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Research Paper

SPATIAL ANALYSIS FOR GROUND WATER QUALITY OF NORTHEAST PART OF KADAPA DISTRICT, ANDHRA PRADESH

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Groundwater is the ideal source of water for human exists. In the olden days, the ground water development is through dug wells. Over a period of time, due to increase in population, the stress on ground water has increased. Consequently, the water quantity and quality were lowered. The quality of ground water is just as important as its quantity. Ground water is less susceptible to bacterial pollution than surface water because an excellent mechanism for filtering out particulate matter, such as leaves, soil, and bugs, dissolved chemicals and gases through which ground water flows screen out most of the bacteria. But freedom from bacterial pollution alone does not mean that the water is fit to drink. Many unseen dissolved mineral and organic constituents are present in ground water in various concentrations. The most common dissolved mineral substances are namely pH, Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Chloride (Cl) and Fluoride (F). Hence monitoring of ground water quality has become indispensable. In the present study water samples were collected all around the study area and Geographical Information Systems (GIS) is used to prepare the spatial variation maps of major water quality parameters in the study area. GIS not only facilitates data capture and processing but also serve as powerful computational tools that facilitate multi map integrations (Subramani *et al.*, 2012). In the present groundwater quality map was prepared by integrating of spatial variation maps of major water quality parameters for Northeast part of Kadapa district, Andhra Pradesh.

Keywords: Groundwater, Water quality, GIS, Spatial interpolation, Integration

INTRODUCTION

Groundwater is an important resource of water supply throughout the world. It is used in Irrigation, Industries, drinking and domestic uses. It is essential to maintain a proper balance between the groundwater quantity and quality otherwise it leads serious problem. In recent years, the growth of industry, technology, population, and water use has increased the stress upon both our land and water resources. Locally, the quality of ground water has been degraded. Municipal and industrial wastes and chemical fertilizers,

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herbicides, and pesticides not properly contained have entered the soil, infiltrated some aquifers, and degraded the ground-water quality. Other pollution problems include sewer leakage, faulty septic-tank operation, and land fill leachates. In some coastal areas, intensive pumping of fresh ground water has caused salt water to intrude into fresh-water aquifers. Water is a solvent and dissolves minerals from the rocks with which it comes in contact. Ground water may contain dissolved minerals and gases. Water typically is not considered desirable for drinking if the quantity of dissolved minerals exceeds 1,000 mg/L (milligrams per liter) (http://pubs.usgs.gov/gip/gw/quality.html). Dissolved mineral constituents can be hazardous to animals or plants in large concentrations; for example, too much sodium in the water may be harmful to people who have heart trouble. Boron is a mineral that is good for plants in small amounts, but is toxic to some plants in only slightly larger concentrations. Water that contains a lot of calcium and magnesium is said to be hard. Water quality analysis is one of the most important factors in groundwater studies. Variation of groundwater quality is a function of physical and chemical parameters that are generally influenced by geological formations and anthropogenic activities. Geospatial technology permits cost effective survey and management of natural resources and this technique has wide-range applications in geo-scientific research including ground water quality.

OBJECTIVE

The objective of present study is to prepare spatial variations of various groundwater quality substances and extract the groundwater quality map of the study area.

