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A GIS BASED APPROACH TO ASSESS GROUNDWATER QUALITY IN KURNOOL DISTRICT

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Abstract-- Water is essential for survival of mankind on the surface of the Earth. The surface water bodies which act as a source of drinking water are prone to pollution by industrial wastes in the current days. As a result people rely on groundwater sources for drinking, irrigation etc., It has become a necessity to evaluate quality of ground water as it is being polluted to a large extent because of rapid urbanization and industrialization. The present study aims to assess quality of groundwater in Kurnool district. The samples are collected at various well locations and are studied for physico-chemical parameters like electrical conductivity, H^+ ion concentration, bi-carbonate, carbonates, sulphates, and chloride concentration. Thematic maps for each physico-chemical parameter is prepared by Inverse distance weightage interpolation method of Geographical Information system (GIS). The assessment of ground water quality is performed by water quality index, which expresses overall quality at a location. Based on the results potential zones are identified by query builder in ArcGIS.

Key words: Ground water, Physico-chemical parameters, Inverse distance weightage, Water quality Index, Query Builder.

1. Introduction

The sustenance of mankind is dependent on the fresh water quality. On entire surface of the Earth, only 2.5% of water is considered to be fresh water. Due to rapid urbanization, sources of water are polluted at an increasing rate which leads to depletion. Kurnool, being second largest district of state is a drought prone area and people are dependent on ground water for drinking purpose. Ground water is self-purified because it passes through various layers of sand. The industrial waste being dumped down leads to environmental distress on ground water. To assess the quality of water, Water Quality Index is coined by Bureau of Indian Standards (BIS) and Indian Council for Medical Research (ICMR). It expresses a single number to depict the quality in a particular location. Though a single number cannot judge the entire quality, it acts as a source of representation of complex water data to simple quality data. The parameters are converted to raster format by interpolation of existing vector data using GIS technologies.

2. Study Area and Data

2.1 Study Area

Kurnool district is the third largest district of the State situated between North latitudes 14°35':16° 09' and East longitudes 75° 56': 78° 58'. It is bounded by Tungabhadra, Krishna Rivers and Mahabubnagar district in the North and Prakasam district in the East, Bellary district of Karnataka State in the West and Anantapur and Kadapa districts in the South. The district comprises of 54 mandals as shown in fig.1

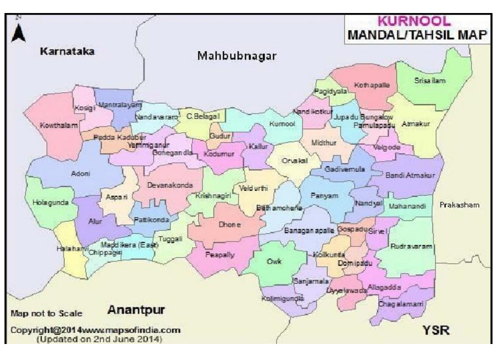


Fig 1: Kurnool district map

2.2 Data

Groundwater quality data from 93 well locations out of 54 mandals was collected from District water board for the monsoon season of year 2016. The parameters assessed for the current study are pH, chlorides, Sulphates, carbonates, bicarbonates, total dissolved solids and total hardness.

