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GEOCHEMICAL CHARACTERIZATION OF GROUNDWATER FROM HARD ROCK TERRAIN OF CHEYYAR TALUK, THIRUVANNAMALAI DISTRICT, SOUTH INDIA

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ABSTRACT

Cheyyar Taluks forms part of Thiruvannamalai District, covering an area of 634 sq.km and lies in the northern part of Tamilnadu. This study area covers three administrative blocks named as Cheyyar, Vembakkam and Anakkavur. Study area is bounded by the Kancheepuram and Arakkonam Taluk in the North and Utthiramerur Taluk in the East and Arcot Taluk in the West and Vandavasi Taluk in the South. The study area total population is 380,367 as per 2011 census. Cheyyar Taluk lies between 120 52'55"N to 120 32'52"N Latitude and 790 19'02"E to 790 44'42"E longitudes. The area constitutes a part of Toposheet Nos. 57P/6, 9, 10, 13 and 57P/14 published by Survey of India. The chief irrigation sources in the area are the tanks, and dugwells and tube wells. The study area is studded with numerous surface water storage tanks of medium and minor types. Rural population is mainly engaged in agriculture in the surveyed area. Paddy and Sugarcane is the major food crop in the area and it is extensively cultivated (two crops) in entire Taluk. The drainage pattern is generally dendritic. All the rivers are seasonal and carry substantial flows during monsoon period. The study area includes part of Palar and Cheyyar river basin. The study area depends on surface and rainwater for domestic and irrigation purposes. The geology of the area constituted by Charnockites of Archeaen age, Epidote- hornblende Gneiss and Hornblende-Biotite Gneiss with Sand, silt ang Graval of sedimentary rocks. The predominant Geomorphologic feature in the study area is pediments, shallow pediments, flood plains, buried pediments, Sedimentary low land, Denudation hills and river basin. Around 25 representative ground water samples were collected and they are physico-chemically analysed. The pH of the groundwater is Basic to Acidic in nature. With reference to TH, the majority of the groundwater sample locations in Cheyyar Taluk are very hard water with little hard to moderately hard water. In comparison with Bureau of Indian Standard (BIS, 1983) for drinking water the majority of the ground water samples in the study area falls above the maximum permissible limit on the basis of TDS and TH. Thus the effect of groundwater on the health of livestock's and human population are discussed in detail for the various ground water chemical parameters.

Keywords: ground water, geochemical, effect of ground water

Introduction

Groundwater is one of the most valuable natural resources, which supports human health, economic development and ecological diversity. Groundwater begins with precipitation that seeps into the ground. The amount of water that seeps into the ground varies widely from place to place, depending on topography of the land surface, amount and intensity of rainfall, and subsurface geology. In the last few decades, there has been a tremendous increase in the demand for freshwater resource due to rapid population growth and industrialization. It has been projected that approximately one third of the world's residents use groundwater for

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drinking and domestic purposes. The quality of groundwater is controlled by several factors including climate, soil characteristics, manner of circulation through the rock types, topography of the area, saline water intrusion in coastal areas, human activities on the ground etc.

Quality and quantity of groundwater is mostly influenced by the geographical location and land use pattern. Since landuse pattern plays an important role in determining the various hydrological phenomena such as infiltration rate, overland flow, evaporation and interception, a number of researchers have determined the link between the land use and groundwater (Senthilkumar et al., 2017). Equally, in developing countries, land use has its impact onwater quality issues and its management. The chemical characteristics of groundwater play an important role in classifying and assessing water quality with respect to various uses.The groundwater is polluted by industrial waste, agricultural waste, seawater intrusion, sanitary sewage, marine pollution, nuclear plant waste and acid rain. This type of polluted water spreads disease to human and other biotic life. In Cheyyar Taluk, most of the habitants are farmers. In some area, land is polluted by fertilizers and possible lithogenic sources. Thus an attempt has been made in this area for hydrogeological studies to find out water quality of this study area.

