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GEO-CHEMICAL ANALYSIS FOR GROUNDWATER QUALITY USING GEOSPATIAL APPLICATION

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Abstract— *Groundwater resources are explored in nature with the development of Irrigation activities, Industrialization and urbanization. But ground water is contaminated due to human and industrial activities. Now a days this is a serious issue so the analysis of water quality is very important to preserve the natural eco system. The assessment of the ground water quality was carried out in the different wards of Coimbatore City. The present work is aimed at collecting the data with reference of top sheets for our study area. After that 41 ground water samples are taken in two seasons. In this sample the following chemical parameters have been considered Viz. pH, Total dissolved solids, Electrical conductivity, Total alkalinity, Total hardness, Calcium, Magnesium. The obtained result of ground water samples of all the selected stations is to be analyze for a geochemical analysis. By using GIS the above chemical parameters are mapped in pre monsoon and post monsoon seasons for the determined water quality index. The results of analyses have been used to suggest models for predicting water quality. The analysis reveals that the groundwater of the area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contaminated.*

Keywords: Groundwater, Chemical Parameters, Geochemical analysis, Water Quality Index.

I. INTRODUCTION

Water is basic requirement for all life on earth. Groundwater is the one of earth most vital renewable and widely distributed resources as well as important source of water supply throughout the world. Groundwater is an essential commodity over the past decades due its increasing usage of drinking, irrigation and industrialization. Quality of groundwater is an equally important as its quality owning to suitability of water for various purposes. Variation of groundwater quality in an area-physical and chemical parameters influenced by geological formations. Chemical properties of groundwater is depends upon chemistry of water in recharge area as well as on different geochemical processes. Geochemical processes are responsible for the seasonal and spatial variations in groundwater. GIS is effective tool for groundwater quality mapping and essential for monitoring the environmental change detection. Database system in order to concentrate values of different chemical constituents. Identification and quantifications of these features are important for generating groundwater potential model of a study area. Currently groundwater is gaining more attention due to drought problem, rural water supply, irrigation project. Different hydrogeological themes are used to identify the groundwater potential zone of present area. In this study, Hydrogeochemical assessment of thondamuthur taluk which is conducted by analyzing water samples based on these components, provide a source of water for different consumptions has encountered a serious groundwater depletion and quality degradation.

II. STUDY AREA

Thondamuthur is a fast developing city in Coimbatore state of India. The city is situated at Latitude of 10.975 and Longitude of 76.81 at the meansea level of 750 and referred in topographic sheet no C43E12, C43E16, C43K9, C43K13. Average annual rainfall is about 200 to 300mm and temperatures ranging from moderate to medium. There has been a recent spurt in housing complexes and premium old age homes in and around this location. As the development of thondamuthur is taking place at much rapid pace, the housing colonies have started utilizing groundwater as a means of water supply for domestic purpose. For the samples collection, 41 bore well locations are identified. These locations were identified in such a way that the bore wells were evenly distributed over the study area. Water samples were collected for periods between March 2016 & Dec 2017. The water from these borewells were used for drinking, household utilities & bathing by residents. The laboratory tests were conducted on these samples for 14 different physical & chemical potable water quality parameters. Ground water plays a major role for Irrigation as well as domestic uses.

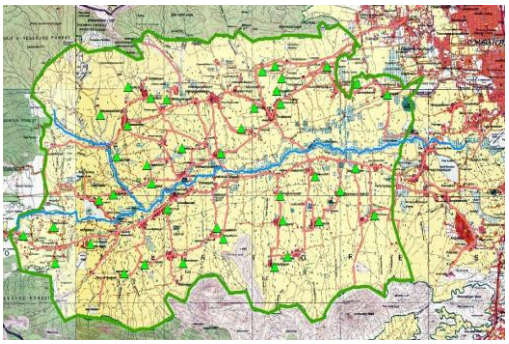

Figure 1 Location map of the study area

3. METHODS AND METHODOLOGY

3.1 CONVENTIONAL DATA BASE

1. Layout Map of Thondamuthur Block

2. Groundwater quality parameters

3.2 SOFTWARE USED

1. Surfer- 8

2. ARC GIS 9.3

3.3 CREATION OF A DATABASE

A Collection of information in such a way that a computer program can quickly select desired pieces of fields. Traditional database are organized by field, records and fields. A field is a single piece of information a record is one complete that of fields and a file is a collection of records. Here data base was created using ground water quality parameters.