3. Methodology

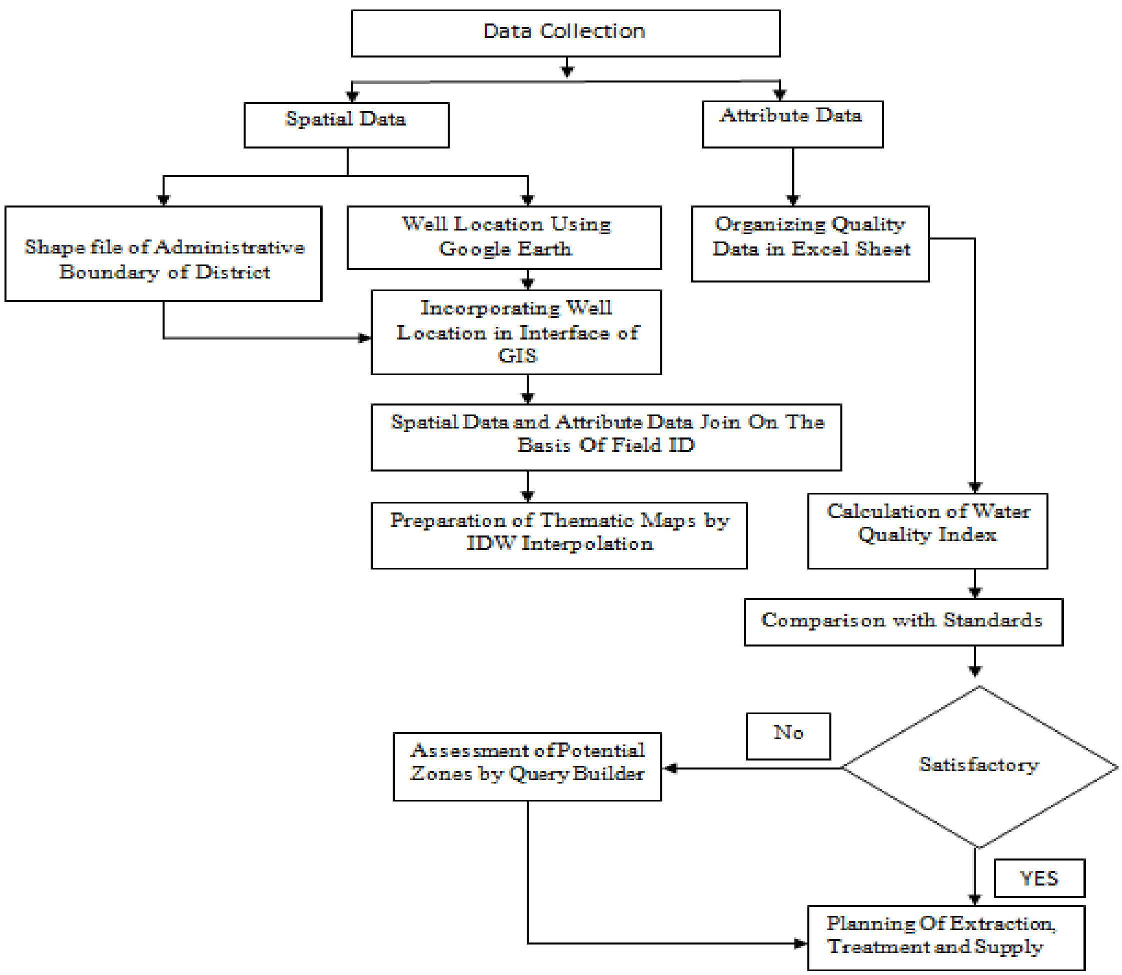
The methodology adopted for current study is shown in fig.2. Spatial data corresponding to administrative boundary of Andhra Pradesh state in shapefile format is downloaded from www.divagis.com. The shapefile of Kurnool district is masked down in ArcGIS software.The well locations at which quality data is collected from District water Board is collected from Google Earth Pro. The well locations in terms of latitudes and longitudes are written down in a notepad and then converted to point shapefile in GIS interface. WGS 1984 is considered as datum file for the current study.Attribute data corresponding to water quality parameters for the pre-monsoon season of 2016 is properly organized in an Excel sheet. Spatial and attribute data are joined together based on field ID using join and relate tool in ArcGIS. Water quality index for the current study is based on six parameters and is calculated based on weighed arithmetic index method (Brown et.al). The first step in calculation is to rate the quality of each parameter. Let q_n be the quality rating of each parameter where n is no.of each parameter. It is given by eq.1

$$q_n = 100 * \frac{x_n - x_i}{S_n - x_i} \qquad \text{eq-1}$$

Where x_n is observed parameter, x_i is 7 for pH and 0 for other parameters. S_n is standard value of parameter under concern. Each parameter is given a unit weight for water quality index calculation by Bureau of Indian Standards (BIS) and Indian Council for Medical Research(ICMR). Water quality Index is given by eq.2. The standard permissible values according to IS 10500 and unit weights for each parameter are given in table-1.

$$WQI = \frac{\sum w_n q_n}{\sum w_n} \qquad \text{eq.2}$$

Where w_n is unit weight of n^{th} parameter and q_n is quality rating of n^{th} parameter from eq.1.Water quality index thus calculated is compared with the laid down standards. The standards are given in table-2. If is satisfies the standards,



Further planning of supply can be performed. If it does not hold good with the standards potential locations of supply are identified by spatial distribution of quality parameters. The spatial distribution of each parameter is observed by executing Inverse Distance Weightage (IDW) interpolation. The algorithm of IDW is such that weightage to the points that are farther from a location is less when compared to points that are nearer. With the weightages incorporated by GIS, point data is converted to surface data wherein the variation of parameters is represented in form of thematic maps. The potential groundwater sources for drinking are thus identified by building queries on the produced thematic maps.

