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Assessment of Groundwater Quality for Drinking and Irrigation purposes, A case study of Vanur Taluk,Tamilnadu,India.

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Abstract - The present study was carried out in Vanur taluk to find out the groundwater suitability for irrigation purposes. A 20 groundwater samples collected from the borewell during premonsoon 2016 and analyzed for major cations and anions. The parameters like pH, TDS EC, Ca, Mg, Na, KI, SAR, Na%, SSP were used to calculate the suitability for Drinking and irrigational purposes. pH, TDS and EC value attributes that groundwater samples are suitable for drinking purposes. SAR, Na%, SSP, KI value indicates groundwater samples are suitable for irrigation purposes. The results were evaluated and compared with WHO (1997). SAR, KI, SSP values revealed that most sample is suitable for irrigation except one or two samples.

Key words: Vanur taluk, Agriculture, SSP, EC, Na%, Groundwater, etc

INTRODUCTION

Water is essential to the survival of man and all living things. Man's activities such as food production, nutrition are dependent on water availability in adequate quantities and good quality (Howari et al 2005). Water is the most common and widespread chemical compound in nature which is a major constituent of all living creatures (Dojlido,1987, Monika Cieszynska etal,2011). Water is available in two forms as surface water and groundwater. Groundwater is present in permeable geological formation is known as aquifer. Groundwater is an essential and vital component of our life support system. More than 95% of the rural population depends on groundwater source for their domestic requirement and in urban area also about 30% to 40% of the population depends on groundwater for the requirement. The groundwater resources are being utilized for drinking, irrigation and industrial purposes (Goswamee etal,2015). Groundwater is polluted in city mainly due to sewage, industrial waste and in the rural areas groundwater is contaminated due to sewage, industrial waste and application of chemical fertilizers in the agricultural fields. (Shirdhar S. Kumbhar, 2014). Due to excess withdrawl of groundwater for irrigation, domestic, and industrial purposes for the past few decades the groundwater level has down forcefully it will unpleasant affect of groundwater quality and quantity(Ramamoorthy,2016). 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 limestone regions where extensive cavern systems are below the water table (Singh, 1982). Water quality data is essential for the implementation of responsible water quality regulations for characterizing and remediating contamination and for the protection of the health of humans and the ecosystem. Regular monitoring of groundwater resources thus play a key role in sustainable management of water resources (Ackah etal,2011).

Study area

The study area Vanur taluk(Fig:1) in the Villupuram district of Tamil Nadu state, it falls between 12˚02'0''N and 79˚45'0''E. The soil of the study area is of mostly with sandy, mixed with soda or other alkali, The study area is underlain by the crystalline metamorphic complex in the northwestern side and sedimentary track on the southeastern side.

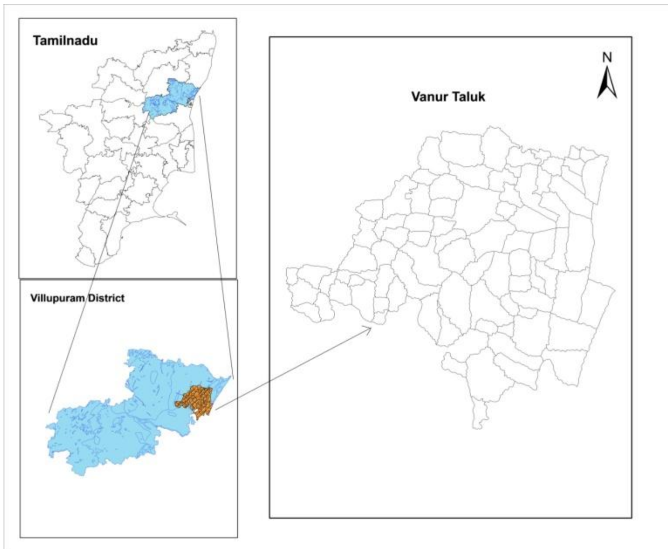

Fig 1.Study area

Materials and Methods:

A total of twenty groundwater samples are collected for the analysis. The groundwater samples were taken from already running motor pumps or after operating the motor pumps for about ten minutes. Sampling, preservation and transportation of water samples were as per standard method (APHA, 1998).

