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Spatial analysis of ground water quality at minjur using geograpic information system

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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.This study aims to assess the spatial distribution of ground water quality of the Minjur. Over exploitation of ground water has become a major challenge not only to the present civilization and also for the future generations.The Ground water samples around the Minjur was collected. 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) and also, Water Quality Index(WQI) was developed using the water quality analysis results. The maps were prepared using ARC GIS software. The results and map were used to monitor effectively and also to draw the attention of government authorities for taking necessary action.

KEY WORDS: Spatial, ground water, geographic.

1. INTRODUCTION

Water is essential for sustenance of life. 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. The knowledge of the occurrence, replenishment and recovery of potable groundwater assumes special significance in quality-deteriorated regions, because of scarce presence of surface water. 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.

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. The measurement of pollutant concentration at every location is not always feasible in view of the time and the cost involved in data collection. Therefore, prediction of values at other locations based upon selectively measured values could be one of the alternatives. In this context, to predict the concentration of pollutants at unmeasured locations, the geostatistical techniques can be used. The basic assumption in using geostatistics is that the properties in the earth have some spatial continuity up to a certain lag distance. The geostatistical concepts and its applications are reported by different researchers around the world.

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. Previous studies indicated that the groundwater recharge zones are distributed in small patches and used as sources of contaminant migration to groundwater. 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 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.

The Aim of this study is to analysis the surface water and sub-surface water quality around the Minjur and also to identify the spatial variation of water quality by using Geographic information system (GIS) software. The main objectives are,

a. To analysis the surface water and sub-surface water quality around the minjur
b. To identify the spatial variation of water quality by using GIS software.
c. To generate integrated ground water quality mapping for the study area.

2. MATERIALS AND METHODS

2.1. Study area: The study area is Minjur, which is the northern part of Chennai metropolitan Area. It is one of the fastest developing areas as the suburbs of the Chennai city, the population of the study area is more than 28,337. The latitude of study area ranges from 13°16' N to 13°27' N and longitude ranges from 80°16' E to 80°27' E. As the development of Minjur is taking place at much rapid pace, the housing colonies have started utilizing groundwater as a means of water supply for domestic purpose. Minjur is the one of the suburban places of Chennai which is highly growing in terms of education, industrialization, agriculture which is expanding leaps and bounds. Minjur in its area wise twice than that of Thiruvottiyur and thrice of Ponneri which is very much near to Minjur. Outer ring road which connects the southern Chennai (Vandalur on NH45) to Minjur is a main part of the CMDA'S second master plan for the greater Chennai. The location map of study area shown in Fig 1.The samples were collected from 12 various locations across Minjur shown in Fig 2.

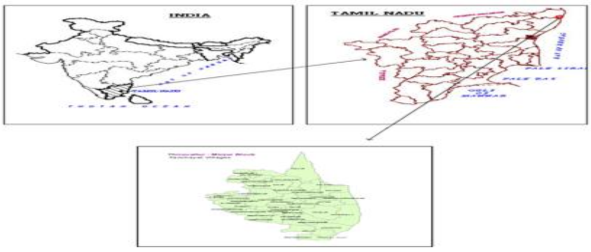

Fig.1.Location map of Study area

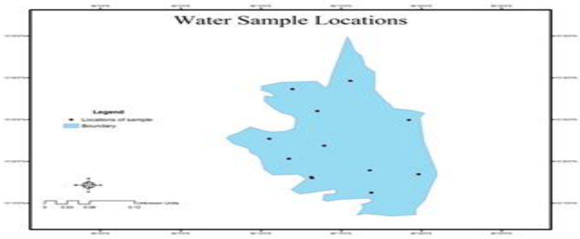

Fig.2.Water Sample Locations

The parameters like pH, TDS, TH, CA2+, MG2+, TA, Cl-, SO4-2, F-, NO3+ were analyzed. Sampling location points are given in the Table 1.

