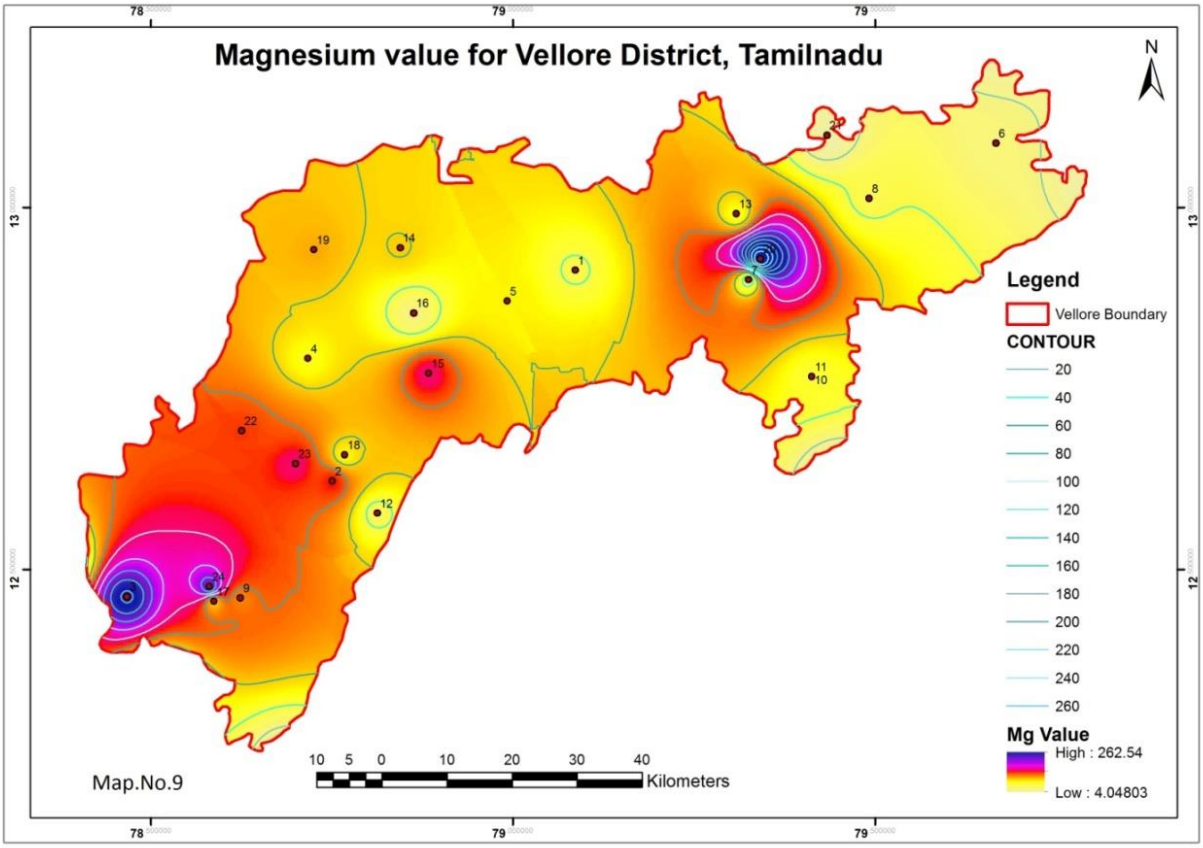

4.7 Sodium (Na):

The Sodium value of all the samples varies in the range of 34 to 955 mg/l. The maximum value of magnesium was obtained at the sample (Ranipet-S20), and the sample minimum value of the magnesium was obtained at the sample (Sholingar-S21). The permissible limit of the Sodium value in the groundwater is 200 mg/l according to the WHO standards. Most of the sodium salts are soluble in water, but take no active part in chemical reactions, as do the salts of alkaline earths. Sodium salts tend to remain in solution unless extracted during evaporation. In saline water, the sodium content may be several hundred times the total amount of the calcium and magnesium contents. (Map No.10 & Fig. No.7)

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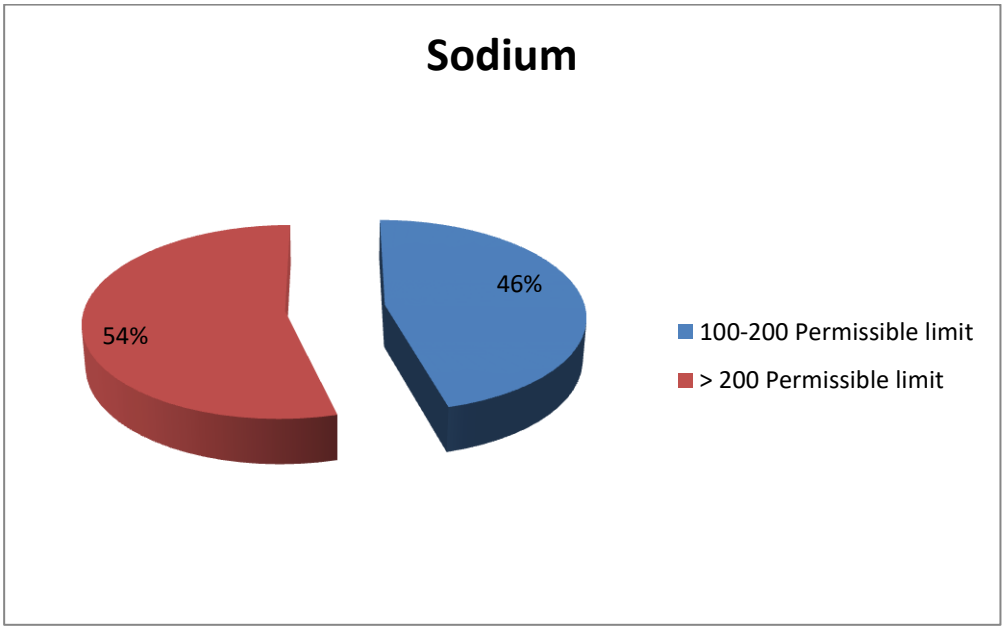

