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Ground Water Quality Assessment of Lalgudi Block, Tiruchirappalli District by Using Gis

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Abstract

Water is a compound and may occur in a liquid form or in a solid form or in a gaseous form. All these three forms of water are extremely useful to all, providing the luxuries and comforts, in addition to fulfilling basic necessities of life. The present study aims to determine the ground water quality in Lalgudi Taluk. Water samples were collected from fifteen samplings points. The Water Quality Index (WQI) explains overall quality based on several physico chemical parameters. This project also aims to assess and map the spatial distribution of ground water quality of panchayat of Lalgudi Taluk by using the Geographical Information System (GIS). Further the study uses Arc GIS for mapping the water quality to identify the spatial variation in groundwater quality. Inverse Distance Weighted (IDW) spatial interpolation technique has been used to estimate the spatial distribution of the ground water parameters and WQI. Correlation matrix have been calculated. It helps to predict the evolution of the relationship between the variables. The correlation matrix allows to have a global view of the more or less strong relationship between several variables. Groundwater quality of this area are not fit for drinking. Remedial actions to be undertaken to overcome the prevailing water pollution issues in this region.

Keywords: Ground water; Drinking water; Contamination; Water sample; Physical and Chemical characteristic

Introduction

Every one of us knows how important and precious the water is. Whenever there is no water in our taps, we become helpless. No life can exist without water, since water is as essential for life as air is. It has been estimated that two-third of human body is constituted of water.

Most of the places in Tamil Nadu and Trichy district, the ground water level is low. But in Lalgudi Taluk, the ground water level is very high approximately less than 2.4m. Most of the water is being pumped for Agricultural purpose throughout the year. Top layer of soil is 0.9m to 1.2m feet with clay and permeability in nature. After it contains only pure river sand up to 24m. Hence the discharge of waste water from houses, industries and pesticide agricultural water is easily penetrate and mixed with ground water. Almost the ground water is pumped using centrifugal pumps for drinking water and other uses. Most of the people are facing drinking water contamination even though the water level is high. The problem is need to be resolved for the people who are living in and around the area.

Water Quality Index Water quality index is one of the most effective tools to communicate information on overall quality status of water to the concerned user community and policy makers [1, 2]. Thus, it becomes an important parameter for the assessment and management of groundwater. Water Quality Indices (WQI) is a simple mathematical tool that can provide a distinct picture of overall water quality status over an area based on important water quality parameters.

Remote Sensing and GIS Remote sensing and GIS are effective tools for water quality mapping and land cover mapping essential for monitoring, modeling and environmental change detection. GIS can be a powerful tool for developing solutions for water resources problems for assessing water quality, determining water availability, preventing flooding, understanding the natural environment, and managing water resources on a local or regional scale [3]. GIS has been used by scientists of various disciplines for spatial queries, analysis and integration for the last few decades [4].

Integration of Spatial and Attribute Database

Spatial interpolation is tool in GIS used to discover the values of unknown points. It is a technique of estimating the values of properties at unsampled locations based on the set of observed values at known locations [5].

Spatial Modelling and Surface Interpolation GIS is a powerful tool to assess the water quality parameter, determining water availability of water, preventing flooding, understanding the natural environment, and managing water resources on a local regional scale [6] GIS techniques facilitate integrate and conjunctive analysis of large volumes of multidisciplinary data both Spatial and non-spatial with in the same geo-reference [7]. Water Quality Index (WQI) is a very useful and efficient method for assessing the quality of water [8]. Spatial analysis extension of GIS allows interpolation of the water quality parameter at unknown location from known values to create a continuous surface which will help us to understand the scenarios of water quality parameter of the study area. There are various Interpolation Techniques such as Inverse Distance weighted (IDW), Spline, Trend surface Analysis and Kriging available in Arc GIS Spatial Analysis extension. In the present study IDW technique adopted to create the spatial distribution maps of water quality parameters and WQI.

Study Area

Lalgudi is a Panchayat in district of Tiruchirappalli, Tamil Nadu. Lalgudi taluk is an administrative area of Tiruchirappalli district of th HYPERLINK "https://en.wikipedia.org/wiki/Indian_state" \h e Indian state of Tamil Nadu. The headquarters of the taluk is the town of Lalgudi. The taluk of Lalgudi was formed 100 years ago by the British East India Company. Lalgudi taluk consists of two revenue blocks named Pullambadi block and Lalgudi block.

Lalgudi is located between 10`52'N, 78`50'E and 10.87N, 78.83E. It has average elevation of 57 meters (187feet) and beautiful taluk, earlier called Thirumuthavathurai, Lalgudi lies close to Coleroon River. Ayyon Vaikal is the river passing through Lalgudi at present [12].