3.4 SCANNING OF TOPOSHEETS

Scanning results in the conversion of the image into an array of pixels thereby producing an image in raster format. A raster file is an image created by a serious of dots called "Pixels" that are arranged in rows and columns. A scanner captures the image by assigning a row in a column and a colour value each dot. The Thondamuthur taluk Map was scanned.

3.5 DIGITIZATION

A Raster image is a type of computerized image that consists of row after row of pixels. There are many different raster image file format. Digitization is the process which converts raster to vector format. Most of the GIS technologies are vector formats are more common, so the raster format is converted into a vector format. In the vector format the position of the line is determined by the co-ordinate which are present at the starting and ending points of the line. Digitization was done by Surfer-8.

3.6 QUERY ANALYSIS

Data query retrieves a data subset from a map by working with its attribute data. The selected data subset may be visually inspected or saved for further processing. Attribute data query requires the one of expressions which must be interpretable by a GIS. These expressions are often different from one system to another.

3.7 SPATIAL INTERPOLATION

Spatial interpolation is a process of using points with known values to estimate values at other points. Spatial Interpolation is a means of converting point data to surface data.

3.8 SUMMARY

The water quality parameters were tested in the laboratory. The Lab Test Procedure was done as per Indian standard code of Practice. The water quality parameters are given in the data base to GIS. The thondamuthur map was scanned and digitized. Digitization was done by Surfer-8. The spatial variation was done, Finally, integrated ground water quality map was created using ARC GIS 9.3.

4. ANALYSIS

4.1 GROUND WATER QUALITY PARAMETERS

The major ground water quality parameters such as,

1. pH
2. Turbidity
3. Electrical Conductivity
4. Total Dissolved Solids
5. Total Hardness
6. Calcium
7. Magnesium
8. Total Alkalinity
9. Chloride
10. Sulphate
11. Nitrate
12. Fluoride
13. Sodium
14. Potassium.

have been estimated in 41 observation wells throughout the thondamuthur taluk. The ground water quality data of the study area as shown in table 5.1 and locations in study area map 5.2. Finally, integrated ground water quality map was created using ARC GIS 9.3.

4.2 ARC VIEW GIS 9.3

Using ARC VIEW 9.3 the spatial interpolation was done on the basis of attribute values. Like pH, TDS, TH, sulphate, chloride, calcium, turbidity and temperature, etc.

For each parameter the spatial analysis was done and map was created except for turbidity As there is less variation in turbidity values.

4.3 INTEGRATED GROUNDWATER QUALITY MAPPING

Spatial variation of ground water quality parameter map were integrated and integrated ground water quality map was created. After integration, the map shows groundwater quality in thondamuthur taluk.

5. RESULTS AND DISCUSSION

5.1 GENERAL

In the present study, ground water quality parameters were analyzed and integrated water quality map of thondamuthur taluk was prepared considering the ground water quality data using GIS.

5.2 RESULTS

Integrated ground water quality map of thondamuthur taluk was prepared from the ground water quality data and shown in figure. The Land use map of thondamuthur taluk was digitized using Surfer-8 then exported to ARC GIS 9.3. The spatial analysis was done using ARC GIS 9.3.

5.3 GROUND WATER QUALITY MAPPING

In order to assess the ground water quality 41 sampling points are identified throughout the thondamuthur taluk and water samples have been collected. The major water quality parameters such as pH, Turbidity, Electrical Conductivity, TDS, TH, Calcium, Magnesium, TA, Chloride, Sulphate, Nitrate, Fluoride, Sodium and Potassium have been estimated. The tested data of 41 locations for each parameters have been converted into spatial variation using GIS.

6. INTEGRATED GROUND WATER QUALITYMAP OF THONDAMUTHUR TALUK

6.1 DISCUSSION

GIS is used to evaluate the quality of ground water in Thondamuthur Taluk. Spatial variation map of major water parameters like pH, TDS, TH, Sulphate, Chloride, Calcium, Temperature, were prepared for thondamuthur Taluk based on these spatial variation maps of major water quality parameters and integrated ground water quality map of thondamuthur taluk was prepared using GIS. This integrated ground water quality map help us to know the existing ground water condition of the study area.

