Surface and Ground Water Quality Analysis around Coum River by Using Arc GIS Software

A. Pradeepkumar, M. Plan, MBA[1], M. Vigneshkumar, M. Tech[2]
[1,2]Department of Civil Engineering, Veltech Avadi, Chennai-60062, Tamil Nadu, India

Abstract

Groundwater is one of the most important natural resources. It is a major source of fresh drinking water in both the rural and urban regions. The groundwater quality, however in recent time has got deteriorated due to the percolation of polluted water in to the soils from the rivers. As a result its quality has not remained potable. The Ground water samples and Surface water samples around the Cooum River were collected in Chennai. Samples were collected at twelve different places to determine the following parameters like Colour, pH, Temperature, Turbidity, Calcium, Magnesium, Sodium, Potassium, Iron, Magnesium, Nitrate, Chloride, Fluoride, Sulphate, Phosphate, Total Hardness, Total Dissolved Solids (TDS), Total Suspended Solids (TSS). Levels of magnesium calcium chlorine, hardness and alkalinity, were higher than the maximum permissible limits set by Bureau of Indian Standards, Delhi. The starting point of the river was not much polluted; it was industrially highly polluted when it enters into the city. Domestic and industrial waste should be properly disposed and or recycled. It is therefore recommended that more strict methods of waste effluent management should be adopted to reduce the inputs of pollutants into the river. Relevant agencies should make continuous effort to control, regulate and manage indiscriminate waste disposal from domestic and industries within the study area.

Keywords

RS, TDS, TSS, GIS, pH

1. Introduction.

Most of the cities in India is rapidly growing and as results facing both groundwater quality and quantity problems as the significant amount of water demand fulfilled from groundwater. Growing urbanization, exploding population, and intensive agriculture are just some of the contributing factors for groundwater quality deterioration. In addition to this, unfavorable climatic condition i.e. low rainfall with frequent occurrence of dry spells, high evaporation and etc. on one hand and an unsuitable geological set up on the other, a definite limit on the effectiveness of surface and subsurface reservoirs. The over dependency on groundwater has led to 66 million people in 22 states at risk due to excessive fluoride and around 10 million at risk due to arsenic in six states in India. Geostatistical approach was widely used by many researchers for the analysis of spatial variations of groundwater characteristics. The spatial distribution of polluted groundwater show some heterogeneity and the pollutant concentration values are rarely available for every possible location of an area.

It is recognized that the statistical approach, has several advantages over the deterministic techniques. The fact of giving unbiased predictions with minimum variance and taking into account the spatial correlation between the data recorded at different locations is an important advantage. In India several ground water related studies have been conducted to determine potential sites for groundwater evaluation and groundwater quality mapping using GIS. Open unlined drains and the pollution dumping sites in the recharge areas act as source of pollution to the groundwater. Groundwater quality maps are effective for identifying locations that involve the threat of contamination. The main aims of this investigation are to provide an overview of present groundwater quality for parameters such as calcium, magnesium, iron, nitrate, manganese, sodium, potassium, pH, TDS, total hardness, alkalinity, and turbidity levels. Geostatistics was used to determine the spatial distribution of groundwater quality parameters in the study area using GIS and geostatistical techniques. The ground water quality index map was also derived using overlay & Index method from the spatial distribution maps in GIS.

1.1 Need for the Study

The ground water source is the major resource for commercial, Industrial and drinking (if in good condition). The main aim of this project is to examine the water parameters in the water and describe its variation in distance through ARC GIS software. Thus enabling the collected data's regarding the

physical and chemical parameters are digitalized into the software for further querying and analysis.

1.2 Objective

1. To analysis the surface water and sub-surface water quality around the Cooum River.

2. To identify the spatial variation of water quality by using GIS software.

2. Study Area

The Cooum River is a polluted river which ends in the city of Chennai (formerly Madras) draining into the Bay of Bengal. Along with the Adyar River running parallel to the south, the river trifurcates the city and separates Northern Chennai from Central Chennai. The river is considered to be the shortest classified river draining into the Bay of Bengal and is only about 72 km (45 mi) long. Its source is in a place by the same name 'Cooum' or 'Koovam' in Tiruvallur district adjoining Chennai district. Of the total length of 72 km, the river flows in urban and peri-urban areas for 30 km and rural areas for 42 km. In Chennai district, the river flows through three corporation zones Kilpauk, Nungambakkam and Triplicane for a total length of 16 km.

