International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 24 No. 2 Jun. 2016, pp. 452-460

http://www.ijisr.issr-journals.org/

GROUNDWATER QUALITY ANALYSIS BY USING GIS TECHNIQUES AT ARIYALUR TALUK, TAMILNADU, INDIA

G. VIJAYAKUMAR[1], G. BASKAR[2], and M. MARGABANDHU[3]

[1]Department of Civil Engineering,
University College of Engineering, Ariyalur,
Ariyalur, Tamil Nadu, India

[2]Department of Civil Engineering,
Institute of Road and Transport Technology,
Erode, Tamil Nadu, India

[3]Department of Physics,
University College of Engineering, Ariyalur,
Ariyalur, Tamil Nadu, India

ABSTRACT: Assessment of groundwater quality is important in many groundwater studies. Water never occurs in its pure state in nature. Groundwater composed of chemical ions in the form of solution. The type and concentration of these elements depends upon the surface, sub-surface environment, rate of groundwater movements and the source of groundwater. In addition to the above natural causes, man also contributes his share in changing the quality of water by sending sewage into ground and contaminating the aquifer by discharging industrial waste into it. The use of groundwater for drinking, agricultural and industrial needs is determined by, physical and chemical characteristics. The hydrochemical studies generally involve (i) a description of the occurrence of various constituents in groundwater, (ii) the relation of these constituents to water use, (iii) identification of geochemical patterns and (iv) the development of a hydrogeochemical model of the area. The present experimental work determines the ground water quality parameters by using GIS software at Ariyalur taluk, Tamil Nadu, India.

KEYWORDS: Spatial distribution, Physico-chemical parameter, Permissible limit, Drinking water standards, Ground water quality.

1 INTRODUCTION

Groundwater is an essential supply of water resource throughout the world. Today the industries and other human activities are creating water quality problems. These activities should affect the ground water quality. The recent trend that is prevailed in all developing countries and one that is also posing a great trouble for them is the enhancement of groundwater sources of water to meet the demands for drinking and irrigation .It is used for agricultural and drinking purposes in most of the countries. Contamination of water is mainly due to the anthropogenic activity by pollutants that include pesticides, unused fertilizers, and effluents that are discharged as waste or sewage from residences and industries, and so on. The serious problems faced by the developing countries are the indiscriminate discharge of effluent from industries and wastes from residences decrease the quality of groundwater. So assessment of quality for groundwater is important aspects in groundwater studies. This hydro chemical study is useful to determine ground water quality of Ariyalur Taluk by using GIS software that is suitable for drinking purposes [1].

2 STUDY AREA

The Ariyalur Taluk is a division of Ariyalur District, located in the Eastern region of Tamil Nadu, India. It lies in between the longitude of 78°55'11.60" E to 79°15'34.36"E and latitude of 10°52' 9.59" N to 11°14'54.89"N . Phsiographically, this area is flat with gentle slope towards the eastern direction. Geomorphologically the area has a flat terrain with moderately high drainage density. This area constitutes dentritic, trellis and combination of these two drainage patterns. The average annual rainfall of the study area is 1231.95 mm. More than 70% of the precipitation is received from the northeast monsoon during October to November.

3 METHODOLOGY

The groundwater quality studies were carried out in Ariyalur Taluk to determine the suitability of water for drinking and domestic purposes. In this study totally 50 ground water samples were collected. These samples physico-chemical characteristics were analyzed in the water testing laboratory. Then the parameters values are comparing with the World Health Organization drinking water standards (WHO 1996) [2] and the results are given in (Table 1). The Study area ground water test parameter values were plotted in the spatial distribution map by using GIS Software. The Spatial distribution map is useful to measure the areas water quality in square. Kilometers.

