Delineation Of Groundwater Potential Zone Using Integrated Method Of Remote Sensing, GIS And Electrical Resistivity In The Hard Rock Terrain Of Mauranipur Watershed, Bundelkhand Craton In India

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The identification of a prospective groundwater recharge zone is crucial for supplementing groundwater resources. It's especially critical in the hard rock region, where groundwater is the principal source of potable water and is fast disappearing due to uncontrolled mining. The present study used a combination of modern methodologies and technologies to analyze the groundwater potential zone occurrence, including geographic information system (GIS), remote sensing (RS), electrical resistivity i.e. VES, and multi-criteria decision analysis (MCDA). Several thematic layers were prepared, including geomorphology, lineament density, drainage density, soil type, geology, rainfall, soil texture, elevation, and land use land cover (LULC), which were weighed according to their impact on the groundwater prospect zone. The analytical hierarchical process (AHP) was used in this study to apply normalization to relative assistance. Vertical electrical sounding was used to find water bearing formations/fracture zones at various points throughout the selected region. The five prospective groundwater prospect zones that were delineated using these methods have been classified as very low, low, moderate, high, and very high. The delineated high groundwater potential zones were found in the northeastern part and a little below the central region, while low to moderate zones were found almost evenly distributed all over the region. The acquired result was validated using well yield data, which showed a 72 percent accuracy with our delineated groundwater potential zone. Hence, the AHP model in the current work has outperformed the competition in terms of prediction accuracy.

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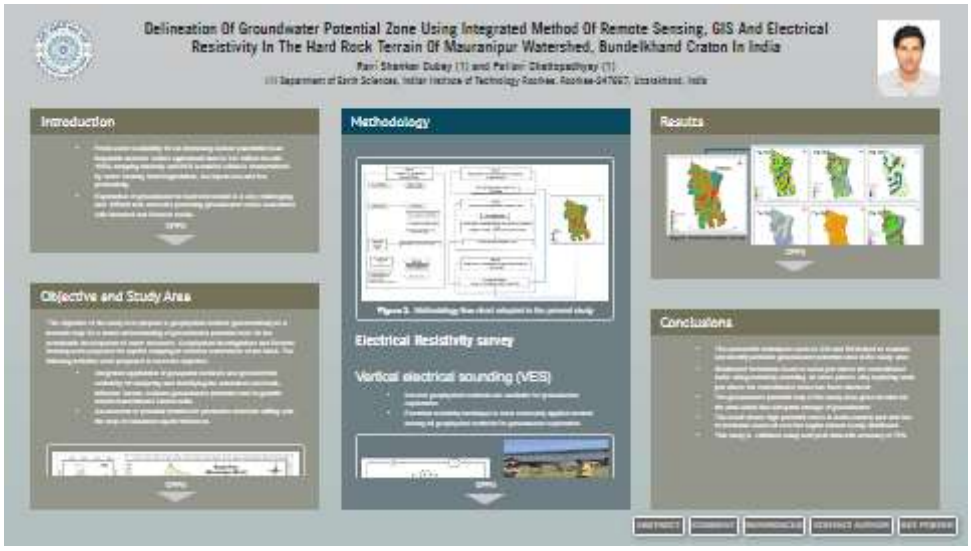

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INTRODUCTION

- Fresh water availability for an increasing human population is an important concern. India's agricultural land is 142 million ha with 135% cropping intensity and 60% is rainfed which is characterized by water scarcity, land degradation, low inputs use and low productivity.
- Exploration of groundwater in hard rock terrain is a very challenging and difficult task when the promising groundwater zones associated with fractured and fissured media.
- Remote sensing (RS) and Geographic information system (GIS) methods have developed as an important tool for mapping the groundwater potential zones.
- The AHP technique is well accepted method for quantitative analysis. AHP is a dependable decision-making tool for problems with different natures and with different criteria.
- A vertical electrical sounding (VES) method has a simple technique and easy interpretation, associated rugged nature used for groundwater studies.
- A suitable map which classified the groundwater potential zone of the study area into very low, low, moderate, good and very good.
- Finally, groundwater potential map validated with borehole data of the survey area.

