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Groundwater pollution in the Palar Riverbed near Vellore, Tamil Nadu, India

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Abstract

Vellore is the second most populous district of Tamil Nadu in India where the Palar River flowing towards east for about 295 Km. The river sets as the major water source recharging the ground water nearby areas. The District is now known for its medical tourism and educational excellence. With more migration into the city, it becomes necessary for the corporation to give a good quality drinking water to the people. Vellore is surrounded by many leather tanneries and small scale dying industries and their effluents are discharged into the Palar River causing impact on the quality of the underground water. Hence, it becomes necessary to study the quality of the groundwater of the city as it greatly influenced by the Palar River. Sampling stations were chosen near residential areas, located at a distance of 2-3 Km from the Palar River. The physico-chemical parameters like pH, temperature, total dissolved solids, electrical conductivity, chloride, hardness and salinity of the samples collected from various sampling stations were studied. The determined physico-chemical parameters were compared with the BIS and ICMR standards for the drinking water to know about the quality of the groundwater. Various physico-chemical parameters studied in the area between Shenbakkam and Keezhminnal of Vellore, show the quality of the underground water in deteriorating state. The underground water of sampling station S13 and S14 needs special attention, as all the parameters such as TDS, electrical conductivity, chloride, hardness and salinity is found to be very high. It may cause laxative effects on health of the people consuming the contaminated water and it is not much suitable for irrigation purpose also. All the other sampling stations have their respective physico-chemical parameters slightly above the BIS and ICMR limits. Hence, proper water treatment is warranted. The outcome of the study emphasizes the necessity of the riparian bed as a common property resource to be used for better community health instead of short-term benefit.

Keywords: Palar River, Vellore, groundwater, water pollution.

Introduction

Vellore is the second most populous district in Tamil Nadu and had population of 906,745 as per 2011 census. In terms of urbanisation level, Vellore district ranks 8th place among the other districts in Tamil Nadu. Vellore is a major transit point for travellers, a hub for medical tourism and is emerging as a tourism hot spot. This place is known for its extreme climatic conditions. Vellore has an arid and dry climate, reaching high temperatures during summer. The city experiences wet winters and dry summers and has an elevation of about 224 meters with the north-east monsoon the highest contributor to rainfall. The mean maximum and minimum temperatures during summer and winter varies between 38.3°C and 18.95°C.

Palar River is the major river draining of the district, flowing towards east for a distance of about 295 km. It runs parallel to the hill ranges of the Eastern Ghats forming a major part of its course. It has a vast flood plain in the lower reaches, but is dry for major part of the year. Ponnaiyar, Cheyyar, Pambar and Malattar are some of the major tributaries of Palar draining the district. Almost all the streams are ephemeral in nature and are mostly structurally controlled (Fig. 1).

Due to migration of population, it becomes necessary for the corporation to give clean drinking water for the entire population. The effluents of the leather industries, usage of the chemical fertilizers for agriculture and small scale dying industries falls heavily on the quality of the drinking water. The impact is felt very much on the drinking water sources which are available for the people, settled on the banks of the river.

In this study, the quality of the water in open wells and the bore wells located on the bank of the Palar River was studied by determining the physico-chemical parameters of the water during the south-west monsoon season (June to September). These studies generate a baseline regarding the quality of the water which is used for drinking and other household purposes.

Area of study

The settlement areas at a distance of 2-3 Km from the bank of Palar River was chosen for the studies. The sampling spots selected were at a distance of about half to one km between each spots. Sampling stations are 1. Shenpakam, 2. Chelliamman koil, 3. Sathuvachari, 4. Venkatapuram, 5. Perumugai, 6. Pututhaku, 7. Keezhminnal (Fig.1). Two samples of water were taken from each chosen area, one from the open well and one from the bore well (being the source for drinking & household purposes).

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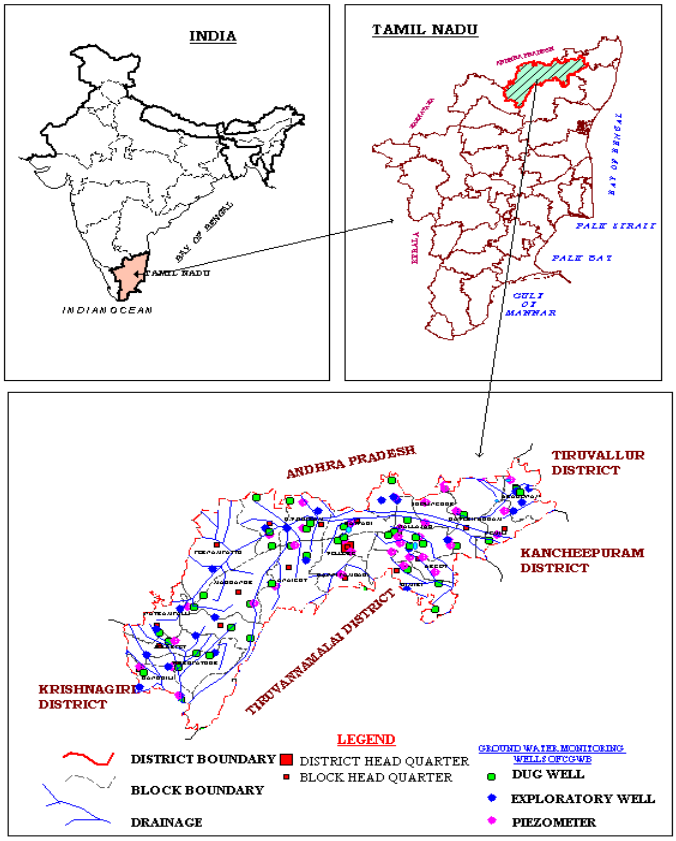
Fig.1. Location of Vellore district in India & the drainage system of Vellore district.