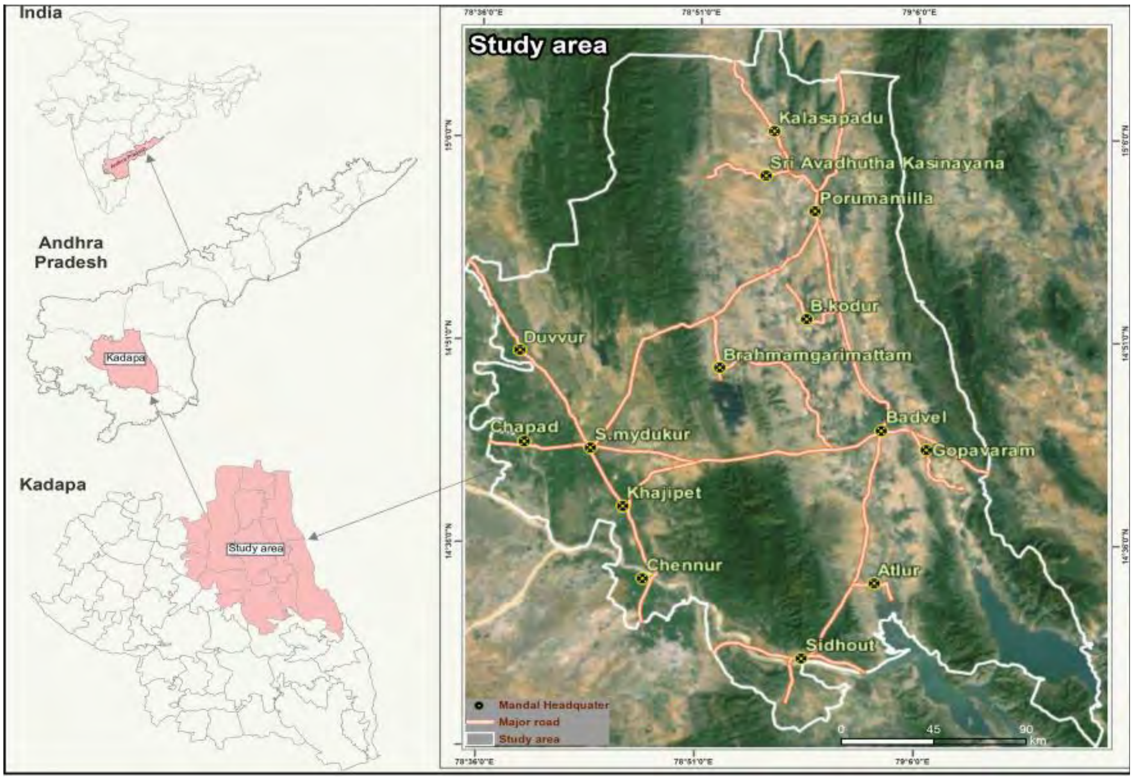
STUDY AREA

The study area has a total geographical area of 4025.38 sq.km out of the total geographical area of 1651 sq.km (41%) of the area is covered by forests with 14 mandals, and 291 revenue villages, lies between north latitude 14^0 20' 50" N & 15^0 13' 54" N and east longitude 78^0 35' 13" E & 79^0 18' 48" E (Figure 1). The annual normal rainfall received by the area is 705 mm. Sagileru River drained in the study area and the important hill is Nallamalais trending in NW-SE direction. Generally the area experience its minimum temperature varying from 28 to 30^c range in November to January and its hottest temperature varies from 40 to 45^c ranges during April to May (Profile of Kadapa District).

METHODLOGY

To understand the quality of water in the study area a total of 232 locations (Figure 2A) water samples were collected. Each of these samples were analyzed and tested for major parameters for their physico-chemical properties subsequently evaluated using the Indian drinking water standards as per BIS guideline. The spatial and the non spatial database were generated for the generation of spatial variation maps of major water quality parameters like pH, Total Dissolved Solids (TDS), Total hardness (TH), Total Alkalinity (TA), Chloride (Cl), and Fluoride (F). Spatial interpolation technique through Inverse Distance Weighted (IDW) approach has been used in the present study for generating spatial distribution of the ground water quality. The spatial variation maps of major ground water quality parameters were prepared as thematic layers. All the spatial variation layers were integrated and the final ground water quality map has been prepared (Danee Joycee *et al.,* 2015).

