

Groundwater Quality of Kosasthalaiyar River Basin, Thiruvallur District, Tamil Nadu, India

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ABSTRACT: Groundwater has now become a vital source of water for domestic and agricultural activities all over the world. The objective of the present study aims to investigate the groundwater quality of Kosasthalaiyar river basin Tiruvallur district, Tamil Nadu. As a part of the study, 20 groundwater samples were collected for which the in-situ physicochemical parameters were analysed such as pH, EC, TDS and temperature was analysed. The study region underline by archaean crystalline rocks and sedimentary rocks. Geomorphologically most of the study region is covered by alluvial plain and pediplain. Groundwater level was measured for all the 20 wells. Groundwater level was fluctuated from 3 to 8m from surface. Most of the groundwater samples were alkaline nature. The EC ranges from 700 to 2,400 $\mu\text{S}/\text{cm}$. The present study shows that 95% of the sample falls within BIS (2012) permissible limit of TDS which may be employed for consuming without the risk.

KEYWORDS: Kosasthalaiyar River basin, Water level, well depth, agricultural, Total dissolved solid

I. INTRODUCTION

Groundwater is mankind's most important, yet most misunderstood, mineral resource. At present one fifth of all the water used in the on earth is acquired from groundwater resources. Even though water resources of the planet earth are abundant, availability of water resources of useful quality of water are limited. The reduction of perennial water resources has been paving way to groundwater to be an important part of groundwater needs. Groundwater supplies are usually free from suspended and organic impurities as a result of natural filtration characteristics of subsurface materials, unlike surface water which will be usually loaded with suspended solids and natural matter. Groundwater also has a more consistent physical and chemical quality unlike surface water. The issue of assessing the groundwater resources as related to its evaluation, development and management is also more complicated in case of hard rock aquifers. The rapidly rising population, urbanization, industrialization and needs for food safety results in unsustainable groundwater development and management which results in deterioration of groundwater in terms of quality and quantity [1]. The groundwater quality, mainly governed by the degree and composition of dissolved solids, is of good significance in deciding its suitability for consuming purpose. Under natural conditions, the spatial and temporal variations in the composition of groundwater depend on rainwater, soil strata, and aquifer materials [2]. The variations the groundwater quality is because of rock–water interaction and oxidation–decrease reactions during percolation of water through aquifers [3,4]. Leaching of salts, ion-exchange process, and residential time of groundwater in the aquifers cause hydrogeochemical variations in groundwater [5]

In India, this percentage is significantly larger and dependence on groundwater more pronounced. At present almost 50% irrigated agriculture is dependent on groundwater resources. The urban aquifers are the only natural resource for drinking water supply, they are often perceived as of lesser relevance for the drinking water supply, resulting in crisis in terms of drinking water scarcity, becoming increasingly polluted thereby decreasing their portability [6,7]. Once contamination of groundwater in aquifers occurs by means of the shape of industrial activities and urban growth, it persists for more than 100 years due to very slow movement of water in them and prompts investigations on their quality [8]. The concentration of several inorganic and organic substances beyond the acceptable range causes an adverse effect on human health. Systematic evaluation of groundwater quality is therefore essential for meeting the raising drinking water need and essential for optimal usage of available groundwater on a sustained basis.

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Numerous workers in India have carried out intensive studies on water quality on diverse tenacities and have implemented innumerable solutions [9, 10, 11, 12]. Chennai is the one of the largest city in India. The different sources of drinking water supply to the Chennai City include large surface but shallow reservoirs, groundwater abstracted from Araniar and Kosasthalaiyar River Basin and southern coastal aquifers, and surface water transfer as a part of inter basin development from Srisailem Reservoir in Andhra Pradesh to Poondi Reservoir of Tamil Nadu. The groundwater quality of Kosasthalaiyar river Basin is dependent on geology, climate, rainfall and topography. Its evaluation is therefore essential to determine its suitability for drinking purpose. The objective of this study is to assess groundwater quality of Kosasthalaiyar River basin, Thiruvallur district, Tamil Nadu and India

