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APPLICATION OF GEO-SPATIAL TECHNOLOGIES FOR GROUND WATER QUALITY STUDIES IN MAHABUBNAGAR DISTRICT, TELANGANA STATE, INDIA

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Abstract: Mahabubnagar district of Telangana state is the largest one geographically which is vulnerable to drought with scanty and erratic rainfall and a hot climate. It consists of 64 mandals with 1,558 villages. The canal command area is restricted to around 4.5 % of the area and the rest of the area lies in non-command areas. The ground water sources like Tube well / Bore well / Filter point wells are prominent sources for water supply in the district. Ground water plays a crucial role in agricultural, drinking and domestic needs of the people especially in non-command areas. Ground water quality changes with time and space in response to rainfall, geology, landforms, structural fabrics and developmental needs of people. Krishna and Thungabhadra are two major rivers traversing through the district. The whole district falling in Krishna river basin and consisting of 13 sub-basins like Koilsagar, Dindi , Jurala, Saralasagar, Thungabhadra, Krishna-I, Krishna-II, Srisailam, Kagna, Kothur, Alwanpally, Chinnavagu, and Amrabad. Groundwater resources have reached a very critical stage in Non-Command areas and thoughtful use, conservation and management is required.

In order to evaluate the spatial distribution of groundwater quality, Habitation wise ground water quality data for different elements like pH, Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Fluoride (F), Chloride (Cl), Iron (Fe) Sulphate (So4) and Nitrate (No3) of Mahabubnagar district was obtained from Rural Water Supply and Sanitation Department, Govt. of Telangana. The Remote Sensing imagery with its synoptic coverage, acts as a tool for finding suitable solution in decision making. Hydrogeomorphic Maps were prepared as part of study by integrating different themes like Lithology, Landforms, Structural fabrics and hydrology layers using Remote Sensing & GIS techniques on 1:50,000 scale. An integrated Remote Sensing & GIS study has been taken up for Mahabubnagar district for studying the ground water quality evaluation and its impacts.

Key words - Bore well, Chemical element, Geology, Geospatial Application, Ground Water, Landform, Quality

1. Introduction

Mahabubnagar district is spread over a geographical area of 18,392 sq km, situated to the south of Ranga Reddy district. It is mainly agrarian and one of the chronically drought affected district. During the last three decades, there is considerable increase in the well irrigation in the district particularly resulting in increase in well density, reduction in well yields and quality deterioration posing challenges in management of ground water resources. In 2011, Mahbubnagar has a population of 40.53 Lakhs of which male and female were 20.50 and 20.03 Lakhs respectively. Good quality of drinking water is essential for human life. Chemical contamination of drinking water is a major concern in drinking water supply. Ground water quality evaluation for different elements is studied with respect to other conventional data using satellite remote sensing techniques.

2. Study Area

The district is bounded by Ranga Reddy district in the North, Nalgonda and Guntur districts in the East, the rivers Krishna/Tungabhadra in the South; Raichur and Gulbarga districts of Karnataka state in the west. The study area lies in between 15.82° - 17.25° of North Latitude; and 77.22° - 79.25° of East Longitudes. The location of the study area is as shown in Figure. 1. Out of the total Mahbubnagar population for 2011 census, about 15% percent people lives in urban regions as against to state average of 39%; and rest of 85% people lives in rural areas of district.

