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Research Article

Performance Evaluation of Groundwater Quality in Tiruvallur

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Abstract

The present area of study is about evaluating the performance of the dug well system in Tiruvallur district. The spread over an area is 3422 sq. km. The latitude of this district is between 12º15' N and 79º15' E, and the longitude is between 13º15' N and 80º20' E. For the study, data collection includes maps, toposheets, water quality data, well locations for about 10 dug well stations, and the spatial variation analysis is done using QGIS. Water Quality Index has been calculated for various parameters such as pH, Total hardness(TH), Total dissolved solids(TDS), Electrical conductivity. This paper assesses groundwater quality status by interpreting with thematic maps, which show the distribution of water quality parameters for the current scenario.

Keywords: *Water Quality Index, Ground Water, QGIS*

Introduction

The dug well-based groundwater recharge program increases the sustainability of wells during the lean period. It improves the overall irrigated agricultural productivity, socio-economic conditions, and quality of life of the local population in the affected areas. Recharge of existing dug wells through rainfall runoff from the farming fields will improve the groundwater situation in the affected areas.

Punia MP [1] made a complete study on twelve hydro-chemical parameters, and among them, three factors were estimated based on the Kaiser Criterion of the Eigenvalues. The comprehensive research mainly focused on factor analysis, which was used primarily in identifying the spatial variations at different points estimating the groundwater quality.

Velayutham Raja [2] brought a correlation analysis between fluoride and nitrate levels and their risk factors. The range of the risk factor was between the range of 0.1 to 12. The spatial distribution plots indicated that about 63 % of properties were exceeding the limit range values. Durgasrilakshmi Hari [3] investigated the complete parameters that were polluting the ground water. Using the GIS tool, the spatial study indicated the exceeding level of, Total Hardness, Conductivity, and ph. The study mainly highlighted groundwater pollution and the need for monitoring

Methodology

Study Area

The Backbone of Tamil Nadu is agricultural production. Here one of the most agricultural areas is the Tiruvallur district. The spread over an area is 3422 sq. km. The latitude of this district is between 12º15' N and 79º15' E, and the longitude is between 13º15' N and 80º20' E. The soil types are red non-calcareous and coastal alluvial, sandy soil mixed with soda or alkali. The average rainfall in this district is 1152.8mm. The maximum temperature is 37.9º C, and the minimum is about 23.6ºC. There is no perennial river flow, and Kosasthaliyar, Aravar, Cooum are some seasonal rivers. There are about 70 dug wells in Tiruvallur District. The blocks chosen in that district are Madhavaram, Ponneri, Poonamallee, and Ambattur. In these blocks, based on industrial, commercial, and residential areas, about ten dug wells are chosen at villages, namely Devampattu, Kolur, Amur, Kadavur, Vilangadupakkam Mitnamalli, Porur, Chinnasekkadu, Arumbakkam, and Mogappair West.

Table 1. Sample Locations and GPS Coordinates

S.NO	PLACE	GPS READING	
		LATITUDE (N)	LONGITUDE (E)
S1	Devampattu	13º27′12"N	80º11′53"E
S2	Kolur	13º26′00"N	80º13′37"E
S3	Amur	13º17′52"N	80º11′02"E
S4	Kadavur	13º10′36"N	80º04′00"E
S5	Vilangadupakkam	13º12′13"N	80º13′02"E
S6	Mitnamalli	13º09′15"N	80º04′25"E
S7	Porur	13º02′04"N	80º09′10"E
S8	Chinnasekkadu	13º09′53"N	80º15′10"E
S9	Arumbakkam	13º04′35"N	80º12′45"E
S10	Mogappair West	13º04′52"N	80º10′41"E

Physico-Chemical Analysis

Samples were collected from 10 dug wells, and the coordinate of the well is shown in Table 1. At each well, the samples were collected using a 1 liter distilled water can, and samples were sent to water quality testing for the following parameters like pH, Total Hardness, TDS, and Electrical Conductivity

Preparation of spatial database

To identify the spatial variation of the parameters, a Geographic Information System is used that interpolates the water quality parameter from the known point to the unknown end, thereby creating a continuous surface depicting the flow of the parameters. QGIS is used to generate the thematic maps by georeferencing the entire Tiruvaluur district under four control points.

