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Research Article

EVALUATION OF GROUND WATER QUALITY FOR DRINKING AND IRRIGATION SUITABILITY: A CASE STUDY IN MARAKKANAM BLOCK, VILLUPURAM DISTRICT, TAMILNADU, INDIA

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ABSTRACT

The present study has carried out in a Marakkanam block, Villupuram district, Tamilnadu to find out a groundwater quality for drinking and irrigation suitability. A twenty groundwater samples collected, and it was analysed for physical and chemical parameters like pH, TDS, EC, Ca, Mg, K, Na, Cl etc and Parameters like SAR, RSC, Na% have also been determined for irrigation purposes. The study reveals that groundwater samples are slightly alkaline nature, fresh and brackish type. Parameters like Ca, Mg, Na, Cl, Fl values attributes it suitable for drinking purposes. SAR, RSC values of groundwater show suitable for irrigation purpose. Na% of groundwater samples fall in doubtful to permissible category except one sample.

INTRODUCTION

Water is a most important natural resource, it is a essential human need and is a valuable national asset. In addition to drinking, it is required for other human activities like, agriculture, industry, bathing, cooking, washing, recreation, navigation, fisheries etc (Suresh, *et al*., 2015). Rapid urbanization and industrialization also tremendously increase the groundwater demand. Now it is recognized that the quality of the groundwater is just as important as its quantity (Ponsingh and Maharani, 2015). The quality of water is of almost the equal importance to quantity in any water supply planning. Natural and anthropogenic effects, including local climate, geology, and irrigation practices influence water quality (Jasrotia, *et al*., 2018). The quality of a water is a function of the physical, chemical, and biological parameters, and could be subjective since it depends on a particular intended use. Further, it is important to be aware of the change in quality due to rock water interaction or any type of anthropogenic activities (Anbazhagan and Nair, 2004; Mukherjee, *et al*., 2008; Ramkumar, *et al*., 2013; Verma, *et al*., 2015). The coastal aquifer in India and various parts of the world are also reportedly poorly affected by the over-exploitation due to high population growth and large scale industrialization in the coastal zones which threatens the coastal freshwater resources globally, rendering groundwater non-drinkable (Sappa, *et al*., 2012; Sappa, *et al*., 2015; Sarath, *et al*., 2012). The geochemistry of soil (Zuane, 1990) and the geological history of rocks (Walton, 1970) have a considerable impact on the chemical contamination of groundwater. Therefore, any groundwater suitability assessment for agriculture should include their chemical composition (Alexakis, 2011).

STUDY AREA

The study area Marakkanam block formed part of Villupuram District of Tamilnadu, a separate union of unique geographical and geological disposition. The study area falls in survey of India Toposheet 57P/11

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and 57P/16. The study area are Marakkanam was surrounded by Vanur block in South, Mailam block in the West, Olakkur block in the North (Fig. 1).

GEOLOGY OF STUDY AREA

Marakkanam block is underlain by various geological formations from the Archeans to semi consolidated formation of Mesozoic and Tertiary ages to the unclassified alluvial formation of Quaternary age.

METHODOLOGY

In order to study the quality of groundwater, 20 groundwater samples were collected from

Borewell during pre-monsoon season. They were determined for pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), chloride (Cl^{-}), sulphate (SO_4^{2-}), nitrate (NO_3^{-}) and fluoride, following the standard water quality procedures prescribed by (APHA, 1992).

RESULTS AND DISCUSSION

Physico-chemical parameters of groundwater

The pH indicates the strength of the water to react with the acidic or alkaline material present in the water. This is caused by the entry of carbonates in the groundwater aquifer due to percolation of water through soil cover (Ali, *et al*., 2017). The pH in the groundwater varied from 6.7 to 8.1, indicating an alkaline nature. The pH values of ground water samples are within the safe limit as prescribed by (WHO, 2004). Though pH has no direct effect on human health, but it shows close relations with some other chemical constituents of water (Pitt, *et al*., 1999).

It is well known that electrical conductance is a good measure of dissolved solids and excessive presence of sodium in water is not only unsafe for irrigation but also makes the soil uncultivatable (Wilcox, 1955; Verma, 1994). Electrical Conductivity for the samples ranges from 320 micro mhos/cm to 2300 micro mhos/cm. Maximum was observed at Athur (Table 1).

