Assessment Of Groundwater Quality For Drinking And Irrigation Purposes In Gingee Block ,Villupuram District, Tamilnadu

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Abstract- *Gingee block has chosen to determine the groundwater quality for drinking and irrigation purpose. In the present study 20 groundwater samples were collected and analyzed for various physical and chemical parameters of groundwater such as TDS, pH, EC, Ca, Mg, Na, K, Cl, NO3, F. The collected samples are compared with the WHO standards of drinking water quality. Overall evolution of the samples shows that the groundwater in the study area is fresh to Brackish, slightly basic in nature, Salinity nature. The values of Na% ,SSP, for the samples are in unsuitable category. The SAR, RSC, KR ,CR for certain samples are in permissible limit.*

Keywords- Gingee, Drinking, SSP, EC,TDS,KR,CR etc

I. INTRODUCTION

Groundwater is the prime source of drinking water supply for many of the Indian rural and urban habitats, like in other parts of the world (Abdul Saleem et al.,2012). Due to inadequate supply of surface water, demand for groundwater resource has increased in many folds in recent times for drinking, irrigation, and industrial purposes in the world. It is estimated that approximately one third of the world's population use groundwater for drinking(Nickson et al., 2005).Due to overexploitation of groundwater for domestic, irrigation and industrial purposes for the past few years the groundwater level has depleted forcefully it will adverse affect of groundwater quality and quantity. Once the groundwater is polluted, it is not easy to restored by stopping the pollutants from the supply. Contamination of groundwater also depends on the geology of the area and it is rapid in hard rock areas especially in lime stone regions where extensive cavern systems are below the water table (Singh, 1982). This is a feature common, not only in developed countries but also in developing countries like India. The changes in quality of groundwater response to variation in physical, chemical and biological environments through which it passes (Singh et al., 2003).

The chemical composition of groundwater is very important criteria that determine the quality of water. Water quality is very important and often degraded due to agricultural, industrial and human activities. Even though the natural environmental processes provide by means of removing pollutants from water, there are definite limits. It is up to the people to provide security to protect and maintain quality of water (Ikhane Philips et al.,2010).

II. STUDY AREA

The study area Gingee (Fig:1)is a located in Villupuram district, Tamil Nadu. The Gingee town Panchayat is located at a distance of 150kms from the State capital, along the Tindivanam-Thiruvannamalai road. The town is well linked by the road network. It is located at a distance of 38kms north of Villupuram, 27kms west of Tindivanam and 38 kms east of Thiruvannamalai. The town is well linked on all directions on the road ways. Tindivanam – Thiruvannamalai road (NH 66) runs as a spine in the centre of the town. Varahanadhi River (Sankaraabarani) is flowing in the eastern side of the town boundary.

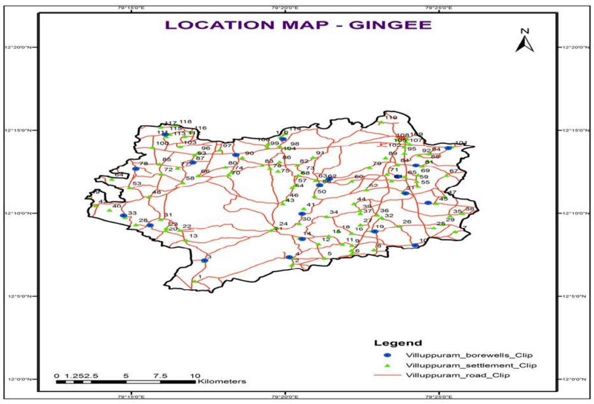

Fig:1,Study area and GroundwaterSamples locations

III. MATERIALS AND METHODS

Samples were collected from bore well and open wells and analysed for different parameters. All samples should be properly labelled with details of the locations, date and time of sampling. Samples are collected at the following locations 1.Sithampoondi,2.Palapatu, 3.Ottampattu, 4.Varikal, 5.Anandhapuram, 6.Athiyur, 7.Saranapuram, 8.Appampattu, 9.Meenambur, 10.Ponpathi, 11.Gingee, 12.Alampoondi, 13.Sathiyamangalam,14.Pasumalaithangal,15.Manalaipadi,16. Kanakankuppam.17.Devathanapettai,18.Uranithangal,19.Kalai yur,20.Nattarmangalam. Water sample collected in the field were analyzed in the laboratory for the major cations and anions using the standard methods as suggested by the American Public Health Association(APHA, 1995).

