Delineation of Groundwater Potential Zones Mapping Multi Criteria Decision Making Technique: A Case Study from Rajapet Watershed Part of Yadadri Bhuvanagiri District, Telangana, India

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Abstract— **Today, water demand is increasing due to rapid urbanization, industrial growth and agricultural utilizations. Groundwater levels are decreasing due to all the above activities, decreasing of annual rainfall year to year due to climatic changes and increasing runoff. Hence, it is necessary to increase groundwater levels from the perspective of groundwater use for future demand. Keeping this in view, we have done a model study for a particular area. The study area consists part of the Rajapet Watershed, Yadadri-Bhuvanagiri district of Telangana, India. And the Study Area covers the 172 sq km, the area lies between 170 21'58" and 17045'16" North latitude and 780 44'16"and 790 02'51" East Longitude, With Toposheet Nos. E44M13 (56 K/13) and E44M14 (56 K/14). In the present study, we carried out delineation of groundwater prospect zones using LISS-IV geocoded data on a 1:50000 scale. The information on structure, geomorphology and hydrology were generated and integrated to prepare a groundwater prospect map for the study area. GIS was used to prepare database on the above layers, analysis of relationship and integrated map preparation. The study area has complex geomorphology. On the basis of geomorphic characteristics, four categories of groundwater potential zones: Very good-good, good moderate, poor-nil and nil are delineated. In the final map, we have identified the areas with less groundwater potentials.**

Index Terms— **Groundwater, potential zones, LISS-IV, Rajapet Watershed.**

I. INTRODUCTION

Water is an essential natural resource, which forms the basis of all life. Water is one among the foremost most essential materials in our day-to-day life. Water is a very important resource in all economic activities starting from agriculture to industry. Only a little fraction of the planet's abundant water is available to us as freshwater. About 97% is found within the oceans and is too salty for drinking, irrigation, or industry. The remaining 3% is freshwater. About 2.997% of it is locked up in ice caps or glaciers or is buried so deep that it costs excessive amount to extract. Only about 0.0035 of Earth's total volume of water is easily available to us as soil moisture, exploitable groundwater, water vapour, and lakes and streams.

Groundwater is a vital resource and a significant source of drinking water for the world's population. Groundwater is also an abundant resource and accounts more than 90% of the global freshwater resources excluding water glacial ice. Groundwater is the source of about 90% country's drinking water. In rural areas, most of the water supply comes from groundwater and more than one-third of our 100 largest cities depend on it for at least part of their supply. Historically, groundwater has been considered to be safe to drink. In present days, usage of surface and groundwater is increasing because of rapid urbanization, industrial growth and agricultural utilizations. Consequently, rapid depletion of surface and groundwater is taking place. Compare to the conventional methods Remote Sensing is an advanced technology, because of its wide coverage and repetitive nature, to identify sub-surface water resources. Keeping this in view, the present study aims at groundwater potential mapping to increase groundwater levels at the arid and semi-arid areas using Remote Sensing and GIS.

II. STUDY AREA

The current study area located in Yadadri Bhuvanagiri district, between the 170 21'58" and 17045'16" North latitude and 780 44'16"and 79002'51" East Longitude in Telangana, India. The topography varies with a moderate slope to the Northwest to southeast, with the highest elevation in the west at 676m and the lowest elevation in the east at 218m above mean sea level. The Musi River and its tributaries Bikkeru, Chinneru, and Bukleru are draining the area, which are the main water sources for agriculture. Because of fewer surface water resources and limited rainfall, the area is suffering from a severe water deficit for household and irrigation purposes.

