

# Groundwater Quality Analysis Using GIS

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**Abstract** – Groundwater meets the drinking needs of 60% population of Kerala and majority of its water requirements are met by groundwater. Water level analysis using GIS interpolation technique helps in the identification of groundwater scarce and depleting areas in the municipality. Quality of these groundwater sources has been studied using standard methods in laboratory. A spatial distribution of various parameters like pH, TDS, Alkalinity, EC, Chloride, has been generated using GIS. The groundwater contaminations are identified. The results from the study can be helpful for monitoring and management of groundwater sources in municipality.

**Key Words:** Groundwater, Quality, Water level, Parameter, spatial interpolation, GIS

## 1. INTRODUCTION

Ground water is one of the earth's most vital renewable and widely distributed resources as well as an important source of water supply throughout the world. Ground water is the water that exists in the pore spaces and fracture of rocks and sediments beneath the earth's surface. It originates as rainfall or snow, and then moves through the soil into the groundwater system, from where it eventually makes its way back to surface streams, lakes or oceans. It is naturally replenished from above, as surface water from precipitation, streams and river infiltrates into the ground. In India most of the population is dependent on groundwater as the only source of drinking water supply [1]. The groundwater can become contaminated either naturally or because of numerous types of human activities, residential, municipal, commercial, industrial, and agricultural activities can affect the groundwater quality.

Nowadays water scarcity is increasing rapidly due to decrease of groundwater. The ground water is polluted due to various artificial manmade activities. So quality of water is reduced. This will produce various adverse impacts on human beings, animal and plants. Therefore it is necessary to monitor the water quality. The study will help us to

inform the public, local authority and government about the crisis of poor groundwater quality. GIS is a very helpful tool in this study. It can provide appropriate platform for convergent analysis of large area effectively and develops suitable management practices of groundwater resources. The present study can be kept as basic data for future investigation.

Groundwater quality of any specific area or specific source can be assessed using physical, chemical, and biological parameters. The values of these parameters are harmful to human healthy if they occurred more than its defined limits[4]. Therefore, the suitability of water resources for human consumption has been described in terms of water quality index, which is one of the most effective ways to describe the quality of groundwater.

## 1.1 GIS SOFTWARE

Geographical Information System (GIS) is an effective tool for groundwater quality mapping and essential for monitoring the environment changes. We can assess groundwater quality distribution, determining water availability and it also helps in understanding the natural environment on a local or regional scale. From GIS, spatial distribution of various pollutants can be found. Mapping of spatial variability of groundwater quality is of vital importance and is particularly significant where it the primary source of portable water. Hence the study of quality parameters is important.

## 2. STUDY AREA

Guruvayur is a pilgrimage town in the southwest Indian state of Kerala. It's known for centuries-old, red-roofed Guruvayur Temple, where Hindu devotees make offerings of fruit, spices or coins, often equivalent to their own weight. Nearby, Mammiyur Mahadeva Temple contains shrines to the deities

Vishnu and Shiva. South of town, St. Thomas Church is believed to have been established by the apostle St. Thomas

in 52 AD. Guruvayur consists of 43 wards. collected randomly according to the aquifer map of Guruvayur . From the aquifer map of Kerala shown in fig. Georeferencing is done and created the aquifer map of Guruvayur municipality.

7 samples were collected randomly according to the aquifer map of Guruvayur. From the aquifer map of Kerala shown in fig b georeferencing is done and created the aquifer map of Guruvayur municipality .



Fig -1: Study area

### 2.2 PHYSICO-CHEMICAL ANALYSIS

Seven samples were selected for this study. The locations and coordinates of the sampling points are shown in Table 1. The samples were collected in a small plastic bottle of one (1) liter capacity rinsed with distilled water. Samples were analyzed for the following parameters: pH, TDS, Electrical conductivity, Alkalinity and chloride using standard methods. The coordinates of the sampling points were recorded by mobile GPS.

Table -1: Sampling location and coordinates

Sample code	Ward No:	Latitude	Longitude
S1	17	76.0447	10.6099
S2	20	76.04798	10.62006
S3	18	76.05019	10.61065
S4	27	76.04697	10.59959
S5	28	76.04198	10.60052
S6	14	76.03593	10.58999
S7	9	76.05646	10.57703

### 2.3 WATER QUALITY INDEX (WQI)

Water quality index (WQI) is an important parameter for the assessment and management of groundwater. It provides a single number which expresses overall water quality at a certain location and time which is based on several quality parameters [6]. For computing WQI, three steps are followed

**Step-1 :** Each of the parameters has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes (table) the maximum weight of 5 has been assigned to the parameter nitrate due to its major importance in water quality assessment. Magnesium which is given the minimum weight of 2 as magnesium by itself may not be harmful.

