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Evaluation of Groundwater Quality for Drinking Purpose in Part of Villupuram District, Tamil Nadu

KEYWORDS Physico-chemical parameters, Upper Manimuktha Sub basin and Water Quality.

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ABSTRACT *Groundwater is the main resources for drinking, irrigation and domestic purpose. Now a day groundwater contaminated by natural and mainly contaminated by anthropogenic activities. This paper mainly focused analysis of the Water quality is very important to preserve and prefect the natural eco system. For this study 48 groundwater samples were collected of plain area in Upper Manimuktha Sub basin, Vellar River, Tamil Nadu, India. The study area lies between 78°42' to 78°59' E and 11°42' to 11°59' N latitude, covering a total area of 497.11 sq.km in which plain area 309.92sq.km and hilly area occupies 187.19sq.km. The groundwater samples were collected from study area based on equal grid method and analyzed using standard methods. The physico-chemical parameters are assessing based on the inverse distance weighted method into GIS techniques. For the water quality, following parameters have been considered Viz. pH, total dissolved solids. Electrical conductivity, total hardness, calcium, magnesium, sodium, potassium, bicarbonate, chloride, fluoride, sulphate, nitrate etc. All the parameters were compared with the WHO and BIS standard and for each samples consider the Water Quality. Based on water quality all the samples in the study area fall in permissible limit except few samples.*

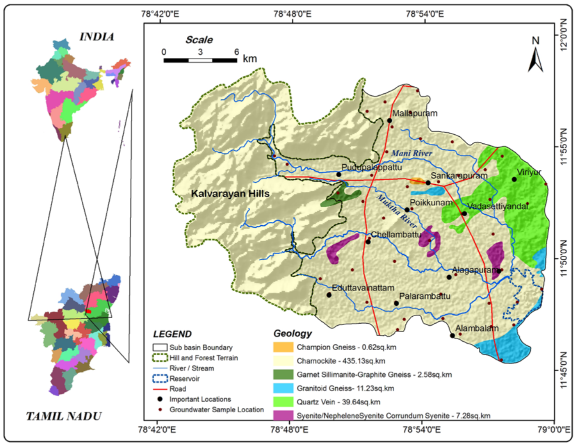
INTRODUCTION

The chemical composition of groundwater is controlled by many factors which include composition of precipitation, geological structure and mineralogy of the watersheds and aquifers, geochemical processes within the aquifer as well as oxidizing-reducing conditions (Andre et al., 2005). As for contamination, it cannot be polluted easily comparing with surface water because it is protected naturally, less affected by drought even when close to point of use, and does not require much treatment, so it is more reliable. Agriculture is a dominant sector in the economic development of India, as it is the source of sustenance for the majority of the population, and contributes 46% of the gross national product (Singh 1983).These processes occurring within the groundwater and reactions with aquifer minerals have a profound effect on water quality and are responsible for the seasonal and spatial variations in

groundwater chemistry (Rajmohan and Elango, 2004). Hence the quality of water along its underground movement is therefore dependent not only on the chemical and physical properties of surrounding rocks but also varies as a result of human activity (Matthess, 1982; Freeze and Cherry, 1979). The hydrogeochemical processes reveal the zones and quality of water that are suitable for drinking, agricultural and industrial purposes. Increased knowledge of geochemical evolution of groundwater in arid and semi-arid regions could lead to improved understanding of hydrochemical systems in such areas, leading to sustainable development of water resources and effective management of groundwater resource (Jalali, 2009).In India, groundwater is the primary source of water for domestic, agricultural and industrial uses. About one billion people are directly dependent upon groundwater resources in Asia alone (Foster 1995), and the dependence on groundwater has increased tremendously in recent years in many parts of India, especially in the arid and semi-arid regions, due to the vagaries of monsoon and the scarcity of surface water. So many studies carried in groundwater quality assessment for drinking purpose (Venkateswaran et al.,2012, and Venkateswaran and Deepa, 2013)