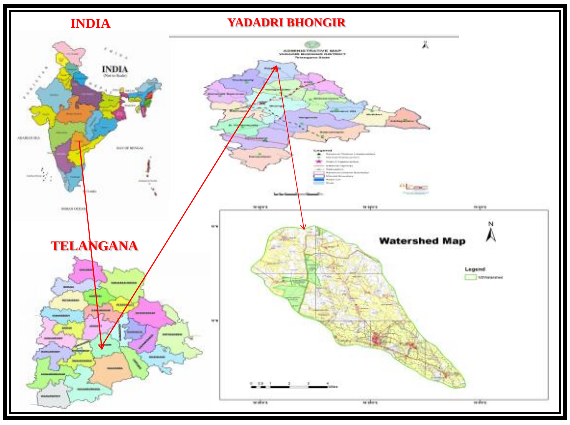

Figure.1 Shows Location of the Study area.

III. LITERATURE REVIEW

In literature survey abstracts on groundwater potential zones and mapping, are collected from scientists of different institutes and universities. They have applied methods for evaluation of the study, which can be implemented in the project study presently being carried. (S.Chakraborty, et al, 2004) have done a project study on 'Identification of Groundwater Potential Zones in the Baghmundi Block of Purulia District of West Bengal Using Remote Sensing and GIS'. Remote sensing techniques with an emphasis on lineament identification, lays a great role in groundwater prospecting and applied on hard rock areas of Purulia district. In this work, Morphometric and Hydro geomorphic analysis has been done to determine the potential water-bearing zone in the study area. The result obtained from the study area is mainly in the form of maps, which show different thematic expressions. Identification of groundwater potential zones is generated from hydrogeomorphological map. (M.A.Khan, et al, 2002) have done a project study on 'Use of Remote Sensing and Geographical Information System in the Delineation and Characterization of Ground Water Prospect Zones'. The present study was carried out to delineate and characterize groundwater prospect zones using LISS-IV geocoded data on a 1:50000 scale. The information on lithology, structure, geomorphology and hydrology were generated and integrated to prepare groundwater prospect map for a region in western Rajasthan. (V.Jothiprakash, et al, 2003) has done a project on 'Delineation of potential zones for artificial recharge using GIS '. In this study, potential zones for artificial recharge in Agniar-Ambuliar-Southvellar river basins in Tamilnadu, India has been delineated through integration of various thematic maps using arc view GIS. A map showing four different potential zones for artificial recharge has been prepared for the study area in Tamilnadu, India. The final map was prepared by integrating various thematic maps, viz., physiography, geology, permeability, and water holding capacity, soil texture, effective soil depth, and drainage intensity. (Y.Srinivasa Rao, et al, 1997) have done a project study on 'Hydrogeomorphological studies by Remote Sensing application in Niva river basin, Chittor District, A.P. To evaluate the hydrogeomorphological conditions of Niva river basin Chittoor district, Andhra Pradesh, geological, hydro geological and geomorphological studies were carried out, through visual interpretation of Land sat 5, FCC with adequate ground truth 10. All the conventional information such as geological, hydrogeological, well inventory data and also the information collected during field checks was used in the finalization of the hydrogeomorphological map.

IV. MATERIAL AND METHODS

In this study QGIS software and data is used to prepare different thematic maps. The data includes DEM data, Satellite image and data from groundwater department of Telangana.

1) Preparation of base map from in QGIS software, and lithological, structural, geomorphological and hydrological maps based on the visual interpretation of satellite image in conjunction with the existing maps/literature. 2) Incorporation of available field observations in the lithological, structural, geomorphological, hydrological and base map overlays. 3) Preparation of groundwater prospects map by combining the lithological, structural, geomorphological and hydrological map overlays and transferring the details on to the base map and preparation of legend indicating hydro geomorphic unit-wise groundwater prospects. 4) Identification of sites having less groundwater potentials.

V. RESULTS AND DISCUSSION

A. Geology

The area includes the peninsular gneissic complex. The granitoids of the peninsular gneissic complex are generally massive, foliated, and rarely gneissic. The rocks vary from light grey to greyish pink in colour, which are leucocratic. Mafic dykes as doleritic composition are dominant. Acid intrusive such as veins of quartz and pegmatite's are in the research area. Mineral occurrences in the study area are quartz, felspar, granite, road metal, gravel, morrum, and ordinary earth. Recent unconsolidated sediments occur along the stream courses. The study area consists of several lineaments such as dykes, faults, and fractures running in different strike directions. These characteristics have a significant impact on the formation and distribution of groundwater.