6.2 pH

The pH values of the analysed samples ranges from 6.9 to 7.44. The ranges are classified in the spatial variation map shown in figure in 1

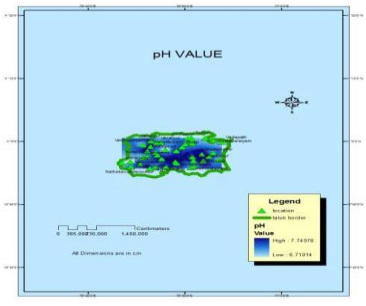

Figure.1. Spatial variation map of pH values

6.3 Total Dissolved Solids

To ascertain the suitability of ground water for any purposes, it is essential to classify the ground water depending upon their hydrochemical properties based on their TDS values. The values ranges from 384–2100mg/l from the spatial variation map it is observed that maximum area of the TDS Value cover <600mg/l.

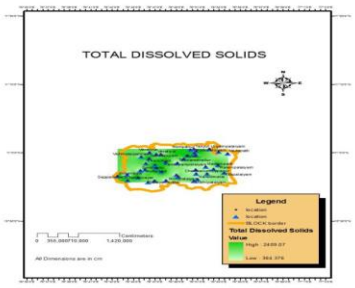

Figure.2. Spatial variation map of TDS values

6.4 Total Hardness

The classification of ground water based on total hardness (TH) shown that a majority of the most desirable limit is 100mg/l as per the sho international standard. The tested values of TH of the samples ranges from 73 to 127. From the map it is observed that most of the area cover <1000mg/l as shown in figure 3

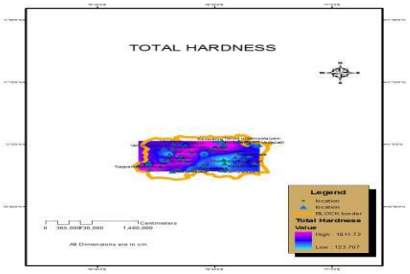

Figure.3. Spatial variation map of Total Hardness

6.5 Sulphate

Sulphate is unstable if it exceeds the maximum allowable limits of 400mg/l. The sulphate concentration various from 40 to 855mg/l and illustrated in the spatial variation map shown in figure 4

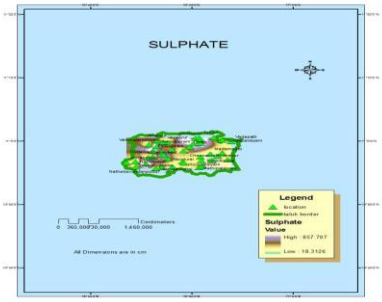

Figure.4. Spatial variation map of sulphate

6.6. Chloride

The chloride ion concentration various between 78 to 944mg/l. The spatial distribution of chloride concentration in ground water of the study area is illustrated in figure 5 which in <600mg/l.

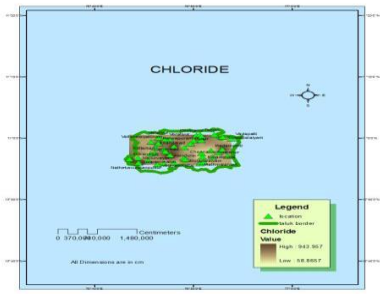

Figure.5. Spatial variation map of Chloride

7. INTEGRATED WATER QUALITY INDEX MAP OF THONDAMUTHUR TALUK

7.1 DISCUSSION

In this study, for the calculation of water quality index, 14 important parameters where chosen. The WQI has been calculated by using the standards of drinking water quality recommended by the World Health Organisation (WHO), Bureau of Indian Standards (BIS). The weighted arithmetic index method has been used for the calculation of WQI of the water body. Further, Quality rating or sun index (qn) was calculated by using the following expression.

qn = 100[Vn-Vio]/[Sn-Vio]

qn = Quality rating for the nth Water quality parameter

Vn = Estimated value of the nth parameter at a given sampling station.

Sn = Standard permissible value of the nth parameter.

