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# Mapping Groundwater Potential in Hard Rock Terrain Through Cartography and Vertical Electrical Profiling Interpretation

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***Abstract* - The goal of the current study is to identify the groundwater potential zones in the Uttar Pradesh district of Lalitpur's Mahrauni block. The landscape in this location is made of hard rock, and the groundwater is scarce due to buried Pedi plains inside the fractured and weathered zone. There is a groundwater potential zone in the thickness of the worn and fractured zone. Ground water resources must be developed because the majority of the surface water in this area dries up in the summer. The preparation of several thematic layers, such as slope, lineament, and hydro-geomorphological units, has involved the use of Survey of India toposheets, satellite images, and other data in addition to field observation data. Overburden thickness map, weathered zone thickness map, and depth to hard rock map are created with the use of the VES approach.**

**The Schlumberger setup is used to investigate the physical characteristics of subsurface structures on Earth as well as to determine their vertical and horizontal variations. Every theme map that affects the presence of groundwater has been examined and combined using ArcGIS's weight assignment feature. The weighted index overlay method was used to draw prospective groundwater potential zones. The outcome demonstrates that the region's groundwater potential may be divided into four categories: very good, good, moderate, and low. The ground-based hydrogeological assessments, which eventually result in the selection of appropriate Tube well sites, are aided by the precise maps created for possible groundwater zones. The aforementioned investigation so amply illustrated the prospective groundwater zone demarcation capabilities of remote sensing, geophysics, and GIS techniques.**

***Keywords:* Remote sensing, Groundwater prospect, weathered zone and fractured zone thickness, VES study, Geo-electric parameters, Schlumberger configuration, ArcGIS, weighted index overlay.**

## 1. INTRODUCTION

In regions with hard rock topography, ground water is typically found in weathered, fractured, and secondary porosity zones. Dr. Jyoti Sarup et al. (2011) and Chaudhary et al. (1996) are two researchers that have recently employed remote sensing and GIS to demarcate groundwater potential zones. Because of the nation's growing need for water resources, particularly in places with insufficient surface water supplies, groundwater exploration is becoming more and more important. Groundwater potential zone identification is greatly aided by GIS and remote sensing **[7]**. It is feasible to identify and highlight a variety of features, such as geological structure, geomorphic properties, and their hydraulic character, which can operate as direct or indirect indicators of the existence of groundwater, by analyzing satellite data in conjunction with sufficient ground truth knowledge.

Hard rock topography dominates the research area, and the region's groundwater is limited to the worn and cracked zone **[2]**. Because it is an agricultural area, the unplanned and excessive pumping of ground water further exacerbates the suffering of farmers and their home requirements.

## 2. AREA OF STUDY

Figure No. 1 shows that the Mahrauni block is located in the Lalitpur District of Uttar Pradesh, India. The coordinates of the place are: Points 78°44′ 57′E, 24°39′ 51′N, 78°41′ 23′E, 24°22′ 16′N, 78°35′ 26′E, 24°30′ 14′N, and 78°58′ 27′E, 24°29′ 29′N are located at the top and bottom, respectively. There are 725 square kilometers in the entire geographic region. The block's geology is mostly composed of hard rock terrain, with the Bundelkhand granitic and gneissic complex sitting on top of it **[1]**. It has the least amount of forest cover in terms of area and is mostly an agricultural region. The hot, dry summers and chilly winters are typical of the sub-humid environment. The slope faces northeast and north. The Mahrauni Block study location in the Lalitpur district was chosen because it has hard rock topography, is difficult, and relies mostly on subsurface water during the summer months when surface water in the area dries up. In this region, almost 90% of rural income comes from raising cattle and producing crops.