IV. RESULTS AND DISCUSSION

4.1 Suitability of groundwater for drinking purposes:

a. pH

The purpose of finding the pH value is to determine whether the drinking water is acidic or alkaline in nature. The pH values of groundwater samples range between 6.6 to 8.2, which indicates that the groundwaters are basic in nature. pH values of groundwater samples are within permissible limit (WHO, 1984). In general, groundwater pH is slightly alkaline due to the influx of HCO_3 ions in the groundwater aquifer which is due to percolation of rain water through soil (Mor, et al,2006 , Alam, et al, 2012).

Table: 1,Comparison of groundwater parameters with WHO standards

Parameters	WHO international standard (1984)		No. of Wells exceeding permissible limits
	Highest desirable limits	Maximum permissible limits	
pH	7- 8.5	9.2	Nil
TDS(mg/l)	500	1500	10,16
EC(µS/cm)	1000	1500	4,7,10,14,16
TH(mg/l)	100	500	Nil
Na(mg/l)	-	200	1,2,4,5,6,9,10,18
Ca(mg/l)	75	200	Nil
Mg(mg/l)	50	150	Nil
Cl(mg/l)	200	600	Nil
SO4(mg/l)	200	400	Nil
NO3(mg/l)	45	-	Nil
F(mg/l)	-	1.5	Nil

b. TDS

Total dissolved solids (TDS) mainly consist of inorganic salts such as carbonates, bicarbonates, chlorides, sulfates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron etc and small amount of organic matter and dissolved gases (Shubhra Singh et al 2015). The TDS concentrations ranges were between 852 to 1692 mg/l. To ascertain the suitability of groundwater for any purposes, it is essential to classify the ground water depending up on their hydro chemical properties based on their TDS values (Catroll, 1962). which are presented in (Table. 2).

Table-2 Classification of ground water based on TDS Classes.

TDS (mg/l)	Nature of water	Sample Number
<1000	Fresh water	3,4,8,9,12
1000-10000	Brackish water	1,2,5,6,7,10,11,13,14,15,16,17 , 18, 19,20
10000-100000	Saline water	Nil
>100000	Brine water	Nil

In the present study sample number 3,4,8,9,12 are fall in fresh water category.15 samples of groundwater fall in brackish water type.TDS value below 1000 mg/l indicating low content of soluble salts in groundwater which can be used for drinking without any risk (Ramamoorthy and Rammohan,2014) .

c. Electrical Conductivity (EC)

In the study area the Electrical Conductivity for the samples ranges from 420 micro mhos/cm to 4650 micro ohms/cm.The electrical conductance is a good indication of total dissolved solids which is a measure of salinity that affects the taste of portable water(Mohamed Hanipha and ZahirHussian,2013). The electrical conductivity is also influenced by ionic mobility, ionic valence and temperature (Ramamoorthy and Rammohan,2014) .

d. Calcium (Ca)

Calcium is an essential nutrition element for human being and aids in maintaining the structure of plant cells and Soils(Chari and Lavanya ,1994). The concentration of calcium

Ranges from 16 to 97 mg/l. The maximum value of the calcium was obtained in Palapattu. e.**Magnesium(Mg)**
The magnesium value of all the samples varies in the range of 9 to 48 mg/l. The maximum value of magnesium was obtained

at Palapattu and Ponpathi .The Magnesium concentration on the study area are derived from the dissolution of magnesium calcite, gypsum/or dolomite from source rock (Garrels and Mackenzie, 1967).

f. Potassium (K^+)

Potassium is an essential element for humans, plants and animals, and derived in food chain mainly from vegetation and soil. The main sources of potassium in ground water include rain water, weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation (Deshpande and Aher,2012). The concentration of potassium ranges from 2 to 188 mg/l. Higher concentration of Potassium in groundwater is due to the presence of silicate minerals from igneous and metamorphic rocks (Zahir Hussain A. and Abdul Jameel. M., 2011). The potassium concentration in water is low because of the high degree of stability of potassium bearing minerals.