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LOCATION MAP

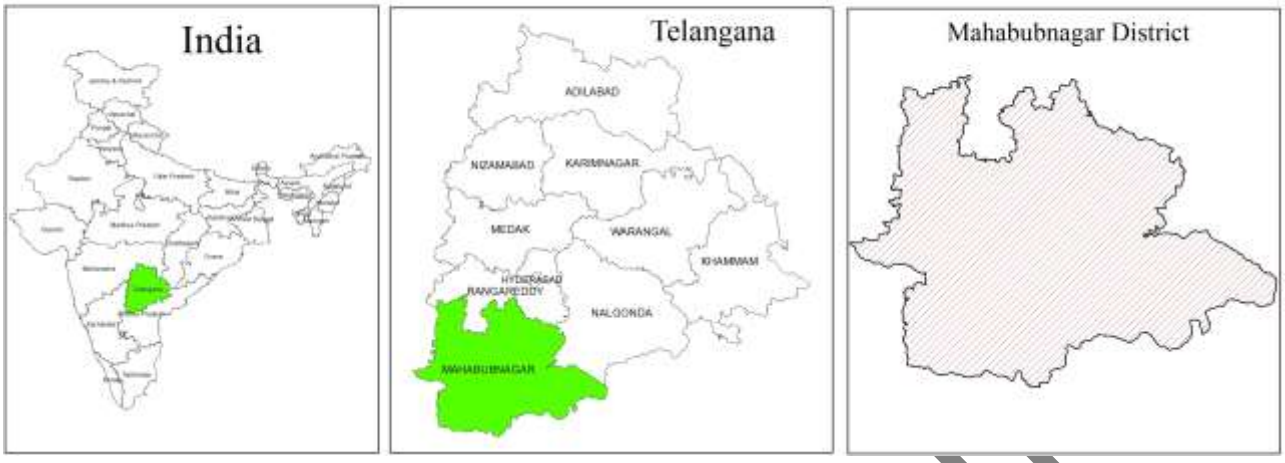

Fig. 2.1 Location Map of the Study Area

3. Rainfall

The District has an average actual rainfall of 594 mm during 1992-2012 years as against to a normal rainfall of 604 mm, the bulk of which is received through the South West Monsoon during the period from June to September. The normal rainfall is hardly 66% of the state average (921 mm). About half of the mandals in the district have rainfall of less than 600 mm. The average normal rainfall in four mandals namely Ghattu, Pangal, Manopadu and Chinna chintakunta is below 500 mm which are falling in South-Western side of the district. The normal rainfall distribution map is as shown in Figure 2. Comparatively the SE (South-East), NNE (North-North East) and NNW (North-North West) mandals of the district shows above normal rainfall as compared to rest of the district.