TDS of the samples analyzed in the study area ranges from 768 mg/l in Nallur to 1632 mg/l in Kulathur. Groundwater in all the sample locations in the study area belongs to Fresh and Brackish water types. 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).

The content of Calcium ranges between 4–92 mg/l. Higher concentration was observed in the village Nallam. The concentration of magnesium was observed in the range between 2.4 to 44 mg/l

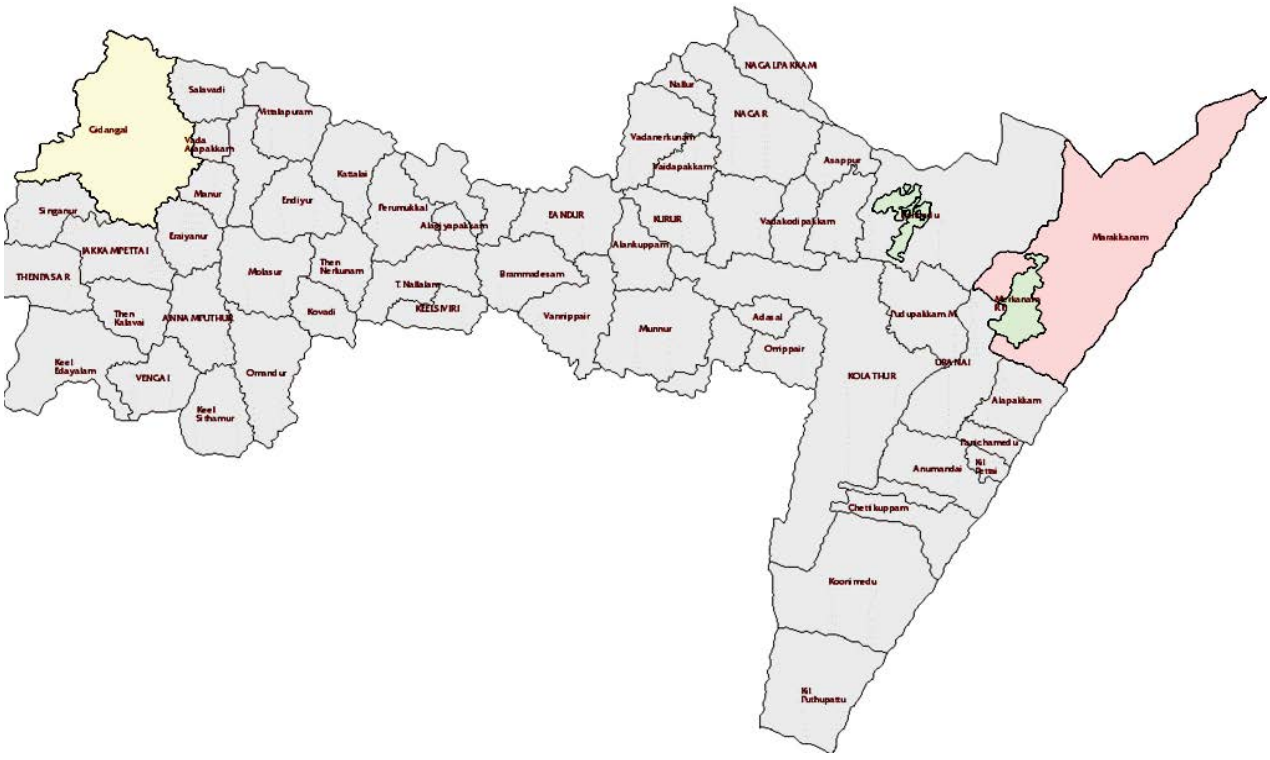

Fig. 1 Study area Marakkanam block.

Table 1. Standard ranges for hydro-chemical parameters for drinking water prescribed by WHO in 2004.

S. No	Substance/Characteristics	Desirable Limit	Permissible limit	No. of Samples Exceeding Permissible limit
1	pH	6.5-8.5	-	Nil
2	TDS (mg/l)	500	1500	2
3	Hardness, (mg/l)	100	500	Nil
4	Calcium (mg/l)	75	200	Nil
5	Magnesium (mg/l)	50	150	Nil
6	Sodium, mg/L	-	200	9
7	Chloride (mg/l)	200	600	Nil
8	Sulphate (mg/l)	200	400	Nil
9	Nitrate (mg/l)	-	45	Nil
10	Fluoride, mg/L	0.6	1.5	Nil

Table 2. Sodium adsorption ratio.