Study Area

CheyyarTaluks forms part ofThiruvannamalai District, covering an area of 634 sq.km and lies in the northern part of Tamilnadu. This study area covers three administrative blocks named as Cheyyar, Vembakkam and Anakkavur. The study area is bounded by the Kancheepuram and ArakkonamTaluks in the North and UtthiramerurTaluk in the East and ArcotTaluk in the West and VandavasiTalukin the South. The study area total pollution is 380,367 as per 2011 census. Generally the occupation of the people is irrigation. CheyyarTaluklies between 12^0 52’55’’N to 12^0 32’52”N Latitude and 79^0 19’02’’E to 79^0 44’42’’E longitudes (Fig 1). The area constitutes a part of Toposheet Nos. 57P/6, 9, 10, 13 and 57P/14 published by Survey of India (Fig 1). The drainage pattern is generally dendritic. All the rivers are seasonal and carry substantial flows during monsoon period. The study area includes part of Palar and Cheyyarriverbasin. The area also includes number of rainfed tanks and a stream, which flows from northwest to southeast direction

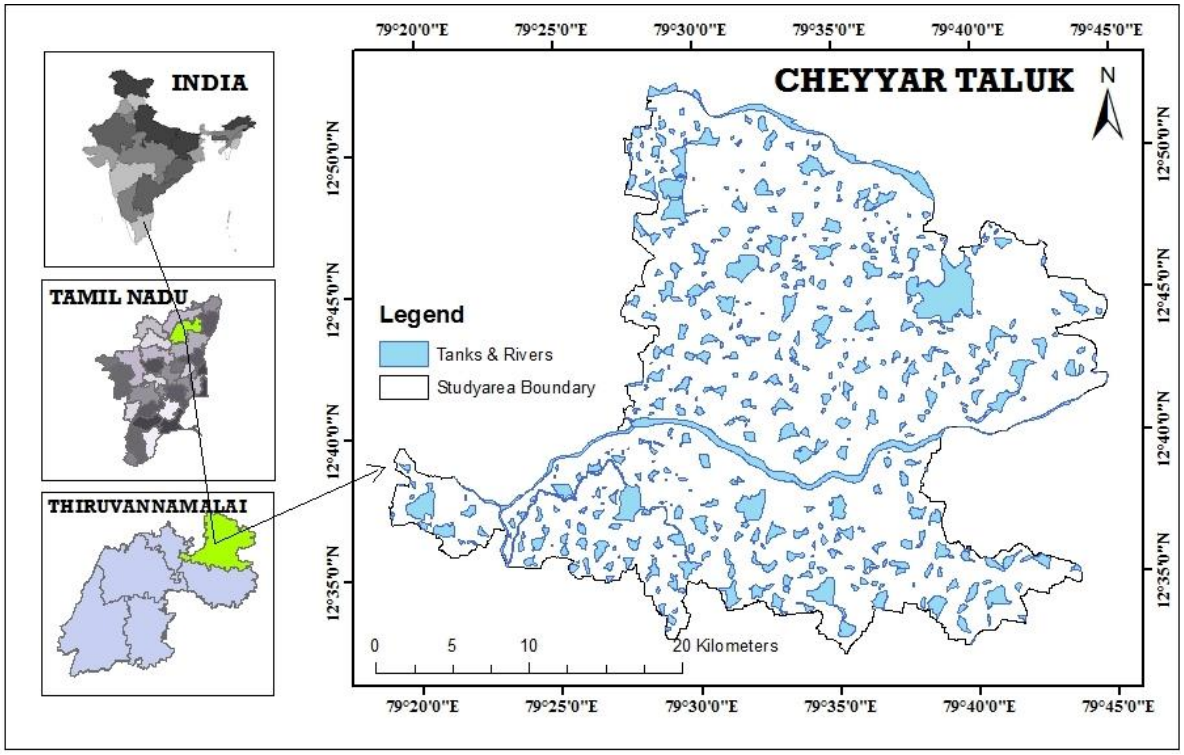

Fig. 1 Location and base Map of the Study area

Geology and Geomorphology

The geology map of the study area is prepared from the district resource map developed by Geological Survey of India (GSI 2005). The hard copy of district resource map has been scanned and digitally brought in GIS platform. The digital map after geo-referencing process, clipped with referenced to the study area boundary. Various formation of the study area is digitized and geology map has been prepared (Fig 2).The geological formation of the entire area comprises of Crystalline formations, Charnockites of Archeaen age, Epidote- hornblende Gneiss and Hornblende-Biotite Gneiss is covered by patches western and southern part of the study area. Sand, silt and graval sedimentary rock types occurred along the river valleys. Groundwater occurrence in the present study area in general fissure and fracture zone in unconfined aquifer condition. Other presence of unconsolidated stated sedimentary rock types like gravel, sand and silt also good source of groundwater in the study area.

The geomorphological study of any area is based on the fact that the specific characteristics of each of the landform vary greatly in terms of shape, size, dimension, and thickness of the overburden material, permeability, porosity etc., depending on the underlying rock type, structural control, climate and vegetative cover. Geomorphology (Fig 3) of the study area dominantly consists of Deep Pediment, Shallow Pediment, Moderate Pediment, Flood Plain, Sedimentary Low land, Denudation Hills and River basin. Flood

plain occur along the river valley is good groundwater potential among the all geomorphic feature present in the study area.

