# ANALYSIS OF GROUNDWATER QUALITY MAPPING USING GIS AROUND SINGANALLUR LAKE LOCATED IN COIMBATORE

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**Abstract -** *Groundwater plays a vital role as important source of drinking water in rural and urban areas of Tamilnadu. Day by day increase of industrial areas in many places, lead to disposal of industrial effluent in to the water bodies without any proper treatments is one of the reasons for ground water quality deterioration. The aim of the study is to map the current situation of groundwater quality around Singanallur Lake located in Coimbatore. Groundwater samples were collected from twenty bore wells covering the area around the Singanallur lake to analyze the groundwater quality parameters such as pH, DO, TDS, EC, Turbidity, Alkalinity, Total Hardness, Chloride, Calcium, Magnesium, Bicarbonates and Sulphate have been estimated for all the samples and results were compared with BIS standards. The result shows the water quality index for both pre monsoon and post monsoon season of the study area. The water quality index has been calculated the values ranged from 110.13 to 207.51. The WQI values from the present study indicate the very poor water quality and unsuitable for drinking purpose. GIS is used as a tool for analysis of spatial distribution of water quality. The spatial distribution map of these groundwater quality parameters were derived through GIS. The analysis reveals that the groundwater of the area needs some degree of chemical treatment before consumption, and it also needs to be protected from further contamination.*

***Key Words***: Groundwater, Singanallur Lake, Water quality index, Spatial distribution and GIS.

## 1. INTRODUCTION

Water is a natural resource forms, the principal component of all living organisms in this world. Surface water naturally by the force of gravity leaches, percolates, infiltrates into the sub surface that ultimately reaches into aquifer ecosystem referred as ground water. Ground water usually undergoes phenomenal changes in their characteristics during their hydraulic and transitional movement during storage or movement in aquifer. In some areas, groundwater also serves as the major source for drinking, irrigation of crops and for use in factories. Water quality is considered as a big issue in many cities of developing countries. Bore well water is valuable than surface water but due to different activities done by human being this water is contaminated. And now-a- days this is the grave problem.

### 1.1. Groundwater Pollution

Groundwater pollution is an introduction of certain pollutants into the groundwater which reduces the quality of groundwater making its use very limited, or in some cases impossible many different chemicals and various synthetic products we use today are usually the main causes of groundwater pollution. Improper management and disposal of industrial waste is also a reason for groundwater pollution.

Singanallur Lake is considered to be the most polluted in the region of Coimbatore. The Singanallur area is also predominantly an industrial zone with dense population and agriculture activities. In this region there is no proper drainage or sewerage system and hence the sewage is discharged into the river. Singanallur stream as it receives waste water discharge from point sources such as spinning mills, small scale industries, and congested residential areas unrestricted domestic sewage effluents, and higher pollution load discharged into stream was carried out to the tank ultimately resulting in deterioration of surface water, as well as groundwater in an aquatic environment.

### 1.1. Geographical Information System

Geographical information system is an integrated computer hardware and software, which can create, manipulate and analyze a geographically referenced database to produce new maps and tabular data.

A GIS is an information system designed to work with data referenced by spatial/geographical coordinates. In other words, GIS is both a database system with specific capabilities for spatially referenced data as well as a set of operations for working with the data. It may also be considered as a higher order map. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps.

## 2. STUDY AREA

Singanallur Lake is situated in the Singanallur village at Trichy road in Coimbatore. Singanallur Lake is located within the latitude of from 10059'42" N to 1101'30" N and longitude of from 7700'18"E to 7702'6" E. The lake is fed by the canals derived from Noyyal River, sanganurpallam drain and ganapathy - Singanallur drain. The perimeter of the lake is 3102 m. Water spread area is 1.153 square kilometer and average depth is 4.25 m. It holds water capacity of 68 Million cubic feet. The maximum and minimum temperature is 39.4°C to 20.7°C.

Altitude of the lake is +362 m above the mean sea level. Three numbers of sluices are present in the lake. This lake has two weirs one at the north east and another at south west side groundwater occurs at shallow levels under semi-confined and unconfined formation. Coimbatore municipality's wastewater of more than 30 Million liters per day flows in the two supply channels into the lake. The study area with sample locations are given in the figure 1.


**Fig -1: Samplings Boundary Locations in the Area**

## 3. METHODOLOGY

### 3.1. Collection of Water Samples

Total 22 sampling stations were selected around Singanallur Lake. The water samples were collected using polyethylene bottles during pre and post-monsoon season of the year 2019-2020 and GPS survey was done. These sampling stations were amongst the bore wells and from surface water, which are being extensively used for drinking and other domestic, industrial and agriculture purposes. Samples were analyzed for different parameters as per the standard methods.