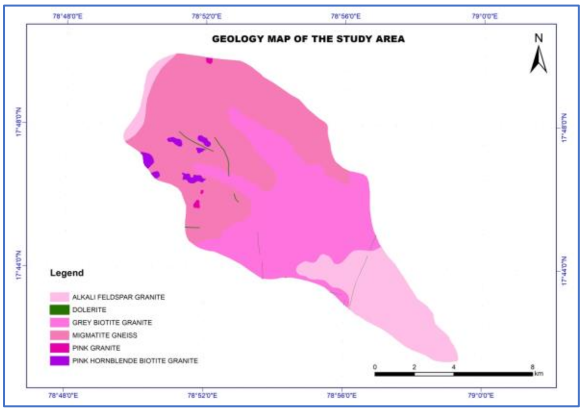

Figure.2 shows the geology of the study area

B.Transportation

An intense road network is observed part of the study area, which is occupied, by part of Hyderabad. The remaining part of the study area is having less intense road network. As road network between dwelling units have reduced surface area, thus, the area for infiltration of water is reduced. Thus, the places where the road network is more could be less groundwater potentials Zones.

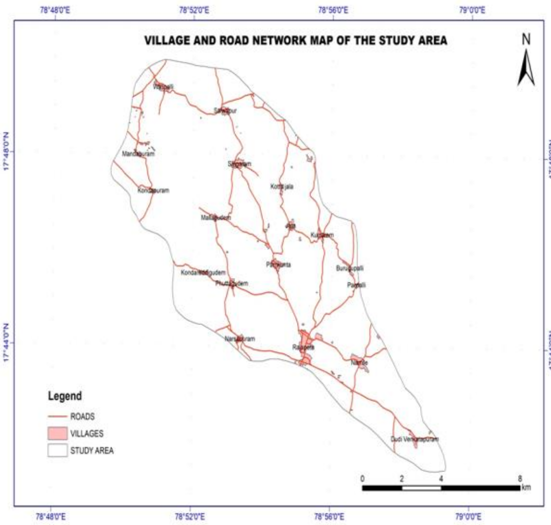

Figure.3 Shows the Road and Transportation Network of the Study area.

C. Drainage Pattern

The drainage pattern is mostly dendritic, which is common in granitic terrain but overall drainage is sub-dendritic to dendritic. The drainage pattern is useful in analyzing geomorphic features and following landform changes (Boobalan et al., 2015). The Northwest part of the area has a high drainage density. Groundwater prospects will be poor in zones with high drainage density, while groundwater prospects will be better in zones with low drainage density (Balachandar et al., 2010). The drainage density of the study area was calculated as the ratio of the total length of streams in the sub-basin area to the total area of the sub-basin. A high drainage density area increases surface runoff and will have poor groundwater potential while a low drainage density area will have good groundwater potential because of more infiltration.

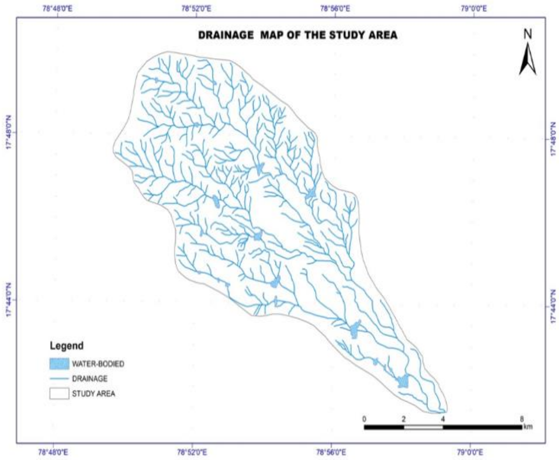

Figure 4 Shows the Drainage of the Study area.