Figure 1: Map Showing Location of the Study Area



RESULTS AND DISCUSSION

Spatial database analysis was done using interpolation method of inverse distance weighted (IDW). This method is an algorithm for spatially interpolating values which are estimated between measurements. In IDW, every value is a weighted average of surrounding points. Weights are computed by taking the inverse of the distance from observations location to the location of the point being estimated. IDW determines cell values by using linearly weighted combination of a set of points (Jagadish Kumar M *et al* 2013). The spatial variation maps were prepared for all major water quality parameters according to Bureau of Indian Standards (BIS) as shown in Table 1. Based on the spatial variation maps of major water quality parameters an integrated ground water quality map was prepared. Results and discussion for the water quality parameters such as pH, Total Dissolved Solids (TDS), Total hardness (TH), Total Alkalinity (TA), Chloride (Cl), and Fluoride (F) are as follows

pH

A scale for measuring hydrogen ion concentration in a solution, called pH scale has been developed. The p in pH stands for 'potenz' in German, meaning power. On the pH scale we can measure pH generally from 0 to 14 (http://epathshala.nic.in/e-pathshala-4/flipbook/). The pH values of the samples in the study area lies from 6.25 to 8.9. Majority of the area falls within desirable limit of 6.5 to 8.5 categorized as good; few areas were falls below 6.5 and above 8.5

Table 1: BIS-Water Quality Standards			
S.No	**Characteristic**	**Desirable limits**	**Permissible limit**
1	pH	6.5-8.5	No relaxation
2	TDS	500 mg/l	2000 mg/l
3	Hardness	300 mg/l	600 mg/l
4	Alkalinity	200 mg/l	600 mg/l
5	Chloride	250 mg/l	1000 mg/l
6	Fluoride	1.0 mg/l	1.5 mg/l

categorized as Poor and spatial variation of pH is shown in Figure 2B.

Total Dissolved Solids (TDS)

"Dissolved solids" refer to any minerals, salts, metals, cations or anions dissolved in water. TDS comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that is dissolved in water (www.water-research.net/totaldissolved solids.htm). The TDS values of the samples in the study area lies from 596 to 1968 mg/l. As per BIS guidelines, TDS of water is classified in to three ranges i.e 0-500 mg/l (good), 500-2000 mg/ l (moderate) and >2000 mg/l (poor). The study area lies in moderate class only and the spatial variation of TDS are shown in Figure 2C.

Total Hardness (TH)

Hardness in drinking water is defined as those minerals that dissolve in water having a positive electrical charge. The primary components of hardness are calcium (Ca^{++}) and magnesium (Mg^{++}) ions. The TH values of the samples in the study area lies from 176 to 1568 mg/l. As per BIS guidelines, TH of water is classified in to three ranges i.e. >300 mg/l (good), 300-600 mg/l (moderate) and >600 mg/l (poor). The study area falls in all three classes and the spatial variation of TH is shown in Figure 2D.

Total Alkalinity (TA)

As per the BIS standard desirable limit of alkalinity of potable water is 200 mg/l, the maximum Permissible level is 600 mg/l and high alkaline water >600 mg/l. Total Alkalinity in the groundwater of the study area varied from 72 to 1000 mg/l, these values were classified as per BIS standards and the spatial variation of TA is shown in Figure 3A.

Chloride (CL)

Chloride, in the form of the $Cl^–$ ion, is one of the major inorganic anions, or negative ions, in saltwater and freshwater. It originates from the dissociation of salts, such as sodium chloride or calcium chloride, in water. These salts, and their resulting chloride ions, originate from natural minerals, saltwater intrusion into estuaries, and industrial pollution. Chloride is one of the most important parameter in assessing the water quality and higher concentration of chloride indicates higher degree of organic pollution. According to BIS the permissible limit of chloride in drinking water is 250 mg/l this concentration limit can be extended to 1000 mg/l of chloride in case no alternative source of water with desirable concentration is available. However ground water having concentration of chloride more than 1000 mg /l are not suitable for drinking purposes. In the study area Chloride concentration fluctuates from 38 to 1776 mg/l and the spatial variation of Cl shown in Figure 3B.

Fluoride (F)

Fluorine is an element, the 9th in the periodic table. Fluorine is highly reactive and naturally found only in a form combined with other elements (a compound). When fluorine gains an electron (when it combines with other elements) it is called fluoride. Groundwater usually contains fluoride dissolved by geological formation. The desirable limit of Fluorides is 0.5 - 1.5 mg/l, beyond this limit the water is considered as poor quality. The fluoride values of the samples in the study area lies from 0.6 to 2.5 mg/l and the spatial variation of Fluoride shown in Figure 3C.