STUDY AREA

The study area lies between 78°42' to 78°59' E longitude and 11°42' to 11°59' N covering a total area of 497.11 sq.km in which hilly area occupies 187.19 sq.km. The major source for recharge in the area is rainfall during monsoon season but average annual rainfall of the study area is 1115 mm. The study area chiefly consists of hard crystalline rocks of Archean age. The depth of dug wells and water table ranges from 15 to 20m and 8 to 18m, respectively. Manimuktha is a main tributary of Vellar River, it traverse in Villupuram district, Tamil Nadu, India shows in Figure 1.Figure 1: Upper Manimuktha sub basin with lithology and important locations



MATERIALS AND METHODS

48 groundwater samples were collected during the December 2015. Figure 1 shows the locations of the groundwater samples wells (mills or domiciliary/irrigation wells). The collection, preservation and chemical analysis for major ions of water samples were made following the standard methods given by the American Public Health Association (APHA 1998).The samples were analyzed using

standard water analysis methods APHA, 1995). The ionic constituents Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, CO_3^{2-}, HCO_3^{-}, and SO_4^{2-} and the non-ionic constituents pH, Electrical conductivity (EC), Total dissolved solids (TDS) and Total hardness (TH) were determined for these groundwater. The base map of the study area was prepared using Survey of India topographic sheets (58 e 9 and 13) and digitized using ArcGIS 9.3 software (Figure 1).Spatial Analyst extension (an extended module of ArcGIS 9.3) was used to interpolate the spatial distribution of the groundwater quality parameters. Inverse Distance Weighted (IDW) interpolation technique was used to create different thematic layers. IDW is an algorithm used to interpolate data spatially or estimate values between measurements. Weights are computed by taking the inverse of the distance from observations location to location of the point being estimated (Burrough and Mc Donnell 1998. The suitability of groundwater for drinking purpose was evaluated by comparing the values of different water quality parameters with those of the WHO 2004 and BIS 2000 guidelines values for drinking water. The flow chart for the methodology adopted was given in Figure 2.

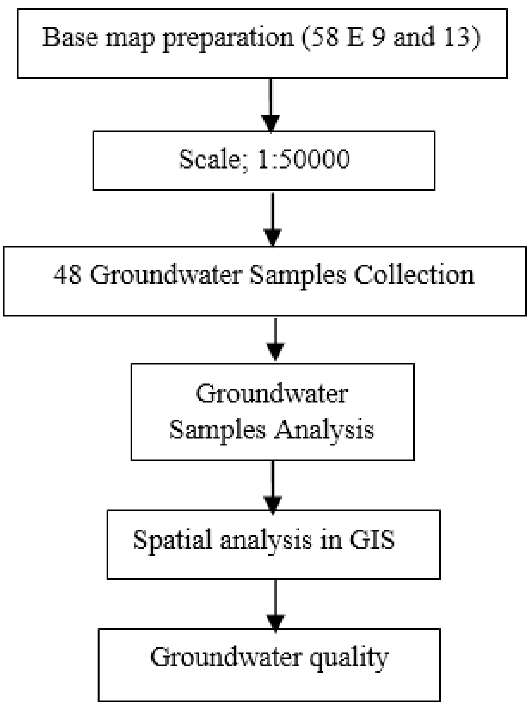


Figure 2: Flow chart of the methodology

RESULT AND DISCUSSIONS

The pH ranges from 6.87 to 8.14 mg/L, the average pH was found to be 7.51 and all the groundwater sample within potable limit (TABLE-1). The electrical conductivity (EC) of the groundwater ranges from 475 to 4080 µS/cm and the average EC was found to be 1392.21 (Figure 3) and 4 samples are fall in the bad and very bad category. The concentration of total dissolved solids (TDS) ranges from 333 to 2,856 mg/L and the average TDS was found to be 974.56 indicating good drinking purpose except 3 samples (11,6,23).The concentration of total hardness (TH) ranges from 136 to 748mg/L and the average TH was found to be 409.21 mg/L it indicate majority of samples fall into the hard and very hard category and only 2 samples fall into moderately hard category (TABLE-1).