D. Slope

Infiltration of groundwater is controlled by the slope of the area. In gently sloping areas, the surface runoff is slow with higher infiltration, while in high sloping areas the runoff is high with lesser infiltration of rainwater. The DEM data was used to create a slope map of the area.

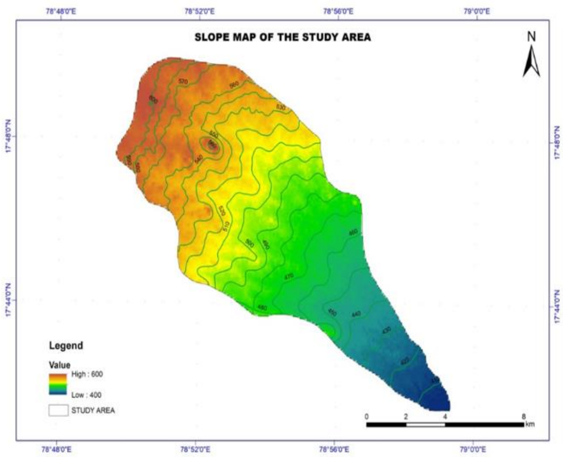

Figure 5 Shows the Slope map of the Study area.

E. Soils

Soil plays a vital role in groundwater because infiltration into the sub-surface depends on the soil texture and type. The soils of the study are mainly clayey, loamy, and gravely red soils in which clayey soils have low infiltration because of impermeability, while loamy soils have high infiltration.

F. Land use/Land cover

This study detects and quantifies LU/LC in the Rajapet watershed of the Yadadri District using satellite imagery and topographic maps. The multi temporal IRS-P6 LISS-IV satellite geo-referenced images are collected from the year 20th March 2010 (Fig. 6 and Table 1) and 15th March 2020 (Fig. 7 and Table 2). LISS IV has a spatial resolution of 5.8 m and terrain SOI maps of 56 K/13 and 56 K/14 (1: 50,000); using scans were mostly converted to virtual mode. Topographic images are geo-referenced by using "Arc-GIS" software (model 10.3).

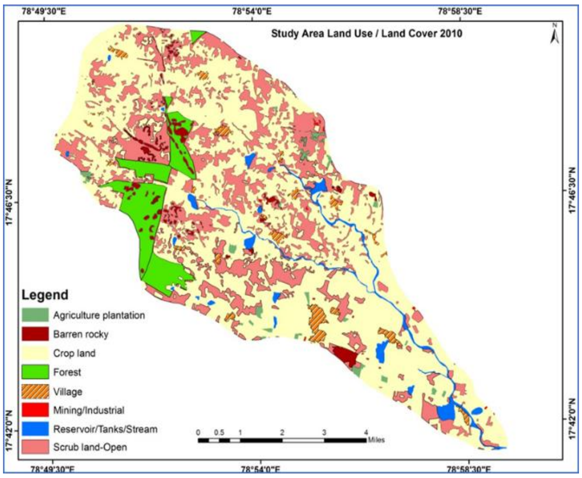

Figure: 6 Shows Land use/Land cover map of the Rajapet Watershed (2010)

Land Cover	Area in 2010 (sq.km)	Area in 2020 (sq.km)	Deviation (-/+)
Agriculture Plantation	2.24	3.58	1.34
Built up Rural	3.32	4.32	1
Built up Urban	4	4.78	0.78
Crop Land	110.62	129.4	18.78
Forest	0.33	0.32	0.1
Mining/Industrial	2.40	3.02	0.62
Reservoir/Tanks	5.23	5.19	-0.04
River/Stream/Drain	0.79	0.78	-0.1
Scrub Land	42.27	19.4	-22.87
Transportation	0.8	1.50	0.7

Table1: Comparison of Land Use/Land Cover in the Rajapet watershed from 2010 to 2020