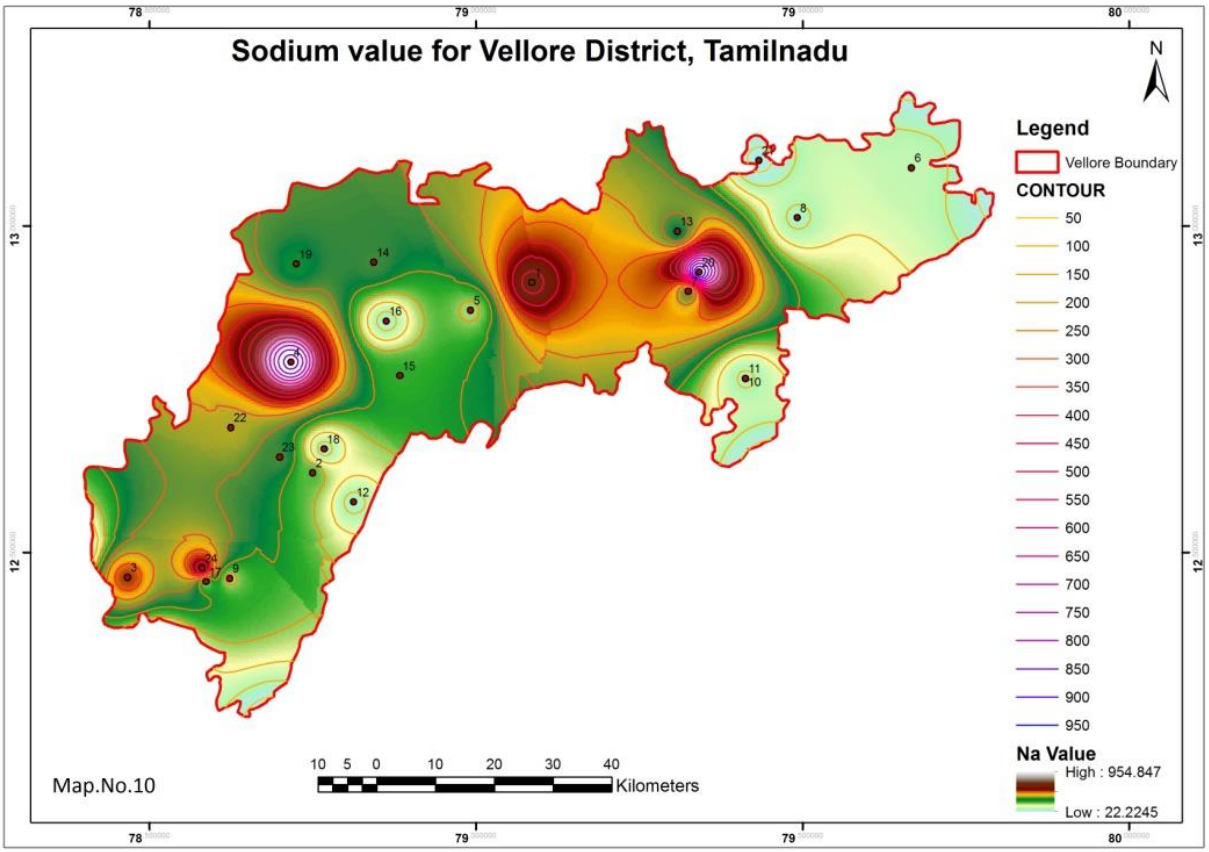

4.8 Potassium (K):

The Potassium value of all the samples varies in the range of 1 to 121 mg/l. The maximum value of the potassium is obtained at the sample (Abdullapuram-S1). The minimum value of the potassium is obtained in the sample (Bommikuppam-S9). The permissible limit of the potassium value in the groundwater is 100 mg/l as per WHO standards. The potassium is derived from silicate minerals like Orthoclase, Microcline, Nepheline, leucite and botite. Parity in concentration of sodium and potassium is found only in water with less mineral contents. (Map.No.11& Fig. No.8)

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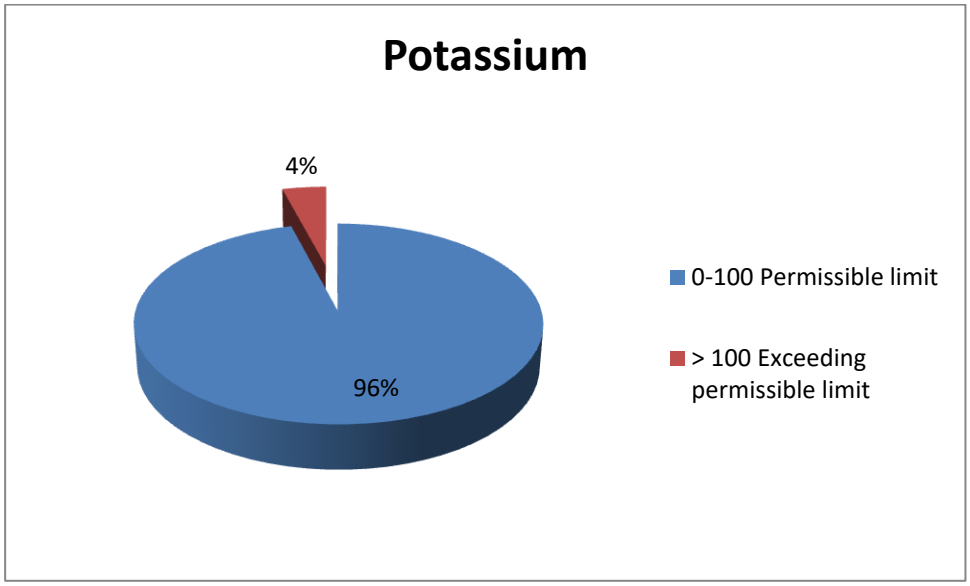