Source- https://planetextinction.com (https://planetextinction.com/what-does-depletion-mean/)

OBJECTIVE AND STUDY AREA

The objective of the study is to propose a geophysical method (geoelectrical) as a thematic map for a better understanding of groundwater potential zone for the sustainable development of water resources. Geophysical investigations and Remote Sensing were proposed for aquifer mapping in selected watersheds of the block. The following activities were proposed to meet the objective.

- Integrated application of geospatial methods and geoelectrical resistivity for analyzing and identifying the watershed and multi-influence factors evaluate groundwater potential zone in granitic terrain Bundelkhand Craton India.
- Assessment of potential location for productive borehole drilling with the help of calculated aquifer thickness.

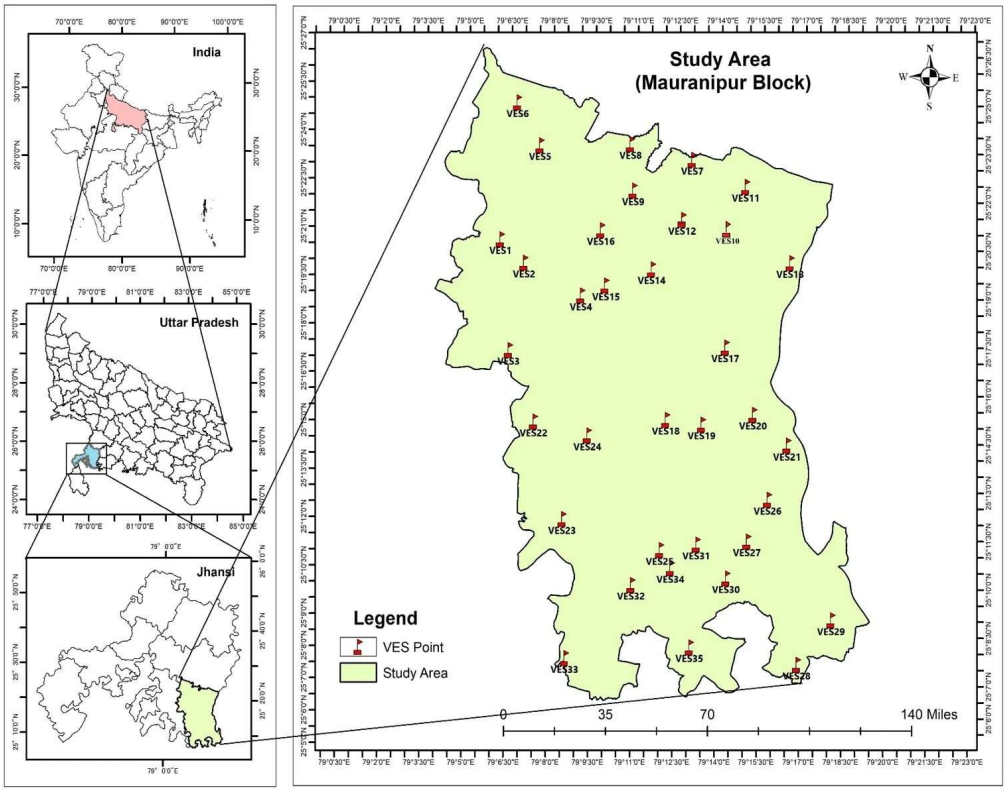


Figure. 1. Location map

- The study area (Figure 1) lies between longitude $79^{\circ}04'30'' - 79^{\circ}19'30''E$ and latitude $25^{\circ}06'30'' - 25^{\circ}26'30''N$ in Jhansi District, Uttar Pradesh, India, which is situated about 252km from Uttar Pradesh's capital city Lucknow. It is largest tehsil in India.
- It covers about 569km2 , which is one of the drought prone areas of Jhansi district.
- The basin is characterized by poor soil cover, scarce vegetation, erratic rainfall and lack of soil moisture for most part of the year.
- Recurring drought coupled with increase in ground water exploitation results in decline in ground water levels.