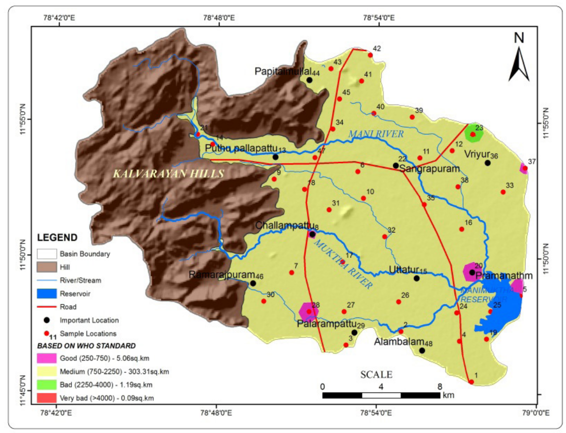


Figure 3: Spatial distribution of EC

The calcium concentration in the groundwater ranges from 32 to 184 mg/L, average of calcium 90.88 mg/L and all the samples within potable limit. The magnesium concentration in the groundwater ranges from 14 to 88 mg/L, average of magnesium 42.29 mg/L and fifteen groundwater samples fall in the not potable limit (TABLE-1). The concentration of sodium in the groundwater ranges from 40 to 572 mg/L, average is126.58 mg/L and two samples fall in not potable limit. Potassium ranges from 4 to 64 mg/L, average of the potassium 18.25 mg/L, 95% of sample fall into the not potable limit

The Concentration of bicarbonate in the groundwater ranges from 81.6 to 448.8mg/L, the average was found to be 245.52 mg/L and all samples within allowable limit (TABLE-1).The sulphate concentration of study area ranges from 8 to 150 mg/L and the average was found to be 57.94 mg/L and all samples under the permissible limit. The concentration of nitrate in groundwater varies from 4 to 64 mg/L and average of the nitrates 25.29 mg/L and three samples fall in not potable limit (TABLE-1).

The chloride concentration of study area ranges from 40 to 1090 mg/L, the average was found to be 190.25 mg/L and all the sample fall in potable limit except one (23).

TABLE-1
PHYSICO-CHEMICAL PARAMETERS OF GROUNDWATER AND ITS COMPARISON WITH STANDARDS

S. No.	Parameter	Range	Class	Well locations
1	pH	6.5	Acceptable	Nil
		6.5 to 8.5	potable	All samples
		>8.5	Not potable	Nil
2	Electrical Conductivity (EC)	<250	Excellent	Nil
		250 to 750	Good	5,8,20,28,37,43 (6)
		750 to 2250	Medium	1,2,3,4,9,10,12,13,14,15,16,17,18,19,21,22,24,25,26,27,29, 30,31,32,322,34,35,36,38,39,40,41,42,44,45,46,48 (38)
		2250 to 4000	Bad	6,11,47 (3)
		>4000	Very bad	23 (1)