Table 1. Groundwater samples of the study area more than the permissible limits prescribed by WHO for drinking purposes and the effect of more concentration on human system

Physico-chemical Parameters	WHO international Standard		Total No. of wells more than the permissible limits	Effects of more concentration on human system
	Most desirable limit	Maximum allowable limit		
Ph	6.5-8.5	-	Nil	Taste
TDS	500	1,500	3	Gastro -intestinal irritation
TH	100	500	Nil	Scale Formation
Ca^{2+}	75	200	Nil	Scale Formation
Mg^{2+}	50	150	Nil	
Cl^{-}	200	600	Nil	Salty taste
SO_4^{2-}	200	400	Nil	Laxative effect

4 RESULTS AND DISCUSSIONS

4.1 HYDROGEN ION CONCENTRATION (PH)

The percentage of hydrogen ion concentration in water is termed as pH and this is the measure of the power of hydrogen ion concentration. The pH is one of the major quality defined parameter and provides information regarding acidic and basic nature of the groundwater [3] is given in the equation.

$$pH = -\log (H^+)$$

Where H^+ is the concentration of hydrogen ion expressed in moles/liter

The pH value indicates where a solution is acidic and neutral or base (alkaline). Aqueous solutions with a pH below 7 are referred to as acidic; and those with a pH above 7 are called basic or alkaline. It has no effect on human health. However, a low value, below 4.0 will create sour taste and higher values above 8.5 show alkaline taste. The study area pH values were ranged 6.90 to 8.10 with an average of 7.52 indicating the acidic to basic nature of the groundwater .The spatial distribution map of ph (Fig 1) indicates 707.29 sq.km areas were suitable and 0.0006 sq.km areas not suitable for drinking purposes.

4.2 ELECTRICAL CONDUCTIVITY (EC)

Electrical conductivity is an important physical character in the water quality assessment. The groundwater samples of Electrical conductivity values vary from 588 to 3158 µs/cm (average of 1337.88). The EC is expressed in terms of the specific electrical conductivity, which is defined as the reciprocal of electrical resistance in Ohm (Q), in relation to a water cube of edge length 1 cm at 25°C. In practice, EC is often expressed in terms of mille Siemens (mS) and micro Siemens (µS).

As per the WHO international standard (1996), EC values were found as desirable limit in 17 stations in ariyalur taluk. This was indicated near the downstream region. The impact of industrial effluents can be denoted by the high values of EC [4].

The permissible and desirable limits were given through spatial distribution (Table 2) map preparation. The results of EC values plotted in the spatial distribution map are given in (Fig 2). One of the powerful physical parameters for the evaluation of water is electrical conductivity based on WHO standard. Most of the study area fell in not potable nature with aspect to EC is due to the heavy rock water interaction. The analytical result reveals that most of the samples fell in permissible due to the anthropogenetic activities for the catchment area or rain feed portion

Table 2. Suitable areas of groundwater based on drinking water standards

S.No	Parameter	Potable Class	Limiting Value	Area in Km^2	Percentage of the Area
1	PH	Not Permissible limit		Nil	Nil
		Most Desirable limit	6.5 – 8.5	707.29	100
		Not Permissible limit	> 8.5	Nil	Nil
2	EC	Most Desirable limit	< 1500	550.11	77.78
		Not Permissible	> 1500	157.18	22.22
3	TDS	Most desirable limit	< 500	55.80	7.89
		Maximum allowable Limit	500 – 1500	643.21	90.94
		Not permissible limit	> 1500	8.28	1.17
4	Ca^{2+}	Most desirable limit	< 75	396.75	56.09
		Maximum allowable Limit	75 – 200	310.54	43.91
		Not permissible limit	> 200	Nil	Nil
5	Mg^{2+}	Most desirable limit	< 50	455.39	64.39
		Maximum allowable Limit	50–150	251.90	35.61
		Not permissible limit	> 150	Nil	Nil
6	Cl^-	Most desirable limit	< 200	626.94	88.64
		Not permissible limit	> 200	80.35	11.36
7	SO_4^{2-}	Most desirable limit	< 400	All samples	100
		Not permissible limit	> 400	Nil	Nil
8	TH	Most desirable limit	< 100	0.81	0.11
		Maximum allowable limit	100 – 500	706.48	99.89
		Not permissible limit	> 500	Nil	Nil