**Step-2** The relative weight (Wi) is computed from the following equation:

$$WQI = \sum W_i X_i$$

W<sub>X</sub> = weight factors of the water quality parameters

Q<sub>X</sub> = q- value of the water quality parameters

X = water quality parameters

**Step-3** A quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the BIS and the result multiplied by 100

$$Q_i = C_i / S_i \times 100$$

Where,

qi is the quality rating

Ci is the concentration of each chemical parameter in each water sample in mg/L

Si is the Indian drinking water standard for each chemical

### 3. RESULTS

The groundwater quality analysis of 7 samples from different areas analyzed by using standard methods. Samples were analyzed for the following parameters: pH, TDS, Electrical conductivity, Alkalinity and Chloride.

#### 3.1 GROUNDWATER QUALITY ANALYSIS

**Table -2:** Characteristics of ground water

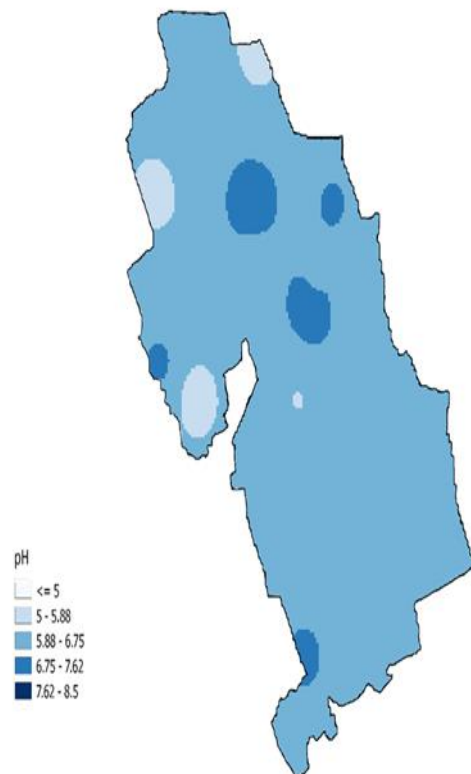
Sample	pH	TDS	EC	CHLORIDE	ALKALINITY	WQI
S1	7.62	155.7	0.324	96	136	44
S2	6.815	253.1	0.477	42	160	67
S3	6.41	168.9	0.3479	34	120	56
S4	6.05	142.7	0.267	50	84	55
S5	5.84	172.7	0.328	26	120	58
S6	6.15	341.5	0.62	110	140	86
S7	6.62	355.4	0.66	76	172	92

#### 3.2 SPATIAL DISTRIBUTION OF WATER QUALITY PARAMETERS

pH is an important parameter of water and determines the acidic and alkaline nature of water. As per the IS: 10500,

2012 the desirable limit of pH for a drinking water 6.5 – 8.5 and permissible limit of pH for a drinking water has no relaxation

From the spatial variation map, it is clear to identify that a lot area is slightly acidic and very nearer to being neutral owing to the general mineralogical characteristics of Kerala.



**Chart -1:** pH Map

The mineral components dissolved in groundwater constitute the dissolved solids. As per the IS: 10500, 2012 the desirable limit of TDS for a drinking water 500 mg/l and permissible limit of TDS for a drinking water is 2000 mg/l.

All the samples are coming under the desirable limit and samples 14, 17, 20 are beyond the desirable limit and within permissible limit. From the map there is a variation of TDS with higher values nearer the south corner, the coastal alluvium part of the of the Guruvayur municipality

All samples are coming under the permissible limit. The spatial variation of electrical conductivity is shown in the map.