Estimation of Water Quality Index (WQI) Water Quality Index (WQI) is a very useful and efficient method for assessing the quality of water. Water Quality Index (WQI) is a very useful tool for communicating the information on overall quality of water. To determine the suitability of the groundwater for drinking purposes. WQI is defined as, a rating reflecting the composite influence of different water quality parameters. It is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers [13] WQI indicates the quality of water with reference to an index number which reflects the overall status of GWQ for drinking purposes. The overall view of WQI of the present study area show higher WQI. The main reasons for the present situation may be due to presence of mining areas, misused ponds, open dumping of solid wastes, improper use of fertilizers [14].

The water quality index (WQI) of the study area is calculated using the formula

$WQI = \Sigma qiWi / (\Sigma Wi)$

Unit weight for the ith parameter

q = Quality rating index for ith water quality parameter (i=1,2,3…etc)

qi is calculated using the following formula, $qi = 100(Vi / Si)$

Vi = Measured value of the ith parameter at a given sampling location

Si = Standard permissible value for the ith parameter.

Wi is calculated using the following formula,

$Wi = K/ Si$

K = constant of proportionality. K is assumed as 5.3

The water quality index is calculated for the sample 1

$WQI = \Sigma qi\ Wi / (\Sigma Wi)$

$(WQI)1 = (99.67 \times 0.623) + (1510 \times 0.017) + (607 \times 0.010) + (118.67 \times 0.0706) + (240 \times 0.176) + (113.6 \times 0.021) + (169.56 \times 0.017) = 146.58$

The calculated WQI values are classified in to five types “excellent water” to water unsuitable for drinking”.

For calculating the WQI, the following 12 parameters have been considered: pH, total hardness, calcium, magnesium, bicarbonate, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides. [10]

Conclusions

The status of ground water quality in the study area is found to be critical. The presence of high TDS and hard water occurs in most of the locations. Calcium and Magnesium value were high and these two parameters are treated. The water quality index shows the quality of the ground water is moderate to very poor and it is not suitable for drinking purposes. Further the study emphasis the assessment of groundwater quality. Spatial distribution of water quality parameters has done. Total hardness of water was seeming to be high. Correlation matrix were evaluated.

Calcium and Magnesium parameter of water are treated, after treating values are within permissible limits. Finally, the present study draws the following recommendations for meeting the present as well as future water demands.

Recommendations: -

1. Rainwater Harvesting must be provided and should be made compulsory for each residential unit as it is considered as the economical solution.

2. Consideration of schemes to construct artificial recharge structure.

3. Provision of government owned treatment units like reverse osmosis, desalination, ion-exchange process etc. to prevent the consumption of marginal quality water.

4. A groundwater assessment and estimation study should be conducted each year for better understanding of groundwater quality variation.

5. Public awareness programmed need to be developed for sustainable management of groundwater.

References

1. Subba Rao N (1997) Studies on the water quality index in hard rock terrain of Guntur district, Andhra Pradesh, India. National Seminar on Hydrology of Precambrian Terrains and hard rock areas, pp 129-34.

2. Tiwari TN, Mishra MA (1985) A preliminary assignment of water quality index of major Indian rivers. Indian J Environ Proc, 5:276-9.

3. Ferry Ledi Tjandra, Akihiko Kondhoh, Mohammed Aslam MAA (2003) Conceptual Database Design for Hydrology Using GIS. Proceedings of Asia Pacific Association of Hydrology and Water Resources 13-15, Kyoto, Japan.

4. Burrough PA, McDonnell (1998) Principles of Geographical Information Systems. Oxford University Press, Oxford, 333 pp.

5. PA Burrough (1986) Principles of geographical information systems for land resources assessment. Oxford: Clarendon press

6. Collet C. (1996) Geographic Information System Needs and Software in: Geographical Information Systems in Hydrology 1st Edition, Kluwer Academic Publishers, Boston, USA.

7. Saraf AK, Choudhury PR (1988) Integrated remote sensing and GIS for groundwater exploration and identification of artificial recharge sites, International Journal of Remote sensing, 10, pp 1825-14.

8. Abassi SA (1999) Water Quality Indices, State-of-the art. JIPHE No.1.

9. Mishra PC, Patel RK (2001) Indian J Environ Ecoplan 5(2), 293-8.

10. Kakati SS, Sarma HP (2007) Water quality index of drinking water of Lakhimpur district. Indian J. Environ. Prot. 27(5): 425-8.