Determination of Water Quality Index

Water Quality Index depicts the range that meets the desirable limit for each parameter. The most effective method can be termed as an indicator of groundwater quality. Water Quality Index is mainly presented by using the Weighted Arithmetic Index Method as described by

(Cude 2001).To assess the groundwater quality, the quality rating scale (Qi) for each parameter was estimated by using the following equation, and the water quality components are obtained by multiplied by weighting factor with that of aggregated by simple arithmetic mean.

Results And Dıscussıon

The levels of these contaminants are minimal and of little consequence unless and until certain contaminant levels are excessive. However, they may affect household activities and be detrimental to human health. Evaluating what levels of contaminants are acceptable and understanding the nature of problems caused by these contaminants are the primary considerations in interpreting a water analysis report.

The comparison between the pH rate of selected dug wells in 10 years shows that there are no significant variations in the following dug wells in Kolur, Porur, Chinnasekkadu, and Arumbakkam. Among these well, Porur and Chinasekkadu have pH below eight, and it didn't change in the last ten years. The main reason would be that this area is considered residential, so a change in pH may affect the residents living there. In Kolur and Arumbakkam, the pH rate is above 8; this is mainly due to the soil type of the landmass as the major soil types found in this area are (1)Inceptisols, (2) Alfisol, (3) Entisol, and (4) Vertisol. Due to the versatile geomorphology variation in soil mass, regions that consist of heavy rocks and minerals with high alkalinity cause an increase in pH.

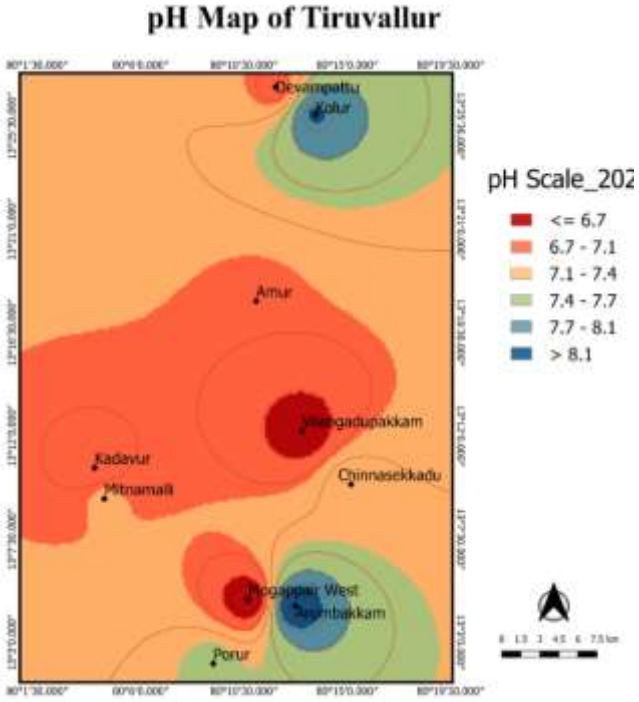

Fig 1: pH Map of Tiruvallur

The scenario of change in TDS rate in 10 years from 2010 indicates that the wells in Vilangadupakkam, Porur, Mogappair West shown in Fig :1 are not having significant differences in TDS rate and also having low TDS rates. These wells have been well maintained and utilized to reduce the number of dissolved solids under the acceptable limit. Wells in Mitnamalli, Chinnasekkadu, and Arumbakkam having a slight increase in TDS rate

but under the maximum permissible limit; this is due to contaminants in these areas and intrusion of polluted water into the GW source. In Kolur, Kadavur, and Amur, a decrease in TDS indicates that wells are in good condition and another factor that rainfall plays a vital role in. Devampattu well shows a considerable increase of dissolved solids showing the condemned state of the well; this is controlled only by cleaning and maintaining the well. Scale formation around the inner wall of the well is also a parameter that causes an increase in TDS.