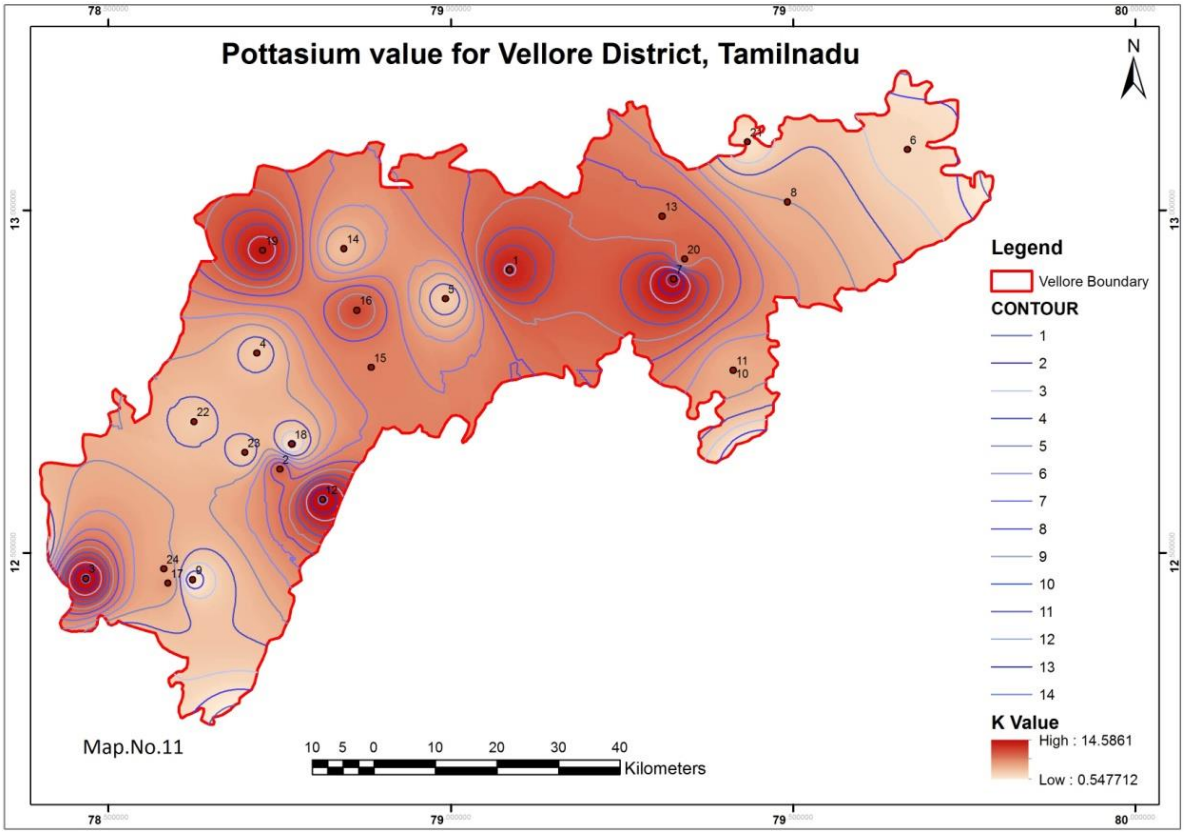

4.9 Bicarbonate (HCO3):

The Bicarbonate value of all the samples varies in the range of 73 to 780 mg/l. the maximum value of magnesium was obtained at the sample (Abdullapuram-S1), and the sample minimum value of the magnesium was obtained at the sample (Sholingar-S21). The permissible limit of the magnesium value in the groundwater is 200 mg/l according to the WHO standards. The dissolved carbon dioxide derived from rain is the primary source of carbonate and bicarbonate ions in groundwater. As it enters the soil, it dissolved more carbon dioxide in water. Carbon dioxide is also released from the organic matter during the decay. Water charged with carbon dioxide dissolves carbonate minerals, as it passes through soil and rock, to give bicarbonates. (Fig.No.9 & Map.No.12)

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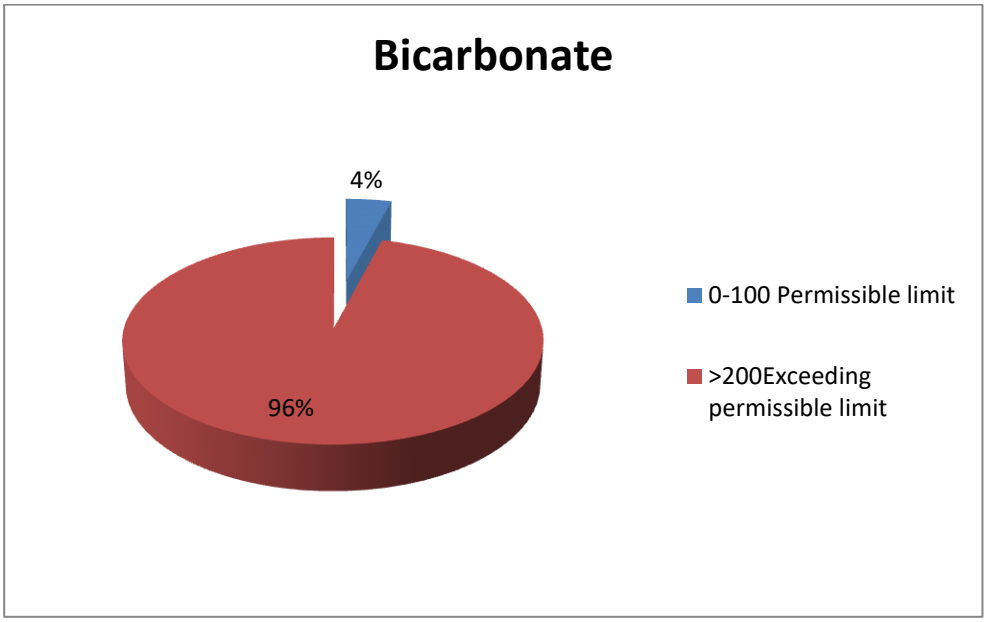