II. MATERIAL AND METHODS

The Kosasthalaiyar river basin (Fig. 1) extends over an area of 3625 km², in the northernmost part of Tamil Nadu. This is a west to east flowing river, starting from the mountainous terrain in the west and reaching the Bay of Bengal in the east. It has several tributaries, particularly in the western regions. The river is basically ephemeral in nature flowing only during a part of the year generally in the period of November to February. Several reservoirs have been constructed across the river such as Poondi, which impounded the flood waters. In fact, the river flow is a major source of water to the city of Chennai. Rainfall being the only source of water in the area, the amount of rainfall received is of utmost importance in evaluating groundwater resources. The average rainfall in the basin varies from about 530 mm to 1430 mm.

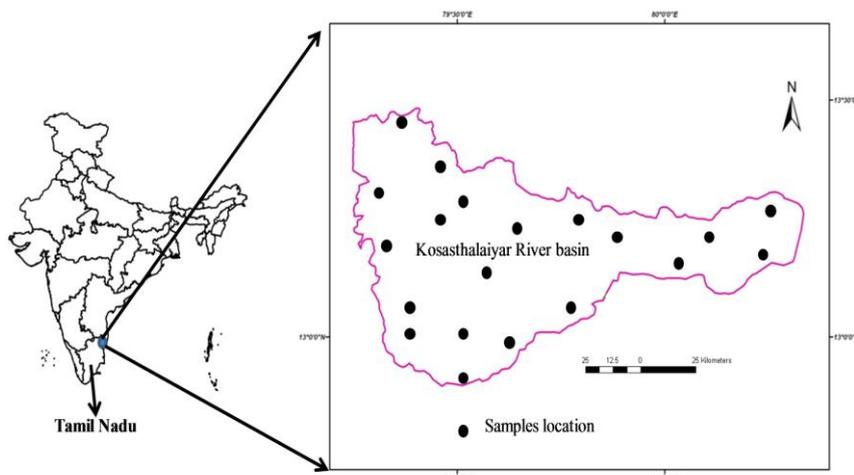


Fig.1 Study area and well locations of the River Basin

The Kosasthalaiyar river basin has a varied geology. The western part is underlain by hard crystalline rocks (Precambrian) while the eastern part contains sedimentary rocks, alluvium and Laterite. Numerous dolerite dyke is traversing in western part of study area. Laterite rocks are present in the north eastern portion, while calcareous gritty sandstone and clay is present in the central and eastern portion, Alluvium in the predominant formation along the river course. The various geological formations in the area are shown in Figure 2.

The study area is basically covered by pediplains, alluvial plains, coastal plains, denudational hills, floodplains, and structural hills (Fig. 3) out of these, the central portion of the study area, is dominated by the pediplains, with a patch of it extending in the north eastern portion. Alluvial plains extend in the north eastern region and in the southern portion. Coastal plains are present in the extreme north eastern portion along the basin boundary patches of denudations hills are present in the central and eastern portion, flood plains stretch in the central and north east portion and small patches of structural hills are present in the north west portion of the study area.

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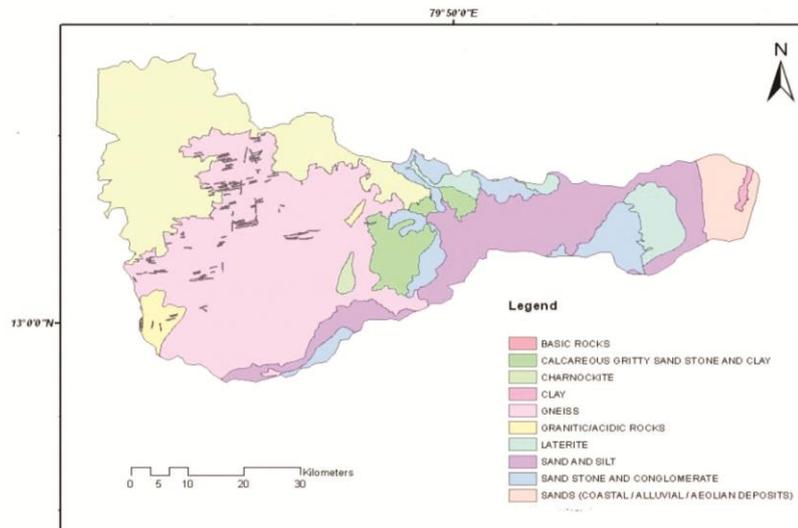