Table.1.Sampling location points

Sample no	Latitude	Longitude	Well type	Depth
1	13°3'N	80°3'E	Bore well	60feet
2	13°27'N	80°17'E	Open well	10feet
3	13°23'N	80°27'E	Bore well	80feet
4	13°35'N	80°28'E	Bore well	95feet
5	13°43'N	80°22'E	Bore well	85feet
6	13°11'N	79°9'E	Bore well	110feet
7	13°1'N	78°1'E	Bore well	70feet
8	13°31'N	80°21'E	Bore well	120feet
9	11°1'N	78°02'E	Bore well	80feet
10	13°'26'N	80°28'E	Bore well	80feet
11	13°21N	80°25'E	Bore well	55feet
12	13°'6'N	80°18'E	Bore well	60feet

2.2. Water quality index (WQI): 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.Conventionally it has been used for evaluating the quality of water for water resources such as rivers, streams and lakes, etc.All the calculation are manipulated in MS-Excel using formulae's.

a. 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.

b. The maximum weight of 5 has been assigned to the parameter nitrate due to its major importance in water quality assessment.

c. Magnesium which is given the minimum weight of 2 as magnesium by itself may not be harmful.The relative weight (Wi) is computed as follows

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

Where, W_i is the relative weight, w_i is the weight of each parameter and n is the number of parameters.

For computing the WQI, the SI is the first determined for each chemical parameter. Which is then used to determine the WQI as per the following equation:

$$SI_i = W_i Q_i$$

$$WQI = \sum_{i=1}^{n} SI_i$$

3. RESULTS AND DISCUSSION

Water sampling is a technique used to analyze water from a variety of different sources. Sampling is a way of taking a small of amount of the source and testing it to provide information on the whole.So the twelve samples were collected around the Minjursite in the interval of one month. The physio chemical test results are given in the Table 2.

Table.2.Water quality analysis results for 12 sampling locations

p^H	TDS	T H	CA^{2+}	MG^{2+}	TA	Cl^-	SO_4^{-2}	F-	NO^{3+}
6.9	1168	460	144	24	236	315	98	0.36	8
7.14	1205	560	152	43	248	295	98	0.25	20
8.1	1386	320	80	29	444	235	89	0.24	35
7.56	1288	190	52	14	432	220	79	0.3	4
7.31	540	162	50	9	156	136	10	0.4	3
7.44	1104	410	104	36	328	235	44	0.13	38
7.83	978	392	114	26	384	160	22	0.25	11
7.63	1198	540	152	38	276	360	31	0.35	9
7.39	1284	430	120	31	456	265	20	0.35	8
7.02	800	376	102	29	372	114	5	0.23	21
7.63	1384	130	33	12	124	86	5	0.13	2
7.44	1409	1050	300	72	412	1250	65	0.47	2