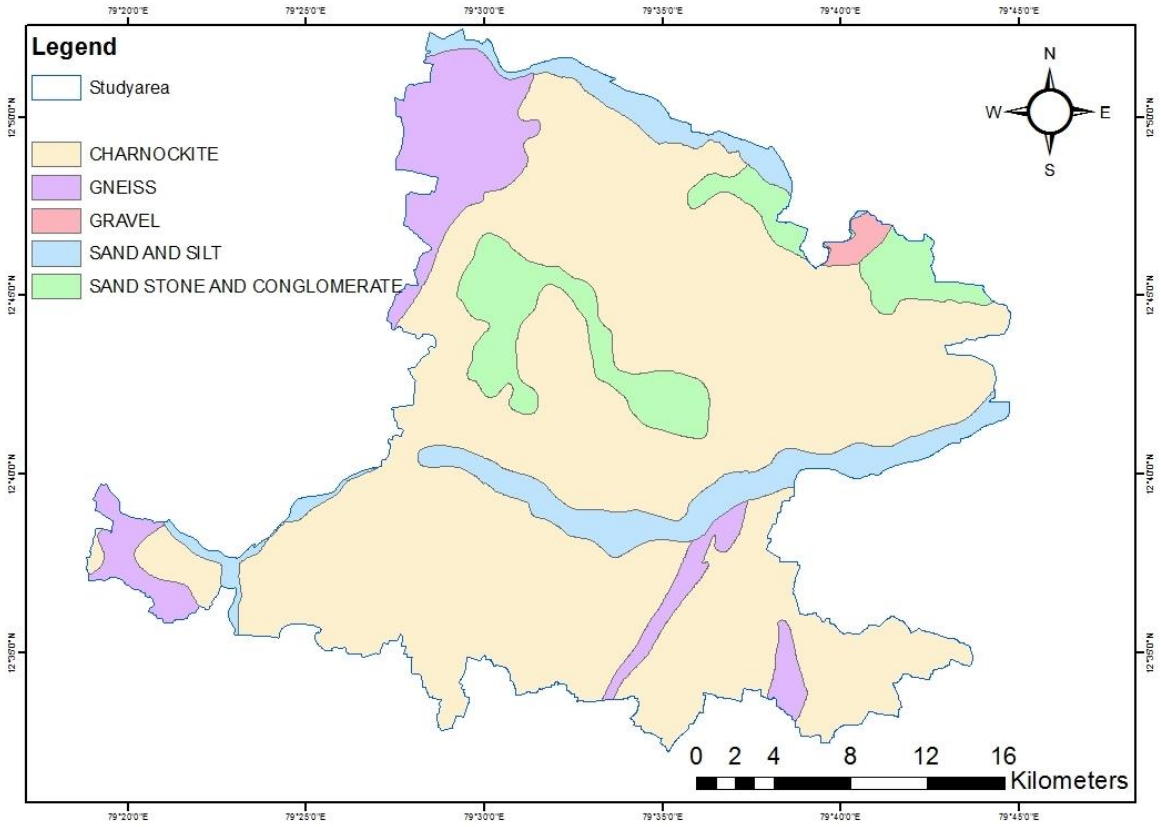

Fig.2 Geology of the study area

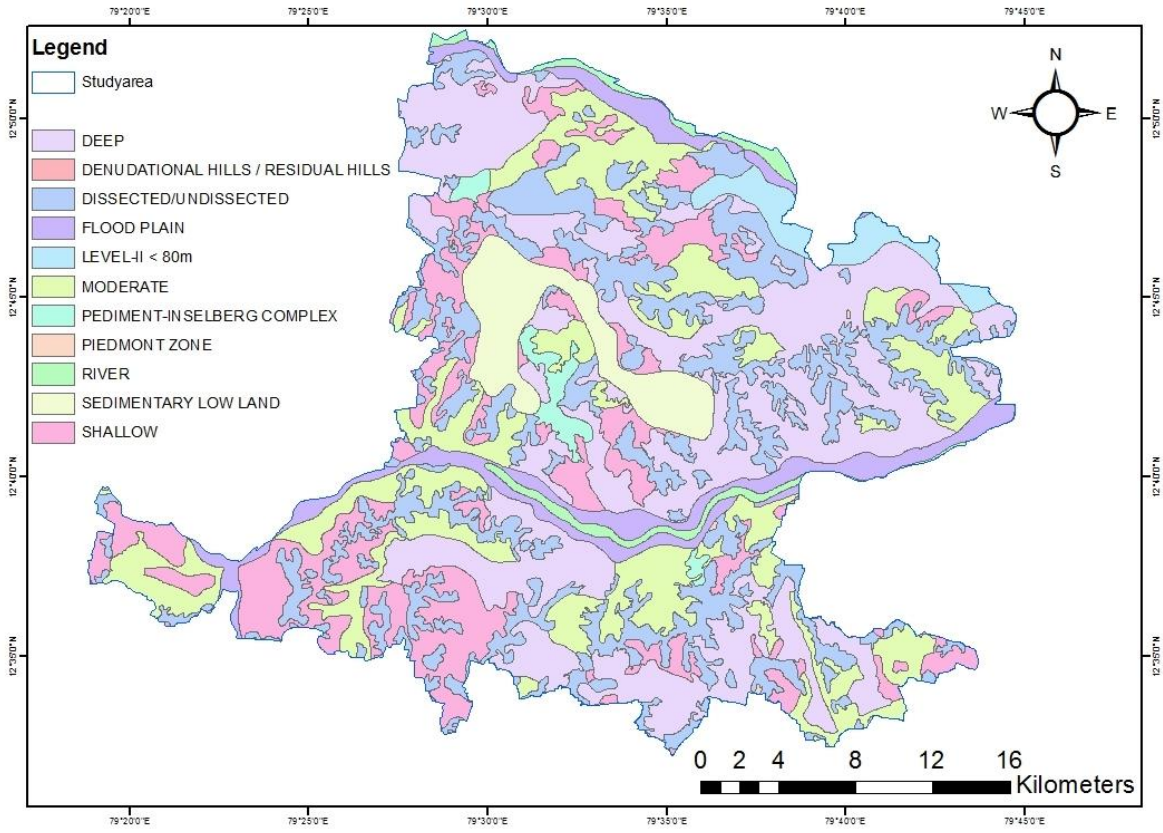

Fig.3 Geomorphology map of the study area

Methodology

Base boundary map was prepared using Survey of India Toposheet and district maps by analyzing the drainage pattern and relief features of the study area. Rainfall data, geomorphology, Geology and land use were collected from the Tamil Nadu Water Supply and Drainage Board, Tamil Nadu. Field study had been carried out and water samples were collected from 28 locations in the study area, and hydrogeochemical analyses had been carried out for those samples. Certain physical parameters and chemical parameters are measured at the sampling site. Groundwater samples are brought to the laboratory with the help of tightly closed 1 liter plastic containers to prevent the samples from atmospheric influences. Groundwater analyses have been carried out by using standard procedures (APHA, 1998; Ramesh and Anbu, 1996; Senthilkumar, 2014). With the chemical analysis results, groundwater has been classified with respect to various uses.

RESULT AND DISCUSSION

In order to bring out the physico-chemical characteristics of the groundwater in the study area the collected representative samples were analyzed for various parameters and are represented in parts per million (ppm) mg/l in Tables 1 respectively. In the study area, the pH values for the water samples ranges from 6.9to7.7. Based on the pH value of the groundwater samples is acidic to basic state (Senthilkumar et al., 2019). The spatial distribution of pH of the study area is shown in Figure 4.