Table-1: Drinking water standards and unit weights (All values except pH and Electrical Conductivity are in mg/L)

S.No	Parameter	Standards	Unit weight
1	pH	6.5-8.5	0.2190
2	Electrical conductivity	300	0.371
3	Total dissolved solids	500	0.0037
4	Total hardness	300	0.0062
5	Chlorides	250	0.0074
6	Sulphates	150	0.01236

Table 2: Water Quality Index Standards (Chatterjee and Raziuddin 2002)

Water Quality Index	Status/Rank
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

4. Results

The distribution of water quality parameters across the district is evaluated by IDW interpolation and the variation is studied by calculating areas for each class of parameter. The variation of pH shown in fig 3 depicts that around 68% of area has suitable range of pH for drinking.

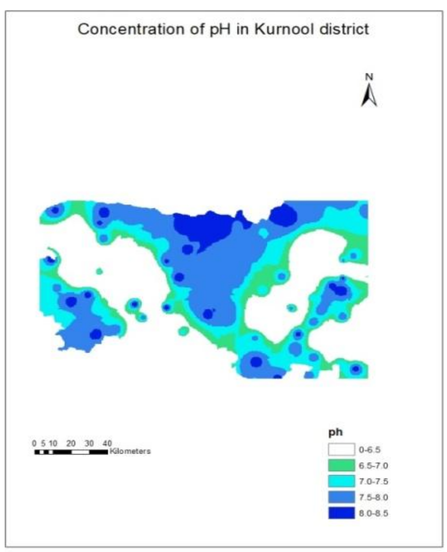


Fig 3: Concentration of pH in Kurnool district

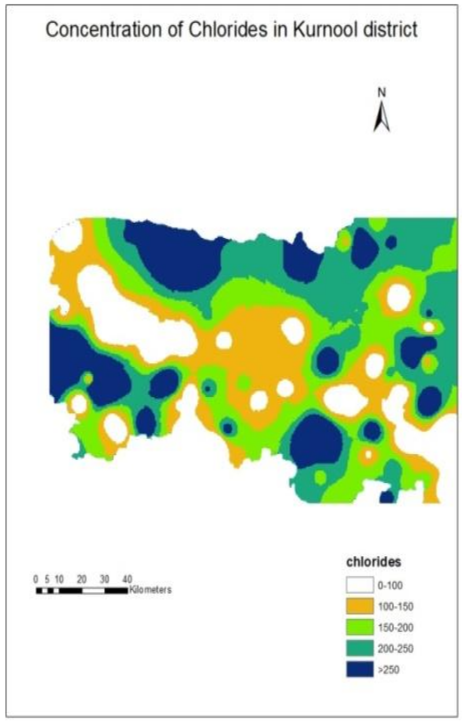


Fig 4: Concentration of Chlorides in Kurnool district

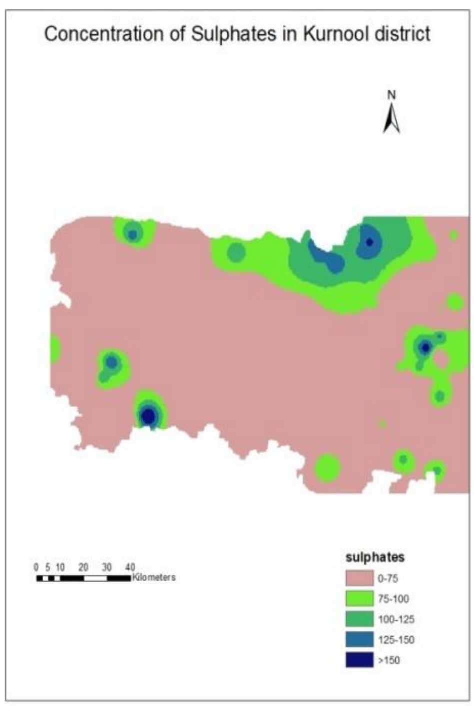


Fig 5: Concentration of Sulphates in Kurnool district

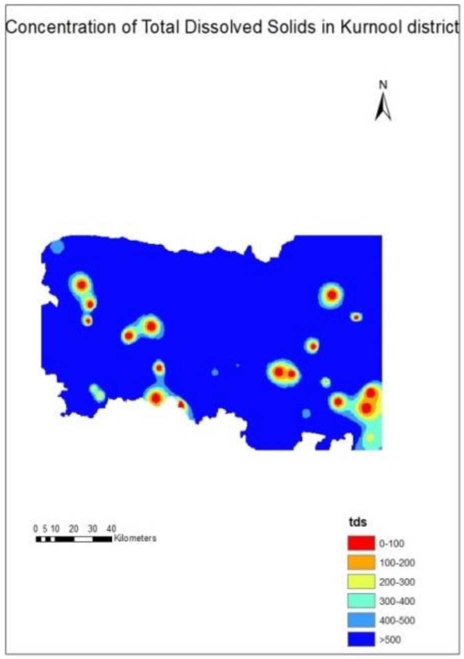


Fig 6: Concentration of Total Dissolved Solids in Kurnool district

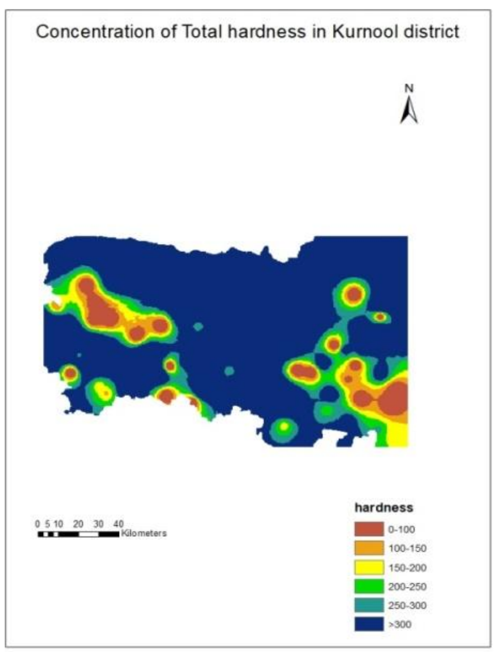


Fig 7: Concentration of Total hardness in Kurnool district

From fig 4 and fig 5, it can be said that 72% of area has chloride content within the permissible limits and nearly 85% of area has permissible sulphate content. Though most of the areas have permissible ranges of chlorides and Sulphates, permissible limit of total dissolved solids (fig 6) is not satisfied in major part of district. The same situation is also observed in distribution of hardness (fig 7) which can be attributed to ground water pollution by industrial wastes. Water quality index for the five parameters is calculated and is shown in table 3