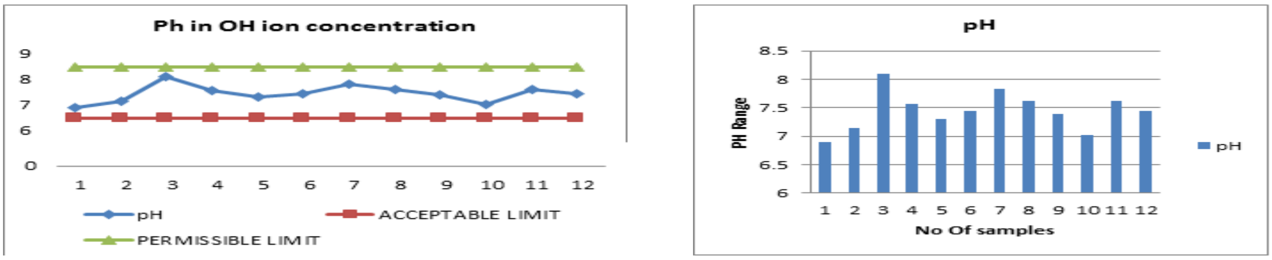

Fig.3.pH values for 12 sampling locations

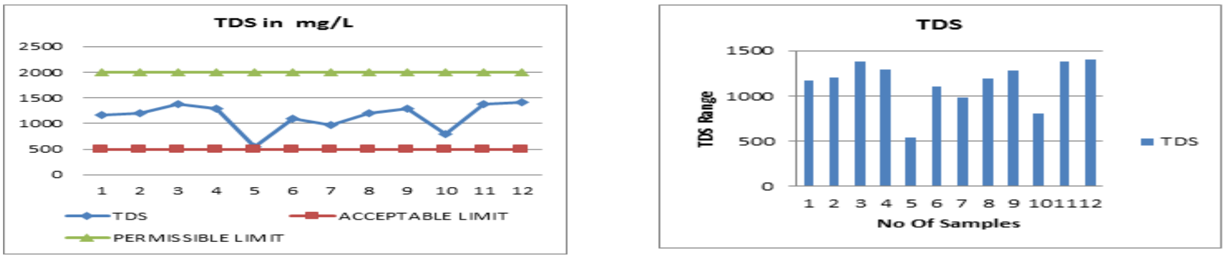

Fig.4.TDS values for 12 sampling locations

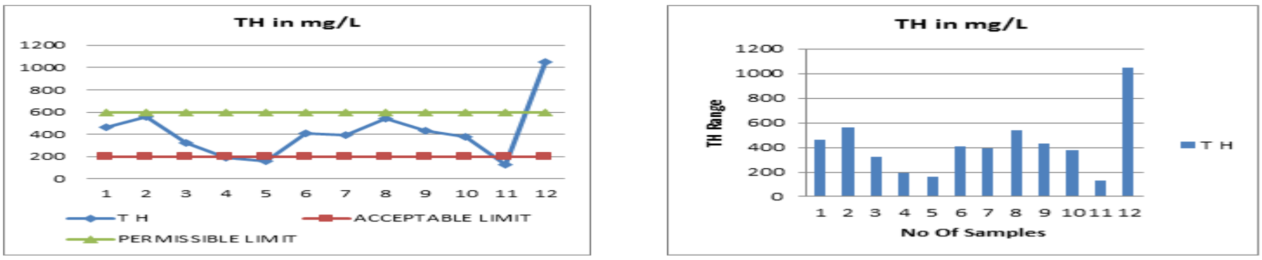

Fig.5.Total hardness values of 12 sampling locations

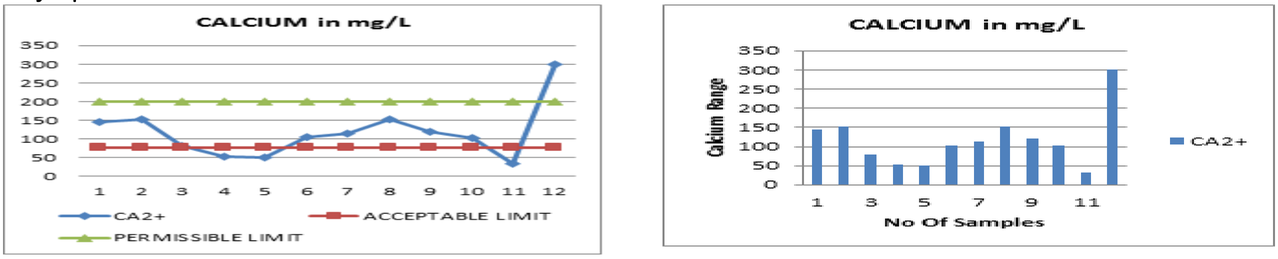

Fig.6.Calcium values for 12 sampling location

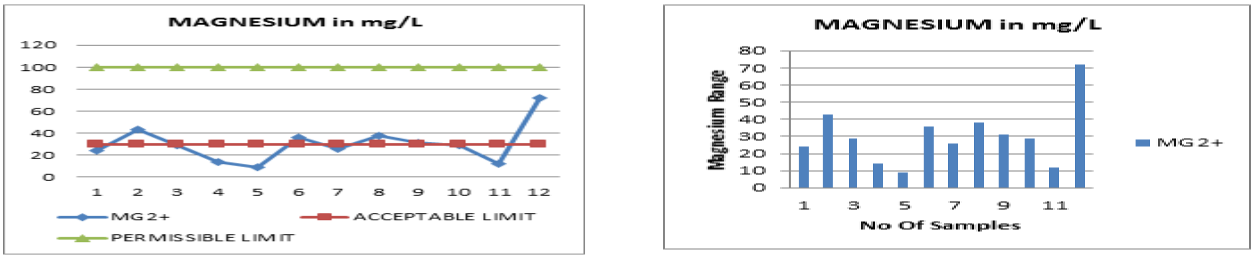

Fig.7.Magnesium values for 12 sampling locations

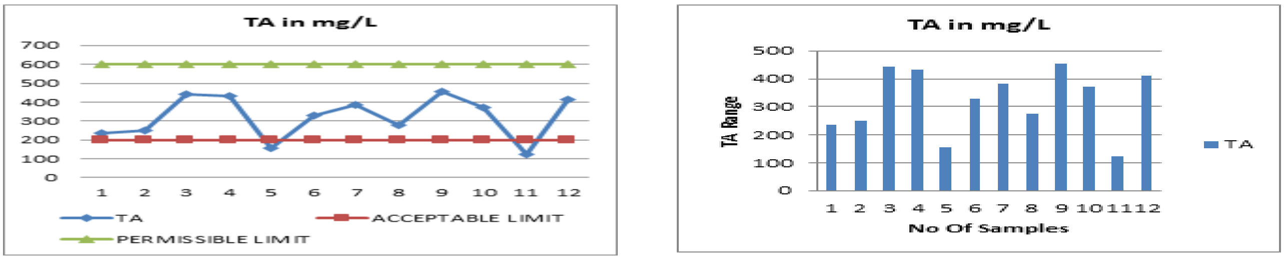

Fig.8.TA values of 12 sampling locations