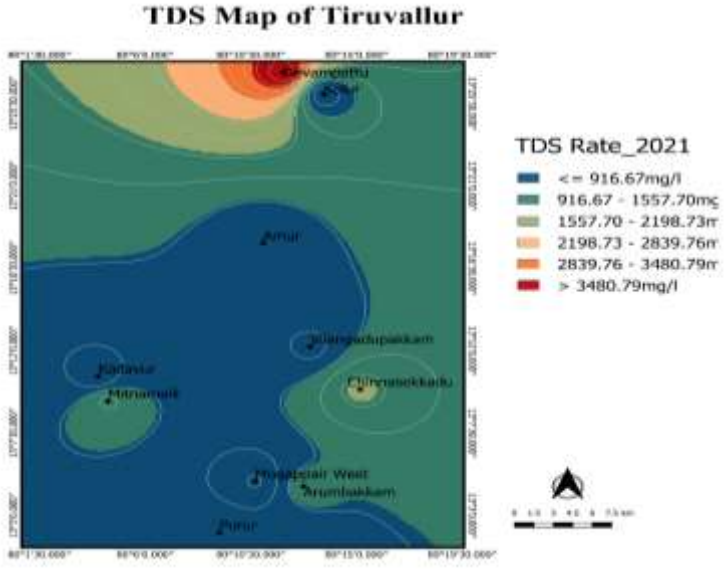

Fig 2: TDS Map of Tiruvallur

In comparison, in the year 2005, the TDS rate was (1390 mg/l), but consequently, it is escalated to (5363 mg/l) within ten years, and the TDS rate was at its peak at (7169 mg/l) by the year 2016, which had the lowest rainfall. Hence, it shows that rain plays a vital role in the TDS rate of Groundwater. Devampattu is the region that indicates a drastic increase in TDS value in the past ten years.

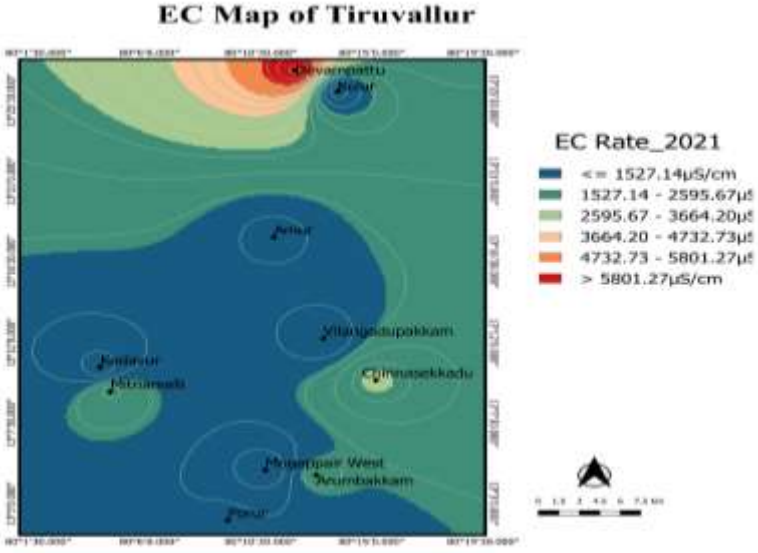

Fig 3: EC Map of Tiruvallur

Electrical Conductivity rate in 10 years from 2010shown in Fig :3 indicates that the dissolved solids rate in water increases in the same manner as TDS. The wells in

Vilangadupakkam, Mitnamalli, Chinnasekkadu, and Mogappair West do not significantly differ in Electrical Conductivity rate but have a desirable Electrical Conductivity range. In Kolur, Amur, Arumbakkam, Kadavur has a slight decrease in TDS rate, assuring that this well comes under an acceptable limit. It is mainly due to the reduction in TDS in the corresponding areas. Devampattu well shows a drastic increase because of its higher TDS value in the past ten years.