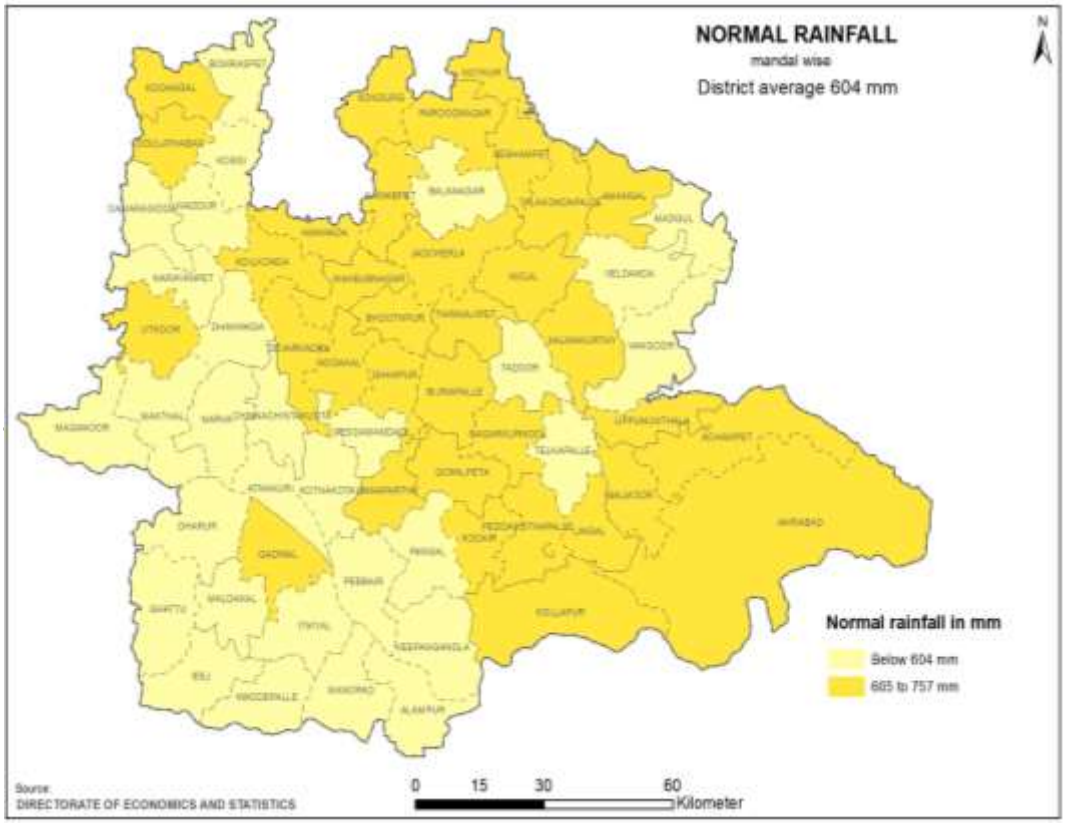

Fig. 3.1 Rainfall distribution of the study area

4. Geography

Mahabubnagar District is physiographically contiguous to the Mysore plateau and is generally characterized by erosional topography. The altitude generally decreases from NW to SE. The minimum and maximum elevation ranges are from 610 m in Shadnagar and Kalvakurthy areas in the north to about 350 m amsl in Achampet, Gadwal, Atmakur and Wanaparthy areas in south and southeastern parts of the district. Two important rivers, viz. Krishna and Tungabhadra flow through the district. The Krishna River enters Telangana State in Makthal taluk of this district and covers Makthal, Gadwal, Atmakur, Wanaparthy, Kollapur, Alampur and Achampet taluks. The Tungabhadra flows through the taluks of Gadwal and Alampur. The Dindi River, which is a tributary of the Krishna flows through Kalwakurthy and Achampet and joins the Krishna River, 18miles east of Chandragiri. Pedavagu and Chinavagu are the other tributaries of the Krishna in the district.

5. Soils

The district is mainly covered by four types of soils viz. red earth (with loamy sub soils and chalks); red sandy soils (Dubbas and Chalkas), Black Cotton Soils (Heavy deep to very deep; and light moderately deep to deep). The major soil type found in the district is red sandy soil. Loamy soils (dubba) are found in 13% of geographical area. The share of red sandy soil (Chalka) is 67% and that of black cotton soil is 20%. In general, the soil quality is shallow and poor in fertility. There are large patches of saline and alkaline soils. Black cotton soil exists in narrow strips, along the banks of river Krishna and Tungabhadra, in Gadwal, Kollapur and Makthal areas. The northern half of the district, especially the area south of Tungabhadra River, is covered by a thick blanket of black cotton soil.

6. Land Use / Land Cover

Land Use & Land Cover (LULC) of the district is prepared on 1:50,000 scale during the year 2011-12 by using satellite remote sensing techniques with limited field checks. It has been revealed that out of a total area of 18,392 Sq. Km; about 62% area is under agriculture land; 9% under fallow lands; 15% of area under forest cover; waste lands and waterbody covers about 6% of area each and remaining 2% area is covered by built up land.

7. Geology

Major portion of the District is underlain by the Oldest Geological formations like Granite Gneiss and Migmatite under Peninsular Gneissic Complex of Archeans. The Dharwar Supergroup rocks are represented mainly by Gadwal Schist Belt, running in NW-SE direction between Narayanpet and Manyapadu. It exposes basic, intermediate and acid volcanic rocks associated with agglomerate and thin bands of banded iron formation. The rocks of Peninsular Gneissic Complex and Dharwar Supergroup are intruded by younger granitoids named as Closepet Granites. The southern part of the district comprises the Proterozoic sedimentary rocks, belonging to Cuddapah Supergroup and Kurnool Group of rocks. The Cuddapah sediments deposited non-conformably over peninsular gneissic and Dharwars, comprise conglomerate, quartzite, limestone, dolomite and shale. The Kurnool Group of rocks overlies Cuddapah rock formations and consists mainly of limestone, shale and quartzite. A thin sequence of Bhima Group of rocks (equivalents of Kurnool Group of rocks), comprising shale and sandstone are exposed in north-western part of the district in Korangal taluk. Trap rocks of basaltic composition occur over the peninsular gneisses and Bhima Group of rocks in Korangal and Shadnagar taluks of the district. The geological map of Mahabubnagar is shown in Figure 3.