Groundwater Quality

After preparing the spatial variation maps of pH, Total Dissolved Solids (TDS), Total hardness (TH), Total Alkalinity (TA), Chloride (Cl), and Fluoride (F) the groundwater quality map has been prepared by overlay analysis of critical

Figure 2 (A) Groundwater Sampling Locations (B) Spatial Variation of pH (C) Spatial Variation of TDS (D) Spatial Variation of TH

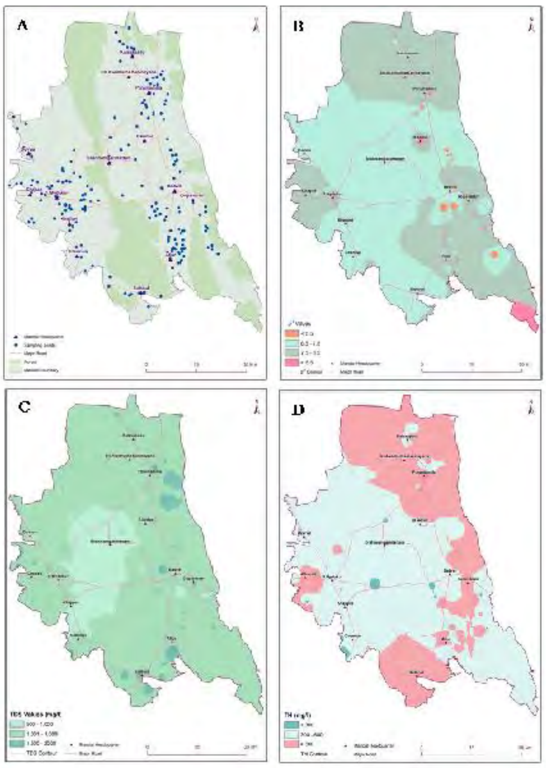
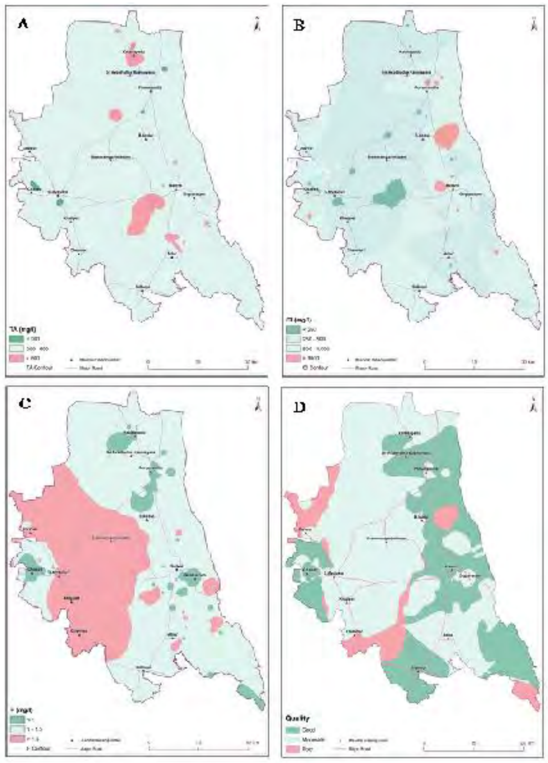


Figure 3 (A) Spatial Variation of TA (B) Spatial Variation of Cl (C) Spatial Variation of F (D) Groundwater Quality



parameters. From the results of overlay analysis water quality has been divided into three categories such as Good, Moderate and poor as shown in Figure 3D.

CONCLUSION

GIS is effective tool for preparation of various spatial variation maps of major water quality parameters such as pH, Total Dissolved Solids (TDS), Total hardness (TH), Total Alkalinity (TA), Chloride (Cl), and Fluoride (F). Spatial distribution maps of various pollution parameters are used to demarcate the distribution of water pollutants in the area. This integrated ground water quality map helps to know the existing ground water condition of the study area. Groundwater quality depends on the amount of the natural recharged water, atmospheric precipitation and inland surface water. The study helps to understand the quality of the water as well as to develop suitable management practices to protect the groundwater resources.

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