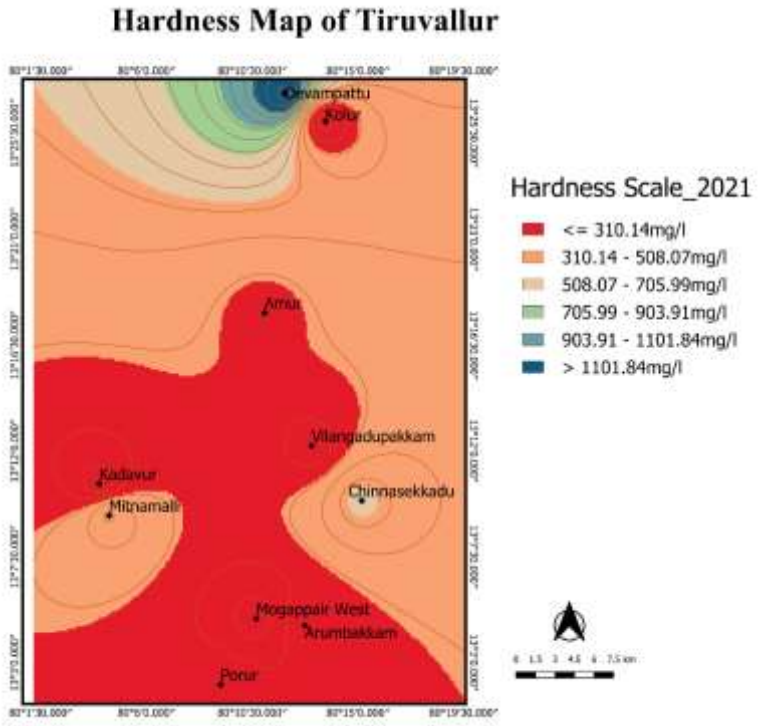

Fig 4: Hardness Map of Tiruvallur

Hardness comparison of dug wells shows that Kolur, Porur, Vilangadupakkam, Chinnasekkadu, Arumbakkam, and Mogappair west are in the same condition after a decade with no significant change in the levels shown in Fig:4. Kolur, Vilangadupakkam, Porur, Arumbakkam, and Mogappair West are having hardness values in between acceptable and permissible limits except for Chinnasekkadu, which is the region having high hardness value due to the excessive application of lime to the soil by chemical and mining effluents. Well, Amur shows a minimal decrease which indicates well-maintained dug well. In Mitnamalli, there is a gradual increase observed due to new establishments around the area, causing the primary issue. In Kadavur, despite increasing counts of industries, showing a significant decrease in water hardness indicates the effluents of industries around these areas have been treated well. Devampattu is holding the worst behavior in the form of maintaining the well. The degradation of the water is drastically increased compared to 2010.

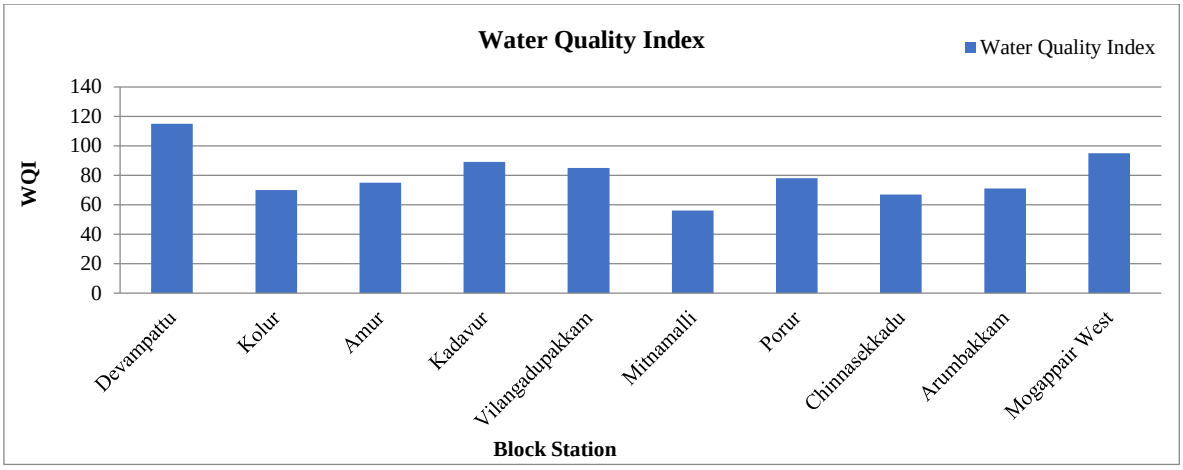

Fig 5: Bar chart on Water Quality Index

The overall status of the water quality scenario is depicted in Fig:5. The block station Devampattu has reached a higher water quality index than the other block station regions within the prescribed limits of drinking water. The study of the water quality parameters indicated that dug well has improved the water quality and water level in Tiruvallur district. The rainfall is also an essential factor for the improvement in groundwater level and quality.

Conclusıons

The study demonstrates the potentials of spatial analysis and interpretations of the groundwater quality of the study area using GIS methodology. Groundwater Pollution can be reduced by appropriately quantifying the domestic sewage that enters from different water bodies. By improving the natural replenishment capacities and percolation from surface waters into aquifers, the amount of Groundwater available for abstraction is increases, and this can be identified by the GIS tool. Continuous monitoring of groundwater table level along with quality study will minimize the chances of further deterioration.

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