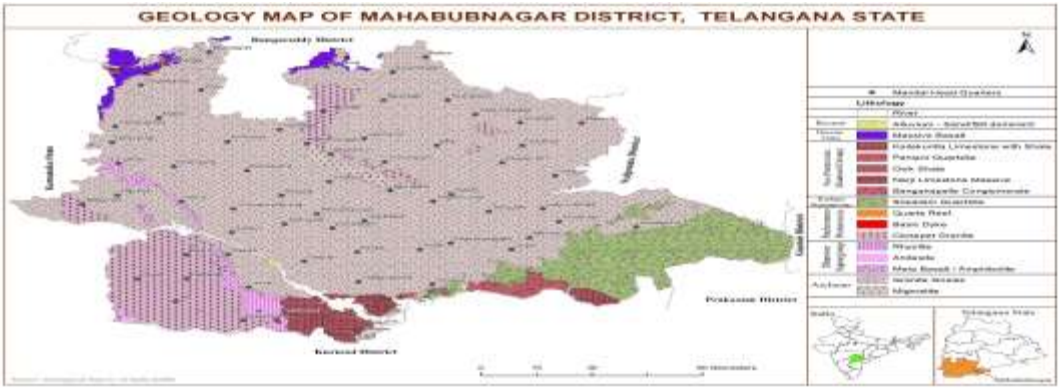

Fig. 7.1 Geology Map of the Study Area

8. Geomorphology

The major part of the district is categorized under pediment/pediplain inselberg complex of granitic gneisses and migmatites with residual hills/valleys in between. Quartzite and shale in the southern part of the district constitute the Srisailam plateau. In the north western part of the district, the Deccan Traps shows their unique step like plateau feature because of their horizontal disposition.

9. Ground Water Quality

Habitation wise ground water quality data for the elements pH, TDS, TH, TA, F, Cl, Fe, No3 & So4 is segregated in to pre and post monsoon seasons based on date of collection. As there are many sources in each habitation, element wise average values are calculated and spatial interpolation is carried out for pre and post monsoon seasons separately using Inverse Distance Weightage (IDW) method by using the spatial analysis tools of ESRI Arc GIS 10 version. Quality evaluation is carried out by using satellite remote sensing techniques and other conventional data.

Out of ground water quality tested sources of 15,905, about 6,352 (40%) sources are quality affected with at least one element whereas it is 33% during post monsoon season. It has been observed that the quality is within permissible limits for the elements pH, Chloride, Iron & Sulphate except at isolated places.

9.1 Fluoride

The ranges of fluoride in the district varies from 0.01-4.00 mg/L (Pre Monsoon) and 0.01-2.35 mg/L (Post Monsoon). The spatial distribution of fluoride map is shown in Figure. 4. The spatial distribution of fluoride concentration is less during post monsoon season as compared to pre monsoon season. There are about 10% sources were quality affected with fluoride during pre monsoon season whereas it is only 5% during post monsoon season in the district. The fluoride concentration is out of range (>1.50 mg/L) in parts of Balanagar, Amangal, Dhanwada, Devarakadra Mandals in the north and Maganoor, Peddamandadi, Ghattu and Alampur mandals in the south side of the district during pre monsoon season. Whereas, in post monsoon season the concentration of fluoride is out of range at some places. The sources for which the fluoride is out of range are found essentially in rock types belonging to Granite Gneiss and Closepet Granite.

