



GROUNDWATER QUALITY ASSESSMENT USING WATER QUALITY INDEX AND GIS, MADURAVOYAL, CHENNAI, INDIA

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ABSTRACT

Groundwater quality has direct implications for domestic, industrial and drinking water purposes. Groundwater samples from fifteen different locations used in this study collected in Maduravoyal located at west of Chennai. In this paper we here summarized the laboratory results of all the samples showing their physico-chemical parameters. The Water Quality Index is found to analyse water for drinking purposes. Overall study reveals that water quality of majority of the areas taken for analysis are not suitable for drinking.

Keywords: Ground Water Quality

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1. INTRODUCTION:

Urbanization, industrialization growth in the metropolitan city Chennai is increasingly growing too fast, thereby great increase in the demand of water and corresponding increase on groundwater pollution and the existing wetlands degradation is on the rise every year. The pollution goes ever increasing due increase of city population and ineffective management (Shanmugam *et al.* 2005). Groundwater is one of the city's basic necessities for drinking - purposes. Due to the encroachment of wetlands and over exploitation of groundwater resulted in intrusion of saline water and simultaneously led to the scarcity of groundwater. Groundwater depth in the recent years went below several feet as it was in the past. Currently Chennai is facing critical problems regarding drinking water as most of the regions are severely affected. However few parts of Chennai are in the verge of contamination of heavy metals, saline water and other major and minor salts. Timely acts can prevent the contamination of above said salts and sewage water into the groundwater. Precautionary measures can be effective only if the ground water quality is examined carefully. The water quality index (WQI) is useful to categorize the groundwater. It is calculated based on Horton

(1965) and Landwehr (1974). Indexing method is under practice since then and was further taken to next level by the latter researchers thereon. By assigning proper weightage to the parameters, WQI is determined accurately (Brown *et al.* 1972). The contaminants that modify the groundwater both physical and chemical character are expressed in (WQI). This weightage index is the simplification of large amount of water components data into a single arithmetical value.

2. STUDY AREA

Samples were collected at Maduravoyal located in the west of Chennai, India. Maduravoyal is located at a latitude of 13° 3' 40" N and at a Longitude of 80°9'50"E. According to census 2011, Maduravoyal had the population of 86,195 and it is situated about 12.87 kilometers from Chennai harbor and 3 Km from the west of Koyambedu area in Chennai city. The neighbouring areas include Nerkundram, Mogappair, Vanagaram, Valasaravakkam, Alapakkam and Porur.