**Fig -2: Collection of Samples**

**Table -1: Sampling Locations, Latitude and Longitude and Type of source**

| Sample No | Location | Type of Water | Latitude | Longitude |
|---|---|---|---|---|
| L 1 | Boat house | Surface | 10°59'53" N | 77°01'10" E |
| L 2 | Lake right side corner | Surface | 10°59'07" N | 77°01'10" E |
| G 1 | Car showroom | Borewell | 10°59'41" N | 77°01'04" E |
| G 2 | Near Tamarind tree | Borewell | 10°59'34" N | 77°01'02" E |
| G 3 | Near Apartment | Borewell | 10°59'45" N | 77°01'01" E |
| G 4 | Near Coconut tree | Borewell | 10°59'38" N | 77°00'59" E |
| G 5 | House right side lake | Borewell | 10°59'51" N | 77°01'05" E |
| G 6 | At Mahal | Borewell | 10°59'57" N | 77°01'14" E |
| G 7 | At Casagrande apartment | Borewell | 10°59'25" N | 77°00'42" E |
| G 8 | At Perumal temple | Borewell | 10°58'50" N | 77°00'54" E |
| G 9 | At Ponnammal thiru kovil | Borewell | 10°59'00" N | 77°01'11" E |
| G 10 | At Home left side lake | Borewell | 10°58'59" N | 77°01'24" E |
| G 11 | Garden left side lake | Borewell | 10°59'05" N | 77°01'32" E |
| G 12 | At Left side lake | Borewell | 10°59'23" N | 77°01'38" E |
| G 13 | Near Railway track | Borewell | 10°59'36" N | 77°01'38" E |
| G 14 | Vasanth Nagar | Borewell | 10°59'42" N | 77°01'31" E |
| G 15 | Factory | Borewell | 10°59'46" N | 77°01'27" E |
| G 16 | Lorry water supply | Borewell | 10°59'52" N | 77°01'26" E |
| G 17 | Near Show room | Borewell | 10°59'55" N | 77°01'20" E |
| G 18 | At Construction site | Borewell | 10°59'56" N | 77°01'22" E |
| G 19 | Near Highway near | Borewell | 10°59'58" N | 77°01'24" E |
| G 20 | At Matric school | Borewell | 10°59'57" N | 77°01'16" E |

### 3.2. Analysis of Physico – Chemical Parameters

**Turbidity**

Turbidity is due to the presence of different types of suspended particles. It is measured by Turbidity meter.

**pH**

The pH value is the negative log of hydrogen ion concentration. pH value is measured by pH meter.

**Electrical Conductivity (EC)**

EC is measured by an instrument called electrical conductivity meter. The instrument is standardized with the help of standard KCl solution.

**Total Dissolved Solids**

TDS can be calculated by TDS Meter. Water with high TDS indicates more ionic concentration.

**Hardness**

Total hardness is determined by titrating the sample against 0.01 N EDTA using Erichrome black T as indicator. The end point is color change from wine red to steel blue. Permanent hardness is determined by repeating the above procedure after boiling the water for few minutes. Temporary hardness is subtracting permanent hardness from total hardness.

### Calcium & Magnesium

It is determined by titrating the groundwater sample against 0.01 N EDTA with murexide or ammonium purpurate as indicator. The end point is color change from pink to purple.

### Alkalinity

It is determined using 0.02 N Sulphuric acid as burette solution and both phenolphthalein and methyl orange as indicator.

### Chlorides

Chlorides are determined by titrating the sample with 0.0282N silver nitrate using potassium chromate indicator. The end point is color change from yellow to brick red.

### Sulphates

50ml of sample is added to 10ml of HCL and boil it. When it boils, add 30 ml barium chloride into it. A white precipitate is formed due to the formation of barium sulphate. Solution is cooled, precipitate is filtered and weighed. Sulphate content is directly proportional to this weight.

The above parameters for the collected samples were compared with standards recommended by BIS (IS 10500:2012) shown in the table 2.

**Table -2: Prescribed IS 10500: 2012 Drinking Water Specification**

| Characteristics | Acceptable Limits | Permissible Limits |
|---|---|---|
| pH | 6.5-8.5 | - |
| Conductivity (µS/cm) | 750 | 2250 |
| Turbidity (NTU) | 1 | 5 |
| DO (mg/L) | >4 | 16 |
| TDS (mg/L) | 500 | 2000 |
| Chloride (mg/L) | 250 | 1000 |
| Magnesium (mg/L) | 30 | 100 |
| Calcium (mg/L) | 75 | 200 |
| Sulphate (mg/L) | 200 | 400 |
| Total alkalinity (mg/L) | 200 | 600 |
| Total hardness (mg/L) | 200 | 600 |

## 3.3. Concept of Groundwater Mapping

Here a groundwater potential map has been generated for the study area using Geographical Information System (GIS). The sampling locations were captured as latitude / longitude data in Degree, Minutes, Seconds (DMS) format. The data was converted to decimal degrees (Longitude DD and Latitude DD) for all the sampling locations. The Spatial Analyst Water quality analysis of around Singanallur Lake using GIS. Tool in the GIS software was employed for interpretation of data. The results were stored as Raster files upon analysis.