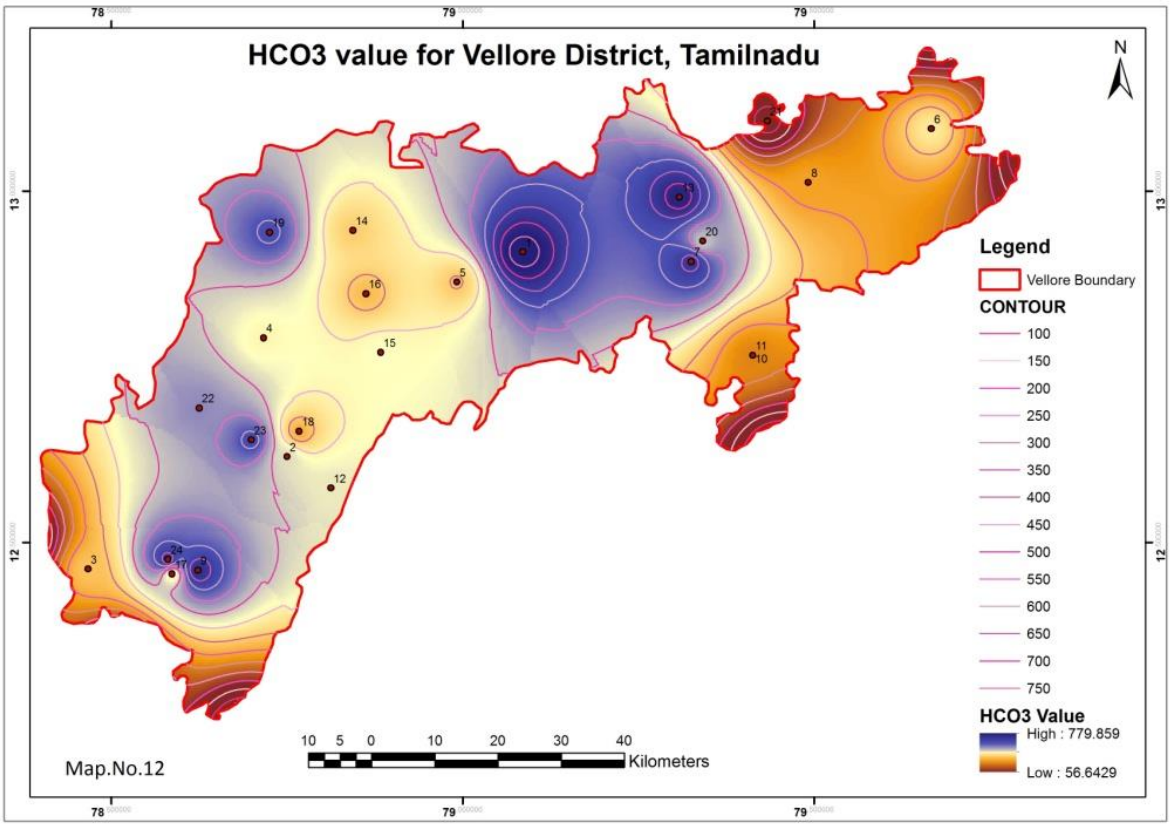

4.10 Chloride (Cl):

The chloride value of all the samples varies in the range of 36 mg/l to 1789 mg/l. the maximum value of the (1789 mg/l) chloride is obtained at the sample (Ambur-S4). The minimum value (36 mg/l) of the chloride is obtained in the sample (Palur-S16). The permissible limit of the chloride value in the ground water is 250 mg/l as per WHO standards. Excessive chloride in portable water is particularly but the criteria set for chloride value is based on its potentially high corrosiveness. Soil porosity and permeability also play an important role in building up the chloride value. (Fig.No.10 & Map.No.13)