11. T Poonam, B Tanushree, C Sukalyan (2013) "Water quality indices-important tools for water quality assessment: a review". International Journal of Advances in Chemistry 15-28

12. Vijaya Sankar M, Abideen S, Babu Selvam M, Gunasekaran T, Hussain Syed Bava MI (2014) A Comparative Study of Ground Water by Physicochemical Parameter and Water Quality In The Lalgudi Taluk Of Angarai Panchayat Of Tiruchirappalli District In Tamil Nādu, India.

13. Rama Krishnaiah CR, Sadashivaiah C, Ranganna G (2009) E-Journal of Chemistry 6(2): 523-30

14. World Health Organization (2012). Guidelines for Drinking-water Quality, Fourth Edition,

Correlation Matrix

The correlation matrix is a statistical technique that gives you the values between -1 to 1 which you can determine the relationship between variables. No direct relation between pH and TDS, but the carbonate, bicarbonate and CO2 concentration as a part of TDS can effect on the values of pH. As pH decreases, H+ displaces Ca 2+ from binding sites and the amountof iCa 2+ increases. Therelationship between pH and ionized magnesium concentration is not as well characterized. As pH increases, the chlorine becomes less effective. As pH decreases, the chlorine becomes more effective. pH is a measure of the acidity and alkalinity of water; hardness is a measure of the dissolved minerals in the water. The correlation matrix gives you an idea about your data set. By this, we can see that if the relationship between two variables

If the relationship is 1 then the relationship is strong

If the relationship is 0 then it means the relationship is neutral

If the relationship is -1 then it means the relationship is negative or not strong

Table 1. Correlation Matrix

	pH	EC	TDS	Ca	Mg	Cl	TH
pH	1						
EC	-0.37389	1					
TDS	-0.3648	0.999227	1				
Ca	-0.31448	0.902183	0.90025	1			
Mg	-0.25675	0.882054	0.880716	0.796676	1		
Cl	-0.42375	0.967004	0.965846	0.784779	0.844989	1	
TH	-0.30063	0.940513	0.938802	0.944316	0.951179	0.860275	1

Figures:

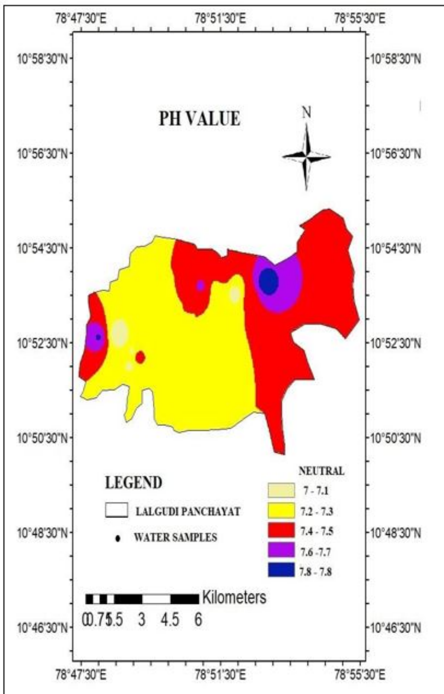

Figure No.1 – Spatial Distribution of PH concentration

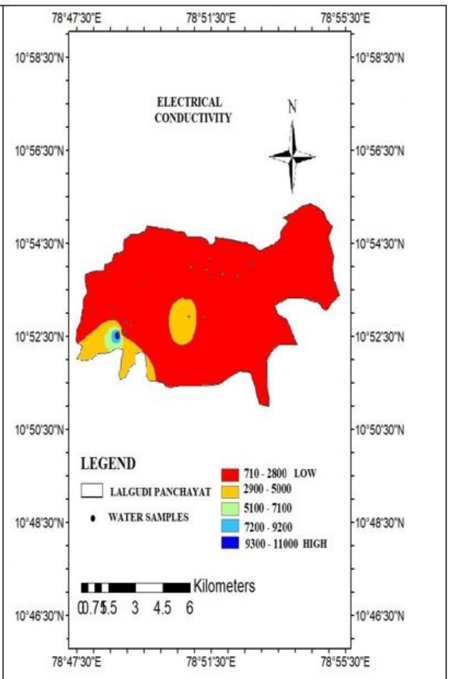

Figure No.2 – Spatial Distribution of Electrical Conductivity

Spatial Distribution of pH Concentrations

pH is an important property of water since it determines the suitability of water for several uses. The maximum permissible limit for in drinking water as given by BIS is 8.5. The value of above Fig No.1 Spatial Distribution of pH concentration in the ground water data collected varied from the range 7 to 7.8. The ground water of study area is almost Neutral.