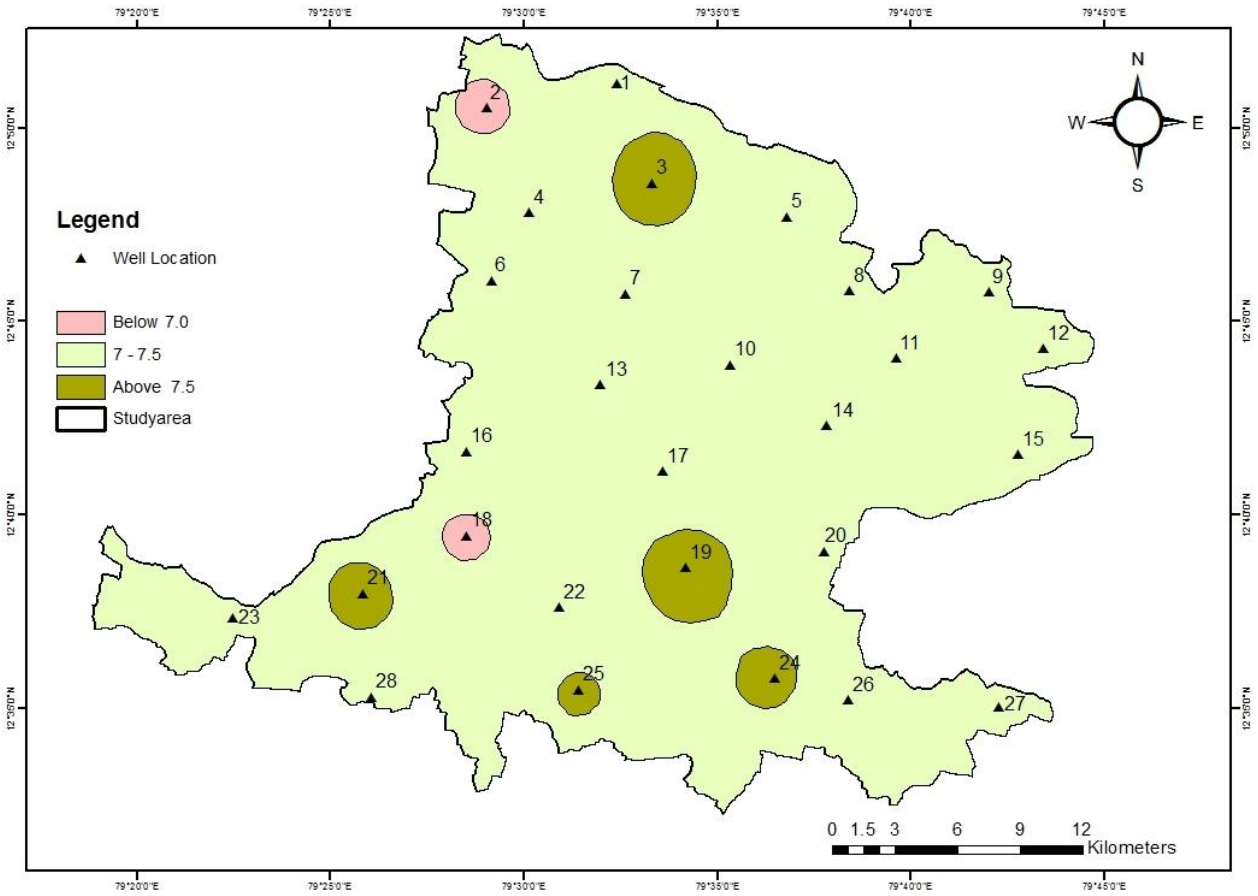

Fig. 4. Spatial distribution map of pH

TDS of the water samples (Fig 5) analyzed in the study area ranges from 544 mg/l in Thirupanangaduto 2029 mg/l in Melma. Groundwater of all the sample locations in the Cheyyar Taluk is belongs to Fresh and Brackish water type. The total hardness ranges from 105 mg/l in Tavasi to 1066 mg/l in Kundiyanthangal. All the groundwater samples fall in the moderately hard, Hard and very hard water type. The calcium content can be as much as 70 to

Table 1 Chemical parameters of the groundwater in ppm (Except EC&pH)

S.No	Location	pH	EC	TDS	Ca	Mg	Na	K	HCO_3	Cl	SO_4	TH
1	Kaganam	7.5	2330	1491	72	58	42	13	281	315	43	420
2	Thennampattu	6.94	2200	1408	74	100	214	4	555	404	29	595
3	Tiruppanangadu	7.68	850	544	58	52	25	8	287	131	5	360
4	Sirunavalpet	7.1	2040	1306	62	51	28	12	354	255	22	365
5	Erayur	7	2390	1530	120	73	230	70	415	603	14	600
6	Tavasi	7.1	1100	704	4	23	22	9	256	85	24	105
7	Naramapallam	7.46	1420	909	110	78	37	16	360	259	19	595
8	Namandy	7.4	850	544	56	62	44	23	311	245	29	395
9	Dharmacheri	7.18	2890	1850	110	128	283	3	750	564	14	800