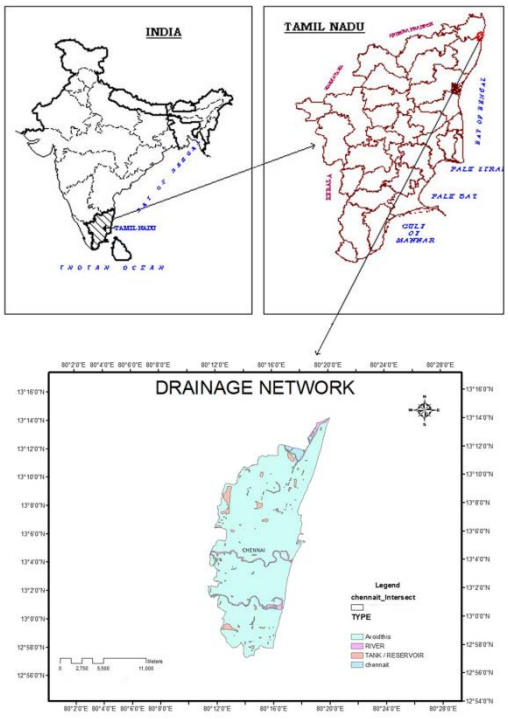


Fig 2.1. Study area

3. Methodology

The Primary data based on the samples that we have collected around Cooum River. The Secondary data is based on data collected like rainfall data, relative weight for 4WQI (Water quality index), Drinking water standards. The samples were subjected to physio-chemical analysis using standard procedure. Reports are collected and analyzed.

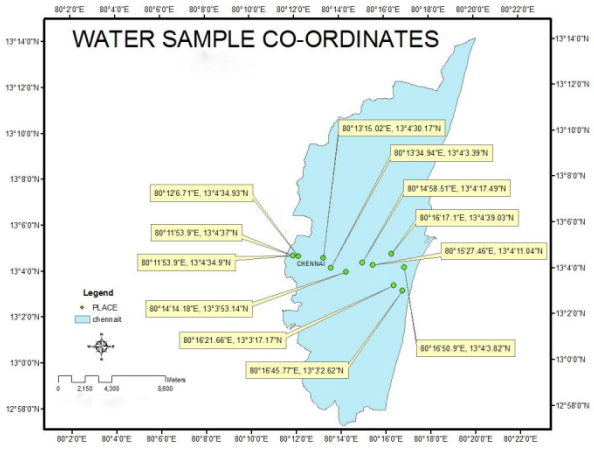


Fig 3.1 Water sample location

3.1 *Chemical parameters*

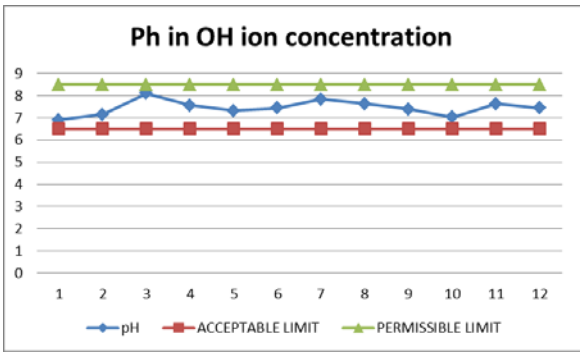
Table 3.1 Acceptable and permissible limits for drinking water

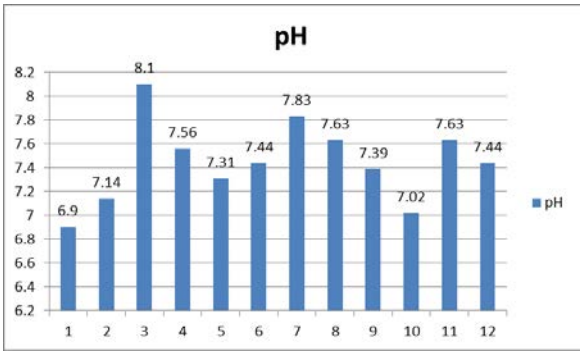
Parameters	Acceptable Range	Permissible limit
Ph	6.5-8.5	6.5-8.5
TOTAL DISSOLVED SOLIDS(mg/L)	500	2000
TOTAL HARDNESS AS CaCo3(mg/L)	200	600
CALCIUM AS CaCo3(mg/L)	75	200
MAGNESIUM AS Mg (mg/L)	30	100
TOTAL ALKALINITY AS CaCo3(mg/L)	200	600

4. Results and Interpretation

S.NO	pH	TDS	T H	CA2+	MG2+	TA	Cl-	SO4-2	F-	NO3+
1	6.9	1168	460	144	24	236	315	98	0.36	8
2	7.14	1205	560	152	43	248	295	98	0.25	20
3	8.1	1386	320	80	29	444	235	89	0.24	35
4	7.56	1288	190	52	14	432	220	79	0.3	4
5	7.31	540	162	50	9	156	136	10	0.4	3
6	7.44	1104	410	104	36	328	235	44	0.13	38
7	7.83	978	392	114	26	384	160	22	0.25	11
8	7.63	1198	540	152	38	276	360	31	0.35	9
9	7.39	1284	430	120	31	456	265	20	0.35	8
10	7.02	800	376	102	29	372	114	5	0.23	21
11	7.63	1384	130	33	12	124	86	5	0.13	2
12	7.44	1409	1050	300	72	412	1250	65	0.47	2