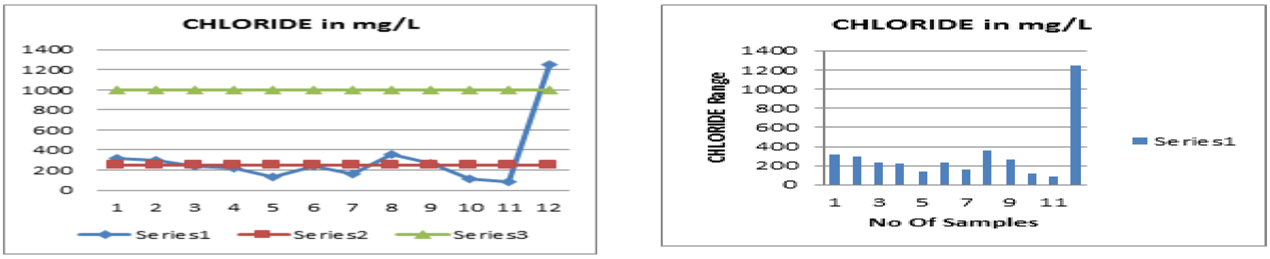

Fig.9.Chloride values of 12 sampling locations

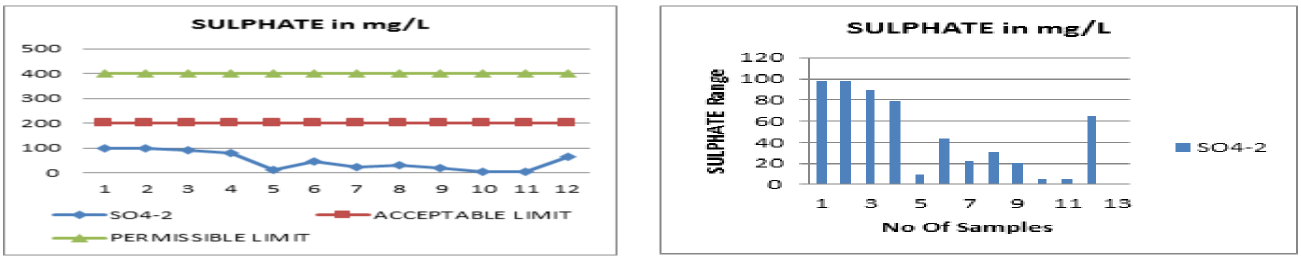

Fig.10.Sulphate values of 12 sampling locations

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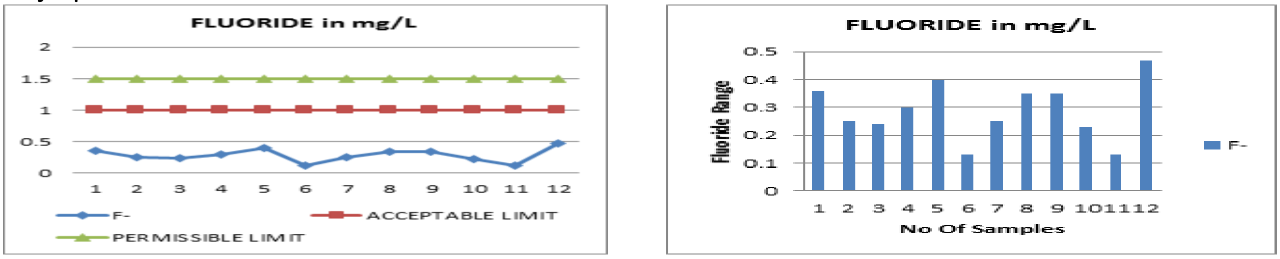


Fig.11.Fluoride values of 12 sampling locations

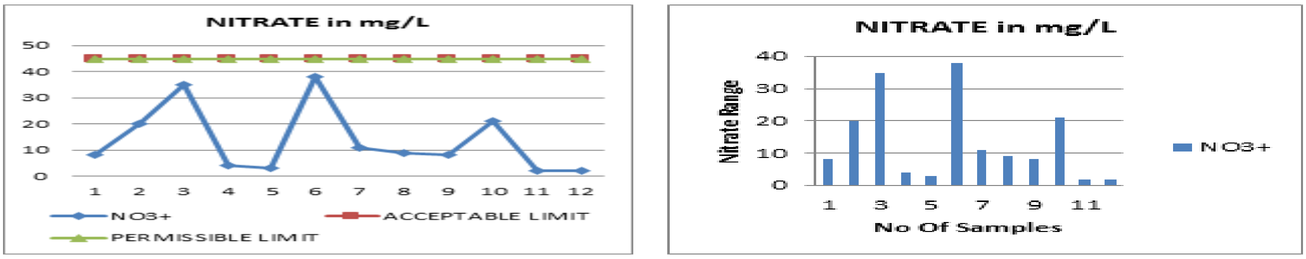


Fig.12.Nitrate values of 12 sampling locations

The sample number 12 was mostly polluted water because TDS, Chloride and Total hardness values exceeds the limit. WQI is 192.13 in this location. WQI values for all the 12 locations are given in table 3.