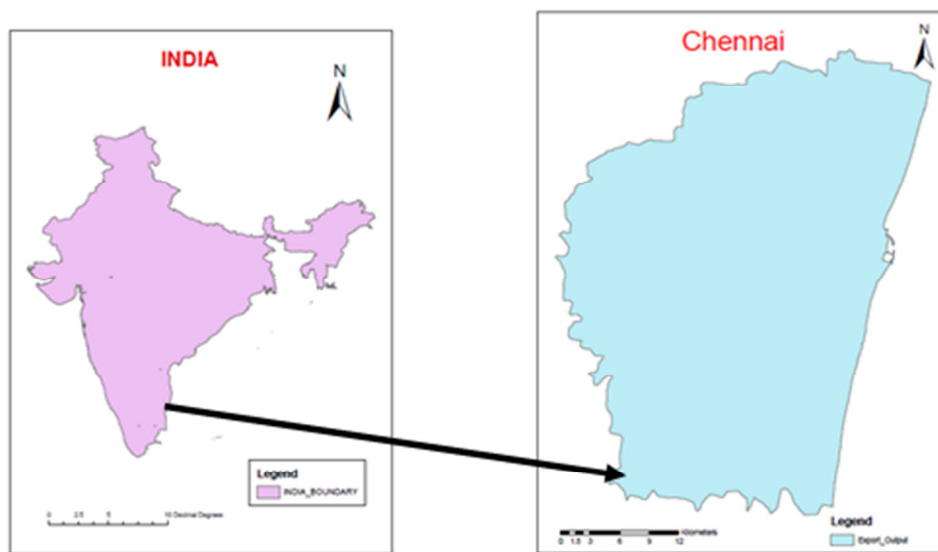


Figure 1 Study Area Map

Table 1 Groundwater sample analysis results of Maduravoyal region

Sample Stations	pH	Chlorides	Total Alkalinity	TDS	Total Hardness	Iron	Phosphate	Nitrate	Fluorides
s1	7	310	360	1512	590	0	1	20	1.5
s2	7	400	540	1932	670	0	2	45	1
s3	7.5	400	500	1920	700	0.3	0	45	1.5
s4	7	280	250	1356	600	0.3	1	45	1
s5	7	250	270	1188	470	0	0.5	45	2
s6	7	290	400	1608	650	0	2	75	1.5
s7	7.5	360	190	1320	550	2	0.5	20	2
s8	7.5	420	590	2112	750	1	2	45	1.5
s9	7	320	340	1056	220	0	0.5	20	1
s10	7.5	370	350	1320	380	0	0.5	45	2

s11	7	500	500	2160	800	0	5	45	1
s12	7	310	390	1320	400	0	2	20	1.5
s13	7	330	350	1926	400	0.3	2	20	1
s14	7	310	330	1188	450	0.3	0.5	20	1.5
s15	6.5	240	200	948	350	0	0	45	1

pH -No Unit, For all other parameters are assigned mg/lit

Table 2 Unit weightage based on the Bureau of Indian drinking water standard (IS: 10500, 1993)

Parameters	Standard Values (Si)	Unit Weight (Wi)
pH	6.5-8.5	0.025080012
Chlorides	250	0.00085272
Total Alkanity	200	0.001065901
Total Hardness	300	0.0007106
Iron	0.3	0.710600346
TDS	500	0.00042636
Phosphate	5	0.042636021
Fluoride	1	0.213180104
Nitrate	45	0.004737336

3. METHODOLOGY

3.1 Insitu data

The groundwater samples were collected from both open and tube wells from fifteen different stations in the year 2014.

3.2 Water Quality Index:

$$\text{Water Quality Index } WQI = \frac{\sum_{i=1}^n W_i q_i}{\sum_{i=1}^n W_i}$$

Where, W is the unit weightage factor, $W_n = K / S_n$ and $K =$ Proportionality Constant.

$$K = \left[\frac{1}{\sum_{n=1}^n \left(\frac{1}{S_i} \right)} \right]$$

Where S_n and S_i are the values of water quality parameters of the Bureau of Indian standards (Table 2).

$$\text{Quality rating } q_{ni} = \left[\frac{(V_{actual} - V_{ideal})}{(V_{standard} - V_{ideal})} \right] \times 100$$

3.3 Water quality parameters and its Spatial distribution

The spatial distribution is done here by the Geographical Information system (GIS) software ArcGIS 9.3. The GIS is the sophisticated tool to describe the spatial analysis of the distribution of the water quality on the two or more axes. Inverse Distance Weighting (IDW) is used in the spatial analysis of the groundwater.

Table 3 Water quality index classification

WATER QUALITY INDEX	DESCRIPTION
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unfit For Drinking

4. RESULTS

Samples collected showed pH less than 6.5 and greater upto 7.5. The spatial distribution of pH is represented in Figure 2. Station 11 shows hardness as 800 (mg/L)(highest) and the station 220 mg/l (lowest). Other samples shows 590, 670, 700, 600, 470, 650, 550, 750, 380, 400, 450 and 350 mg/l respectively. Total dissolved solids varies from 948 to 2112 mg/l. All samples has the high TDS content that are not within the range. Alkalinity is from 190 to 540 mg/L and the samples 2 ,3, 8 and are found to be high in alkaline nature .The stations 4, 5 ,7, 9, 11, 12, 13, 14, 15 and 10 are reasonable .Here chlorides are more than the permissible limit of 250 mg/L. Samples 5 and 15 are good and the other samples is from 290 to 500 mg/L .The Iron is very low except the samples except 7 and 8.Station 6 have high value of Nitrate value greater than the permissible limit and other samples are acceptable. Classification of Water quality index shows values in the study area varies from 21 to 518. Stations 7,3 and 14 has the highest WQI and it indicates unfit for drinking (Table 4).