10	Pallavaram	7.5	2240	1434	58	101	185	31	168	691	250	560
11	Azhinjalpettu	7.3	2710	1734	52	73	207	207	458	539	201	430
12	Kilneerkundram	7.11	2890	1850	160	108	253	2	586	624	29	846
13	Melbuderi	7.4	1170	749	132	78	18	20	183	451	43	650
14	Karanai	7.5	1390	890	14	21	54	13	364	42	5	120
15	Pulivalam	7.5	1010	646	16	79	42	39	37	206	178	364
16	Vinnavadi	7.33	1080	691	86	56	34	16	433	128	5	445
17	Munugapattu	7.2	1830	1171	78	97	133	2	470	344	19	595
18	Mulagaripattu	6.9	1860	1190	74	111	124	15	574	305	28	640
19	Melma	7.7	3170	2029	76	68	22	9	378	447	27	470
20	Vengodu	7.04	2900	1856	124	92	292	82	750	542	29	690
21	Parathanthangal	7.6	1210	774	27	13	225	2	519	301	101	122
22	Murugathampoondi	7.2	1860	1190	80	36	161	196	61	353	371	350
23	Kundiyanthangal	7.14	2300	1472	184	147	34	7	470	525	24	1066
24	Veleripattu	7.6	2430	1555	140	97	115	156	336	601	84	750
25	Kodayambakkam	7.53	1780	1139	94	106	94	11	543	294	28	670
26	Kadugnur	7.03	2350	1504	112	90	221	9	628	425	29	650
27	Kaliyur	7.1	2420	1549	98	88	262	10	616	454	29	605
28	Kuthanur	7.43	2580	1651	156	120	166	35	793	432	28	886