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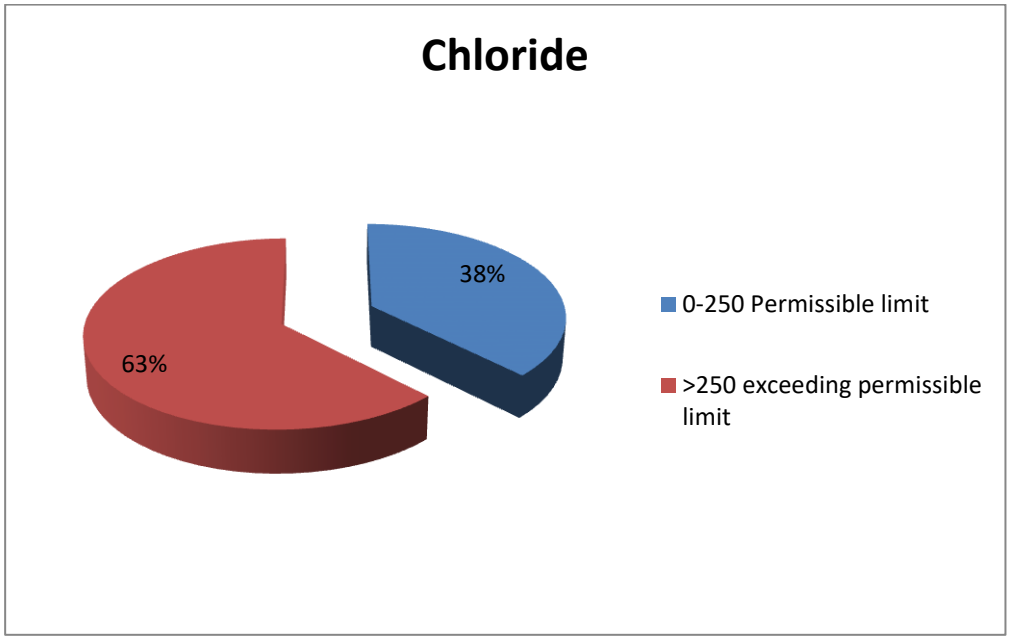

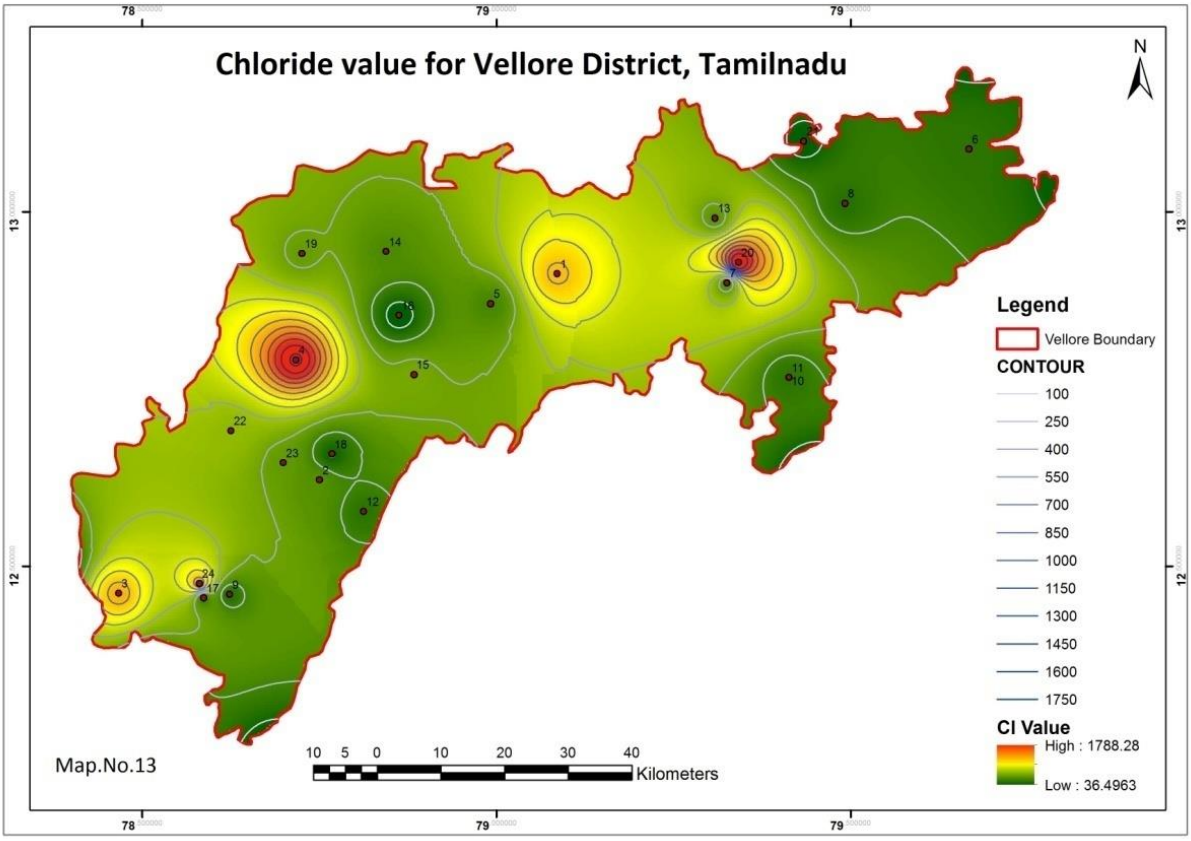

4.11 Sulphate (SO4):

The sulphate value of all the samples varies in the range of 10 to 478 mg/l. The maximum value of the sulphate is obtained at the sample (Ranipet-S20). The minimum value of the sulphate is obtained in the sample (Arakonam-S6). The permissible limit of the sulphate value in the groundwater is 200 mg/l as per WHO standards. High concentration of sulphate may cause gastro-intestinal irritation particularly when magnesium and sodium ions are also present in drinking water resources. (Fig.No.11&Map.No. 14)