## 3.4. Water Quality Index

The water quality Index is obtained by Brown's equation and it was also calculated by weighted index method to determine the suitability of groundwater for drinking and irrigational purposes.

In the first step, each of the eleven parameters has been assigned a weight ($w_i$) according to its relative importance in overall quality of water for drinking purposes. The weightage assigned to each parameter was shown in table 3

In the second step, the relative weight ($W_i$) is computed from the following equation.

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

**Table -3: Relative Weight of Chemical Parameters**

| Chemical parameters | Indian standards | Weight (*wi*) | Relative weight (*Wi*) |
|---|---|---|---|
| Turbidity (NTU) | 1-5 | 4 | 0.1176 |
| EC (µS/cm) | 750-2250 | 4 | 0.1176 |
| pH | 6.5-8.5 | 4 | 0.1176 |
| TDS (mg/L) | 500-2000 | 4 | 0.1176 |
| DO (mg/L) | 4-6 | 2 | 0.0588 |
| Hardness (mg/L) | 200-600 | 2 | 0.0588 |
| Calcium (mg/L) | 75-200 | 2 | 0.0588 |
| Magnesium (mg/L) | 30-100 | 2 | 0.0588 |
| Chloride (mg/L) | 250-1000 | 3 | 0.0882 |
| Sulphate (mg/L) | 200-400 | 4 | 0.1176 |
| Alkalinity (mg/L) | 200-600 | 3 | 0.0882 |
| | | $\sum wi = 34$ | $\sum Wi = 1.000$ |

In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to guidelines laid down in the BIS and the result was multiplied by 100. $q_i = (C_i/S_i) * 100$

$C_i$ = concentration of each chemical parameter in each water sample

$S_i$ = Indian drinking water standard for each chemical parameter

In the fourth step, for computing the WQI, the $SI_i$ is first determined for each chemical parameter, which is then used to determine the WQI as per the following equation.

$$SI_i = W_i\, q_i$$

$$WQI = \sum SI_i$$

$SI_i$ is the sub index of $i^{th}$ parameter

$q_i$ is the rating based on concentration of $i^{th}$ parameter

**Table-4: Water Quality Classification Based on WQI Value**

| WQI Value | Water Quality | Grading |
|---|---|---|
| <50 | Excellent | A |
| 50-100 | Good water | B |
| 100-200 | Poor water | C |
| 200-300 | Very poor water | D |
| >300 | Water unsuitable for drinking | E |

## 4. RESULTS AND DISCUSSION

The Physico-chemical parameters of water sample were analysed and the results have been compared with Bureau of Indian standards.

**Table -5: Summary of Physico-Chemical Parameters**

| Parameters | Pre monsoon (2019) | | Post monsoon (2020) | | BIS (2012) | |
|---|---|---|---|---|---|---|
| | Max | Min | Max | Min | Acceptable limit | Permissible limit |
| pH | 8.49 | 6.89 | 8.71 | 6.92 | 6.5-8.5 | - |
| Turbidity (NTU) | 0.9 | 4.5 | 5.7 | 0.7 | 1 | 5 |
| EC (µS/cm) | 4300 | 1700 | 4700 | 1800 | 750 | 2250 |
| TDS (mg/L) | 2881 | 1139 | 3149 | 1206 | 500 | 2000 |
| DO (mg/L) | 1.4 | 0.3 | 1.7 | 0.2 | >4 | - |
| Alkalinity (mg/L) | 490 | 200 | 523 | 310 | - | - |
| Total Hardness (mg/L) | 945 | 360 | 1350 | 460 | 200 | 600 |
| Calcium (mg/L) | 178 | 64 | 198 | 96 | 75 | 200 |
| Magnesium (mg/L) | 143.7 | 31.59 | 193.6 | 61.9 | 30 | 100 |
| Chloride (mg/L) | 924.7 | 324.89 | 1250.6 | 378.8 | 250 | 1000 |
| Sulphate (mg/L) | 373 | 225 | 468 | 256 | 200 | 600 |