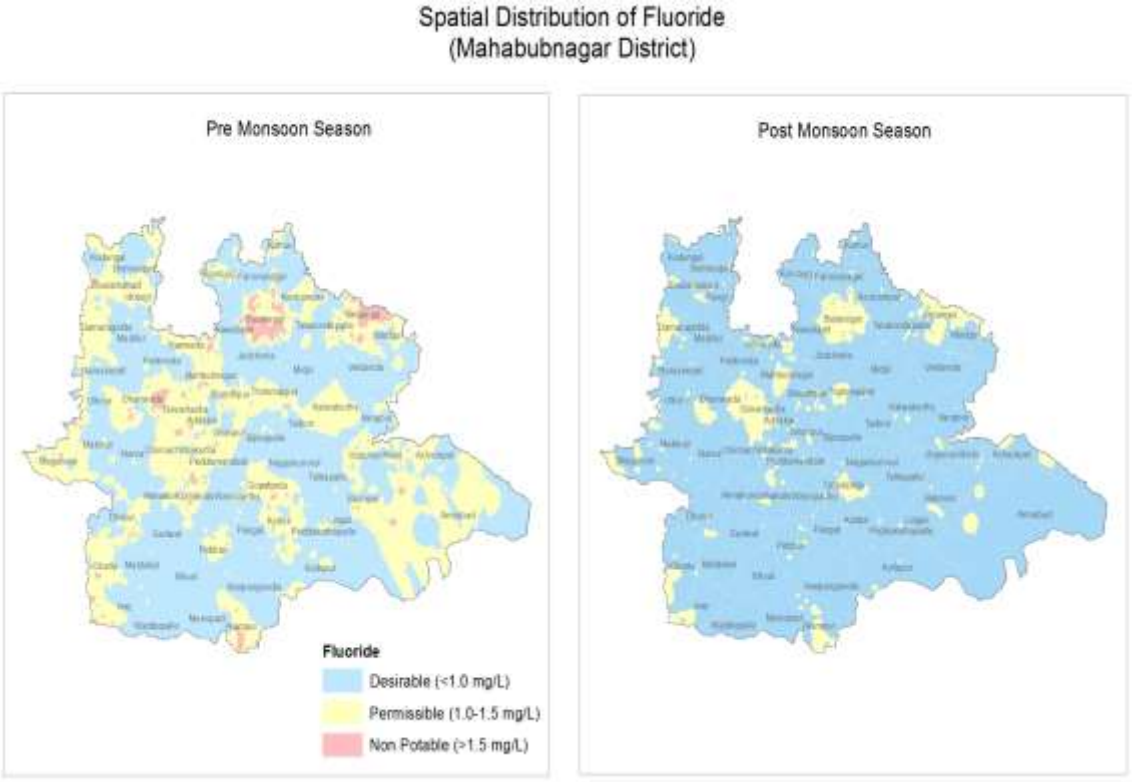

Fig. 9.1 Spatial distribution of fluoride

9.2 Total Dissolved Solids (TDS)

The spatial distribution of TDS map is shown in Figure. 5. The ranges of TDS in the district varies from 98-9165 mg/L (Pre Monsoon) and 103-8935 mg/L (Post Monsoon). There are about 3% sources were quality affected with TDS during pre and post monsoon seasons in the district. The concentration of TDS is out of range (>2000 mg/L) in some of the areas of Manopad, Waddepalle, Ieez and Narva Mandals. The essential rock types in these areas are Rhyolite/Andesite/Metabasalt/Amphobolite belonging to Dharwar supergroup. In Granitic areas it is out of range at isolated places and remaining areas of the district it is within permissible limits.