Fig. 2 Regional geology of the river basin

The study area has various types of land uses such as forests, agriculture, wet lands, build up, and water bodies. Maximum portion of the study area is covered by agriculture. Most of the north western portion is covered by forests with a few patches present in southern and central portion. Most Settlements are located in the eastern portion. All over the study area wastelands are present in small patches of long water bodies present in the area and a very small patch of wetlands is present in the north western portion **Figure 4.**

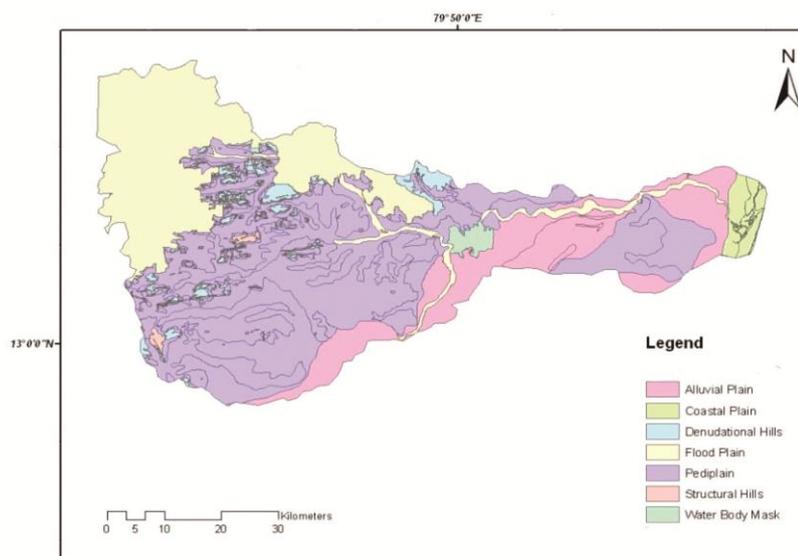


Fig. 3 Regional geomorphology of the river basin

Intensive field study was carried out and measurement of groundwater level and electrical conductivity (EC) of groundwater in several wells in the study region was made during January 2010. Based on this survey, 20 representative wells were chosen for monitoring (Fig 1). Groundwater levels in these wells were measured and water samples were collected during January 2010. Most of the monitoring wells are of depth greater than 10 m and are used

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for drinking and agricultural purposes. During the field visit, groundwater level was measured using a measuring tape. Groundwater samples were collected in clean polyethylene bottles of 1000 ml capacity. The bottles were cleaned by washing them after soaking them in 1:1 diluted HNO₃. Additionally, these bottles were washed again before sampling with distilled water. Temperature, EC and pH of the groundwater samples were measured in the field using electrode. Total dissolved solids (TDS) was calculated from the relationship $TDS = EC \times 0.64$ [13].