### 4.1. GRAPHICAL REPRESENTATION & GIS MAPPINGS

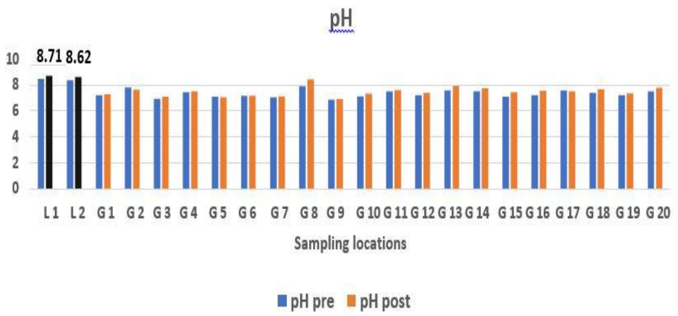


Chart -1: Variation of pH

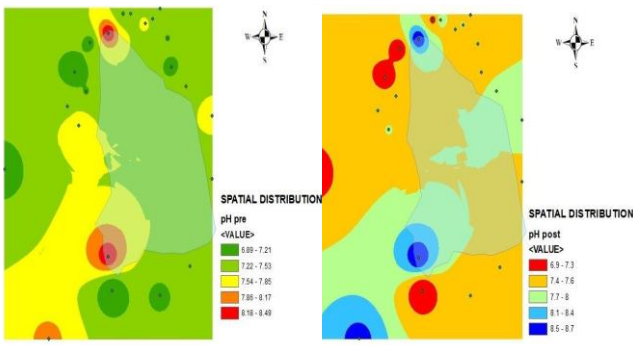


Fig -3: Spatial distribution of pH pre & post monsoon

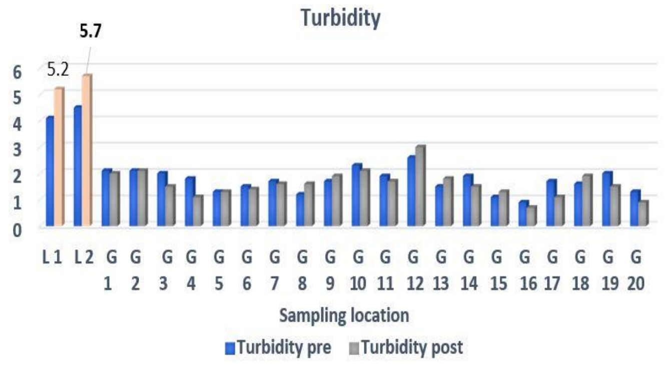


Chart -2: Variation of Turbidity

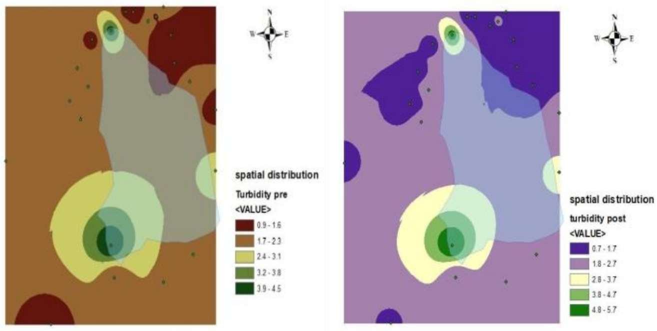


Fig -4: Spatial distribution of Turbidity pre & post monsoon

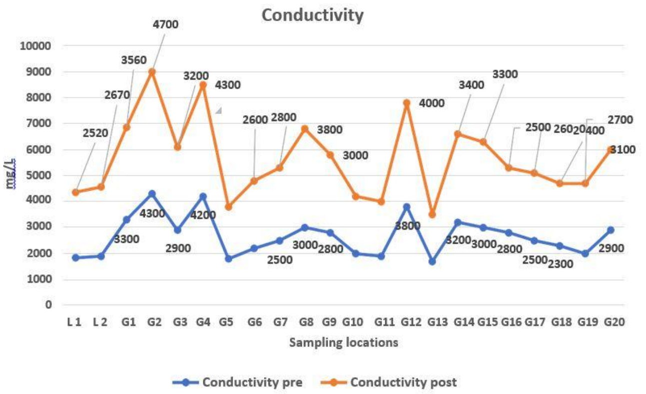


Chart -3: Variation of Conductivity

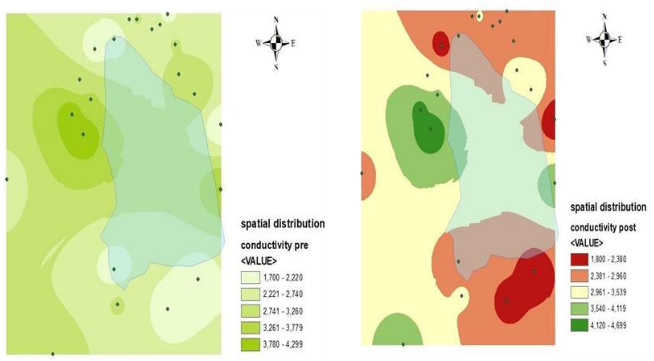


Fig -5: Spatial distribution of Conductivity pre & post monsoon

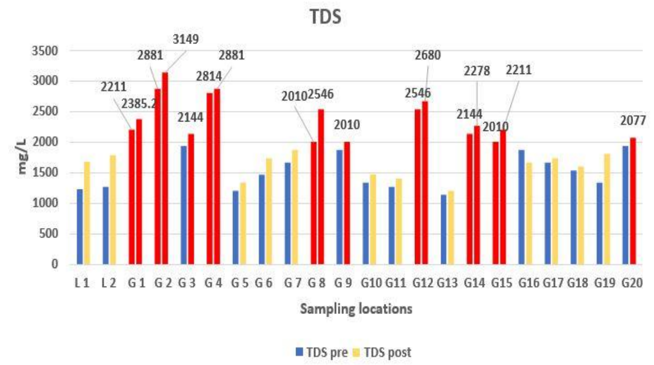


**Chart -4: Variation of Total Dissolved Solids**

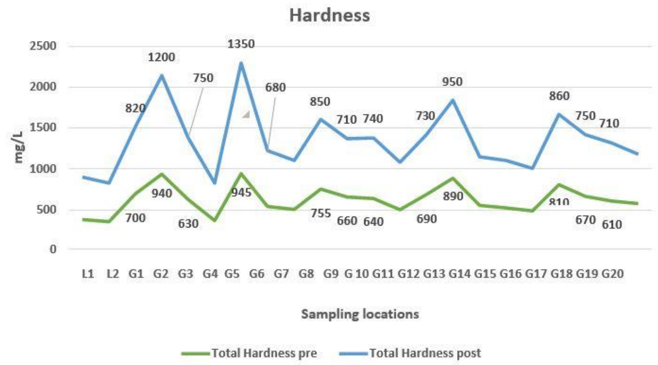


**Chart -6: Variation of Total Hardness**

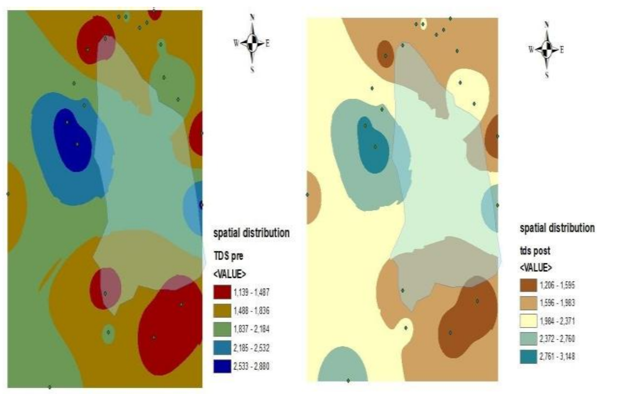


**Fig -6: Spatial distribution of TDS pre & post monsoon**

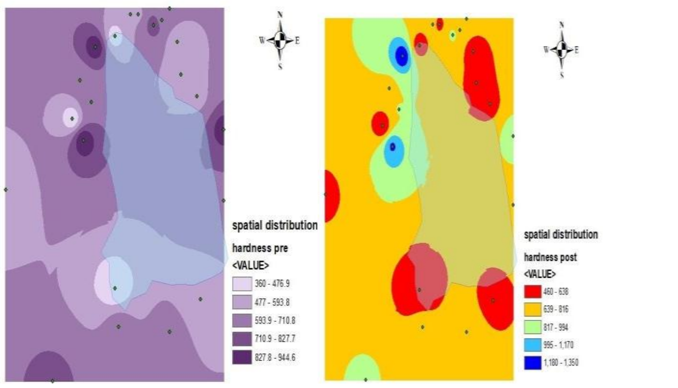


**Fig -8: Spatial distribution of Hardness pre & post monsoon**

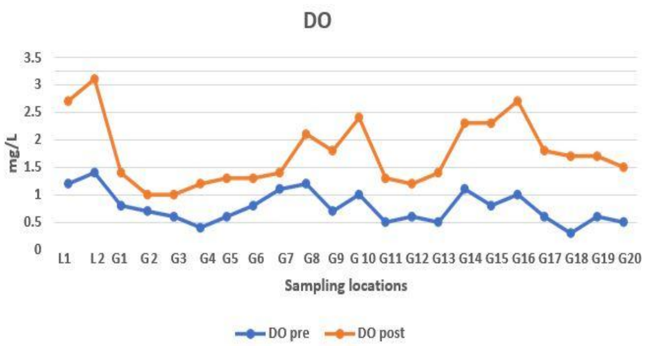


**Chart -5: Variation of Dissolved Oxygen**

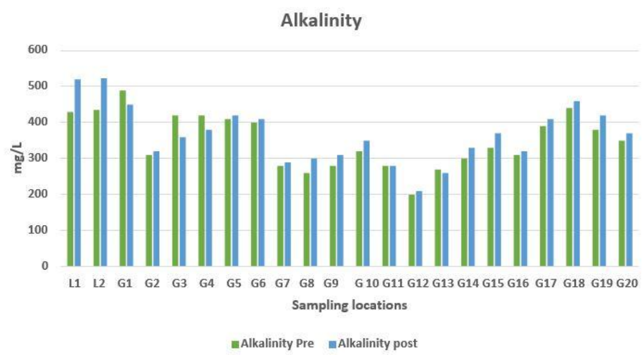


**Chart -7: Variation of Alkalinity**

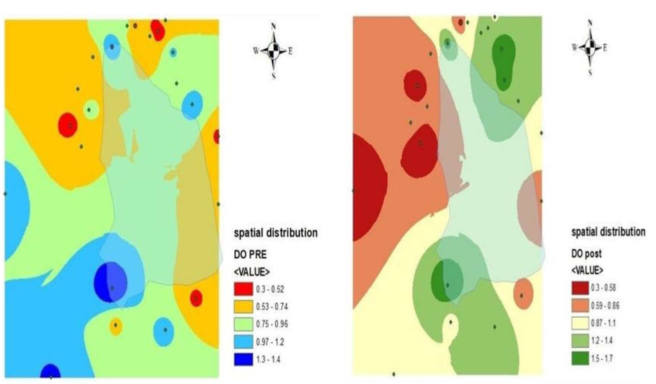


**Fig -7: Spatial distribution of Dissolved Oxygen pre & post monsoon**

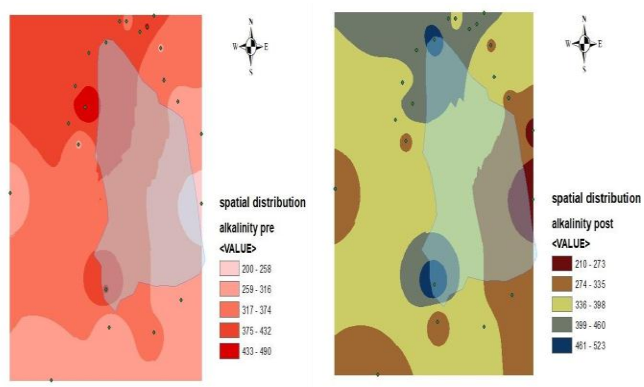


**Fig -9: Spatial distribution of Alkalinity pre & post monsoon**

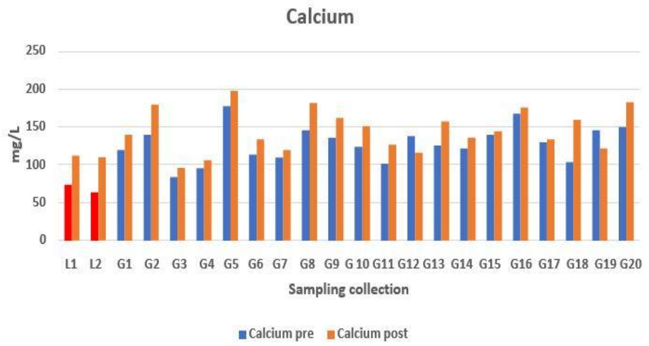