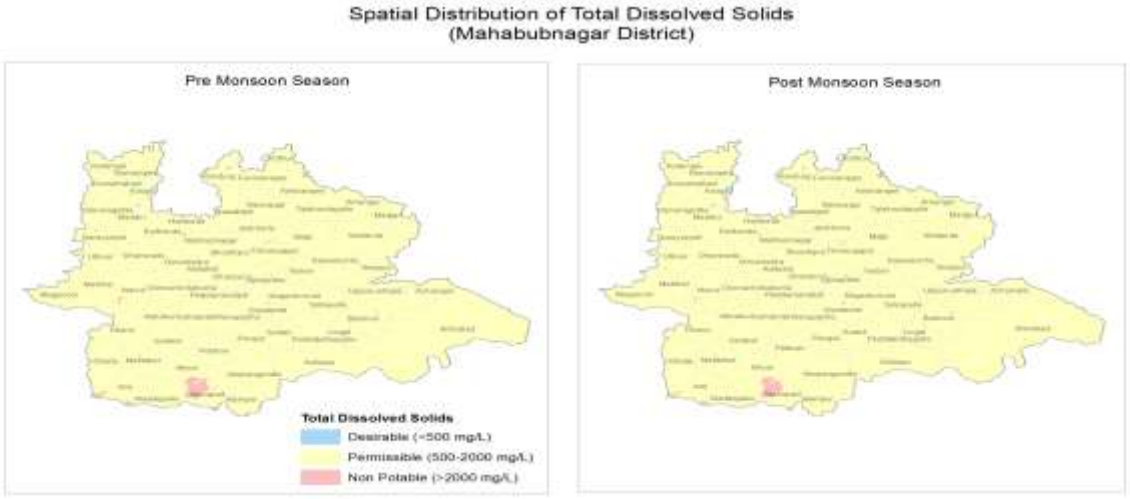

Fig. 9.2 Spatial distribution of Total Dissolved Solids

9.3 Total Hardness (TH)

The ranges of Total Hardness in the district varies from 100-3,886 mg/L (Pre Monsoon) and 100-999 mg/L (Post Monsoon). There are about 21% sources were quality affected with Total Hardness during pre and post monsoon seasons in the district. The spatial distribution of Total Hardness reveals that it is out of range in majority areas of NNW-SSW (North North West-South South West) directions of the district. The rock types in these areas are essentially belongs to Granite Gneiss, Closepet Granite, Dharwar Group of Rocks; and Kurnool Group of rocks (Lime Stone and shale). The Mandals affected are parts of Alampur, Manopad, Waddepalle, Ieez, Itikyal, Gadwal, Atmakur, Dharur, Maganur, Makthal, Utukur, Narayanpeta, Dhanwada. It is also out of range in Keshampeta mandal (North side of the District). The TH quality distribution map is shown in Figure 6. In rest of the areas it is within the permissible limits except at isolated places.