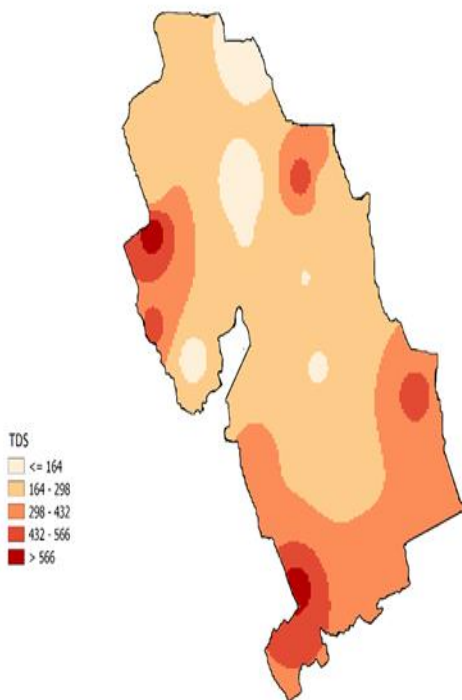


Chart-2 : TDS Map

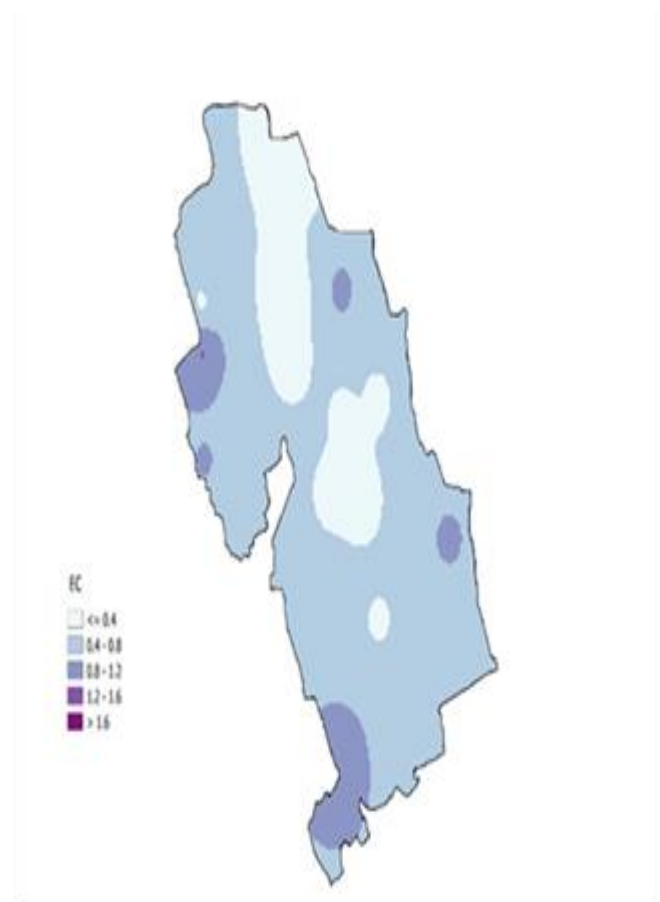


Chart -3 : EC Map

Electrical conductivity is the capacity of water to carry an electrical current and varies both with number and types of ions in the solution. As per the IS: 10500, 2012 the permissible limit of EC for a drinking is 1.410 milli siemens.

Alkalinity is a measure of capacity to neutralize acids. As per the IS: 10500, 2012 the desirable limit of alkalinity for a drinking water 200 mg/l and permissible limit of alkalinity for a drinking water 600 mg/l. all the samples are coming

under the desirable limit except sample 18, which is coming beyond the desirable limit but within the permissible limit. From the map a small area showed to be above desirable limit.

permissible limit of chloride for a drinking water 1000 mg/l. All the samples are coming under the desirable limit. From the map the spatial variation of chloride concentration in groundwater is shown. Higher values of chloride were found towards the south and west of the map, mostly in the coastal alluvium part due to salt water intrusion.

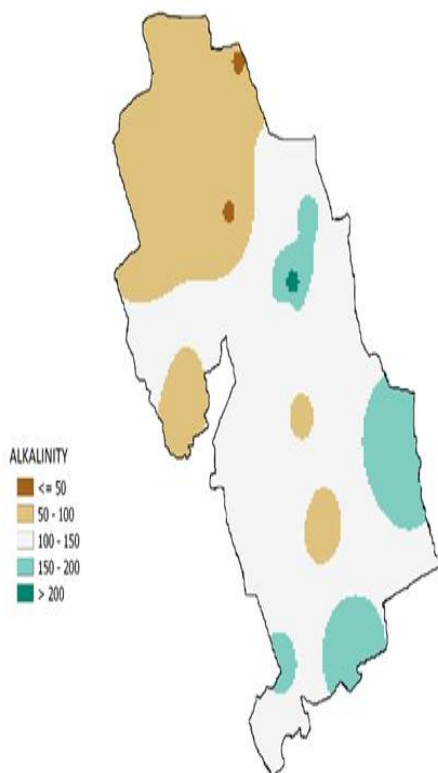


Chart-4 : Alkalinity Map

The presence of chloride in natural waters can be attributed to dissolution of salt deposits, discharges of effluents from chemical industries, oil well operations and sea water intrusion in coastal areas. As per the IS: 10500, 2012 the desirable limit of chloride for a drinking water 250 mg/l and

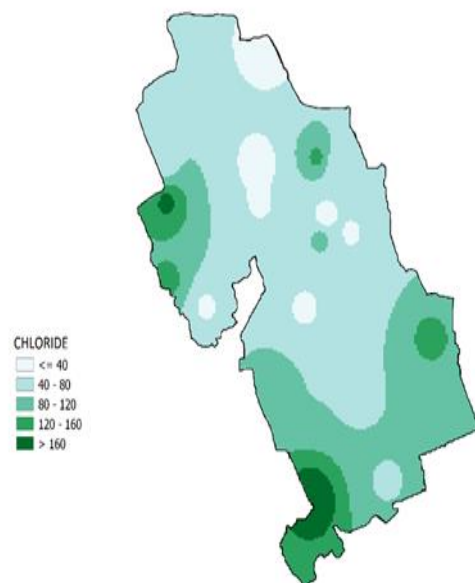


Chart-5: Chloride Map

#### 4. CONCLUSIONS

Ground water is the major source of drinking water for majority of population in the country. Hence the quality investigation is essential. The temple city of Guruvaur was found to have minor problems. These problems arises mainly due to the salt water intrusion. There is a need to conserve the wells with proper cover and measures to implement rain water harvesting, this would recharge the aquifer and benefit the people as a whole.

The overall quality of ground water was estimated using water quality index. The water quality index merged all the

parameters in to a single value easily recognized by the common people. The ground water quality differed in different regions of the study area, but not a single sample was found to be unsuitable for drinking.

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