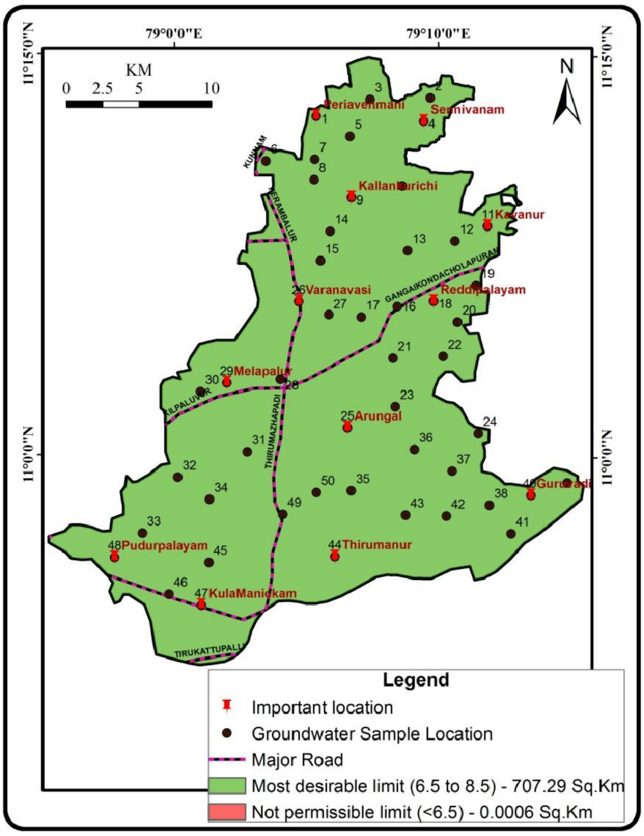

Fig. 1. Spatial distribution of drinking water quality based on pH

4.3 TOTAL DISSOLVED SOLIDS (TDS)

Total Dissolved Solids (TDS) is the total amount of all inorganic and organic substances including cations or anions and other impurities that are dispersed within a volume of water. For the suitability of groundwater for any purpose, it is classification mainly depends upon its hydrochemical properties, based on the TDS values [5].

During this study, it is observed that 94 % samples fell under most desirable and maximum allowable category and 6 percent of samples fall under not permissible class of water. When the TDS value of water affects human health, the groundwater is not considered to be most desirable for drinking purposes and also has a negative psychological reaction while bathing. The locations falling under the favorable zone limit are shown in the final result map and the results are given in (Table 2) .TDS values plotted in the spatial distribution map are given in (Fig 3).

4.4 CALCIUM (CA)

One of the alkaline earth metals and the one that is widely scattered over the earth's crust and also is the second dominating ion in the groundwater of the study area. The value of calcium varies from 28 to 52 mg/l, with a mean of 85.58 mg/l. All the samples examined, most had exceeding values, only a few samples fell within the WHO limit . It is because of the rate of decomposition of feldspar group of minerals [3]. The desirable limit of calcium ionic concentration in drinking water is 75 mg/l. If the presence of calcium is more in drinking water, it will cause formation of Kidney stones. The principal source of calcium is the disposal of sewage and industrial effluents; that has no known ill-effects on the health of human beings [6].

The concluded results for calcium level are given in maps (Fig 4). The favorable and unfavorable zone limits were given through spatial distribution (Table 2) map preparation. Most of the study area falls under most desirable and maximum allowable limit based on calcium element with respect to WHO standard for calcium limit.