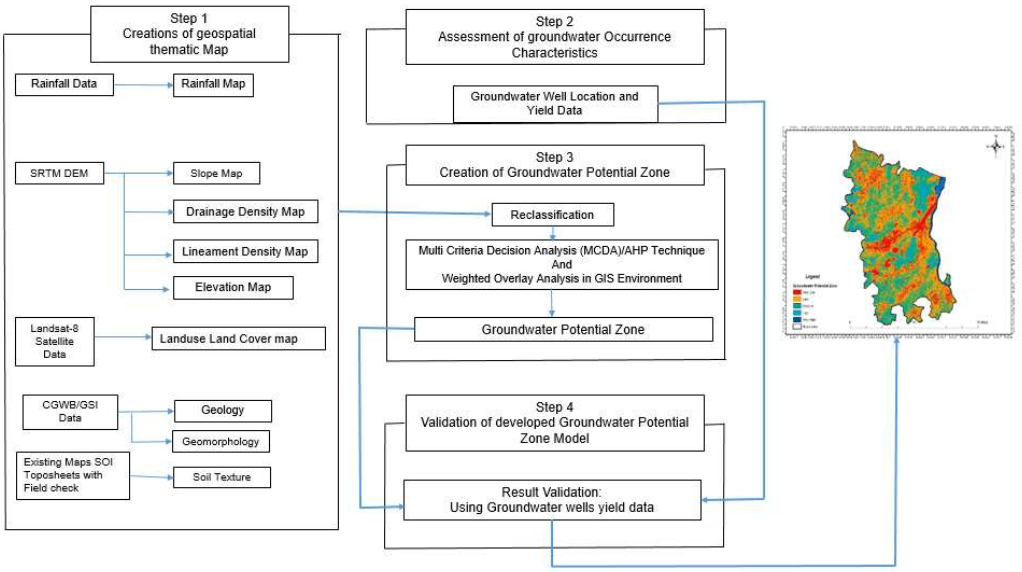
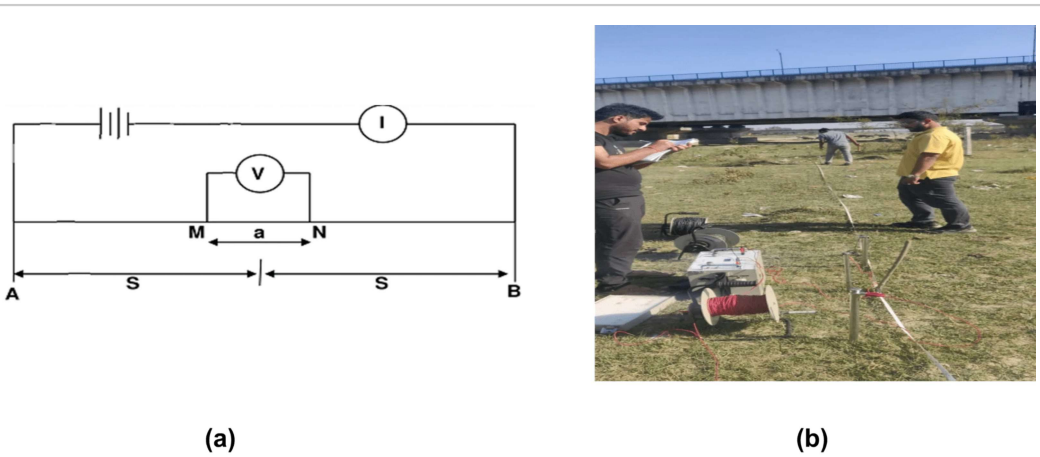


Figure 2. Methodology flow chart adopted in the present study

Electrical Resistivity survey

Vertical electrical sounding (VES)

- Several geophysical methods are available for groundwater exploration.
- Electrical resistivity technique is most commonly applied method among all geophysical methods for groundwater exploration.