Table 3: Water Quality Index

Parameter	Avg of Observed values	Unit weight(w)	Quality rating(q)	w*q
PH	7.90526	0.219	60.350667	13.216796
Chlorides	234.068	0.0074	93.6272	0.6928413
Sulphates	71.7945	0.01236	47.863	0.5915867
TDS	1111.97	0.0037	222.394	0.8228578
TH	450.653	0.0062	150.21767	0.9313495
		Sum= 0.24866		Sum=16.255431
				WQI=65.37212

From table 3 WQI is found to be 65.37212, which when compared with standards given by BIS indicate that quality of water is poor. As the quality of water is poor, suitable locations to draw water for drinking purpose are identified based on building queries from the observed data. Using query builder in ArcGIS, a query was built on standards for drinking water as shown in fig 8 and fig 9 and thus potential zones for drinking water were found to be Adoni, kuppagal, J.Bangla, Kodumur, Erragudi, Kothapali, Mallapalli, Alur, Banaganapally, Velgodu, Veldurthy, Nandavaram, Kanla, Pagidyala, Orvakal, Pamulapadu, Garladinne, Yemminganur, Tuggali.

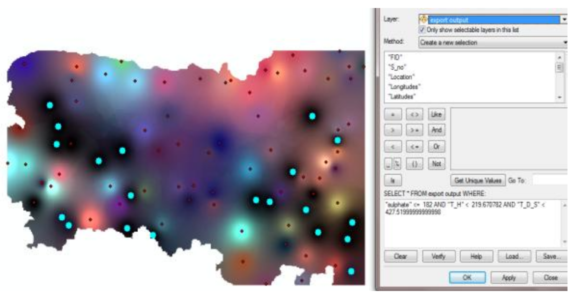


Fig 8: Query builder based on attributes

5. Conclusion

From the analysis performed by interpolation of existing vector data, it is found that major part of district's ground water resources are subjected to pollution. The water quality index which was calculated on five parameters doesnot meet with the standards laid down with NCMR and BIS. For sustenance potential zones from which ground water can be evacuated and used for drinking purpose after treatment are found based on building queries.

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