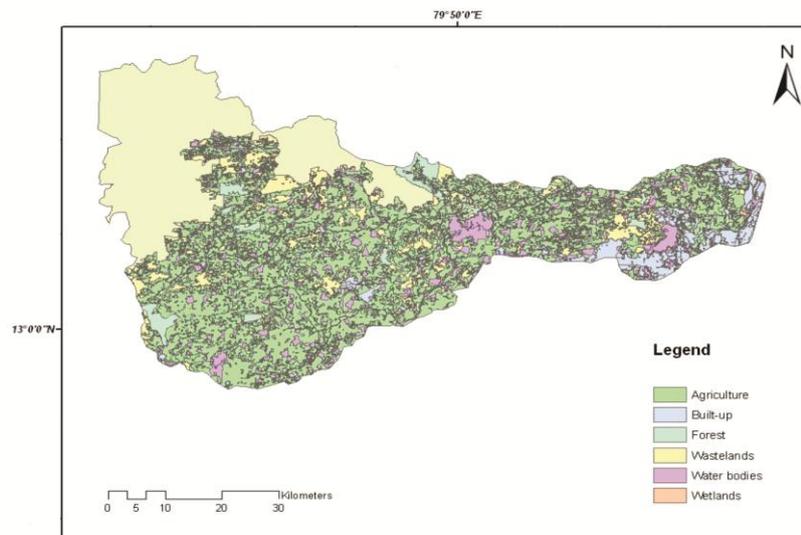


Fig. 4 Land use map of the river basin

III. RESULT AND DISCUSSION

A. Hydrogeology: The occurrence and chemistry of groundwater are controlled by the physiography, rainfall, climate and geological condition of the study area. This area is naturally underlain by sedimentary and gneiss rock. Laterite and calcareous gritty sandstone is acting as a good groundwater potential aquifer in this region and. Groundwater occurs in the weathered and fractured part of the rocks in unconfined condition. The depth of wells in this area ranges from 10 to 25 m. Both dug wells and bore wells exist in this area. Groundwater is the main source of water for irrigation and domestic purposes. Rainfall is the major source of groundwater recharge in this area. The groundwater levels in the area are generally moderate to deep, varying from about 3 m to 19 m below ground level. Figure 5 shows the spatial variation of groundwater levels, below ground level in the area during April 2010.

B. Physical parameters: pH values play a significant role in maintaining the carbonate and bicarbonate levels in groundwater. The mean pH values noted are within the range of 7.1–8.3 for groundwater samples. The pH values are observed within the permissible limit (6.5–8.5) of BIS [14] in all of the sampling stations and abnormal changes were not detected. The moderate alkalinity may be attributed to the presence of bicarbonate ions, which are produced by the free mixture of CO₂ with water to make carbonic acid, which in turn affects the pH of the water [15]. This slight alkalinity indicates the presence of weak basic salts in the soil [16]. However, the decrease in pH level below neutral value does not cause any adverse effects. Groundwater of north part of study region is nearly neutral condition and its pH values gradually have been increasing from north to southern direction. The spatial distribution map for pH is illustrated in figure 6. EC is a way of measuring the capability of water to conduct an electric current and this depends on concentration of all ions. The EC ranges from 700 to 2,400 $\mu\text{S}/\text{cm}$. The maximum allowable limit of EC for drinking water is 3,000 $\mu\text{S}/\text{cm}$ according to BIS [14]. Maximum concentration of electrical conductivity values was observed in part of east and west direction of study area. Lowest concentration of electrical conductivity values was observed in southern and north western part of the study area. This study shows that none of the samples show electrical conductivity values above maximum permissible limits of (drinking water quality). The electrical conductivity of groundwater values may also increase by the uses of fertilizers for agricultural activities (Fig. 7).