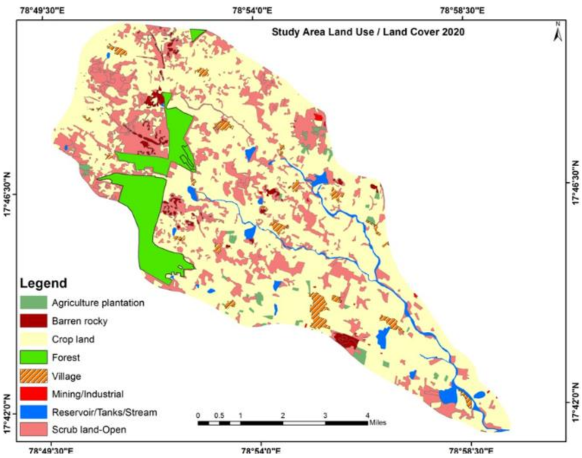

Figure:7 Shows Land use/Land cover map of the Rajapet Watershed(2020)

G. Geomorphology

Groundwater potential mapping relies heavily on an area's geomorphology, which reveals a close relationship between geomorphic units and groundwater resources (Subba Rao, 2003). The geomorphic features identified through the interpretation of satellite imagery of the area are denudation hills, residual hills, dyke ridges, inselbergs, pediplains, pediments, floodplains, valley fills, etc. and in addition, groundwater availability is also influenced by weathered residuum. Pediments are poor water-bearing because of their negligible weathering thickness. Structural hills and ridges act as barriers to groundwater movement. Valley fills and flood plains are good water bearing landforms because of the accumulation of thick unconsolidated/ weathered sediments.

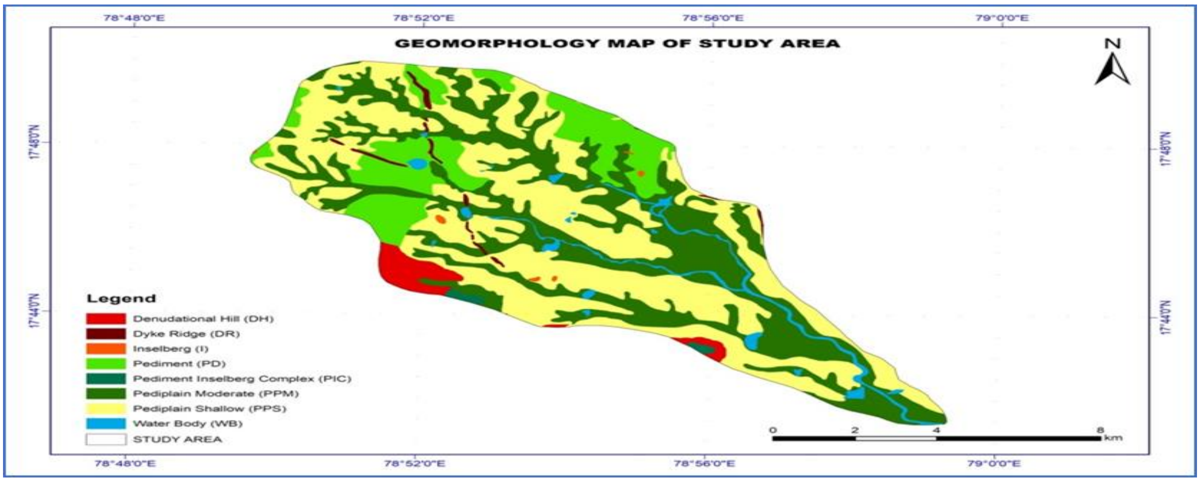

Figure. 8 shows the geomorphology of the study area.

H. Lineament and Lineament Density

Lineaments play an important role in groundwater distribution. These are weaker bedrock zones and are regarded as good occurrences for groundwater potentiality (Rao et al., 2003). In satellite images, they appear as linear, curvilinear, and rectilinear patterns. Most of the lineaments are trending in the NW-SE directions. The lineament density map represents the total length of the linear.