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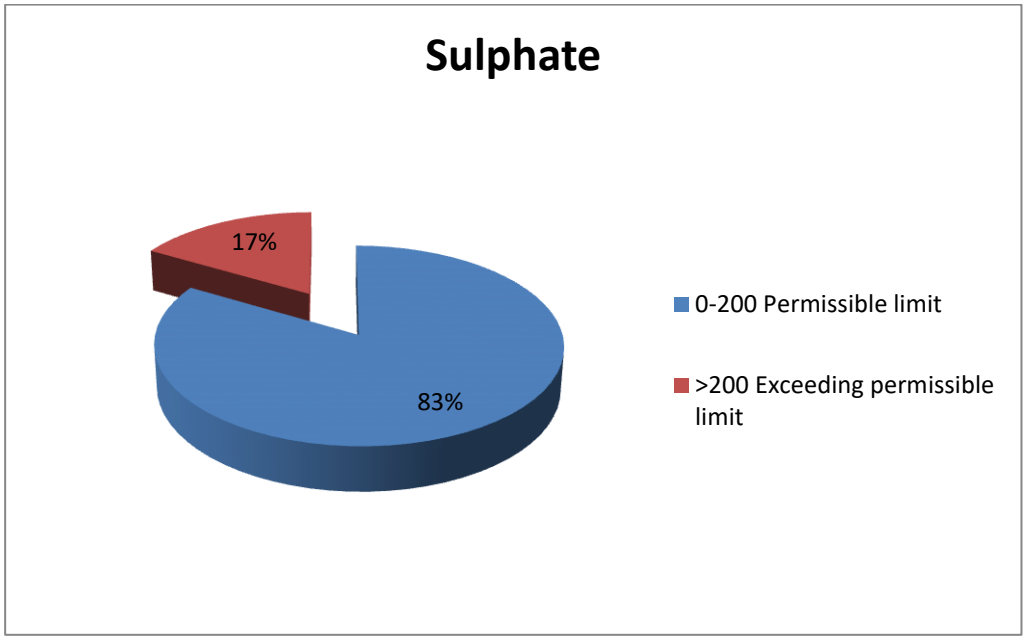

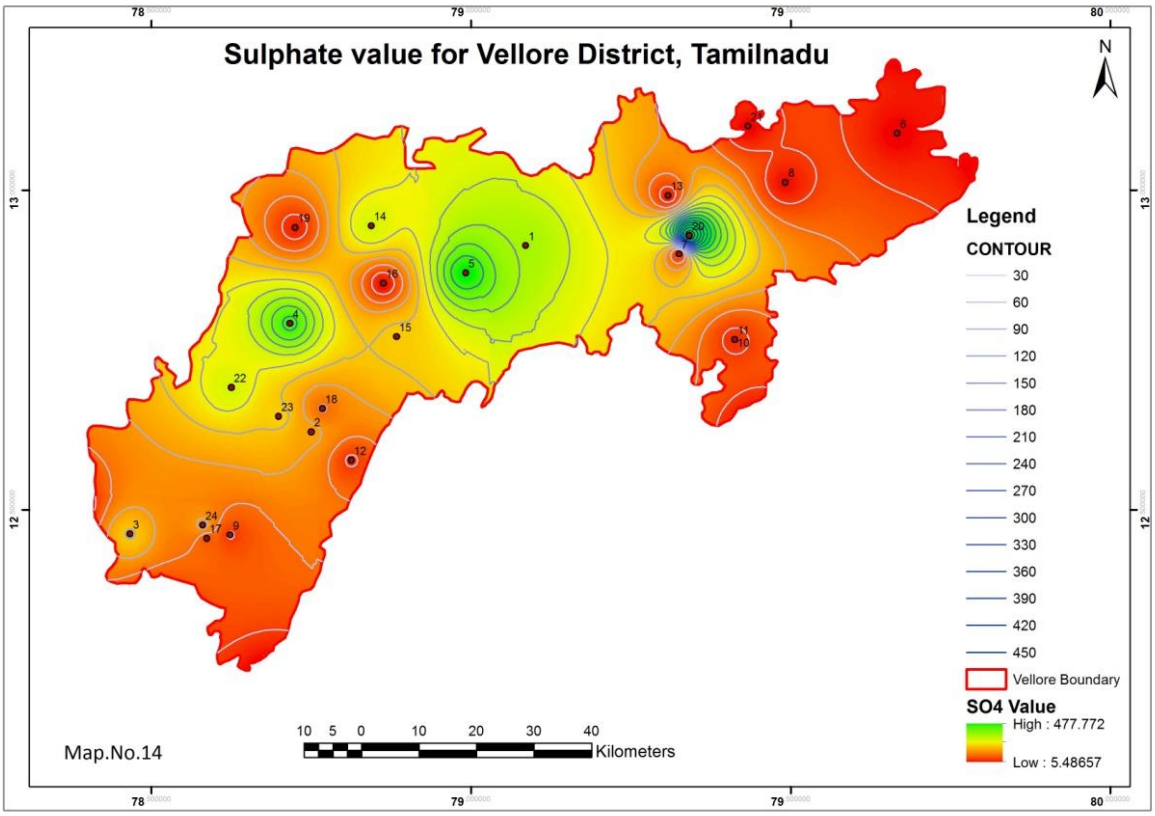

4.12 Nitrate (NO3):

The nitrate valueo f all the samples vary in the range of 35mg/l to 96 mg/l. the maximum value (96 mg/l) of the nitrate is obtained at the sample (Pasalikuttai-S17). The minimum value (35 mg/l) of the nitrate is obtained in the sample (Alankuppam-S3). The permissible limit of the nitrate value in the ground water is 45 mg/l as per WHO standards. The contamination of groundwater may be due to sewage and other wastes rich in nitrates. The presence of nitrate in groundwater may be due to leaching of nitrate with percolating powder. Toxicity of nitrates in infants causes methaemoglobiaemia.(Fig.No.12Map.No.15)