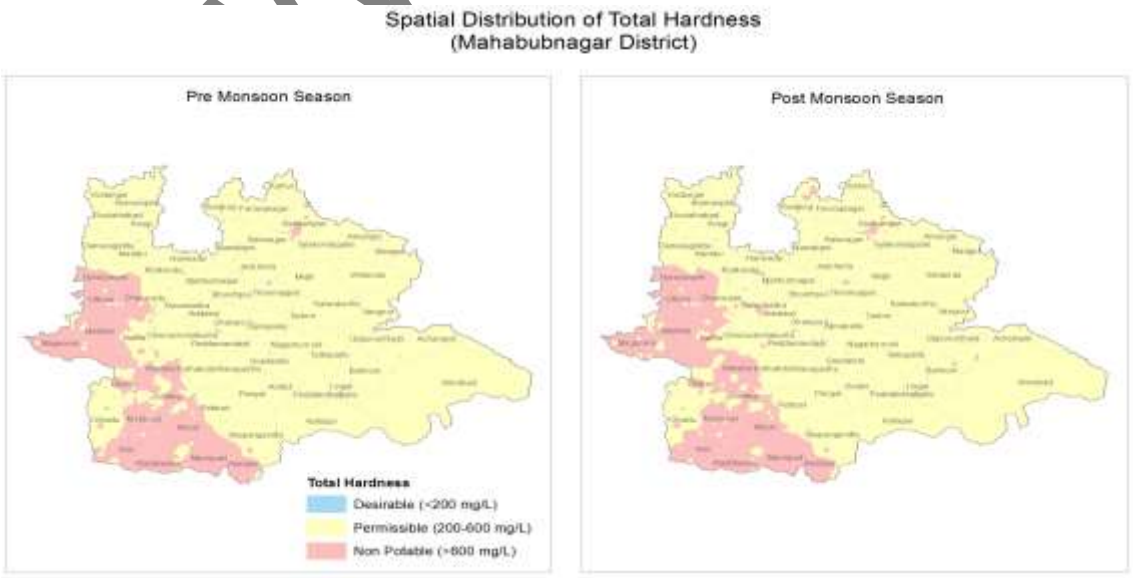

Fig. 9.3 Spatial distribution of Total Hardness

9.4 Total Alkalinity (TA)

The spatial distribution of TA map is shown in Figure. 7. The ranges of TA in the district varies from 100-2866 mg/L (Pre Monsoon) and 100-997 mg/L (Post Monsoon). There are about 5% sources were quality affected with Total Alkalinity during pre and post monsoon seasons of the district. The concentration of TA is out of range (>600 mg/L) in some of the areas of Manopad Mandal during pre monsoon season; whereas it is out of range in some parts of Manopad, Waddepalle, Ieez and Narva Mandals. The essential rock types in these areas are Rhyolite/Andesite/Metabasalt/Amphobolite belonging to Dharwar supergroup. In Granitic areas it is out of range at isolated places and remaining areas of the district it is within permissible limits.

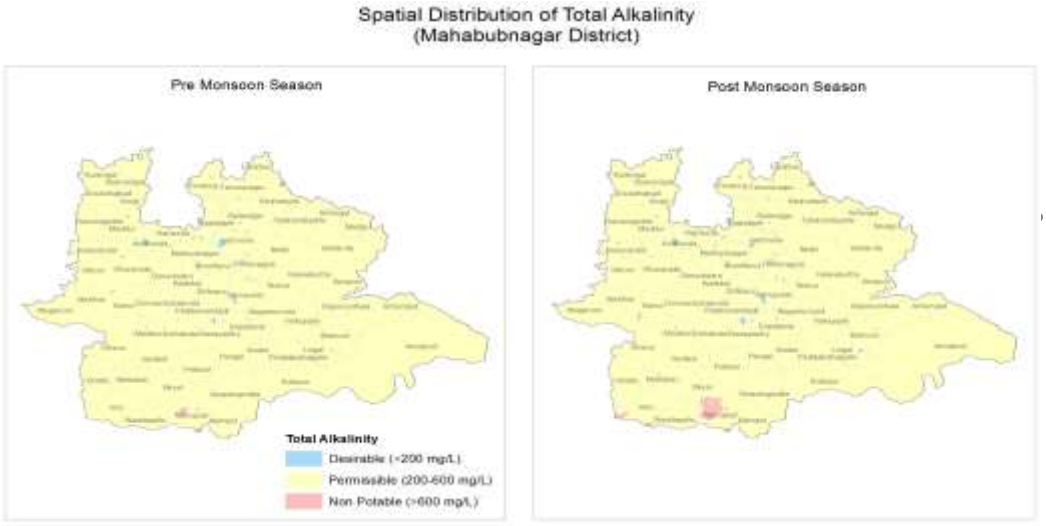

Fig. 9.4 Spatial distribution of Total Alkalinity

9.5 Nitrate (NO3)

The spatial distribution of Nitrate is shown in Figure. 8. The ranges of Nitrate in the district varies from 10-176 mg/L (Pre Monsoon) and 10-99 mg/L (Post Monsoon). There are about 8% sources were quality affected with Nitrate during pre and post monsoon season in the district. The concentration of Nitrate is out of range (>45 mg/L) in some of the areas of Manopad, Amrabad, Wanaparthi, Bijinapalle, Hanwada, Nawabpeta, Kosgi, Kothur, Balanagar, Thimmajipeta mandals etc. The essential rock types in these areas are Rhyolite belonging to Dharwar supergroup; and Granite Gneiss/Closept Granite.