Sample Stations	WQI
S1	33.60657
S2	24.24486
S3	105.0792
S4	94.19099
S5	43.97791
S6	35.07519
S7	518.3094
S8	272.6744
S9	22.38743
S10	44.88742
S11	26.86605
S12	34.4139
S13	94.85211
S14	104.1635
S15	21.30794

Table 4 Water quality index for the study area Maduravoyal

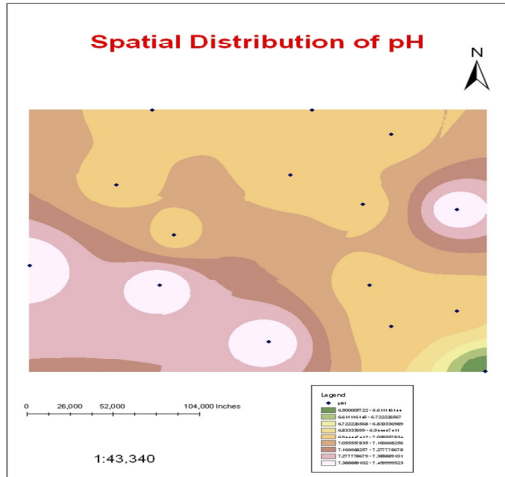


Figure 2 Spatial distribution of pH

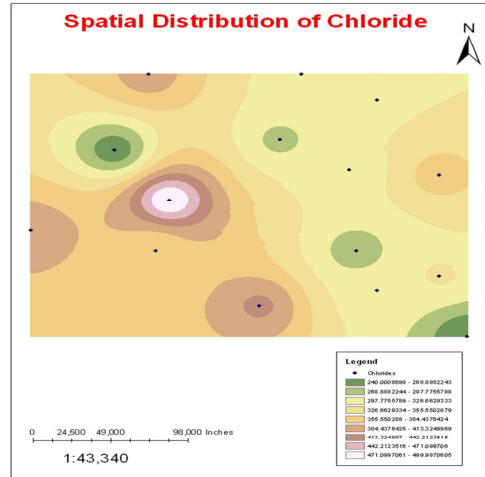


Figure 3 Spatial distribution of Chloride (mg/l)

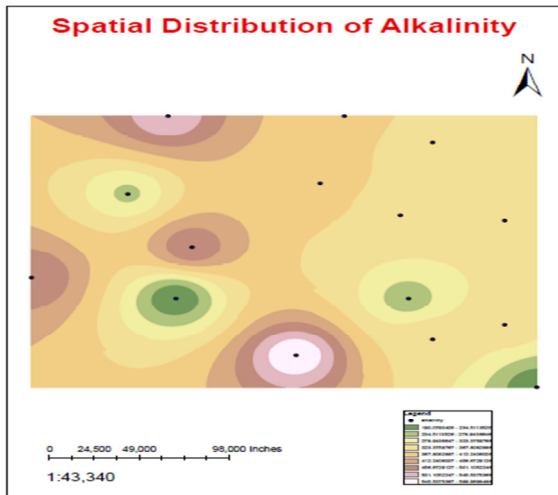


Figure 4 Spatial distribution of Total Alkalinity (mg/l)

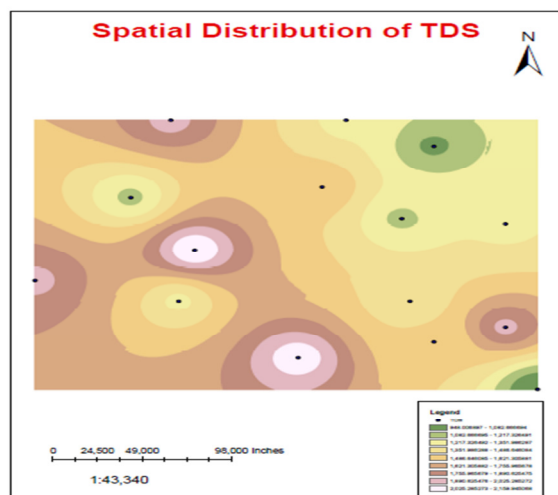


Figure 5 Spatial distribution of Total Dissolved Solids (mg/l)