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3	Total Dissolved Solvent (TDS)	<500	Acceptable	5,8,20,28,37 (5)
		500 to 1500	Allowable	1,2,3,4,7,9,10,12,13,14,15,16,17,18,19,21,22,24,25,26,27,29,30,31,32,33,34,35,36,38,39,40,41,42,43,44,45,46,48 (39)
		>1500	Not potable	6,11,23,47 (4)
4	Total Hardness (TH)	<75	Soft	Nil
		75 to 150	Moderately Hard	5,28(2)
		150 to 300	Hard	4,8,20,37,43 (5)
		>300	Very Hard	1,2,3,6,7,9,10,11,12,13,14,15,16,17,18,19,21,22,23,24,25,26,27,29,30,31,32,33,34,35,36,38,39,40,41,42,44,45,46,47,48 (41)
5	Bicarbonate (HCO_3)	<300	Desirable	1,2,3,4,5,7,8,9,10,12,13,14,15,16,17,19,20,21,22,24,25,26,27,28,31,32,33,34,35,36,37,40,41,43,44,45,46,48 (38)
		300 to 600	Allowable	6,11,18,23,29,30,38,39,42,47 (10)
		>600	Not potable	Nil
6	Chloride (Cl)	<200	Acceptable	1,2,3,4,5,7,8,9,10,12,13,14,15,16,17,19,22,23,24,25,26,27,28,29,31,32,33,34,35,36,37,39,40,41,42,43,44,45,46,48 (35)
		200 to 600	Allowable	6,11,18,19,23,29,30,38,41,42,45 (12)
		>600	Not potable	23 (1)
7	Sulphate (SO_4)	<400	Potable	All sample
		>400	Not potable	-
8	Nitrate (NO_3)	<45	Potable	1,2,3,4,5,7,8,9,10,12,13,14,15,16,17,18,19,20,21,22,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48 (45)
		>45	Not potable	6,11,23 (3)
9	Fluoride (F)	<1.5	Permissible	1,2,3,4,5,7,9,10,11,12,13,14,16,17,18,19,20,21,24,25,26,31,32,33,34,35,36,37,38,39,41,42,43,44,47 (33)
		>1.5	Not permissible	3,6,8,15,22,23,27,28,29,30,32,40,45,46,48(15)
10	Calcium (Ca)	<75	Acceptable	4,5,7,8,9,10,12,17,20,21,25,28,34,35,37,40,43,44 (18)
		75 to 200	Allowable	1,2,3,6,11,13,14,15,16,18,19,22,23,24,26,27,28,29,30,31,32,33,38,39,41,42,45,46,47,48 (30)
		>200	Not potable	-
11	Magnesium (Mg)	<30	Acceptable	4,5,8,20,28,34,37,40,43 (8)
		30 to 50	Allowable	1,3,7,9,10,12,13,14,15,16,17,18,19,21,22,25,26,31,35,38,44,45,46 (24)
		>50	Not potable	2,6,11,23,24,27,29,30,33,36,39,41,42,47,48 (15)
12	Sodium (Na)	<250	Potable	1,2,3,4,5,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48 (46)
		>250	Not potable	6,23 (2)
13	Potassium (K)	<10	Potable	4,5,8,9,10,17,20,25,28,34 (10)
		>10	Not potable	1,2,3,6,7,11,12,13,14,15,16,18,19,21,22,23,24,26,27,29,30,31,32,33,35,36,37,38,39,40,41,42,43,44,45,46,47,48 (38)

The concentration of fluoride contamination ranges from 0.2 to 3.6mg/L and the average of fluoride 1.29 mg/L. Figure 4 shows maximum samples fall in not potable limit. The fluoride contamination in the groundwater indicate the presence of fluoride bearing minerals (Krishna Kumar et al. 2011; Ramachandramoorthy et al. 2010).

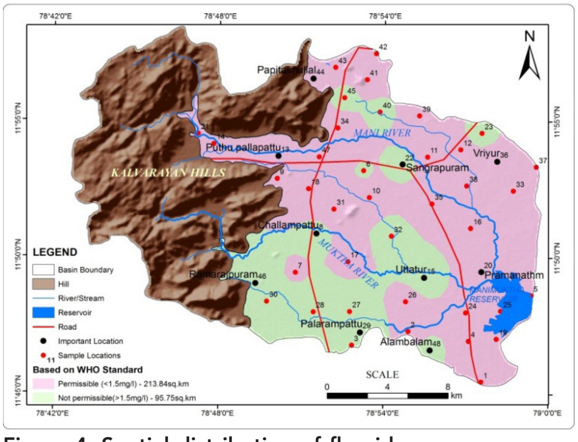

Figure 4: Spatial distribution of fluoride

CONCLUSION

In the present study, 48 groundwater samples were collected from Upper Manimuktha Subbasin, Villupuram district, Tamil Nadu, India. Detailed analyses were carried out to determine the geochemical processes responsible for quality deterioration. The pH value reveals that the groundwater is slightly basic in nature. The groundwater samples are dominated by Cl, SO_4, HCO_3, Ca, Mg, and Na ions. The quality of ground water in the study area is impaired by surface contaminants sources, mineral dissolution and evaporation.

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