Sample collection

The samples which were used extensively for drinking, household purposes and agricultural purposes were identified. The groundwater samples from the sampling locations were taken after operating the motor pumps for about 10-15 min. Totally 14 samples were collected from seven locations using spot sampling procedure. The samples were collected in the pre-cleaned polythene bottles with necessary precautions.

Analysis

The pH, temperatures, conductivity and total dissolved solids of the samples were noted at their sampling point itself. The samples were subjected to the physical and chemical tests. These include hardness, total dissolved solids and chlorides. Standard procedure involving spectrophotometry and volumetry were used for the experiment. Salinity was calculated for the samples collected. The results were compared to BIS and ICMR standards.

Results and discussions

pH contributes to the corrosivity. Lower the pH, higher the corrosivity. The pH of the samples collected lies between 6.5 and 8.4. When compared with the standard values of BIS and ICMR, the samples are found to be in the permissible limit as prescribed. The samples collected from stations S10 and S9 are found to be acidic, can be more corrosive when compared to the samples collected from S13 and S14 (Guptaa *et al.,* 2010). The temperature of the samples varies from 26°C to 31°C during the rainy season (Table 1) (Fig. 2).

Total dissolved solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form. The rainy season has diluted the water, thus contributing to the reduction in the amount of dissolved solids in the samples collected. Samples collected from S11, S12, S1 and S6 are having TDS between 200 to 400 ppm, while the samples collected from S13, S14, S7 and S2 are in the range of 500 ppm and above. Waters with higher solids content have laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them (Parmar & Parmar, 2010). The conductivity of the samples collected is high in the sampling stations S13, S14, S7 and S2; at a range between 1900 to 2500 ppm, whereas the conductivity is found to be low for the samples collected in the sampling stations S11, S12, S1 and S6; at a range between 500 to 700 ppm. All the samples fall well within the limits of BIS and ICMR (Fig. 3).

Higher concentration of chloride in water is often found in conjunction with higher sodium concentration. ICMR and BIS have prescribed 250 mg/l as the maximum permissible value. If the chlorine value exceeds 300 mg/l and the presence of a major cation is sodium, then the water becomes salty (Ravisankar & Poongothai, 2008). Chloride presence in the various samples collected ranges between 700 to 2500 ppm. The lowest amount of chloride is in the sampling station S5 (791 ppm) and highest

Table 1. Physico-chemical parameters of water during the rainy season.

Station name	Type	pH	TDS (mS/cm)	EC (mS/cm)	Chloride (ppm)	Hardness (ppm)	Salinity (%)
Shenbakkam 1 (S1)	OW	7.7	317	634	894	680	3.201
Shenbakkam 2 (S2)	BW	8.0	506	1012	947	721	5.100
Chelliamman koil 1 (S3)	OW	7.4	471	942	846	692	4.681
Chelliamman koil 2 (S4)	BW	7.9	382	763	983	801	3.631
Sathuvachari 1(S5)	OW	7.4	481	962	791	648	4.447
Sathuvachari 2(S6)	BW	7.8	322	643	948	753	3.053
Venkatapuram 1(S7)	OW	7.6	528	1055	1005	655	5.293
Venkatapuram 2 (S8)	BW	7.3	479	958	1059	826	5.055
Perumugai 1(S9)	OW	6.9	377	754	1106	906	3.778
Perumugai 2(S10)	BW	6.5	453	906	1283	1006	4.725
Puttuthakku 1(S11)	OW	7.1	296	592	1499	1108	2.827
Puttuthakku 2(S12)	BW	6.7	312	624	1894	1006	3.031
Keezhminnal 1(S13)	OW	8.2	593	1186	2524	1900	5.801
Keezhminnal 2(S14)	BW	8.4	546	1092	1986	1270	5.347

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amount is in the sampling station S13 (2524 ppm) making the water in this area salty (Fig. 4).

Fig. 2. pH & salinity Vs sampling stations.