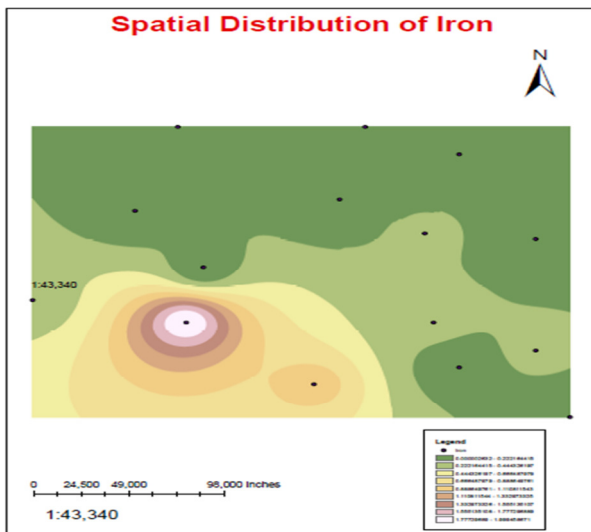


Figure 6 Spatial distribution of Iron (mg/l)

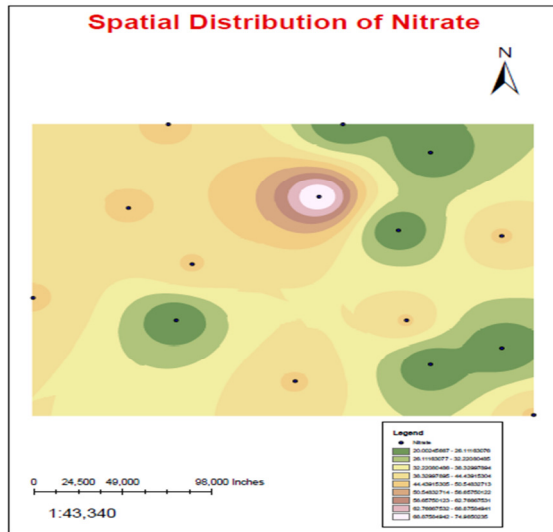


Figure 7 Spatial Distribution of Nitrate (mg/l)

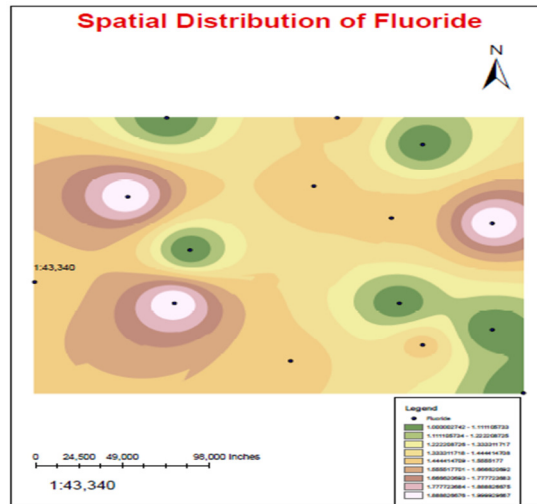


Figure 8 Spatial Distribution of Fluoride (mg/l)

5. CONCLUSION

The Inverse Distance Weighting method in GIS show the spatial distribution of the groundwater quality parameters in the Maduravoyal area. The parameters like Conductivity, TDS, Iron, fluorides and chlorides are very high and further increase in any of these parameters may affect human and livestock directly. Proper and effective water quality management can bring the back to form by introducing or building proper drainage, sanitation etc. From this investigation, it is that most of the locations fall under the very poor range of WQI. So that study indicates the water in that area needs some purification process for drinking purpose.

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