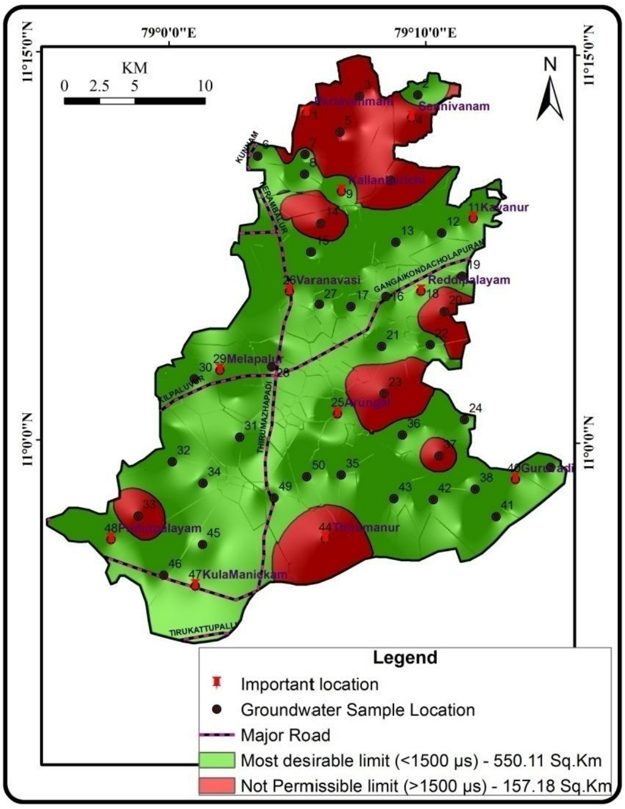

Fig. 2. Spatial distribution of drinking water quality based on EC

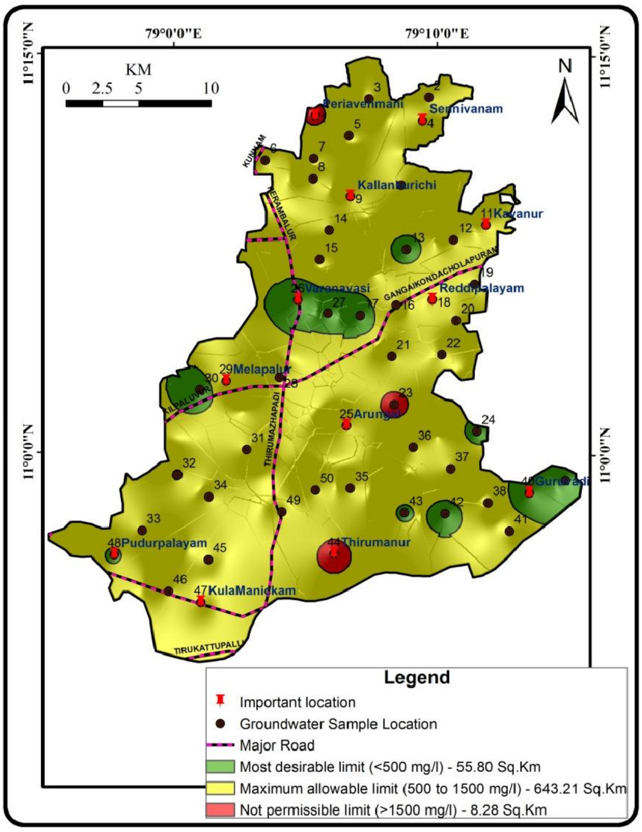

Fig. 3. Spatial distribution of drinking water quality based on TDS

4.5 MAGNESIUM (MG)

The Magnesium concentration ranged from 16 to 94 mg/l in the study area.. Magnesium is the 3rd dominating ion in the groundwater of the study area with an average value of 47.56 mg/l. Calcium and Magnesium cause most of the hardness and scale forming properties of water. A higher concentration of Mg has laxative effect on human health [7] in the (Table 2) the limiting values for magnesium is given.

The spatial distribution maps are given in (Fig 5). The concentration of the magnesium was found to be high due to rock water interaction. The higher concentrations were observed in northern portion of the study area and 33, 44samples locations.

4.6 CHLORIDE (CL)

Chloride is a less constituent of the earth's crust but a major dissolved constituent of most natural waters. The chloride concentration varies between 28 to 488 mg/l respectively. All common chlorides are soluble and contribute to the total salt content of soils. The high chloride concentration was noticed in only a few locations. The chloride ions in drinking water are generally not harmful to human beings. A high concentration of chlorides may be due to improper disposal of wastes [8]. The limiting values for chloride are given in (Table 2). The spatial distribution maps are given in (Fig 6)