Table 3Water Quality Index values for 12 sampling locations

Sampling locations	WQI	Water quality
1	105.8659	Poor water
2	117.2189	Poor water
3	118.461	Poor water
4	94.51044	Good water
5	55.0176	Good water
6	108.2393	Poor water
7	94.95103	Good water
8	113.3657	Poor water
9	111.4255	Poor water
10	88.26089	Good water
11	67.10976	Good water
12	192.1383	Poor water

Arc GIS analysis:

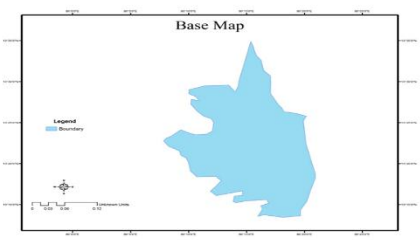
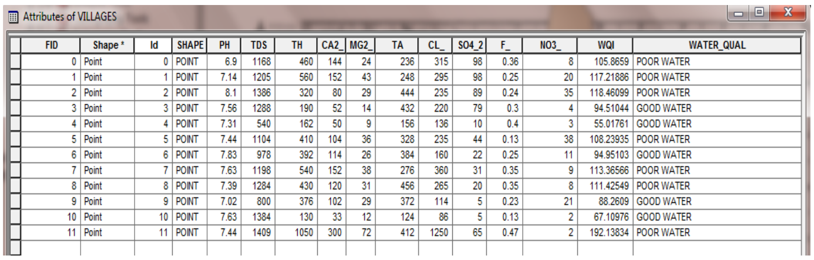