g. Fluoride(F)

The concentration of fluoride in groundwater of the basin varies between 0.5to1. However, all samples show within the permissible limit hence it is suitable for drinking purpose. High concentration of fluoride in groundwater may be due to breakdown of rocks and soils or infiltration of chemical fertilizers from agricultural land(Mohamed Hanipha and ZahirHussian,2013. Skeletal fluorosis is an important disease due to presence of high fluoride content in groundwater(Mangale Sapana, et al.,2012).

h. Chloride(Cl)

Chloride originates from sodium chloride which gets dissolved in water from rocks and soil. It is good indicator of groundwater quality and its concentration in groundwater will increase if it mixed with sewage or sea water(Deshpande and Aher,2012). The chloride value of all the samples varies in the range of 108 mg/l to 212.4 mg/l. The maximum value of the (212.4 mg/l). The maximum value of chloride is obtained at the sample (S14). The minimum value (108 mg/l) of the chloride is obtained in the sample (S12). Soil porosity and permeability also play an important role in building up the chloride value in the groundwater (Jain, et al., 2005)

i. Nitrate (NO3)

The maximum nitrate concentration 20 mg/l. The higher value of nitrate is the most common indication of agriculture impact on groundwater quality. Nitrate values for the village were not within the permissible limits according to the WHO standard (1984). The contamination of groundwater may be due to sewage and other wastes rich in nitrates(VenkateswaraRao ,2011) The presence of nitrate in groundwater may be due to leaching of nitrate with percolating powder(Mohamed Hanipha and ZahirHussian,2013). Toxicity of nitrates in infant's cause's methaemoglobiaemia(US-EPA,2012).

j. Sulphate (SO4)

The sulphate value of all the samples varies in the range of 7.5 to 84.1 mg/l. The maximum value of the sulphate is obtained at the Palapattu village. High concentration of sulphate may cause gastro-intestinal irritation particularly when magnesium and sodium ions are also present in drinking water resources(Indrani Gupta , et al.,2011).

V. GROUND WATER SUITABILITY FOR IRRIGATION PURPOSES

The concentration and composition of dissolved constituents in groundwater determine its quality for irrigation use. The suitability of groundwater for irrigation is liable on the effects of the mineral constituents in the water on both the plants and soil (Richards,1954). Higher salt content in irrigation water causes an increase in soil solution osmotic pressure (Thorne and Peterson, 1954). Effect of salts on soil causing changes in soil structure, permeability and aeration in directly affect plant growth. Since plant roots extract water osmosis, the water uptake of plants decreases.

The osmotic pressure is proportional to the salt content or salinity hazard. The salts, besides affecting the growth of plants directly, also affect the soil structure, permeability and aeration, which indirectly affect the plant growth. An important factor allied to the relation of crop growth to water quality is drainage. If a soil is open and well drained, crops may be grown on it with the application of generous amounts of saline water; on the other hand, a poorly drained area combined with application of good quality water may fail to produce as satisfactory a crop (Todd,1980)

5.1.Sodium Percentage (% Na)

Percent sodium (% Na) is also widely utilized for evaluating the suitability of water quality for irrigation(Wilcox,1948). Excess sodium concentration in groundwater produces the undesirable effects because Na reacts with soil to reduce its permeability and support little or no plant growth (Raju et al,2009) (Vasanthavigar et al,2010). The % Na is computed with respect to relative proportions of cations present in water, where the concentrations of ions are expressed in meq/l, using the following formula:

Na% = (Na + K)×100 {(Ca +Mg + Na + K)} (meq l)

Table :3.Classification based on % Na in groundwater

Na %	Water class	No.of samples
<20	Excellent	NIL
20-40	Good	NIL
40-60	Permissible limit	6
60-80	Doubtful	10
>80	Unsuitable	4

The calculated value of Na% ranges 47.5 to 85.6. Sodium percentage value should not go beyond 60% in irrigation waters. The 50% samples are fall in doubtful category. (Table.3). Maximum value is observed in the sample Ananthapuram.The Na% was higher may be dissolution of minerals from lithological composition, and the addition of chemical fertilizers by the irrigation waters(Subba Rao, et al 2002)