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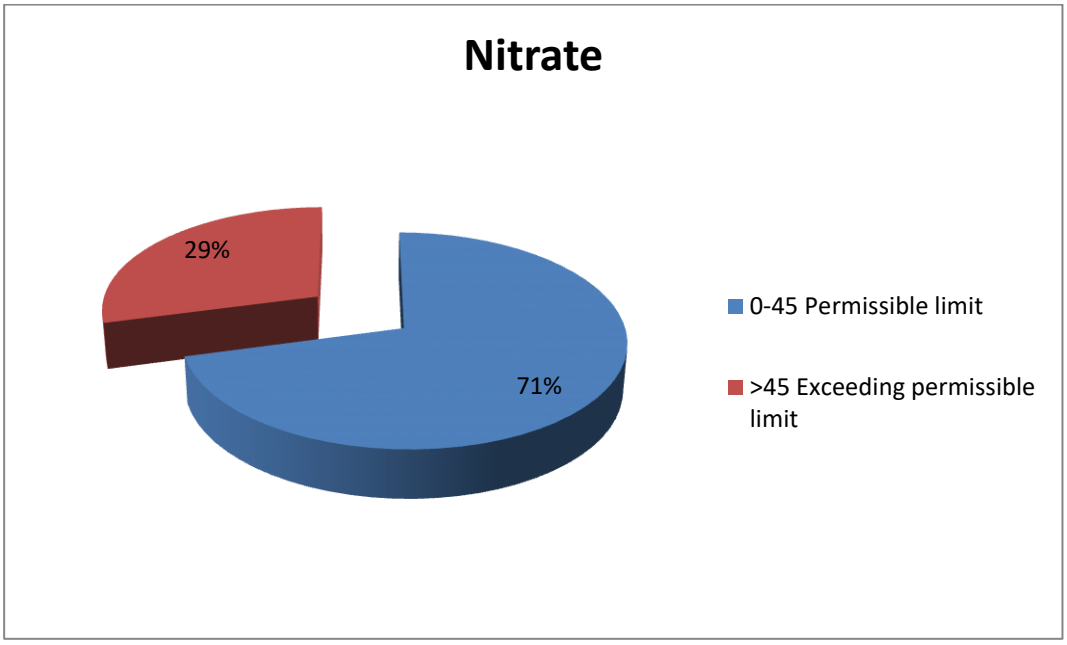

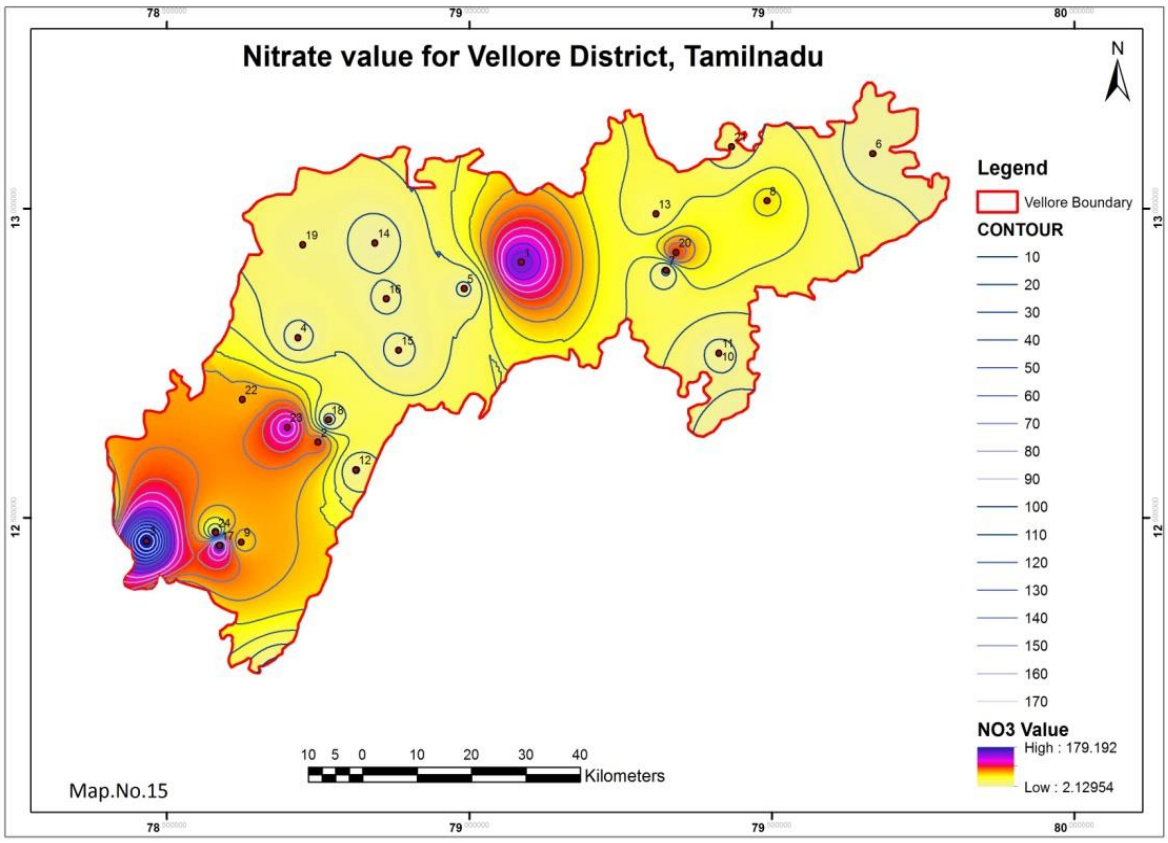

4.13 Fluoride (F):

The fluoride value of all the samples varies in the range of 0.6 to 2.2 mg/l. the maximum value of the fluoride is obtained at the sample (Kavalur-S12). The minimum value of the fluoride is obtained in the sample (Bommikuppam-S9). The permissible limit of the fluoride value in the groundwater is 1.5 mg/l as per WHO standards. The high concentration of the fluoride is due to fertilizer usage in agricultural activities for killing the insects. Skeletal fluorosis is an important due to presence of high fluoride content in groundwater. (Fig. No.13 & Map.No.16)