110 ppm. In the study area calcium varies from 5 ppm inTavasi to 184 ppm in Kundiyanthangal. The magnesium varies from 13 ppm in Parathanthangal to 147 ppm in Kundiyanthangal. The concentration of Potassium ranges from 1ppm or less to about 10 to 15 ppm in potable water and from 100 ppm to over several thousand ppm in some brines. Common sources of Potassium are the products formed by the weathering of orthoclase, microcline, biotite, leucite and nepheline

in igneous and metamorphic rocks (Senthilkumar et al., 2014). In the study area, the concentration of sodium and potassium ranges from 18 to 292 ppm and 2 to 207 ppm respectively.

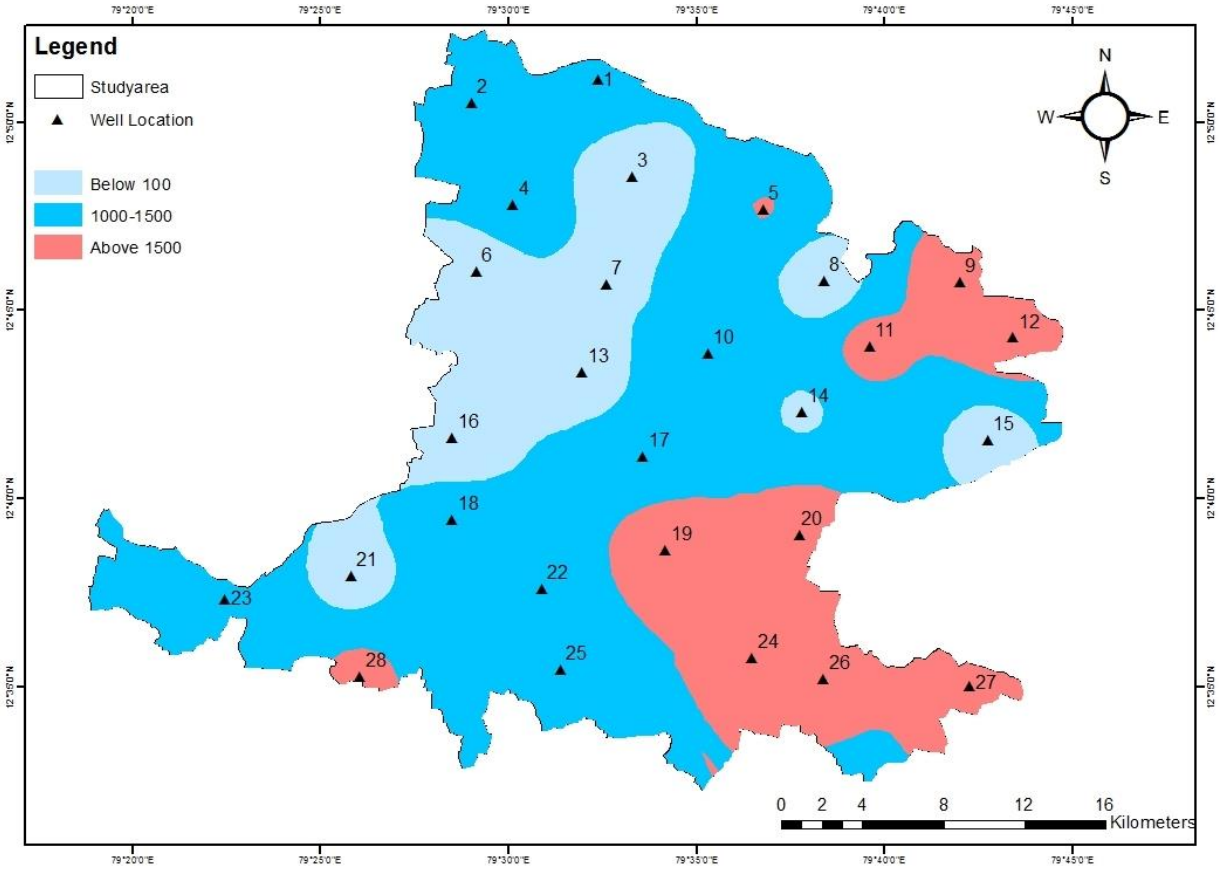

Fig. 5. Spatial distribution map of TDS

The concentration of Bicarbonate ranges from 37 ppm in Pulivalam to 994 ppm in Kuthanur. The Carbonate is not found in this area. In the study area the Chloride concentration in the analysed samples varies from 42 ppm in Karanai to 691 ppm in Pallavaram. According to the classification based on the chlorides the groundwaters in the study area falls under, Fresh, Fresh-Brackish and Brackish types. The concentration of sulphate ranges from 5 ppm at Karanai to 371 ppm in Murugathampoondi.

BIS classification of groundwater

Standards of physical and chemical parameters for drinking water (BIS, 1983) have been compared with the results of chemicalanalysis of groundwater samples of the study area and are presented in the Table2.

The chemical concentrations if exceeds the maximum permissible limit, cause adverse effect on living beings after consumption. From the above table it is understood that in many of the samples the values of chemical parameters, does not exceed the maximum permissible limit. The higher values in few samples viz.,Melma, Vengodu, Dharmacheriin study area imply the presence of groundwater contamination.