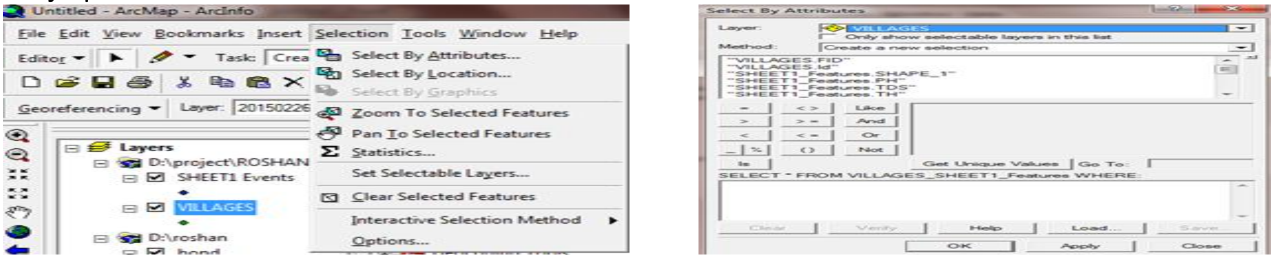
Fig.13.Base map of Minjur village


Attributes of VILLAGES

FID	Shape *	Id	SHAPE	PH	TDS	TH	CA2_	MG2_	TA	CL_	SO4_2	F_	NO3_	WQI	WATER_QUAL
0	Point	0	POINT	6.9	1168	460	144	24	236	315	98	0.36	8	105.8659	POOR WATER
1	Point	1	POINT	7.14	1205	560	152	43	248	295	98	0.25	20	117.21886	POOR WATER
2	Point	2	POINT	8.1	1386	320	80	29	444	235	89	0.24	35	118.46099	POOR WATER
3	Point	3	POINT	7.56	1288	190	52	14	432	220	79	0.3	4	94.51044	GOOD WATER
4	Point	4	POINT	7.31	540	162	50	9	156	136	10	0.4	3	55.01761	GOOD WATER
5	Point	5	POINT	7.44	1104	410	104	36	328	235	44	0.13	38	108.23935	POOR WATER
6	Point	6	POINT	7.83	978	392	114	26	384	160	22	0.25	11	94.95103	GOOD WATER
7	Point	7	POINT	7.63	1198	540	152	38	276	360	31	0.35	9	113.36566	POOR WATER
8	Point	8	POINT	7.39	1284	430	120	31	456	265	20	0.35	8	111.42549	POOR WATER
9	Point	9	POINT	7.02	800	376	102	29	372	114	5	0.23	21	88.2609	GOOD WATER
10	Point	10	POINT	7.63	1384	130	33	12	124	86	5	0.13	2	67.10976	GOOD WATER
11	Point	11	POINT	7.44	1409	1050	300	72	412	1250	65	0.47	2	192.13834	POOR WATER