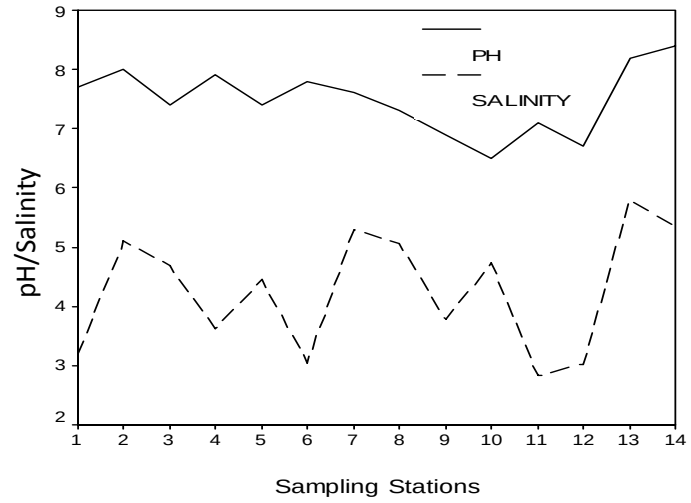


Fig.3.TDS & conductivity

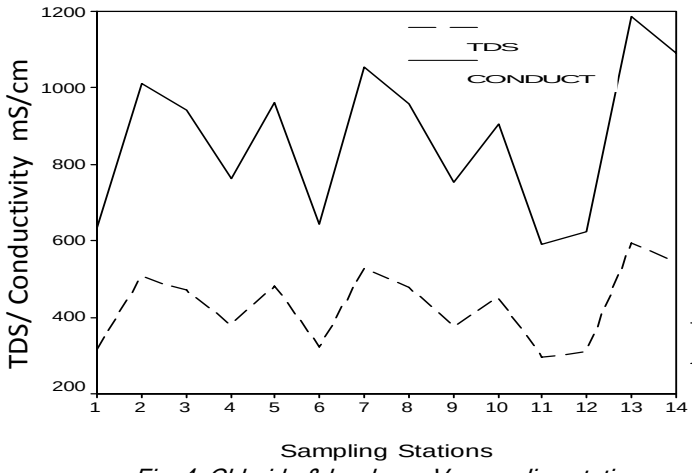
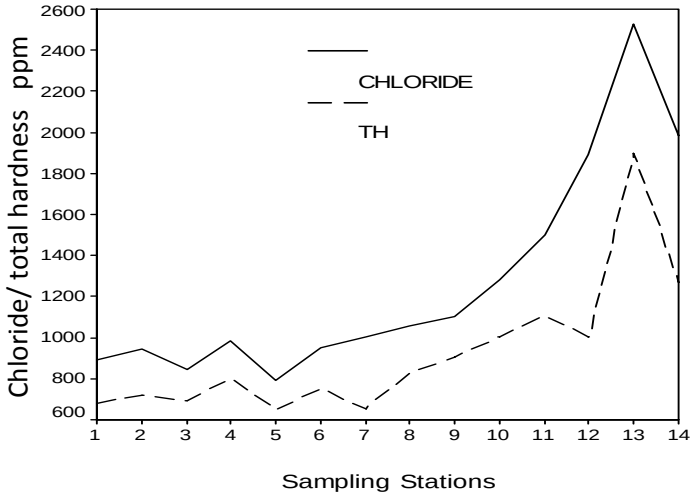


Fig. 4. Chloride & hardness Vs sampling stations.



In the present study most of the samples collected have high amount of hardness and crossed the permissible limits, with S13 having highest total hardness of 1900 ppm and S5 has lowest hardness of 648 ppm.

Table 2. Water classification based on salinity.

Salinity (%)	Water condition
<1%	Fresh water
1 to 3%	Slightly saline
3 to 10%	Moderately saline
10 to 35%	Very saline
>35%	Brine

According to Durfor Beckers (1964), water with 180 mg/l or more is very hard. Most samples exhibited total hardness above the limit set by Durfor. Presence of too much hardness in the water makes the people using the water prone to disease like kidney stones and other ailments (Ravisankar & Poongothai, 2008) (Fig. 4).

In the water collected, only 1% of the sample shows to have slightly saline water, whereas 92% of the samples show to be moderately saline. Lowest salinity is found in the sampling station S11 and the highest salinity is recorded in the sampling station S13 (Afkhami, 2003) (Table 2) (Fig. 2). Salinity impacts on the environment in a number of ways; particular, the reproductive cycle can be upset if good quality water is not available at critical times. Apart from the direct impact of salinity on ecological processes, there are secondary impacts on ecological processes as the more salt-intolerant species are removed from the landscape. Where, for example, trees dies and the physical structure of the ecosystem changes and habitat for a range of flora and fauna disappears (Afkhami, 2003).

Conclusion

The underground water in Vellore is deteriorating and the sampling station S13 and S14 needs special attention, as all the parameters such as TDS, electrical conductivity, chloride, hardness and salinity is found high. It may cause laxative effects on health of the people consuming that water and it is not much suitable for irrigation purpose also. All the other sampling stations have their respective physico-chemical parameters slightly above the BIS and ICMR limits. Hence proper water treatment is required in terms of community health.

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