Chart -8: Variation of Calcium

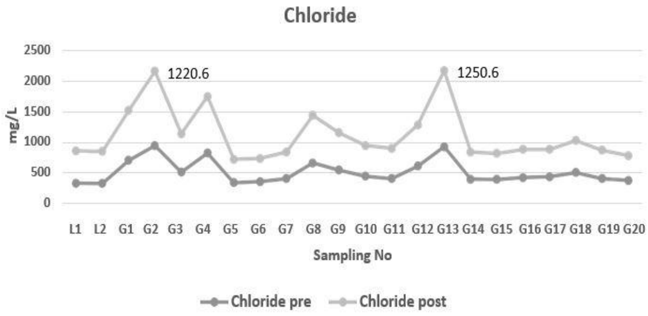


Chart -10: Variation of Chloride

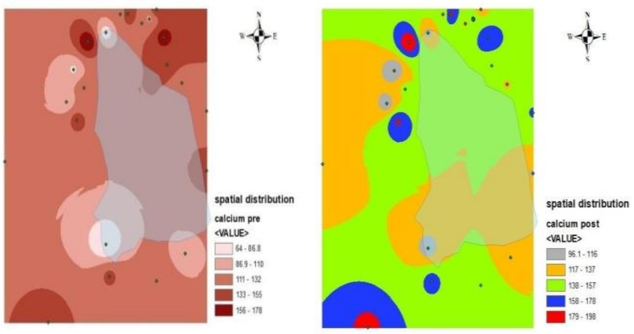


Fig -10: Spatial distribution of Calcium pre & post monsoon

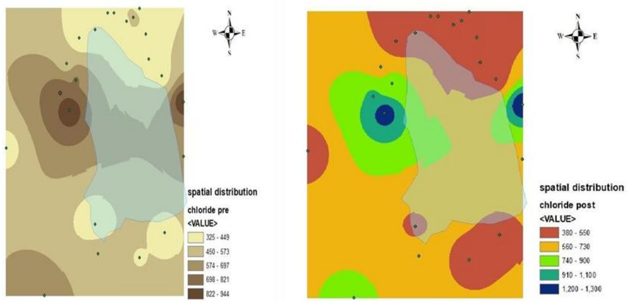


Fig -12: Spatial distribution of Chloride pre & post monsoon

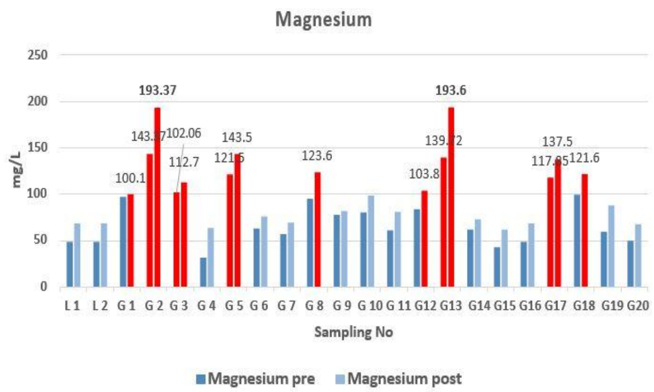


Chart -9: Variation of Magnesium

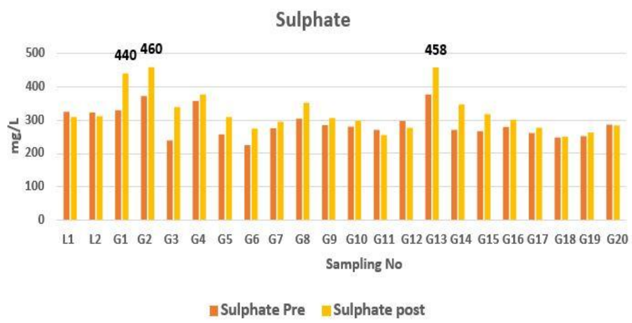


Chart -11: Variation of Magnesium

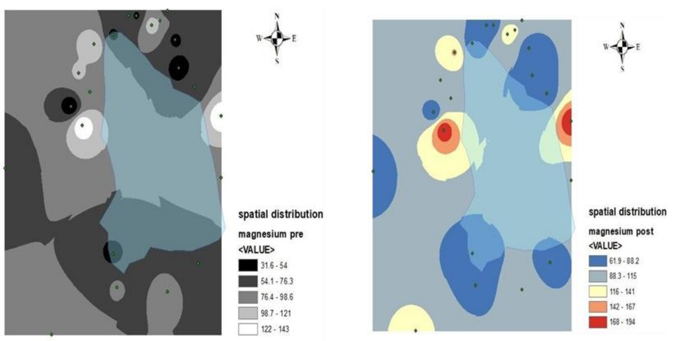


Fig -11: Spatial distribution of Magnesium pre & post monsoon

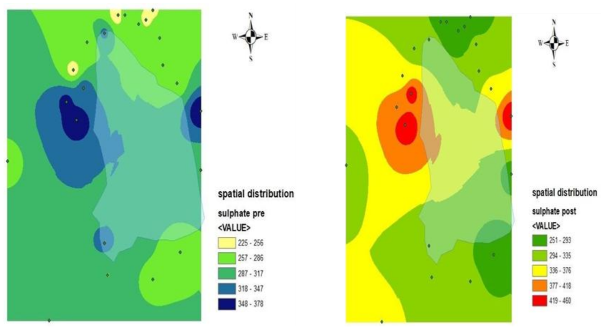


Fig -13: Spatial distribution of Sulphate pre & post monsoon

### 4.2. Analysis of Water Quality Index

Table -6: Water quality index (WQI) values

| S.NO | Pre Monsoon (2019) | | | Post Monsoon (2020) | | |
|---|---|---|---|---|---|---|
| | WQI | Rating | Grade | WQI | Rating | Grade |
| L 1 | 128.49 | Poor water | C | 163.46 | Poor water | C |
| L 2 | 128.84 | Poor water | C | 165.65 | Poor water | C |
| G 1 | 182.93 | Poor water | C | 200.85 | Very Poor water | D |
| G 2 | 220.04 | Very poor water | D | 261.36 | Very poor water | D |
| G 3 | 156.51 | Poor water | C | 173.95 | Poor water | C |
| G 4 | 174.40 | Poor water | C | 187.65 | Poor water | C |
| G 5 | 152.87 | Poor water | C | 178.86 | Poor water | C |
| G 6 | 129.95 | Poor water | C | 147.80 | Poor water | C |