5.2 Sodium Absorption Ratio (SAR):

The sodium adsorption ration (SAR) indicates the effect of relative cation concentration on sodium accumulation in the soil; thus, sodium adsorption ration (SAR) is a more reliable method for determining this effect than sodium percentage(Richards,1954). SAR is calculated from the ratio of sodium to calcium and magnesium. Calcium and magnesium ions are important since they are tending to counter the effect of sodium. Higher concentration of SAR leads to breakdown in the physical structure of the soil (Shubhra Singh et al 2015).Sodium adsorption ration (SAR) is calculated using the following formula:

$$\mathbf{SAR = [Na+] / \{([Ca^{2+}] + [Mg^{2+}]) / 2\}^{1/2}}$$

Ions are expressed as milliequivalents per liter (meq/L). The sodium adsorption ration (SAR) content in study area has shown (Table:4)range from 2.8 to 22.3. Maximum value (22.3) of SAR value is observed in the sample S9. 60% of samples fall in good category for irrigation purposes.

Table:4,SAR classes of groundwater

Parameter	Range	Water class	No.of Samples
SAR	< 10	Excellent	12
	10 - 18	Good	4
	18 - 26	Doubtful	4
	> 26	Unsuitable	Nil

5.3 Soluble Sodium Percent (SSP)

The Soluble Sodium Percent (SSP) for groundwater was calculated by the formula,

$$SSP = \frac{Na \times 100}{Ca^{2+} + Mg^{2+} + Na^{+}}$$

Where the concentrations of Ca^{2+}, Mg^{2+} and Na^{+} are expressed in milli equivalents per liter (epm). The Soluble Sodium Percent (SSP) values less than 50 or equal to 50 indicates good quality water and if it is more than 50 indicates the unsuitable water quality for irrigation (Deshpande S.M. and Aher K.R.,2012). Maximum value of (89.2) SSP was observed in S5 and minimum was observed in S15. All samples are fall unsuitable for irrigation purposes.

5.4.RESIDUAL SODIUM CARBONATE (RSC)

The relative abundance of sodium with respect to alkaline earths and boron, and the quantity of Bicarbonate and Carbonate in excess of alkaline earths also influence the suitability of water for irrigation purposes. This excess is denoted by Residual Sodium Carbonate (Richards 1954) and is determined by the formula.

$$RSC= (HCO_3+CO_3)-(Ca^{++}+ Mg^{++})$$

Where the concentrations are expressed in milliequivalents per liter.

Table 5. RSC classification of groundwater.

RSC (epm)	Nature of the water	No.of Samples
>2.5	Unsuitable for irrigation	1
1.25-2.5	Marginal quality	1
<1.25	Probably safe	18

Most (90%) of the groundwater sample in the study area is safe for irrigation purpose ranges from -5.1 to 3.1.

5.5. Corrosivity ratio(CR)

The Corrosivity Ratio (CR) value of the study area is accounted and the results for the seasons are tabulated in Table. 6. The study make it clear that 95 % of the groundwater samples fall under safe conditions and only one sample fall under unsafe conditions.

Table 6 Groundwater quality based on Corrosivity ratio

Sl.No	Percentage of samples	<1	>1	Remarks
1	95%	19	1	

VI. CONCLUSION

The results revealed that groundwater in the study area were mostly slightly alkaline. Based on the concentration of TDS, groundwater samples are good to fair category. The electrical conductivity value of study area range from 420 to 4650 µS/cm. The cation and anion values of groundwater samples of study area fall within the permissible limit as per WHO .The concentration of fluoride is within the permissible limit as per WHO(1984). SAR value of groundwater samples in the study area suitable(60%) for irrigation purposes. Irrigation water quality based on % Na indicates that 30% of the water samples fall within the permissible category.RSC and CR values of groundwater sample shows suitable for irrigation purposes. Soluble Sodium Percent (SSP) of samples from study area fall in unsuitable for irrigation purposes. Samples had a low alkalinity hazards and medium to high salinity in them are restricted to use for irrigation, and in that areas salt tolerant cropping pattern can be done.

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