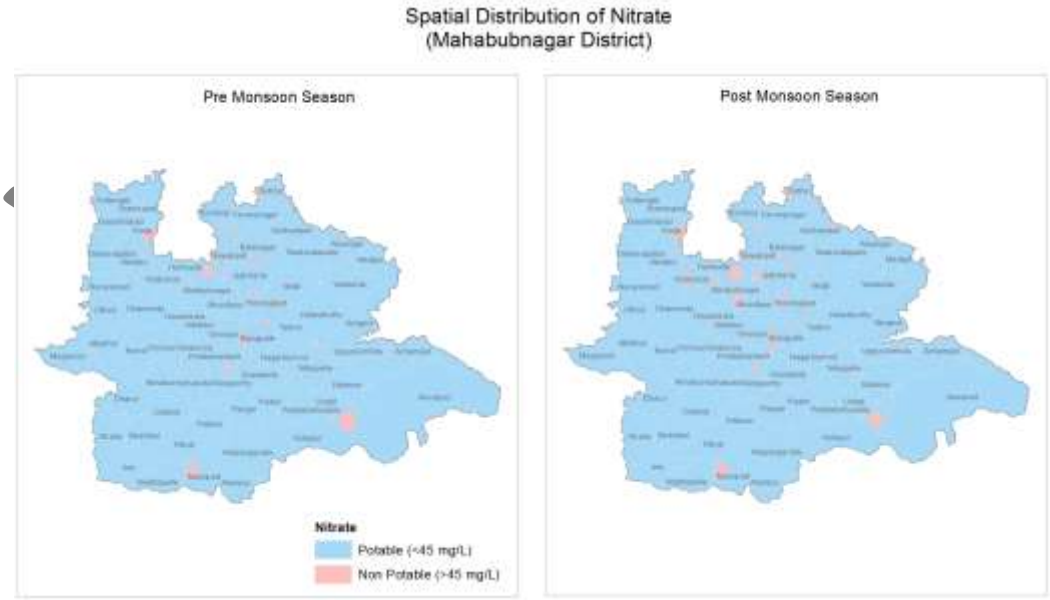

Fig. 8. Spatial distribution of Nitrate

10. Results and Discussions

The ground water quality maps are useful in assessing the usability of water for different purposes especially for drinking purpose. It has been found that the ground water quality is essentially out of range for the elements Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA) and Fluoride (F) in the areas where the normal rainfall of the district is below 604 mm. But the Nitrate contamination is essentially found in the areas where the normal rainfall is 604 mm and above. In the command areas the Total Hardness concentration is more. This could be because of extensive irrigation practised in command areas and recharge from the nutrient rich surface waters. The origin for fluoride contamination occur geogenically. Fluoride in ground water occurs because of fluoride bearing minerals present in the parent rock. The situation is aggravating where the rainfall is less and a longer residence time will usually increase the concentration of fluoride/dissolved in the absence of sufficient rainfall. Human activities influence groundwater quality primarily through contamination. Major sources of groundwater contaminants for nitrate contamination include landfills, septic systems, and untreated sewage. Because of low and erratic rainfall, the concentration of fallow lands is more and thus it will lead to other quality problems. As per the National Forest Policy of India a minimum of 33 percent of the total geographical area should be under forest/tree cover to maintain environmental stability and ecological balance; that are vital for sustenance of all life-forms including human, animal and plants. The role of forests as carbon sinks endows them added recognition as an important environmental factor. However, in the district, the area under forest cover is 15% which is below the desired 33 percent.

11. Recommendations

- The spatial distribution analysis of groundwater quality in the study area indicated that about 40% of the sources are not satisfying the drinking water quality standards prescribed by the ISI having non-potable ground water during pre monsoon season.
- Element wise ground water quality mapping necessitates of making the public, local administrator and the government to be aware on the crisis of poor groundwater quality prevailing in the area.
- The government needs to make a scientific and feasible planning for identifying an effective groundwater quality management system and its implementation.
- Ground water quality of more and more number of habitations is getting quality affected because of geogenic and anthropogenic activities; dynamic and temporal variations of ground water quality should be monitored continuously.
- Continuous monitoring of groundwater table level along with quality study will minimize the chances of further deterioration.
- To improve ground water quality and to enhance ground water storage, ground water conservation and artificial recharge structures must be taken up scientifically on watershed basis
- Geospatial technologies should be used in monitoring the status of habitations in terms of studying regional water quality monitoring, to know up to date status of the water quality affected habitations and to alert the administration / local community for taking alternate remedial measures.

Acknowledgments

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