| G 7 | 132.38 | Poor water | C | 144.19 | Poor water | C |
| G 8 | 167.58 | Poor water | C | 201.53 | Very Poor Water | D |
| G 9 | 152.27 | Poor water | C | 165.66 | Poor water | C |
| G 10 | 138.79 | Poor water | C | 155.29 | Poor water | C |
| G 11 | 122.79 | Poor water | C | 136.34 | Poor water | C |
| G 12 | 172.10 | Poor water | C | 181.35 | Poor water | C |
| G 13 | 171.71 | Poor water | C | 205.62 | Very Poor Water | D |
| G 14 | 148.13 | Poor water | C | 162.48 | Poor water | C |
| G 15 | 139.58 | Poor water | C | 158.06 | Poor water | C |
| G 16 | 139.61 | Poor water | C | 144.61 | Poor water | C |
| G 17 | 159.76 | Poor water | C | 168.65 | Poor water | C |
| G 18 | 149.80 | Poor water | C | 166.87 | Poor water | C |
| G 19 | 133.93 | Poor water | C | 155.78 | Poor water | C |
| G 20 | 143.88 | Poor water | C | 155.70 | Poor water | C |

Table -7: Classification of Water based on WQI in %

| WQI Value | Water Quality | Grading | Percentage (%) | |
|---|---|---|---|---|
| | | | Pre Monsoon (2019) | Post Monsoon (2020) |
| <50 | Excellent | A | 0 | 0 |
| 50-100 | Good water | B | 0 | 0 |
| 100-200 | Poor water | C | 95.45 | 81.81 |
| 200-300 | Very poor water | D | 4.5 | 18.18 |
| >300 | Water unsuitable for drinking | E | 0 | 0 |