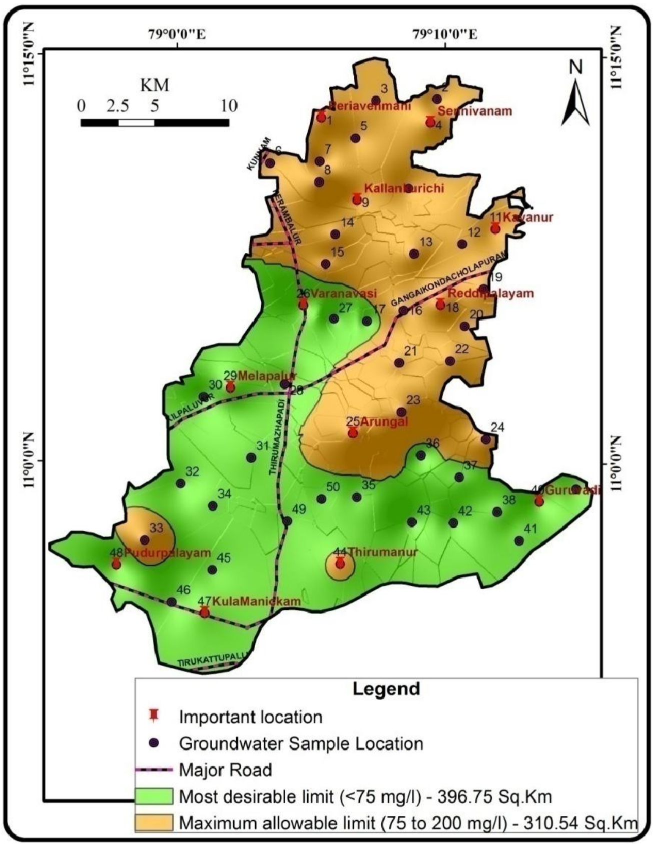

Fig. 4 . Spatial distribution of drinking water quality based on Ca

4.7 SULPHATE (SO_4)

The sulphate content of natural water is important in determining the suitability of water for residential use. Sulphur combines with oxygen to form the sulphate ion (SO_4). The sulphate concentration in the groundwater ranged from 2 to 112 mg/l, with a mean of 18.06 mg/l. The limiting values for sulphate are given in (Table 2). Sulphate is unstable if it exceeds the most desirable limit of 400mg/l and causes a laxative act on human system with the excess magnesium in groundwater [9]. Excess sulphate may cause cathartic action.

4.8 TOTAL HARDNESS (TH)

In general, surface water is softer than groundwater. Hardness represents the concentration of calcium and magnesium ions. Because, these are the most polyvalent cations and other ions, such as iron, manganese contributes to the hardness of water and they are present in lower concentrations. The hardness of water is classified as hard and soft. The high total hardness value is termed as "hard", while water of low hardness values is termed as 'soft". Total Hardness ($CaCO_3$) was calculated using this formula is given in the equation [10].

$$TH \text{ (as } CaCO_3\text{) mg/l} = (Ca^{2+} + Mg^{2+}) \text{ mg/l} \times 50$$

The hardness value ranged from 84 mg/l to 460 mg/l with an average value of 215.42 mg/l. The hardness in groundwater is derived largely from contact with the soil and rock formations. The most desirable limit is 100 mg/l of TH for drinking purpose is 500 mg/l as per the WHO Standard. The high concentration of hardness may cause kidney problems. High level of calcium may be the reason for high hardness in water. The results of the groundwater based on Total Hardness are given in (Table 2). The spatial distribution map is shown in (Fig 8).