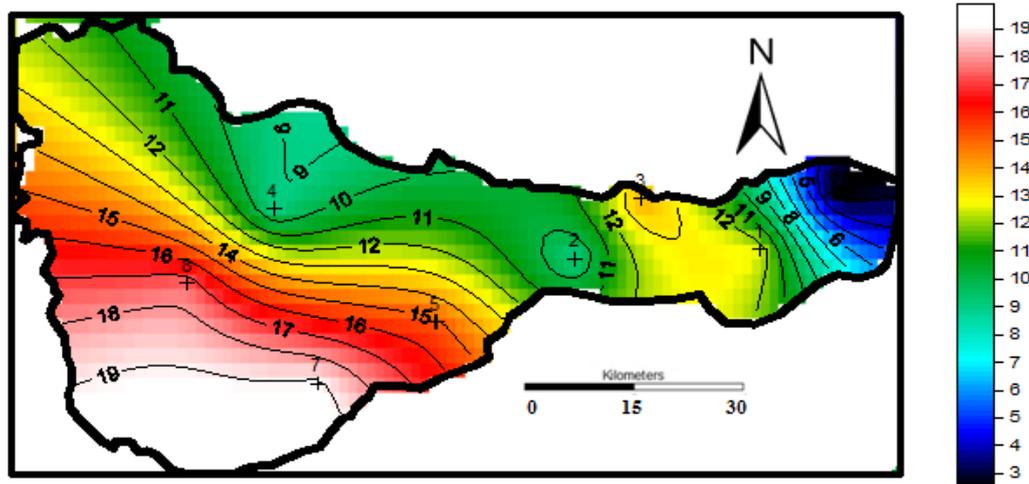


Fig. 5 Regional groundwater levels in the study area April 2010 (m bgl)

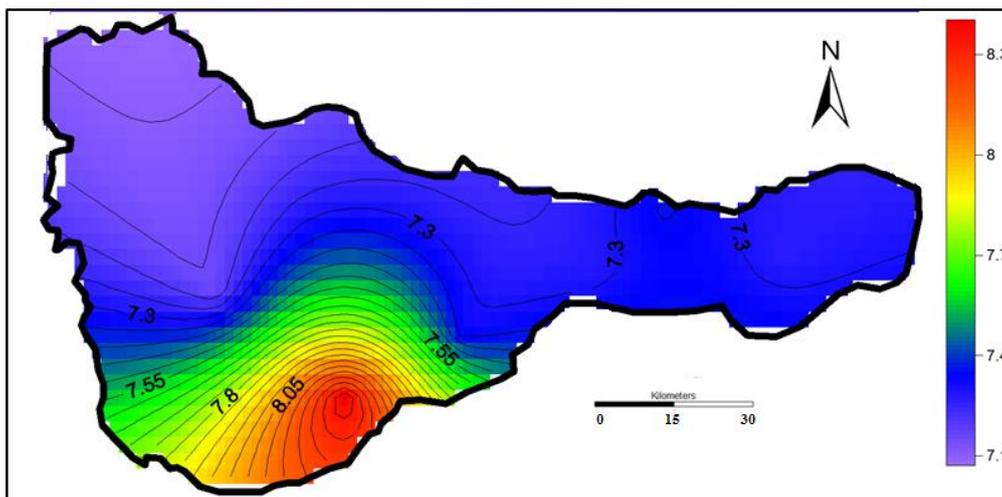


Fig. 6 Spatial distribution of pH in groundwater of entire river basin

C. Total dissolved solids: To determine the suitability of groundwater for any applications, it is important to classify the groundwater based upon their hydrochemical properties based on the TDS values [17]. The total dissolved solids (TDS) values are observed within the range of 448–1536 mg/l for groundwater samples (Figure 8). About 95 % groundwater samples in the study area are fresh and the remaining 5 % of samples are brackish. Nearly 5% of the groundwater samples show higher TDS values (>2000 mg/l) which are above the permissible limit of BIS (Table 1). The present study shows that only 95% of the sample falls within BIS [14] permissible limit of TDS which may be employed for consuming without the risk.