(a) (b)

Figure 3: (a) Schlumberger Configuration, (b) VES Survey

The apparent resistivities calculated as;

$$\rho_a = \frac{\Pi\left\{\left\{\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2\right\}\right.}{MN}\left(\frac{\Delta V}{\Delta I}\right)$$

RESULTS

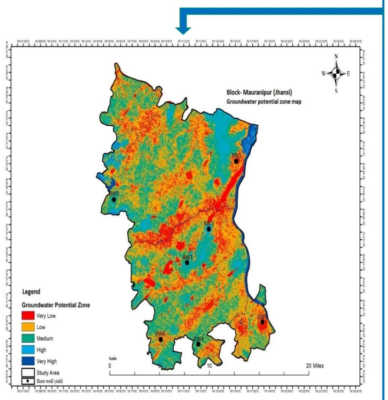


Figure 5. Groundwater potential zone map

Table 1: Weightage properties of different parameter used for groundwater potential zone

class	Area in (Sq. km.)	Area (%)
Very Low	70.91	12.61
Low	252.06	44.60
Moderate	197.75	35.18
High	30.08	4.77
Very high	18.42	2.84
Total	569.22	100

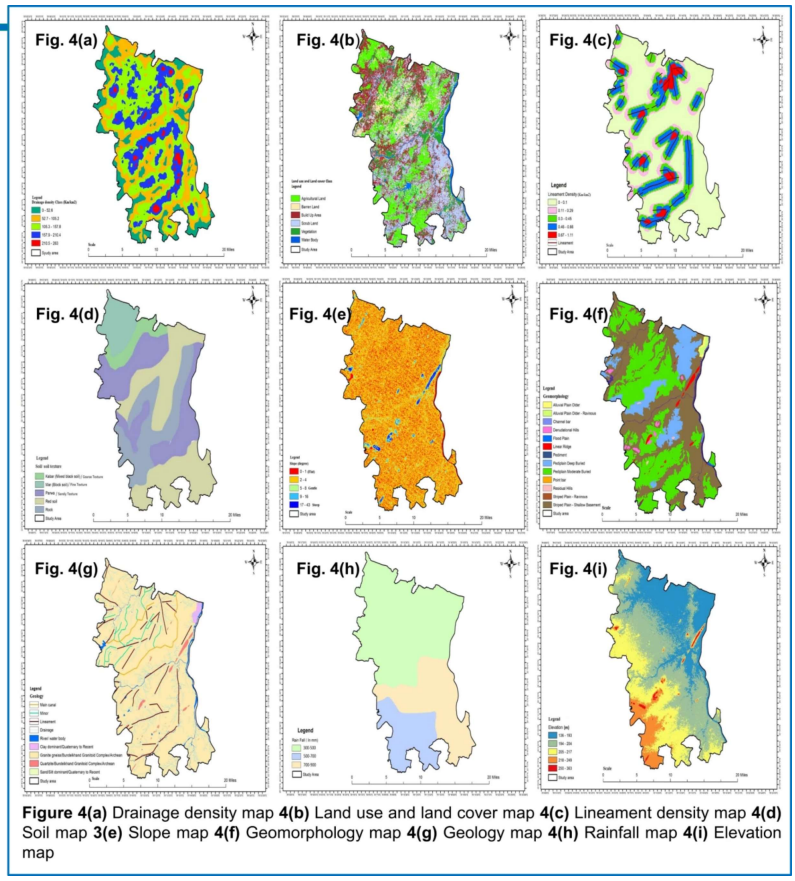


Figure 4(a) Drainage density map **4(b)** Land use and land cover map **4(c)** Lineament density map **4(d)** Soil map **3(e)** Slope map **4(f)** Geomorphology map **4(g)** Geology map **4(h)** Rainfall map **4(i)** Elevation map