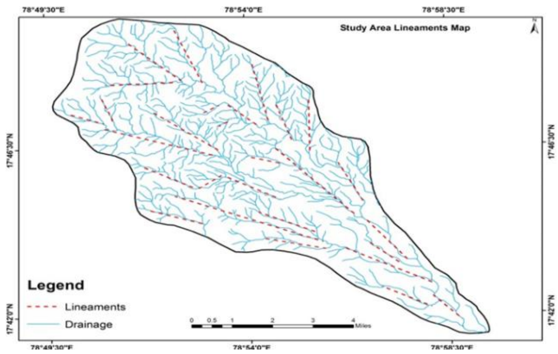

Figure. 9 Shows the Lineament and Lineament Density of the Study area.

I. Groundwater Prospects Map

By integrating all the thematic maps we get groundwater prospects map (Fig 10). High yield ranges of groundwater are observed along Musi river and surrounding major streams and tanks, good-moderate yield ranges are observed in the remaining major part of the study area and good- moderate - ranges are observed South and East and South East Part of the study area, poor- nil yield ranges are observed in the North and west and NorthEast and Northwest part of study area .

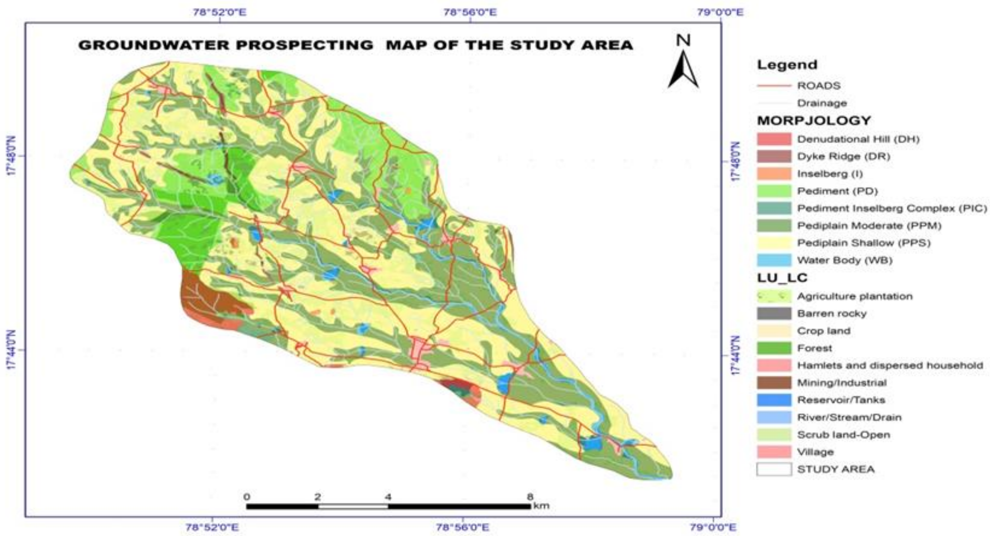

Figure.10 Shows the Groundwater Prospects Map of the Study area.

VI. CONCLUSIONS

The study area comprises a Rajapet Watershed part of Yadadri-Bhuvanagiri district of Telangana, India. The area is drained by the Musi River. The landforms observed in the study area are pediplain with moderate and shallow weathering, pediments, pediment inselberg complex and dykes. The area is underlain mainly by the oldest rocks of the Archaean Group of pink and grey granites and lineaments, adamellite-granodiorite suites and migmatite. Structures observed in the study area are lineaments, conformed lineaments (along Musi river), inferred lineaments are observed in the study area. Though drainage network is distributed in the entire study area, most of it is distributed in the south-eastern part of the study area. The map showing four different potential zones for artificial recharge has been prepared for the study area. The final (groundwater prospects) map was prepared by integrating various thematic maps, viz., and geomorphologic, structural, geological and hydrological maps. The present study shows the areas of less groundwater potential zones so that we can improve groundwater levels in the perspective of groundwater use for future generations.

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