Spatial Distribution of Electrical Conductivity

Electrical conductivity is the capacity of electrical current that passes through the water. It is directly related to concentration of ionized substances in water and may also be related to problems of excessive hardness. In study area, electrical conductivity varies from 710 to 11000 µm/cm. Fig.2 shows that spatial distribution of EC of water in the study area. Most of the area were covered by 710 to 2800 µm/cm

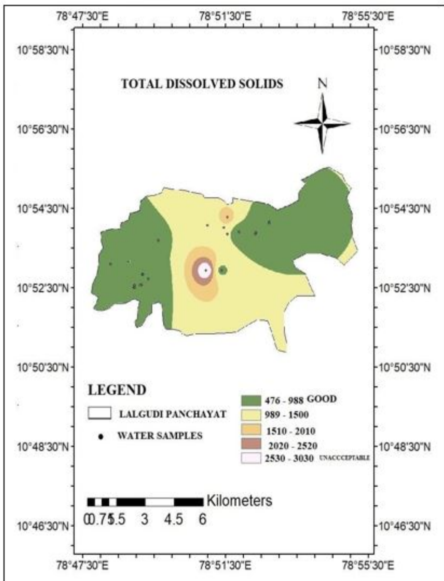

Figure No.3 – Spatial Distribution of Total Dissolved Solids

Spatial Distribution of Total Dissolved Solids Subsurface water containing TDS value more than 1000 mg/l is termed as brackish water. TDS contents are within permissible limit (500-2000 mg/l). In study area, Fig 3

Spatial Distribution of Total Dissolved Solids ranges from 476 – 3030 mg/l. The groundwater of this area is slightly saline, which are unsuitable for drinking.

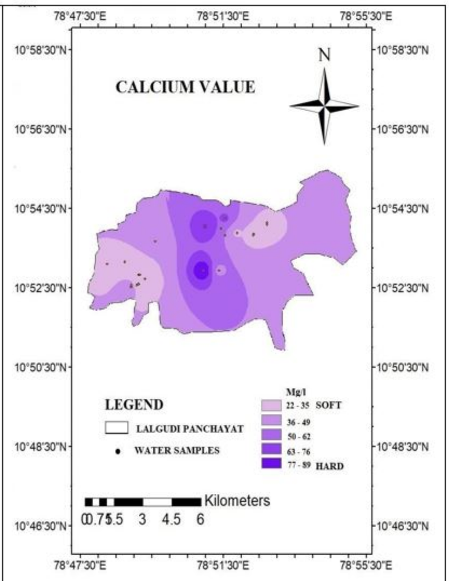

Figure No.4 – Spatial distribution of Calcium Value

Spatial distribution of Calcium Value

The permissible limit of calcium as per BIS is 75-200 mg/l. Figure 4 shows the spatial distribution of Calcium in the groundwater of the study area, which ranges from 22 – 89 mg/l. Some regions having moderately hard water.

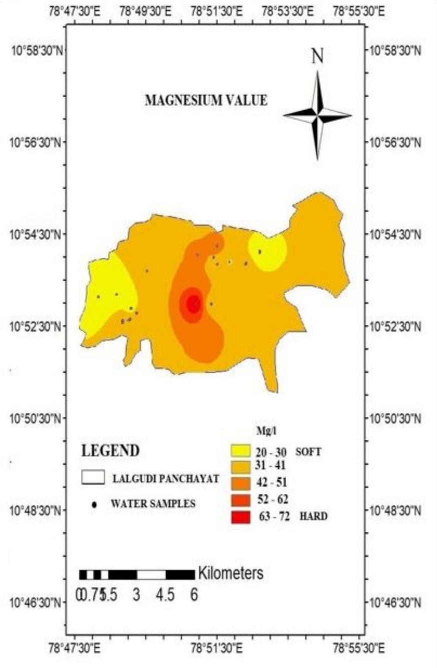

Figure No.5 – Spatial distribution of Magnesium Value

Spatial distribution of Magnesium Value

Figure 5 spatial distribution of Magnesium in the groundwater of the study area and it varies in between 20 mg/l to 72 mg/l. Dissolve calcium and Magnesium in water are the two most common minerals that make water hard.