4.1. pH





• PH value should lie between 6.5 to 7.5 as per IS10500

• Max. ph value is 8.1 and min value of 6.9

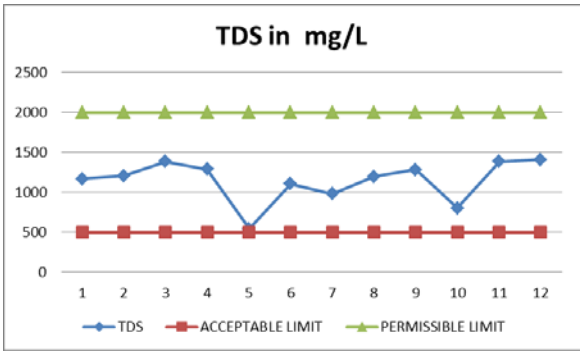
• Mean average value of 7.45 and hence its not completely affected.

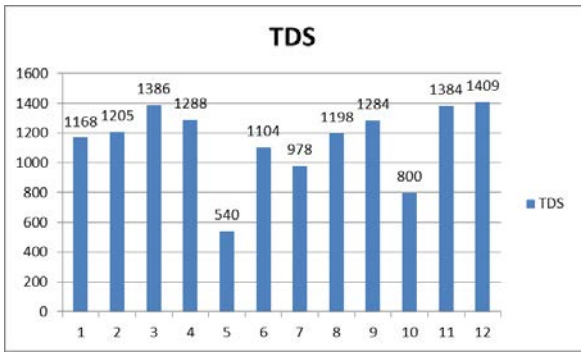
• Acceptable Range-6.5-8.5

4.2 TDS

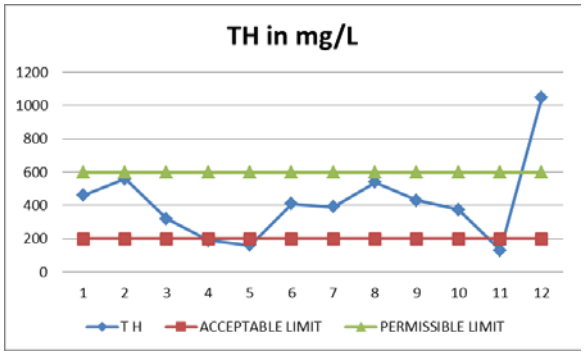
• Max. TDS value is 1409mg/L and min value of 540mg/L

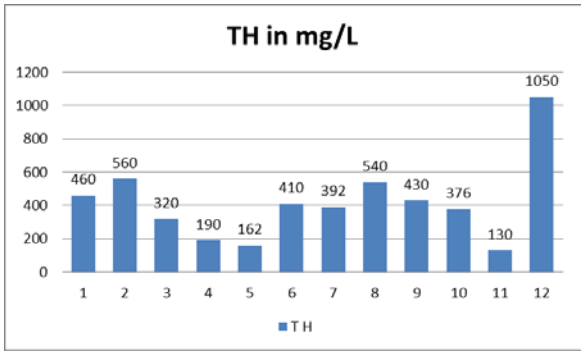
• Mean average value of 1145 and standard deviations of 260.45, TDS levels are not affected.





4.3. T H





• Max. TH value is 1050 mg/L and min value of 130 mg/L

• Mean average value of 418 and standard deviation of 242.89.

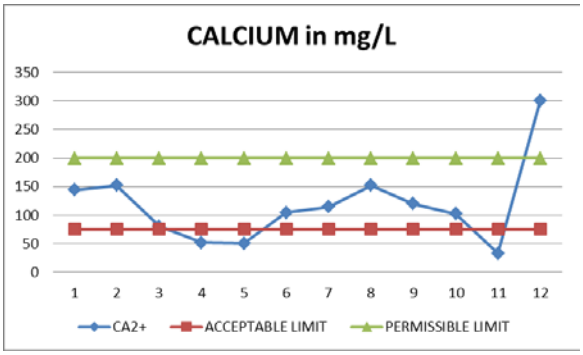
4.4 CA2+

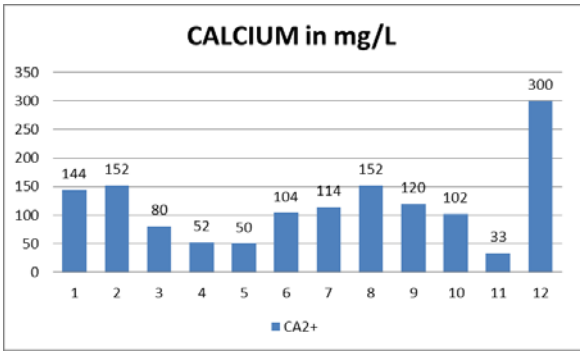
Calcium Acceptable Range-75 mg/L , Permissible limit-200 mg/L