SAR	Water class	No. of Samples
<10	Excellent	14
10 to 18	Good	6
18 to 26	Doubtful	Nil
>26	Unsuitable	Nil

maximum was observed in the village Nallur and Vallakuppam. The concentration of Calcium and Magnesium are within the permissible limit as per WHO. Ca and Mg ions presence of groundwater may dissolve the $CaCO_3$, and $CaMg(CO_3)_2$ present in the rocks. The prolonged agricultural activities prevailing in the study area may also directly or indirectly influence mineral dissolution in groundwater (Bohlke, 2002).

Sodium concentration in groundwater ranges from 58 to 425 mg/l with an average of 199.9 mg/l. According to WHO (2011) guidelines, the maximum admissible limit is 200 mg/l. The following groundwater sample locations show concentration of Na^+ above permissible limit as per (WHO, 2004), Endiyur, Nallam, Birammadesam, Paravur, Nallur, Vappari, Kulathur, Vallakuppam. Higher concentrations of Na^+ in groundwater may either be due to chemical weathering of feldspars or over exploitation of groundwater resources (Hem, 1985). Excess sodium in groundwater causes hypertension, congenial diseases, kidney disorders and nervous disorders in human body (Ramesh and Elango, 2011). The concentration of potassium in ground water is also quite low and range from 1 to 25 mg/l maximum was observed in Endiyur.

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 content in study area has shown variation from 120 to 400 mg/l. all the groundwater samples fall within the permissible limit. Nitrate concentration of study area fall within the permissible limit maximum was observed in the study area is 40 mg/l.

IRRIGATION WATER QUALITY

Sodium Adsorption Ratio (SAR)

The excess amount of sodium concentration present in water sample reduces the permeability, and hence, the available water for the plant is reduced (Ahamed, *et al*., 2013). Sodium replacing adsorbed calcium and magnesium is a hazard, as it causes damage to the soil structure resulting in compact and impervious soil (Arveti, *et al*., 2011). If water used for irrigation is high in Na^+ and low in Ca^{2+} the ion exchange complex may become saturated with Na^+ which destroys the soil structure, due to the dispersion of clay particles (Todd, 1980) and reduces the plant growth. Excess salinity reduces the osmotic activity of plants (Subramani, *et al*., 2005). 14 samples from the study area fall in excellent category rest of the samples fall in good category. The groundwater samples shows suitable for irrigation purposes. The SAR is computed, using the formula (Hem, 1991) (Table 2).

$$SAR = Na^+ / \sqrt{(Ca + Mg)/2}$$

Residual sodium carbonate (RSC)

RSC values were calculated to find out the harmful effect of CO_3 and HCO_3 on the water quality for agricultural purpose (Eaton, 1950; Richards, 1954). According to USSL diagram, an RSC value <1.25 meq/L is probably safe for irrigation. If it is >2.5 meq/L, it is not suitable for irrigation. In the present study shows all groundwater samples are suitable for irrigation purposes.

Sodium Percentage (Na%)

Sodium is an important ion used for the classification of irrigation water due to its reaction with soil,

reduces its permeability (Janardhana, *et al*., 1992; Venkateswaran, 2010). Sodium is usually expressed in terms of percent sodium or soluble-sodium percentage (%Na). Percentage of Na^+ is widely used for assessing the suitability of water for irrigation purposes (Wilcox, 1955). The Na% is computed with respect to relative proportion of cations present in water as Where, all ionic concentrations are expressed in meq/l. The sample collected from location Karur shows unsuitable category rest of the groundwater shows permissible to doubtful category.

CONCLUSION

The groundwater quality in Marakkanam block has been evaluated for their chemical composition and suitability for drinking and agricultural uses. In general groundwater fresh and brackish type. Chemical Parameters like Calcium, Magnesium, Sodium, Potassium, Nitrate, Fluoride shows within permissible as per WHO and it is suitable for drinking purposes. SAR, RSC values of groundwater shows suitable for irrigation purpose. Na% reveals that doubtful to permissible category except one sample fall in unsuitable category.

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