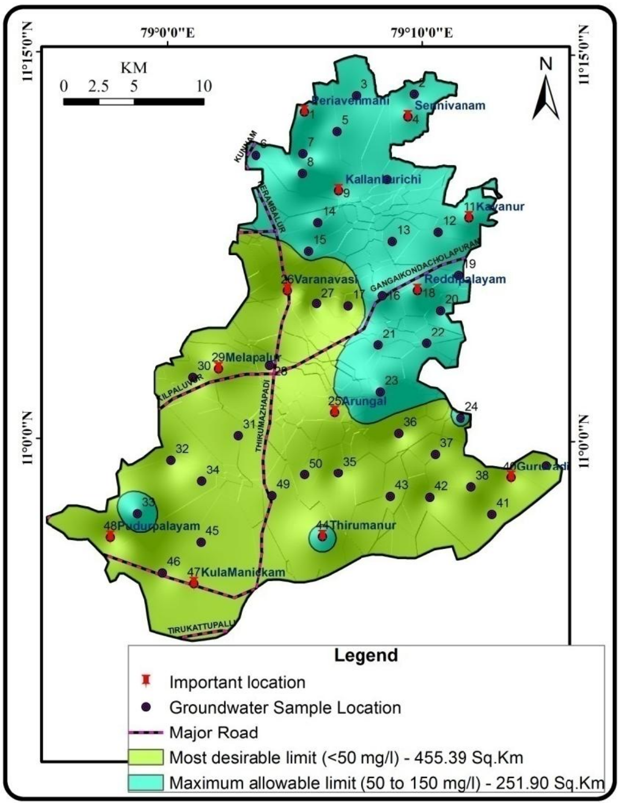

Fig. 5. Spatial distribution of drinking water quality based on Mg

4.9 BICARBONATE (HCO_3)

The bicarbonate concentration of the groundwater samples in 4.22 to 1099.15 mg/l, with an average value of 554.63 mg/l. The highest value was noticed in upper part of the study area. The hardness of groundwater is determined by the quantity of dissolved cations present in the nature. The anions associated with these cations determine whether the hardness is permanent or temporary.