## 5. CONCLUSION

The results obtained from various studies were compared with bureau of Indian standards. The present study has been carried out to evaluate the Physico – chemical characteristics of groundwater around Singanallur Lake located in Coimbatore district. The spatial distribution of groundwater quality in the study area has been visualized by GIS. Twenty two samples were collected and analyzed for both pre and post monsoon season. TDS, EC, TH, magnesium was exceeding the permissible limits.

WQI results showed that 95.45 % and 81.81% of the groundwater samples were found as a poor category and 4.5 % and 18.18 % found as very poor water quality during pre (2019) and post (2020) monsoon seasons respectively. It results that the lake water was not suitable for drinking and irrigation uses because of the discharge of domestic sewage into the lake. From the present study, it is clear that the water in Singanallur lake region is not for very good quality.

## REFERENCES

[1] Angaleeswari Mand A. Valliammai, (2017) "Assessment of Ground Water Quality Using Water Quality Index in Western Zone of Tamil Nadu, India", Chemical Science Review and Letters pp 6(23), 1750-1757,

[2] Balasundaram N., (June 2016) "Environmental impact of Singanallur lake water" International Journal of engineering sciences & research Technology, 5(6),

[3] Jeyaraj M, Nirmaladevi G, and Magudeswaran P (oct-2014) "Seasonal variation in Physico-chemical parameter of surface water and ground water of singanallur lake, a rivulet from river Noyyal" International Journal for Research & Development in Technology Vol:2 Issue:4,