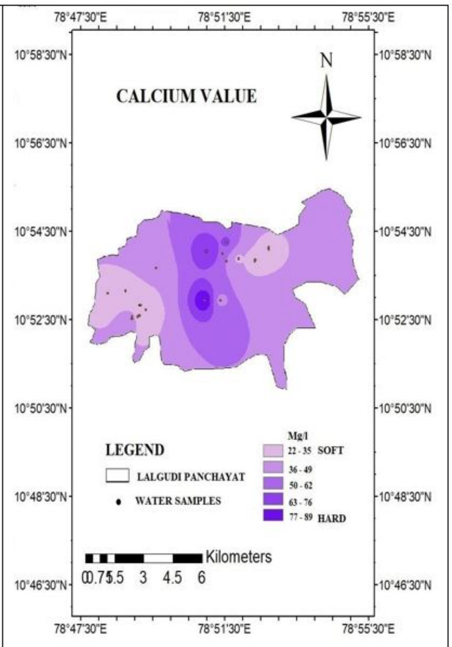

Figure No.6 – Spatial distribution of Chloride Value

Spatial distribution of Chloride Value

Chloride is one of the most important parameters in assessing the water quality and higher concentration of chloride indicates higher degree of organic pollution According to BIS/ICMR the permissible limit of chloride in drinking water is 250 mg/l. Figure 6 Spatial distribution of Chloride in the study area and it is fluctuating in between 24-280 mg/l.

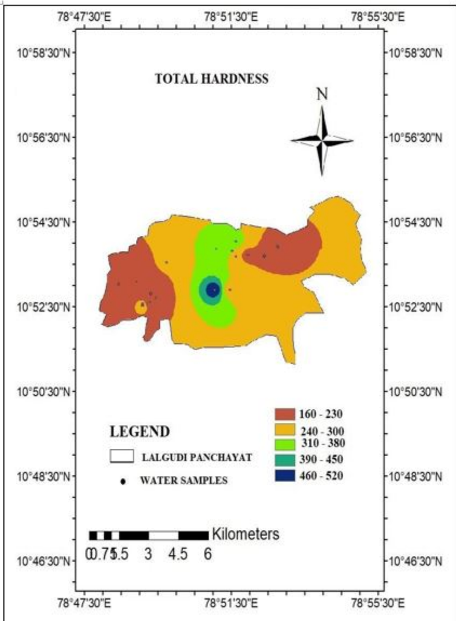

Figure No.7 – Spatial distribution of Magnesium Value

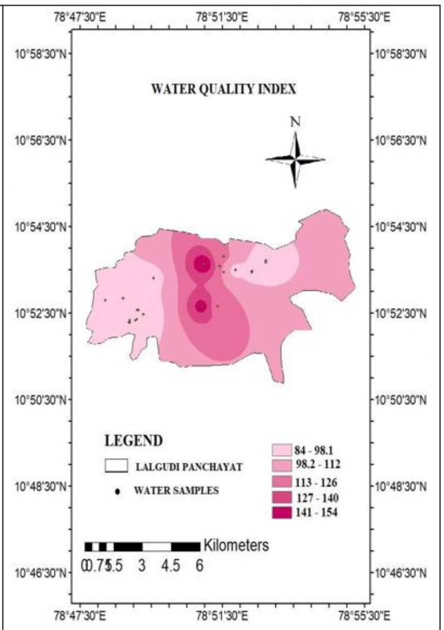

Figure No.8– Spatial distribution of Chloride Value

Spatial distribution of Total Hardness

Hardness in water is caused due to presence of carbonates and bicarbonates of calcium and magnesium, chlorides, nitrates and sulphates of calcium and magnesium. Most of the villages are within the desirable limit. Softening of water may be required to impart palatability to water. Spatial distribution of Total Hardness is shown in (Fig. 7) in which it ranges between 160 to 520 mg/l.

Spatial distribution of Water Quality Index

Figure 8 shows Spatial Distribution of WQI in the study area and it is varying from 84 to 154. The poor water quality may be due to mismanagement practices. Calculated WQI are mostly unfit for drinking which ranges above 100. Thus, the study area has poor groundwater quality.

Table 2: Parameters Studied Before and After Treatment of Ground Water

S.NO.	PARAMETERS	BEFORE TREATMENT				AFTERTREATMENT			
	SAMPLES	1	2	3	4	1	2	3	4
1.	CALCIUM	84	80	79	90	60	55	48	65
2.	MAGNESIUM	51	60	45	41	25	30	29	27

Calcium Recommended Limit – 75 (ICMR/BIS)

Magnesium Recommended Limit – 30 (ICMR/BIS)

Highly Contaminated four water samples from different places of Lalgudi Block are collected, and then Calcium and Magnesium content are treated.

Calcium content before treatment usually exist in Calcium Carbonate. Calcium and Magnesium content in groundwater was above the permissible limits after treatment the value came to recommended limit. Groundwater was boiled, the carbon oxide gas came out which leads to calcium carbonate in groundwater.

Calcium and Magnesium are the two parameters that determined the hardness of water. Before treating water were unfit for drinking. By treating water samples by boiling and addition of lime, the process taken and then calcium and magnesium content came to permissible limits.