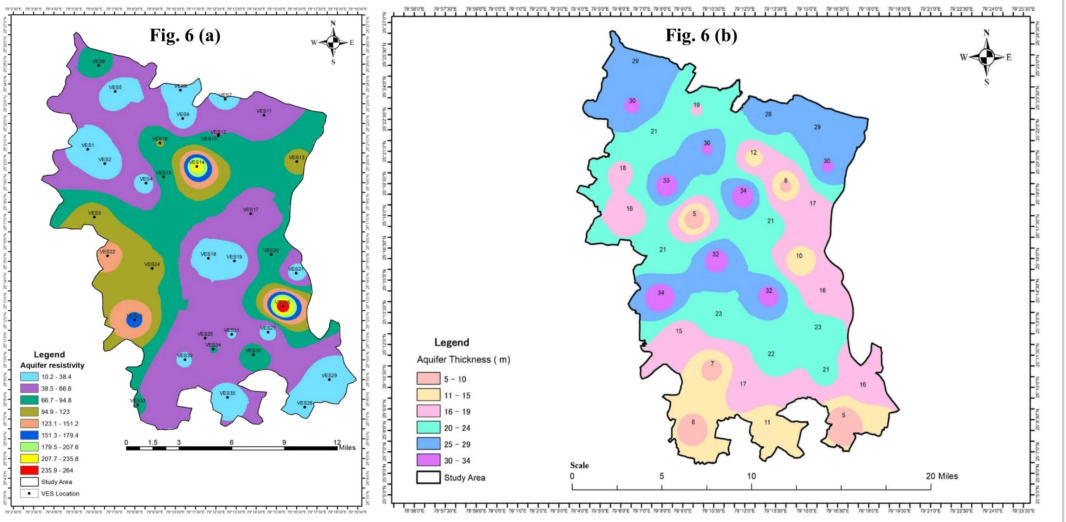


Figure 6: (a) Aquifer resistivity map, (b) Aquifer thickness map.

CONCLUSIONS

- The successful techniques such as GIS and RS helped to evaluate and identify probable groundwater potential zone in the study area.
- Weathered formations found to occur just above the consolidated rocks using resistivity sounding. At some places, clay replacing sand just above the consolidated rocks has been observed.
- The groundwater potential map of the study area gives an idea on the area which has adequate storage of groundwater.
- The result shows high potential zones in north-eastern part and low to moderate zones all over the region almost evenly distributed.
- This study is validated using well yield data with accuracy of 72%.

ABSTRACT

The identification of a prospective groundwater recharge zone is crucial for supplementing groundwater resources. It's especially critical in the hard rock region, where groundwater is the principal source of potable water and is fast disappearing due to uncontrolled mining. The present study used a combination of modern methodologies and technologies to analyze the groundwater potential zone occurrence, including geographic information system (GIS), remote sensing (RS), electrical resistivity i.e. VES, and multi-criteria decision analysis (MCDA). Several thematic layers were prepared, including geomorphology, lineament density, drainage density, soil type, geology, rainfall, soil texture, elevation, and land use land cover (LULC), which were weighed according to their impact on the groundwater prospect zone. The analytical hierarchical process (AHP) was used in this study to apply normalization to relative assistance. Vertical electrical sounding was used to find water bearing formations/fracture zones at various points throughout the selected region. The five prospective groundwater prospect zones that were delineated using these methods have been classified as very low, low, moderate, high, and very high. The delineated high groundwater potential zones were found in the northeastern part and a little below the central region, while low to moderate zones were found almost evenly distributed all over the region. The acquired result was validated using well yield data, which showed a 72 percent accuracy with our delineated groundwater potential zone. Hence, the AHP model in the current work has outperformed the competition in terms of prediction accuracy.

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