[4] Indian Standards Institution, Status of Surface and Ground water Resources, (2012)

[5] K. Murali, R. Elangovan (June 2013) "Assessment of Groundwater Vulnerability in Coimbatore South Taluk, Tamilnadu, India Using Drastic Approach" International Journal of Scientific and Research Publications, Volume 3, Issue 6,

[6] K. Murali and R. Elangovan, (2013) "Hydro chemical analysis of Groundwater Quality in Coimbatore South Taluk, Tamilnadu", India Pollution Research,32(1), 25-29,

[7] L. Sankar, K. BalaKumar (April 2016) "Spatial and seasonal variation in ground water quality of river Palar basin using multivariate techniques" International Journal of Engineering Sciences & Research Technology: 2277- 9655.

[8] M Lenin Sundar, P Sankar, S Varun Venkatraman and K I Mohan, (April, 2015) "Analysis of groundwater quality around Coimbatore Big tank, Tamilnadu, India" International Journal of earth sciences and engineering, vol. 08, no. 02, pp. 99-105.

[9] Nalini Jebastina, and Prince Arulraj (2017) "GIS Based Assessment of Groundwater Quality in Coimbatore District, India" J Environ Anal Toxicol, an open access Journal Volume 7 • Issue 3 • 1000454.

[10] Priya K.L, Nalini Jebastina and Prince Arulraj G. (2011) "Ground water quality in the singanallur sub-basin of Coimbatore city" journal of Industrial Pollution Control 27(1) (pp 15-18).