• Max. Ca2+ value is 300 mg/L and min value of 33 mg/L

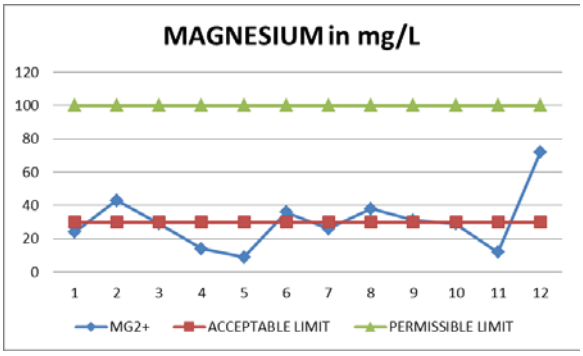
• Mean average value of 116.91 and standard deviation of 70.20.

• Calcium concentration is higher at the dead end of the river area.





4.5 MG2+

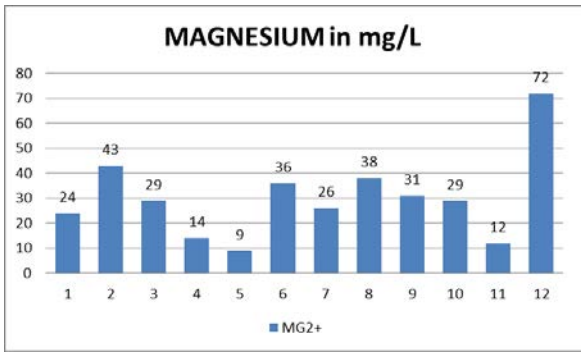


• Magnesium Acceptable Range-30 mg/L, Permissible limit-100 mg/L

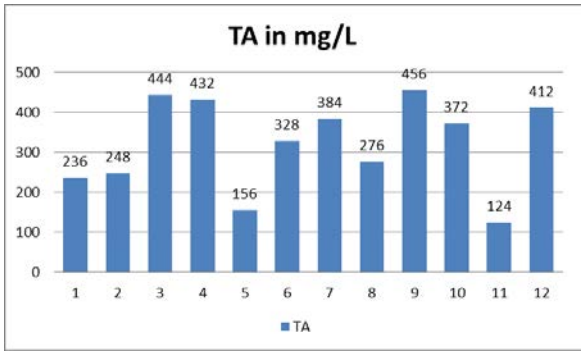
• Max. Mg2+ value is 72 mg/L and min value of 9 mg/L

• Mean average value of 30.25 and standard deviation of 16.81.

• Magnesium concentration are higher at the end.



4.6) TA



• Total Alkalinity Acceptable Range-200 mg/L , Permissible limit-600mg/L

• Max. alkalinity value is 456 mg/L and min value of 124 mg/L

• Mean average value of 322.33 and standard deviation of 113.28.

• Calcium concentration are not in acceptable range, but within permissible limits.

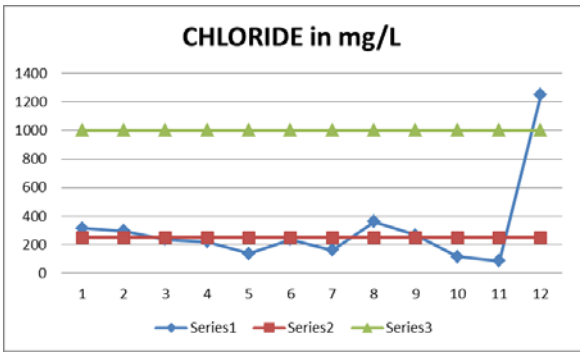
4.7 Cl-

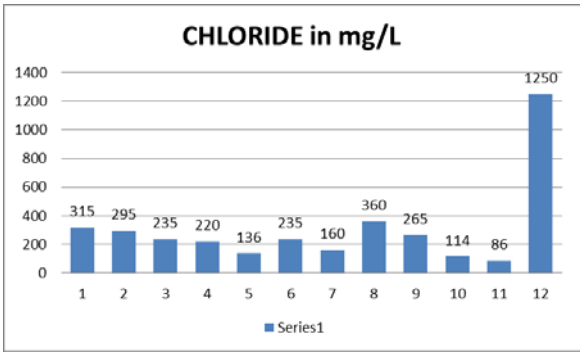
• Chlorine Acceptable Range- 250 mg/L , Permissible limit-1000 mg/L

• Max. alkalinity value is 1250 mg/L and min value of 86 mg/L

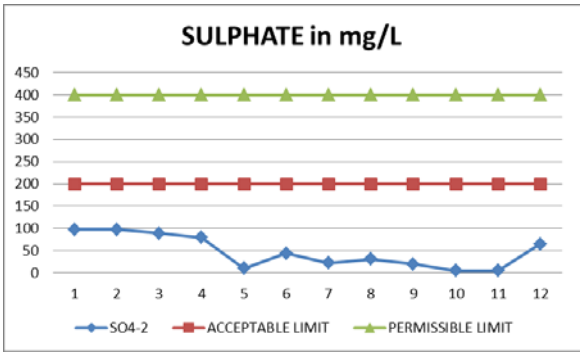
• Mean average value of 305.91 and standard deviation of 308.79.