Results and Discussion:

Groundwater chemistry

In the study area, the pH values for the water samples range from 6.72 to 8.2, which are basic in nature. Most of the samples fall within the permissible limit as specified by WHO 1997.The highest value of pH value 8.2 was observed in the station S12.TDS value of study area ranges from 139 to 1670. According to the WHO (1997) classification of water based on TDS, all the samples are within the permissible limit except two samples (S6 & S17). Electrical Conductivity (EC) is an indication of the concentration of total dissolved solids and major ions in a given water body (Deshpande and Aher 2012). The Electrical conductivity values range from 194.6µs/cm to 2340 µs/cm. The highest value of EC was observed at S17. The Ca value of study area ranges from 84.2 to 231 mg/l with an average of 133.08 mg/l. The most abundant cation in ground water is sodium (Na) with an average value of 129.17 mg/l (56 to 186 mg/l) in the study area. Magnesium concentration of study area ranges 22.2 to 62 mg/l higher concentration of magnesium in the groundwater maybe due to dissolution of magnesium calcite, gypsum/or dolomite from source rock (Garrels and Mackenzie, 1967). Potassium concentration of groundwater samples ranges from 2.8 to 5.6 mg/l with an average of 4.11 mg/l. The lower concentration of potassium in groundwater because of the high degree of stability of potassium bearing minerals (Ramamoorthy et al,2015). Chloride concentration ranges from 69 to 234.6 mg/l in groundwater of the study area, with an average value of 145.31 mg/l. Nitrate concentration range from 10.4to 34.2 mg/l in groundwater with an average value of 19.77 mg/l and Higher concentration of nitrate in groundwater samples it may result bluebaby disease/ methaemoglobinaemia in children(Gilly etal 1984). Sulphate concentration in groundwater ranges from 16.7 to 64.3 mg/l having an average value of 41.30 mg/l whereas Fluoride concentration ranges from 0.78 to 1.76 mg/l with an average of 1.09 mg/l. The permissible limit of the fluoride value in the groundwater is 1.5 mg/l as per WHO 1997. 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).

Water quality for Drinking purposes:

The concentration of groundwater samples are compared with WHO 1997.Most of the samples fall within the permissible limit except one or two samples, the present study shows groundwater potable for drinking purposes.

Water quality for Irrigation Purposes:

Sodium Absorption Ratio (SAR)

SAR is used to determine the suitability of groundwater for irrigation purposes.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:

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

SAR value of groundwater ranges from 1.5 to 5.44. All the groundwater samples fall in < 10 category(RSC) , so it is fit for Irrigation purposes.

Table :1 Classification based on SAR

Parameter	Range	Water class	No.of Samples
SAR	< 10	Excellent	20
	10 - 18	Good	NIL
	18 -26	Doubtful	NIL
	> 26	Unsuitable	NIL

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 adverse 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 sodium percentage (Na %) is calculated by the given formula,

$Na\% = (Na^+ + K^+)*100/ (Ca^{2+} + Mg^{2+} + Na^+ + K^+)$

Where, all the Ionic concentrations are expressed in meq/L. % Na should not exceed 60% in irrigation waters (Shubhra Singh et al.,2015). % Na values range from 19.7 to 48.2. All collected samples are fall within the permissible limit.

Table :2 Classification based on % Na

Parameter	Range	Water class	No.of Samples
% Na	< 20	Excellent	20
	20 - 40	Good	NIL
	40- 60	Permissible	NIL
	60- 80	Doubtful	NIL
	>80	Unsuitable	NIL

Kelly Ratio:

Sodium measured against Ca^{2+} and Mg^{2+} is used to calculate Kelley's ratio((Kelly et al., 1940).

Kelly ratio was calculated by the given formula

Kelley's Ratio (KR) = $Na^+ / Ca^{2+} + Mg^{2+}$

A Kelley's Ratio value of >1 indicates an excess level of sodium in waters. Hence, waters with a Kelley's Ratio less than one are suitable for irrigation, while those with a ratio more than one are unsuitable for irrigation (Deshpande and Aher 2012). In the current study all the groundwater of study area are fall in <1 category it indicates suitable for irrigation purpose.

Table :3 Classification based on Kelly Ratio

Parameter	Range	Water class	No.of Samples
KI	< 1	Suitable	20
	>1	Unsuitable	NIL

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 milliequivalents per litre (epm). The Soluble Sodium Percent (SSP) values < 50 or equal to 50 indicates good quality water and if it is > 50 indicates the unsuitable water quality for irrigation (Deshpande S.M. and Aher K.R.,2012). In the current study 25% of samples fall in unsuitable category.

Table :4 Classification based on SSP

Parameter	Range	Water class	No.of Samples
SSP	< 50	Suitable	15
	>50	Unsuitable	5

CONCLUSION

The study reveals that most of the samples fall within the permissible limit except few places. The concentrations of major cations and anions in the groundwater sample are fall within the permissible limits for drinking purpose except in few places. The suitability of groundwater for irrigation is evaluated based on the following parameters Na%, SAR, KI, SSP. According to the output of this parameter, all the groundwater samples in the study area are fall in Excellent and suitable category. This study emphasize that quality of the groundwater should be monitor with constant frequency to avoid the contamination through various sources.

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