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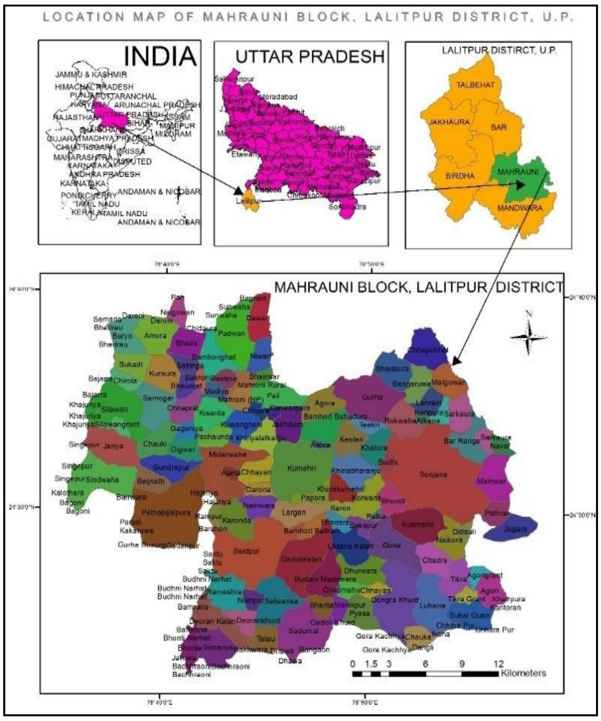


Figure 1: Location Map of the study area

The recognized ground control points (GCP) on the Survey of India (SOI) topographical maps (54 L/10, 54 L/11, 54 L/14, and 54 L/15, at 1:50,000 scale) are used to georeference the map. Afterwards, 1:50,000 scale satellite imagery from IRS P6 LISS-III is georeferenced to SOI topography maps. Using ArcGIS's spatial analyst tool, a slope map was created using SRTM DEM 30m images. Additionally, suitable ground truth and satellite data were used to create the hydro geomorphology and lineament density. For field surveys, Oregon 650 GPS units and the geophysical equipment DDR3 resistivity meter are utilized. By using Schlumberger electrode setup to conduct vertical electrical soundings (VES), a vertical shift in resistivity is ensured. After field data analysis using Ip2Win software, the overburden thickness map, weathered zone thickness map, and depth to hard rock map were created. Once every map is ready, we do weighted index overlay analysis. With the help of this approach, we may combine, rank, weight, and visualize a variety of information kinds and assess several criteria simultaneously. Weights have been assigned to each thematic map's specific parameters throughout the weighted overlay analysis process.