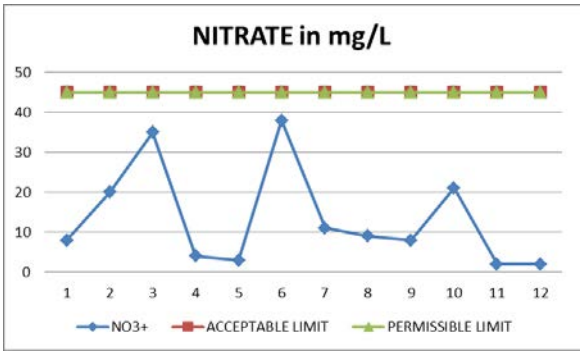
• Calcium concentration is higher at the end of river area.





4.8) SO4-



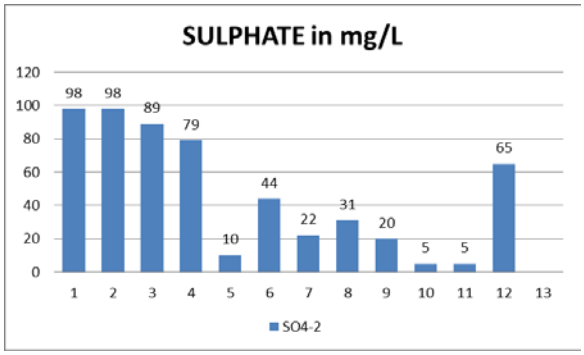


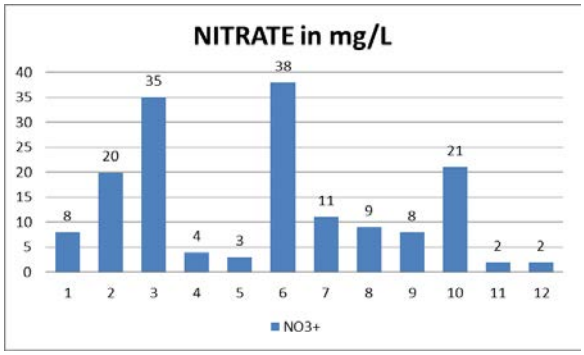
• Sulphate Acceptable Range-200 mg/L , Permissible limit-400 mg/L

• Max. alkalinity value is 98 mg/L and min value of 5 mg/L

• Mean average value of 47.16 and standard deviation of 36.71.

• Sulphate concentration is completely low. It does not affect the water quality.





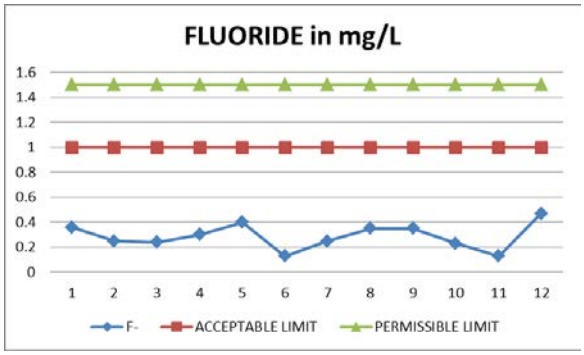
4.9) F-

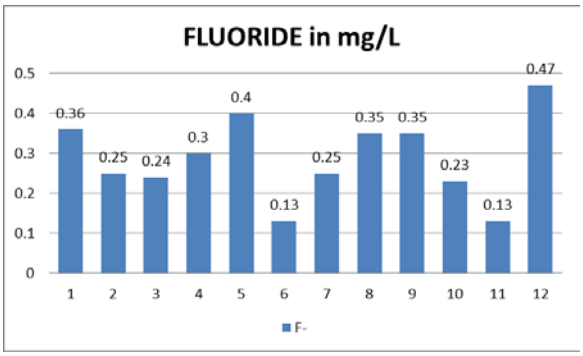
• Fluoride Acceptable Range-1 mg/L , Permissible limit-1.5 mg/L

• Max. alkalinity value is 0.47 mg/L and min value of 0.13 mg/L

• Mean average value of 0.288 and standard deviation of 0.103.

• Fluoride concentration is within acceptable limits.