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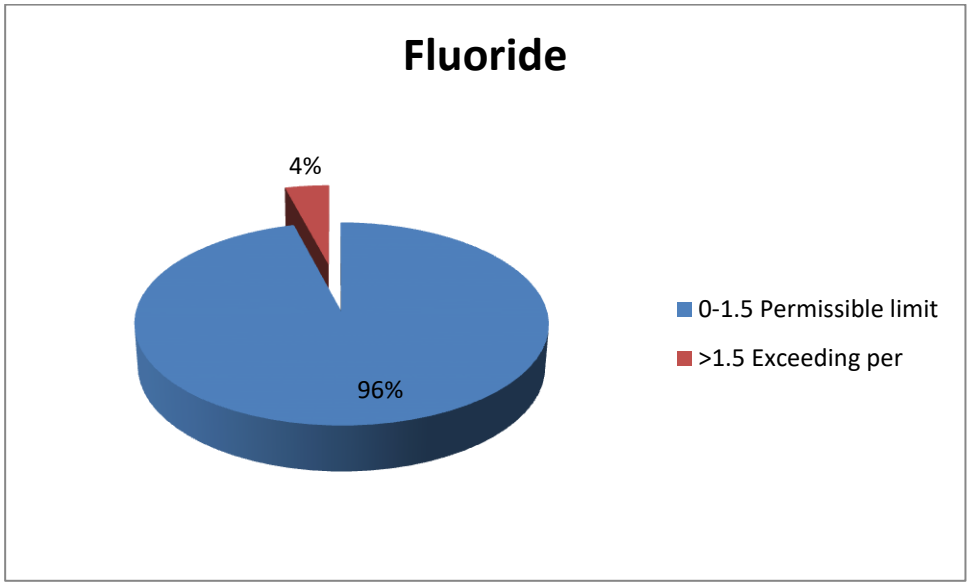

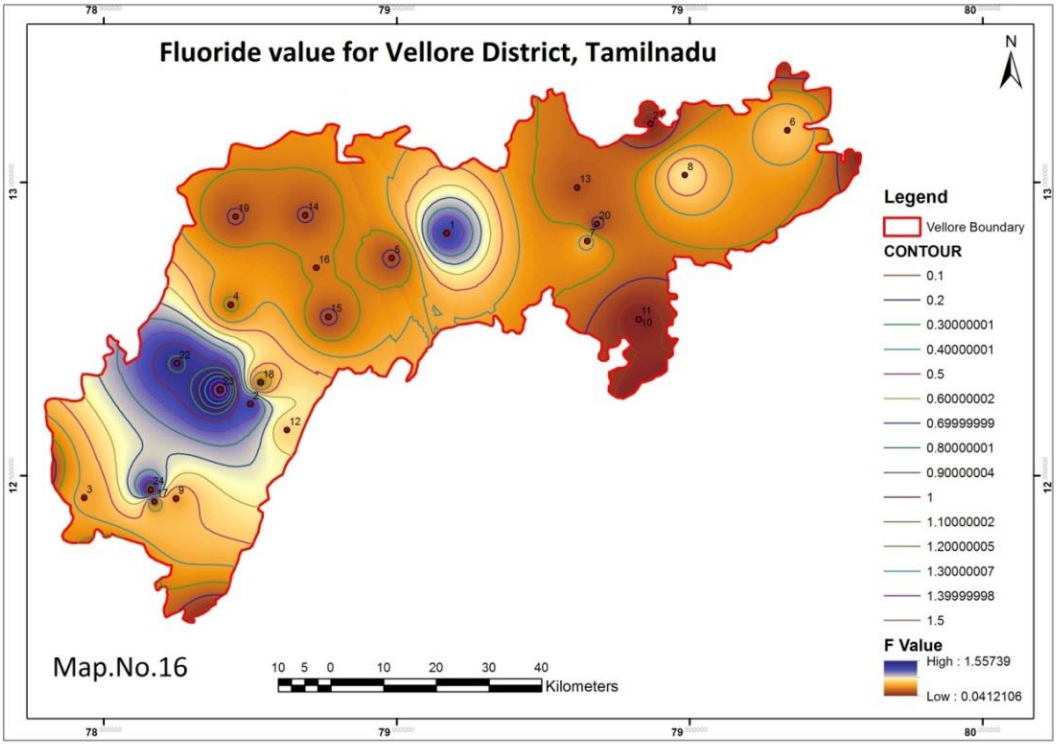

5. CONCLUSION

Ground water is extremely important to the future economy and growth of the country. If the resource is to remain available as high quality water for future generations, It is important to protect from the possible contamination. This freshwater crisis is already evident in many part of india, particularly Tamilnadu, varying in scale and intensity, depending mainly on the time of the year. In Tamilnadu water crisis plays a major role, varying in scale and intensity depending mainly on the time of the year. The underground water in vellore is deteriorating and the maximum sampling stations needs special attention, as all the parameters such as Ph, TDS, Electrical conductivity, Chloride, Hardness and bicarbonate is found high. It may cause laxative effects on health of the people consuming that water and it is not much suitable for irrigation purpose also. The minimum sampling stations have their respective physic- chemical parameters at certain sampling locations may be due to the unscientific disposal of solid wastes, the depth of wells and nature of the geological materials with which the groundwater comes in contact may influence the quality of the water. Hence proper water treatment in terms of community health.

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