Fig.14.Attributes of WQI In Arc GIS

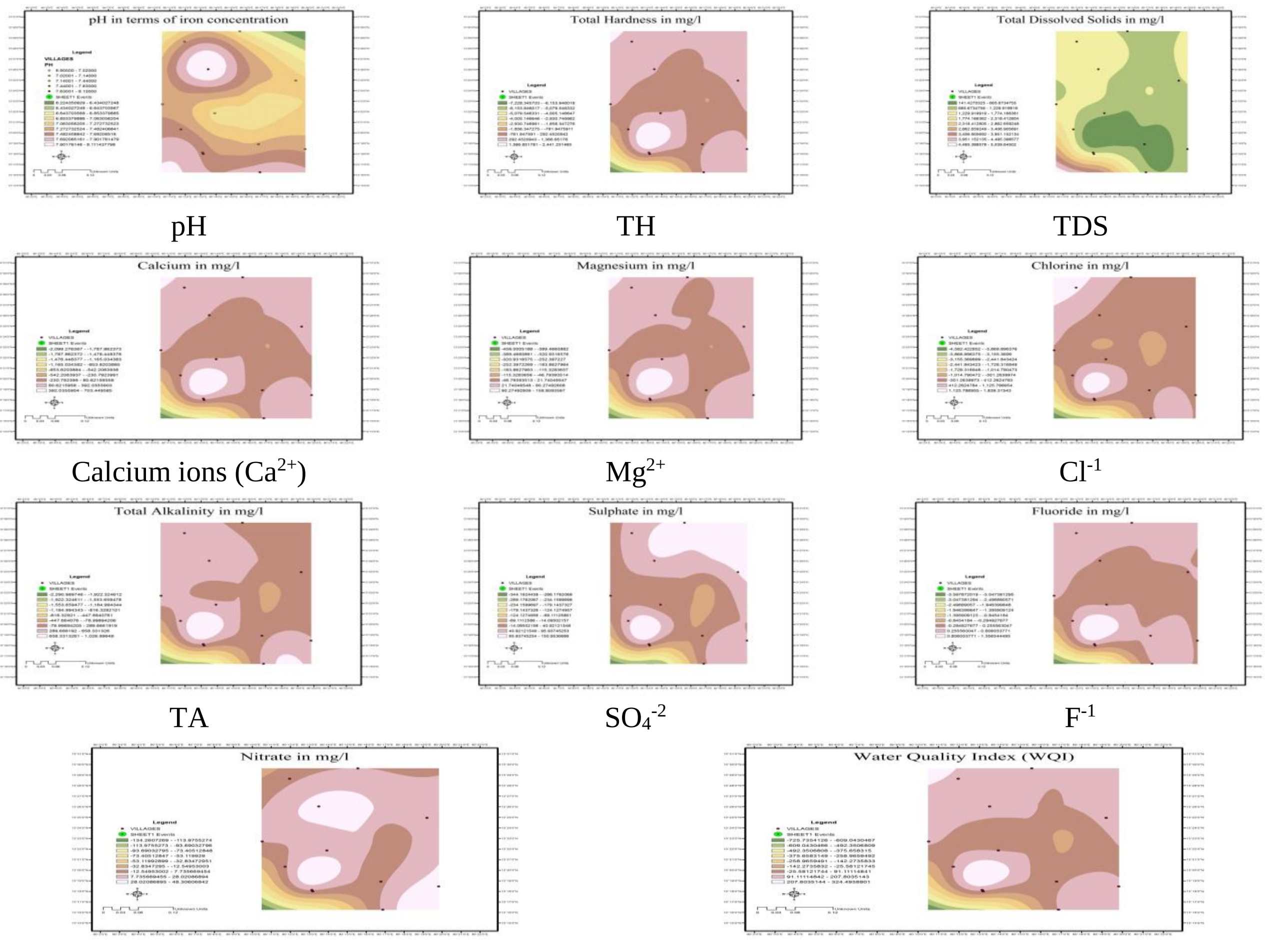
Then WQI data are stored in MS Excel table format. It is linked with the Arc Gis Software using the OBJECT ID using join option.



1 2

Fig.15.Querying For Water Quality

Finally, the parameters were analyzed with respect to variation in space using the spline curve technique. Thereby describing the locality where the concentration of chemical compositions is higher or lower. These charts can be used to describe the areas of high quality with that of the worst.



pH TH TDS

Calcium ions (Ca^{2+}) Mg^{2+} Cl^{-1}

TA SO_4^{-2} F^{-1}

NO^{+3} WQI

Fig.16.Spatial Analysis Result

4. CONCLUSION

The physio-chemical parameters wereanalyzed 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's can be manipulated for water quality mapping of a Minjur village with increasing the number of sample points.

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