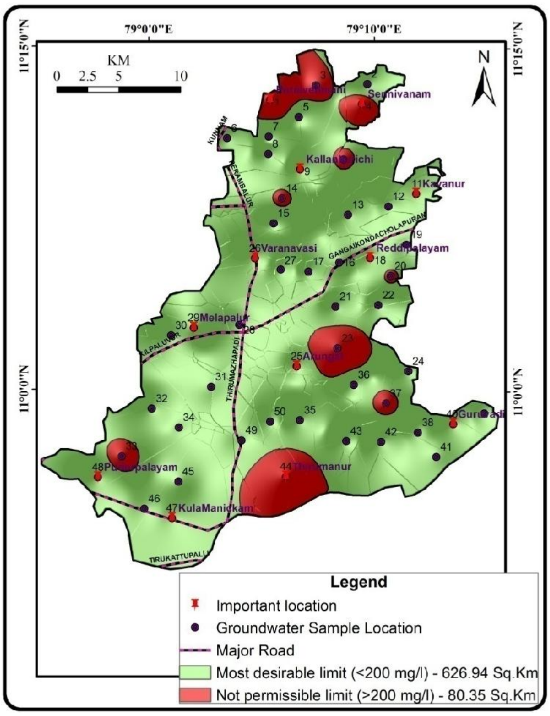

Fig. 6. Spatial distribution of drinking water quality based on Cl

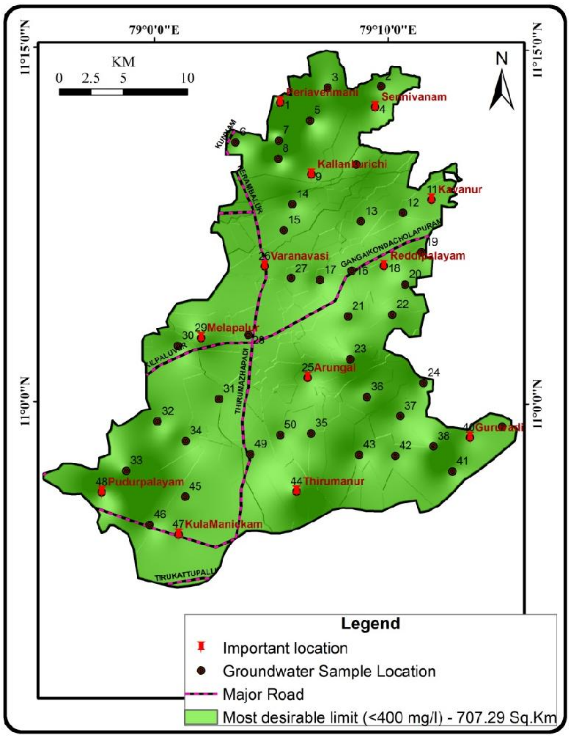

Fig. 7. Spatial distribution of drinking water quality based on SO_4

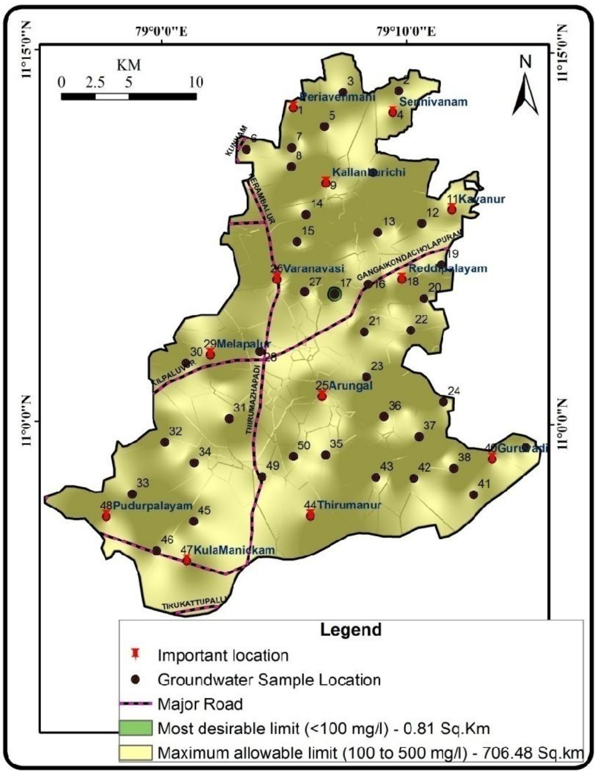

Fig. 8. Spatial distribution of drinking water quality based on TH

5 CONCLUSIONS

Analysis report of groundwater Ariyalur region showed that certain parameters like TDS, EC, and Cl high in some water sample locations. In some locations they even exceeded the desirable limits. Spatially, the majority of the study area fell in desirable limit for drinking purposes. Based on the WHO limiting standards, the pH, Ca^{2+}, Mg^{2+}, Cl^{-}, SO_4^{2-}, and TH falls within the limitation zone in all the samples.

REFERENCES

[1] C. Sadashivaiah, C. R. Ramakrishnaiah and G. Ranganna, “Hydrochemical Analysis and Evaluation of Groundwater Quality in Tumkur Taluk, Karnataka State, India”, International Journal of Environmental Research and Public Health, pp.158-163.

[2] WHO (1996) Guidelines for drinking water quality. Geneva 1:53–73

[3] Hem. J.D , “Study and interpretations of the chemical characteristics of natural water”, U.S. Geological Survey, Alexandria, Virginia, USA, U.S. Geological Survey Water Supply Paper 2254, 263 p,1985

[4] Subrahmanyam, K. and Yadaiah, P, ”Assessment of the impact of industrial effluents on water quality in Patancheru and environs, Medak district, Andhra Pradesh, India". Hydrogeology Journal, 9(3): 297–312,2001

[5] Freeze, R.A. and Cherry, J.A,"Ground Water”, Prentice Hall, Inc,Englewood Cliffs, New Jersey, USA,p604,1979

[6] Kotaiah and Kumaraswamy, “Environmental Engineering Laboratory Manual”, Charotar Publishing House, Gujarat, 1994.

[7] Dhembare, A.J. Pondhe. G.M, and Sing.C.R," Groundwater characteristics and their significance with special reference to public health in Parvara area”, Poll Res.17 (1): 87-90,1998.

[8] Kesavan KG and Parameswari R, “Evaluation of groundwater quality in Kancheepuram”, Indian J. Environ. Prot.25(3), 235-239,2005.

[9] Bhagavathi Perumal S, Thamarai P,” Ground water quality after Tsunami in coastal area of Kanyakumari, South Tamil Nadu, India”, Int J Environ Sci;2 (2):99-118,2007.

[10] Raghunath, I.M, Wiley Eastern Ltd., New Delhi,India,1987.