Table 5.1 Groundwater classification based on BIS (1983)

Parameters (in ppm)	Highes Desirable	Sample location	Maximum Permissible	Sample locations	Above Maximum Permisible limit
pH	6.5-8.5	1 -28	8.6-9.2	-	-
TDS	<1000	3,6-8,13-16, 21	1000-1500	1-2,4,10, 17-18, 22-23, 25,	5,9,11,12,19, 20,24, 26-28
TH	<300	6,14,21	300-600	1-5, 7, 8, 10, 11, 15-17, 19, 22,	9, 12, 13, 18, 20,23-28
Ca	<75	1-4,6, 8, 10-11,14-15,18,21,	75-200	5,7,9,12,13,16,17,19, 20, 22-28	-
Mg	<30	6,14	30-150	1-5,7-13,15-28	-
Cl	<250	3,6,8,14-16,	250-1000	1-2,4-5,7,9-13,17-28	-
SO4	<150	1-9,12-14, 16-21, 23-28	150-400	10,11,15,22	-

Conclusion

From the geological, geomorphologic, and geochemical studies reveal that the study area depends on surface and rainwater for domestic and irrigation purposes. The geology of the area constitutes by, Charnockites of Archeaen age, Epidote- hornblende Gneiss and Hornblende-Biotite Gneiss with Sand, silt angGraval of sedimentary rocks.The predominant Geomorphologic feature in the study area is pediments, shallow pediments, flood plains, buried pediments, Sedimentary low land, Denudation hills. The pH of the groundwater is BasictoAcidic in nature. Groundwater is good for drinking water in most of the places, except in Erayur, Azinjalpattu, Kilneerkundram, Melma, Vengodu, Veleripattu, Kadugnur, Kuthanur and Dharmacheri.With reference to TH, the majority of the groundwater sample locations in CheyyarTaluk are very hard water with little hard to moderately hard water types. In comparison with Bureau of Indian Standard (BIS, 1983) for drinking water the majority of the ground water samples in the study area falls above the maximum permissible limit except on the basis of TDS and TH.

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