Vio = Ideal value of nth parameter in pure water. (i.e., 0 for all other parameters except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg/L respectively)

Unit weight was calculated by a value inversely proportional to the recommended standard value **Sn** of the corresponding parameter. **Wn = K/ Sn**

Wn = unit weight for the **nth** parameters.

Sn = Standard value for **nth** parameters.

K = Constant for proportionality.

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

WQI = Σqn Wn / ΣWn

Table 1. Water Quality Index (WQI) and status of water quality (Chatterji and Raziuddin 2002)

Water quality Index Level	Water quality status
0-25	Excellent water quality
26- 50	Good water quality
51-75	Poor water quality
76-100	Very poor water quality
>100	Unsuitable for drinking

Table 2 Drinking water standards recommending agencies and unit weights.(All values except Ph and electrical conductivity are in mg/L)

S.NO	Parameter	Standard	Recommended agency	Unit Weight
1	Ph	6.5-8.5	ICMR/BIS	0.2190
2	Electrical Conductivity	300	ICMR	0.371
3	Total Dissolved Solids	500	ICMR/BIS	0.0037
4	Total alkalinity	120	ICMR	0.0155
5	Total Hardness	300	ICMR/BIS	0.0062
6	Total Suspended Solids	500	WHO	0.0037
7	Calcium	75	ICMR/BIS	0.025
8	Magnesium	30	ICMR/BIS	0.061
9	Chlorides	250	ICMR	0.0074
10	Nitrate	45	ICMR/BIS	0.0412
11	Sulphate	150	ICMR/BIS	0.01236
12	Dissolved oxygen	5.00	ICMR/BIS	0.3723
13	Biological oxygen demand	5.00	ICMR	0.3723

RESULTS:

Table 3 calculation of water quality index in pre monsoon season

1	Turbidity	0	10	0.36076	0	0
2	Ph	7.21	8.5	0.425	7.21	5.95
3	Electrical Conductivity	710	300	0.012	710	2.839
4	Total Dissolved solids	462	500	0.00721	462	0.6662
5	Total Hardness	267.78	300	0.012	267.78	1.0711
6	Calcium	53.66	75	0.048	53.66	3.4342
7	Magnesium	32.545	30	0.120	32.545	13.0179
8	Total Alkalinity	300	120	0.030	300	7.5
9	Chloride	88.050003	250	0.0144	88.050003	0.5071
10	Sulphate	48.330002	150	0.0240	48.330002	0.7732
11	Nitrate	5.18	45	0.0801	5.18	0.9220
12	Flouride	0	0	0	0	0
13	Sodium	0	35	0.103	0	0
14	Potassium	24	24	0.1503	24	15.03
				$\sum Wn$ = 1.3867		$\sum wn.qn$ = 51.7107
						WQI VALUE = 37.290

Table 4 calculation of water quality index in post monsoon season

S.NO	PARAMETERS	OBSERVED VALUE	STANDARD VALUE	UNIT WEIGHT	QUALITY RATING	wn.qn
1	Turbidity	0	10	0.36076	0	0
2	Ph	7.11	8.5	0.425	7.33333	3.116
3	Electrical Conductivity	716	300	0.012	238.66667	2.863
4	Total Dissolved solids	452	500	0.00721	90.4	0.651
5	Total Hardness	278.5	300	0.012	92.83333	1.113
6	Calcium	58.619999	75	0.048	78.159998	3.751
7	Magnesium	36.560001	30	0.120	1.2186667	0.146
8	Total Alkalinity	320	120	0.030	266.66667	7.999
9	Chloride	92.07	250	0.0144	36.828	0.530
10	Sulphate	56.130001	150	0.0240	37.420000	0.898
11	Nitrate	6.11038	45	0.0801	13.578622	1.087
12	Flouride	0	0	0	0	0
13	Sodium	38	35	0.103	108.57142	11.182
14	Potassium	30	2 24	0.1503	125	18.787
				$\sum Wn$ = 1.3867		$\sum wn.qn$ = 52.132
						WQI = 37.587