4.10) NO3+

• Nitrate Acceptable Range-45 mg/L , Permissible limit-45 mg/L

• Max. alkalinity value is 38 mg/L and min value of 2 mg/L

• Mean average value of 13.416 and standard deviation of 12.478.

• Usually nitrate concentration should not be higher and hence drinking with care should be taken.

5. Water Quality Index

Water quality index (WQI) is a dimensionless number that combines multiple water quality factors into a single number by normalizing values to subjective rating curves

5.1 Calculation of Water Quality Index

Conventionally it has been used for evaluating the quality of water for

Water resources such as rivers, streams and lakes, etc. Computing WQI of Groundwater, in three steps:

All the calculation is manipulated in MS-Excel using formulae's.

Step 1

Each of the selected parameters has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes.

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 as follows

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i}$$

Step 3

A quality rating scale (qi) for each parameter is assigned

$$qi = (Ci/ Si) \times 100$$

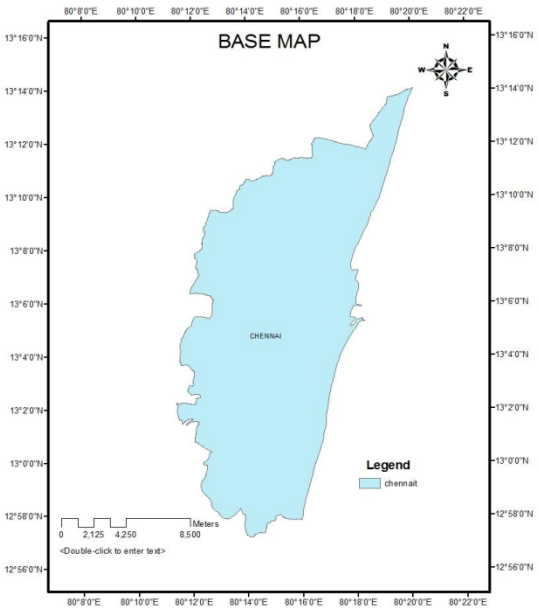
Where qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/L,

Si is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of the BIS 10500.

Sliis the subindex of ith parameter qi is the rating based on concentration of ith parameter, n is the number of parameters.

6. Arc GIS analysing

6.1 Base Map



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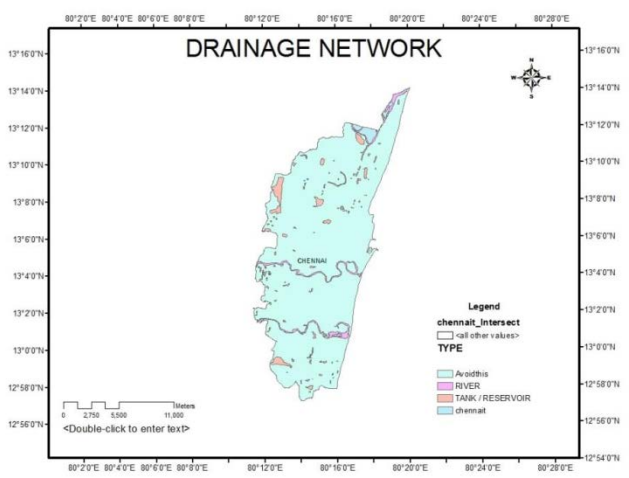


6.2 Attributes of WQI in Arc GIS

Source: Arc GIS 9.3 Software 1) Start editing features

2) Select the domain id shape file for places (i.e., 12points)

3) Select tools-> Add XY Date

4) Select the MS EXCEL File in which parameters and WQI are stored.

5) XY co-ordinate system table appears.

6) Select the co-ordinate system as WGS 1984

7) Now the geological co-ordinate system is selected and the table's dates are added to the DOMAIN ID

6.3 Quering Procedure for Water Quality

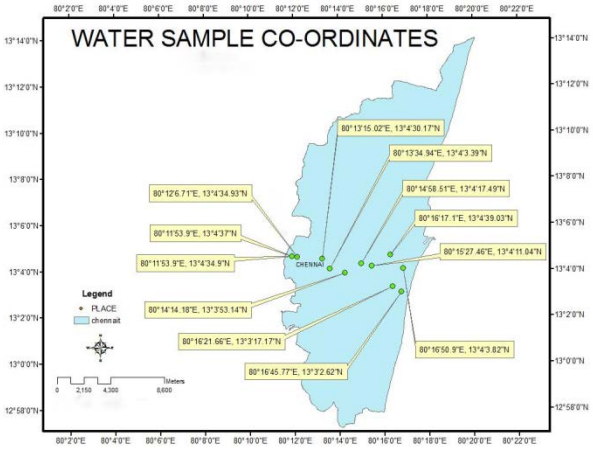
1) Selection -Select by Attributes

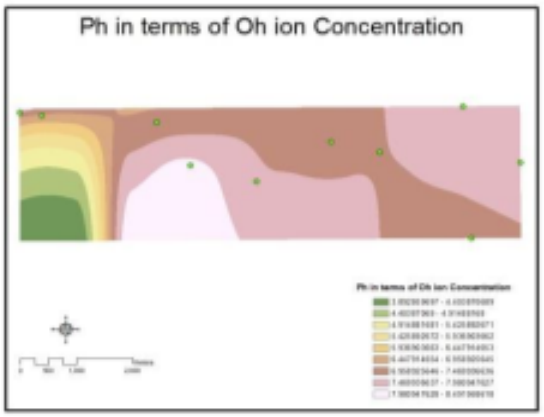
2) Perform the query by applying attributes.