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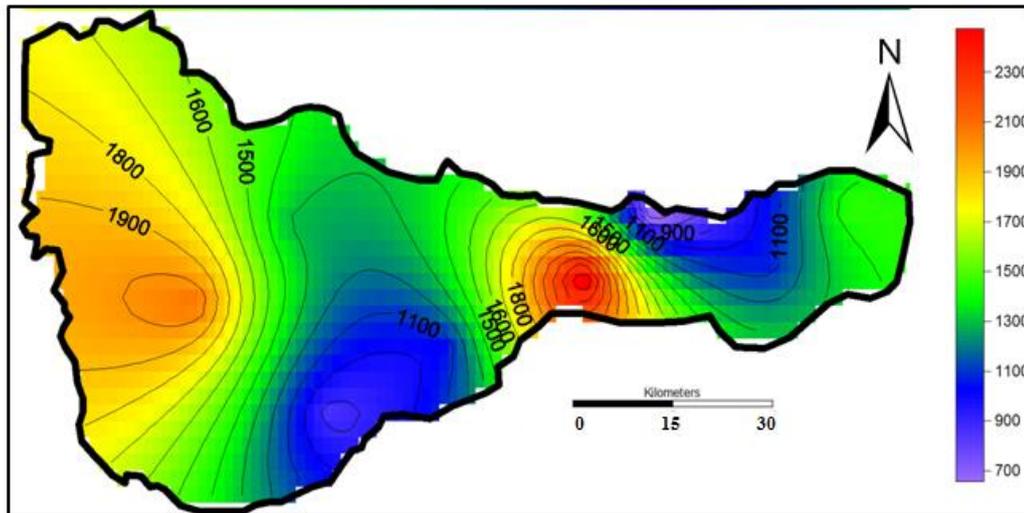


Fig. 7 Spatial distribution of EC ($\mu\text{S}/\text{cm}$) of groundwater during 2010

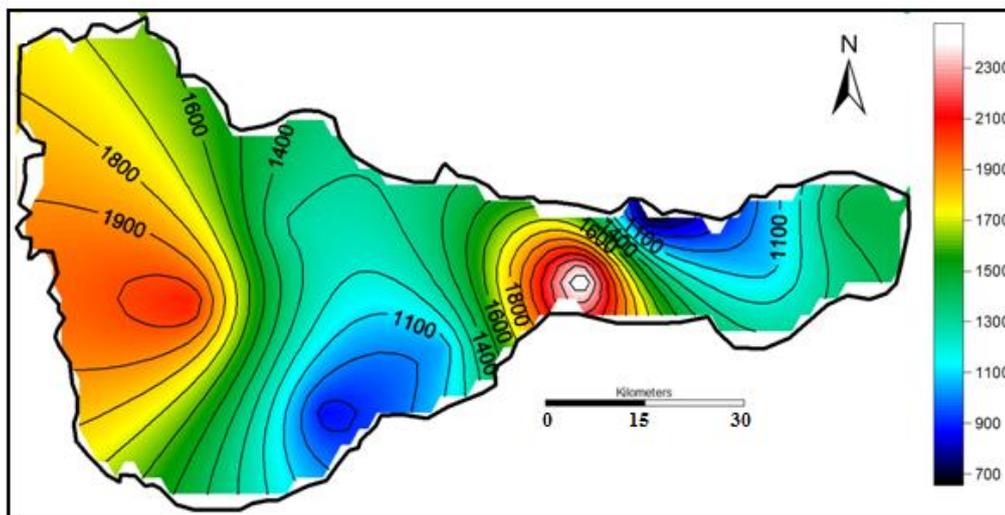


Fig. 8 Spatial distributions of TDS (mg/l) of the groundwater during 2010

Table 1 Number of samples were collected during 2010 which are compared with TDS and then classified the nature of water

TDS (mg/l)	Nature of water	Number of samples in April 2010
<1000	Fresh water	18
1000 -10000	Brackish water	2
10000-100000	Saline water	Nil
>100000	Brine water	Nil

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IV. CONCLUSION

Groundwater in Kosasthalaiyar river basin is generally alkaline and fresh to brackish in nature. The principal economy of the region depends entirely on agriculture activities. This region is intensively cultivated by making use of groundwater from dug and bore wells. The study region is underlain by Achaean crystalline rocks and sedimentary rocks. Clay, gneiss, laterite, sandstone are the major geology in this region. Geomorphologically most of the study region is covered by alluvial plain and pediplain. Groundwater level was measured for all the 20 wells. Groundwater level was fluctuated from 3 to 8m from surface. Most of the groundwater samples were alkaline nature. The EC ranges from 700 to 2,400 $\mu\text{S}/\text{cm}$. The present study shows that 95% of the sample falls within BIS (2012) permissible limit of TDS which may be employed for consuming without the risk.

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