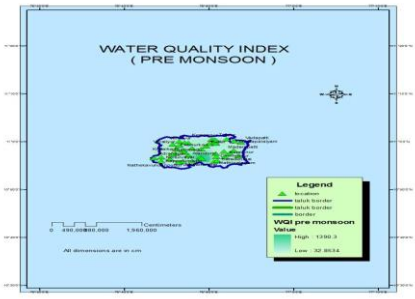

Figure.6. WQI for pre monsoon

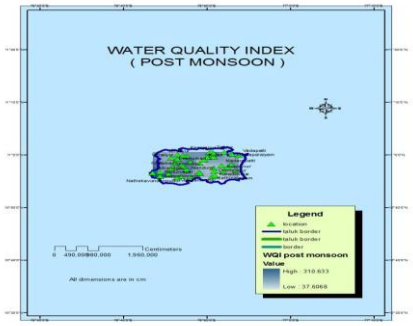

Figure.7. WQI for post monsoon

7.2 DISCUSSION

Water quality index of the present waterbody is established from important various physicochemical parameters in different seasons. The values of various physicochemical parameters for calculation for calculation of water quality index are presented in table 3. Season wise water quality index calculations are depicted in the table 4, 5 and 6. The water quality index obtained for the water body in different seasons of study period i.e., pre monsoon and post monsoon are 131,151,167 and 178,148,135 respectively, which indicate the very poor quality of water (Chatterji and Raziuddin 2002). This water quality rating study clearly shows that, the status of the water body is eutrophic and it is unsuitable for the human uses. It is also observed that the pollution load is relatively high during summer season when compared to the winter and rainy seasons. The above water quality is also supported by the following physicochemical parameters variations observed during the different seasons of the study. Among all the physicochemical parameters selected for the Water Quality Index calculations, pH is an important parameters which determines the suitability of water for various purposes. In the present study pH ranged between 6.2 & 7.8. In many of the collections the pH remained exactly neutral. However, when the average values for three seasons are taken into account the water body was found to be slightly alkaline.

Electrical conductivity and total dissolved solids were also found to be very high. Season wise it is found to be high during summer season. Chloride is one the important parameter is accessing the water quality. Munawar (1970) is of the opinion that higher concentration of chlorides indicates higher degree of organic pollution. In the present study the concentration of chloride fluctuated between 381,520,738 mg/l and 401,540,597 mg/l. Seasonally, chloride was found to be high during summer season low during rainy season. A similar observation has been made by Shastry et.al.,(1970) and Sinha (1995).

The pH values ranged between 7.8 to 7.56 indicating samples was neutral to slightly alkaline. Sulphate concentration ranged between 180,192,176 to 219,186,824 mg/l which were high the figure above the permissible limit. High concentration of Nitrate maybe due to leaching from nitrogenous fertilizers. Total hardness ranged from 566 1812 mg/l have propped the standard limit of 300 mg/l

It is observed from the results that the maximum and minimum value of WQI has been found to be 276 and 32.85 delineated as per the table 2 which fall under the excellent and poor category respectively. In the present study it is observed that majority of the ground water samples (44.4%) qualify in the good category and are acceptable for domestic use and 7.4% samples qualify in the excellent category which are of pristine quality; 33.4% samples qualify in the fair category which needs filtration and disinfection treatment and 14.8% samples qualify in the poor category which needs special treatment. It may also be reflected that parameters particularly chloride, sulphate, nitrate and hardness are found to be higher compared to the permissible level resulting TDS value at higher order owning to anthropogenic contribution viz. agricultural activities in the Thondamuthur taluk.

8. CONCLUSION

Water quality is dependent on the type of the contamination added and nature of mineral present at the particular bore well location. Monitoring of the water quality is done by collecting samples and analysis of physic chemical characteristics of water samples at different location of the study area. The spatial distribution map of TDS, TA, TH, Chloride, Fluoride, Potassium and pH were not within the permissible limit throughout the study area. The spatial distribution map of all parameters illustrate than 45% of the study area is under very high risk zone and 53% of the study area is in high and moderate risk zone. Thus the spatial distribution maps of various quality parameters are used to identify the quality of the ground water in the study area. The WQI values from 37.606 – 310.633, which shows that the study area is in very high risk zone.

This study shows the use of GIS integrated with analytical data and WQI to assess the ground water quality WQI helps us to understand the status of groundwater in the study area. It also helps us to understand whether the overall quality of groundwater body poses a potential threat to various uses of water. Regions of low ground water quality should be targeted for more detailed investigation and to take immediate remedial measure. To safe grade the groundwater.

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