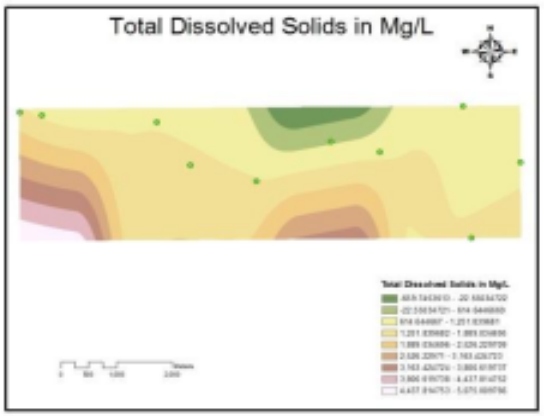
6.4 Spatial Analysis Report

Finally, the parameters are analysed with respect to variation in space using the spline curve technique. Thereby describing the locality where the concentration of chemical compositions are higher or lower.

This chart can be used to describe the areas of high quality with that of the worst.







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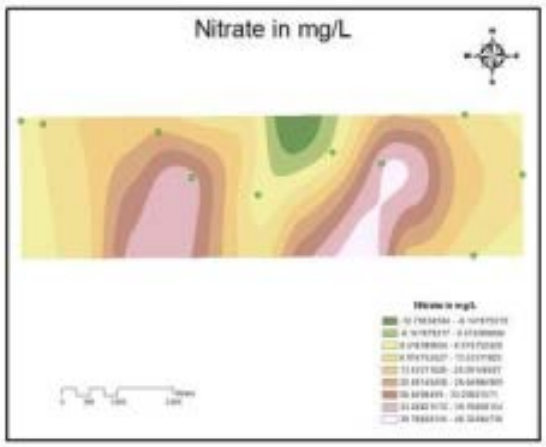

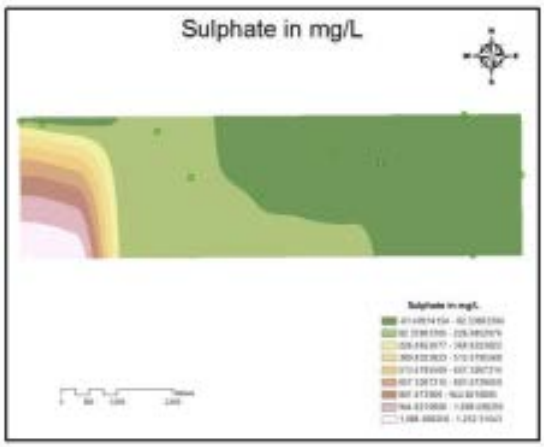

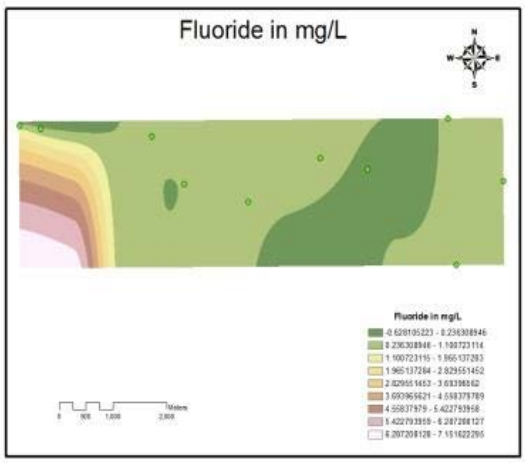

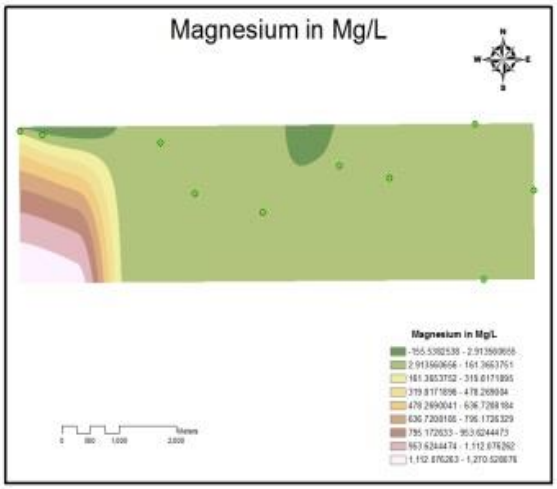

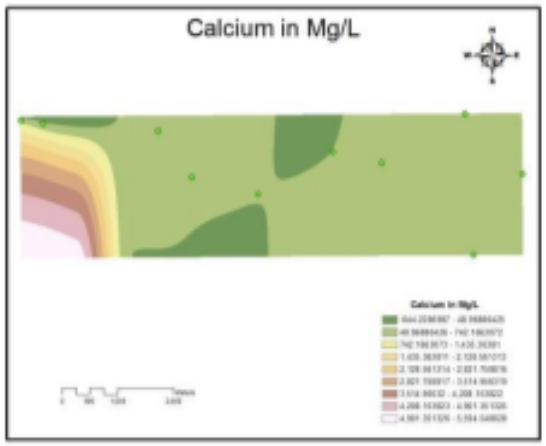

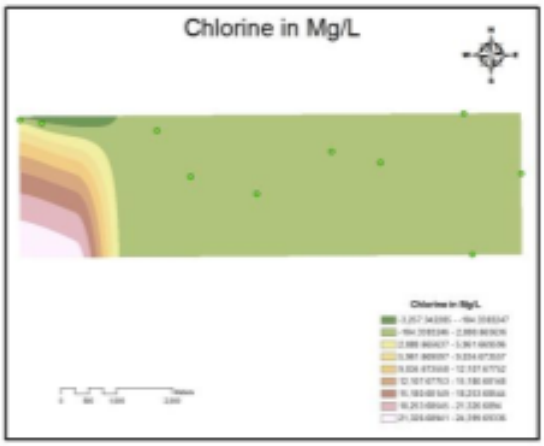

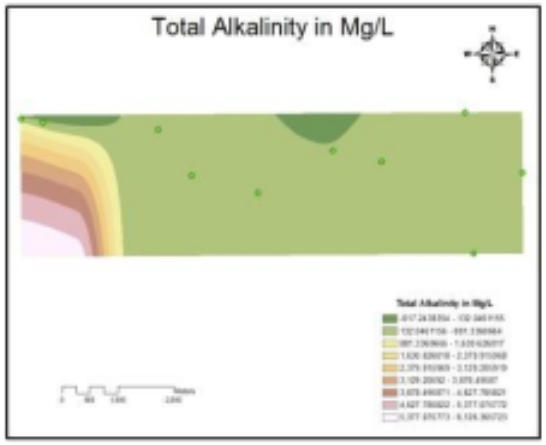

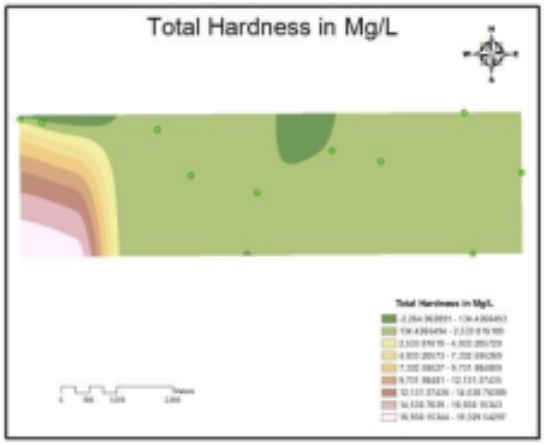

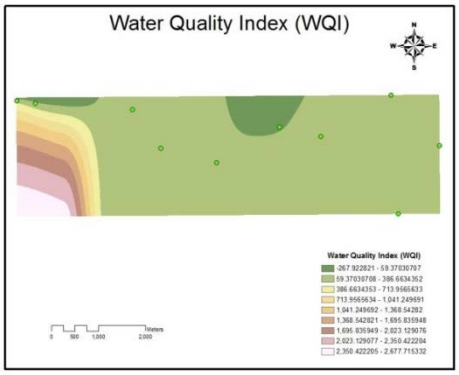

Conclusion

The physio-chemical parameters are examined and the characteristic values are analyzed for water quality index (WQI). The data's are loaded in the WGS 1984 co-ordinate system. Hence they can be queried and analyzed in Arc GIS software. The scope of this study would create a base water quality map using the physical parameters like pH, TDS, TH, CA2+, MG2+, TA, Cl-, SO4-2, F-, NO3+.

Arc GIS helps in interpolating the ground water quality with its spline curve system and provide the mapping of water quality index. With the result analysis, each and every properties of the sample are compared with others. The special variations along the river path are studied and can be mapped for determining the water quality index mapping.

The geostatistical analysis in Arc GIS gives the distribution of ground water characteristics and the chemical parameters that are referenced to it. These data can be manipulated for water quality mapping of a state or district with increasing the number of sample points.

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