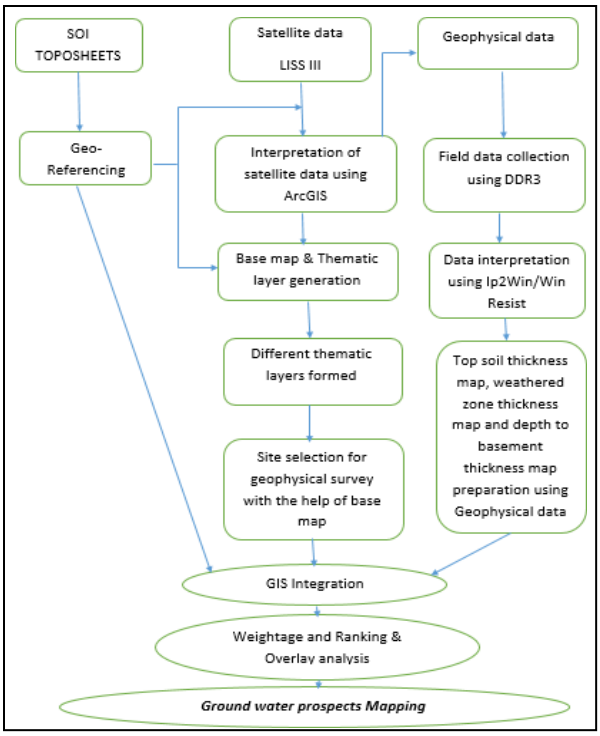


**Chart 1:** Research methodology employed

**3.** POSSIBLE DIFFERENT THEMATIC LAYERS

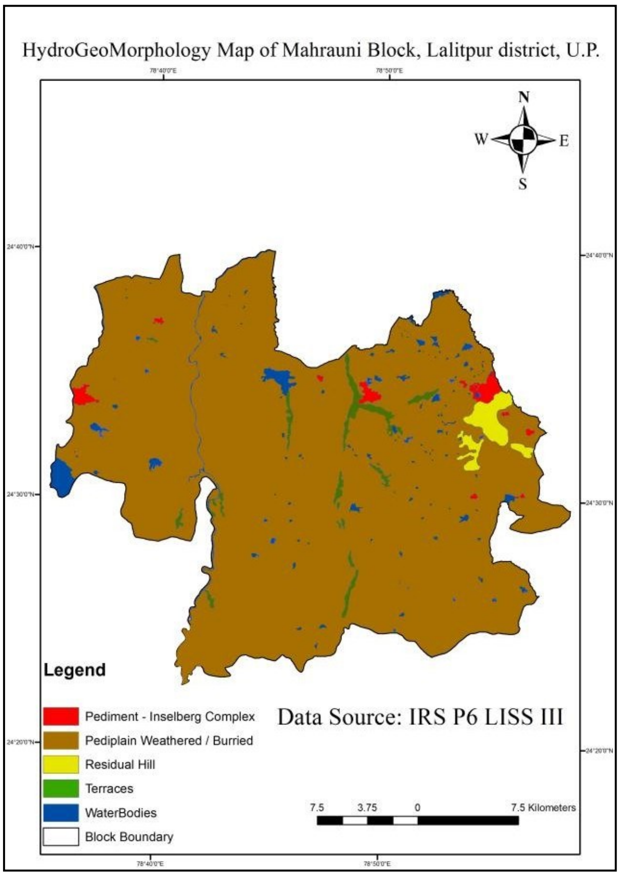


**Figure 2:** Map of Hydro- geomorphology

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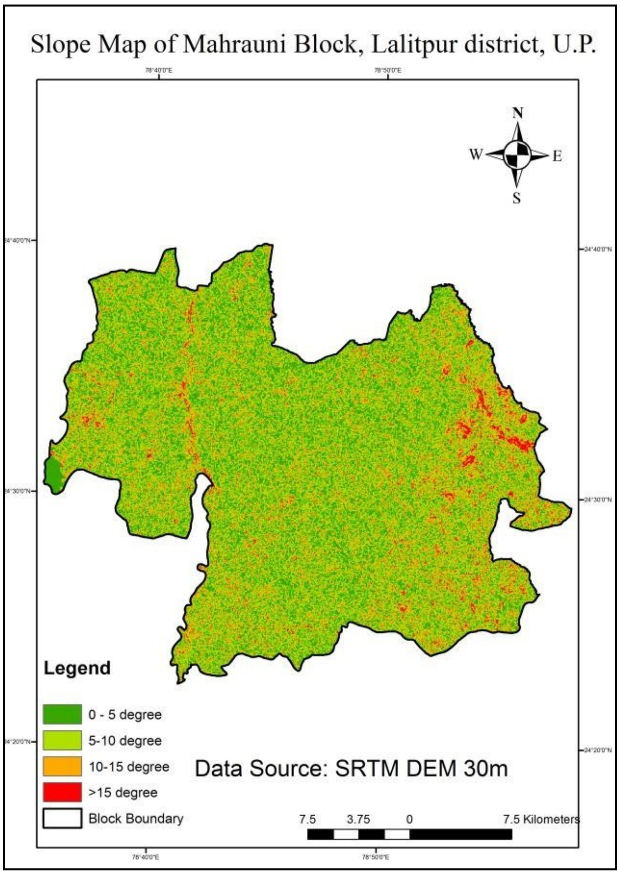


**Figure 3:** Slope Map

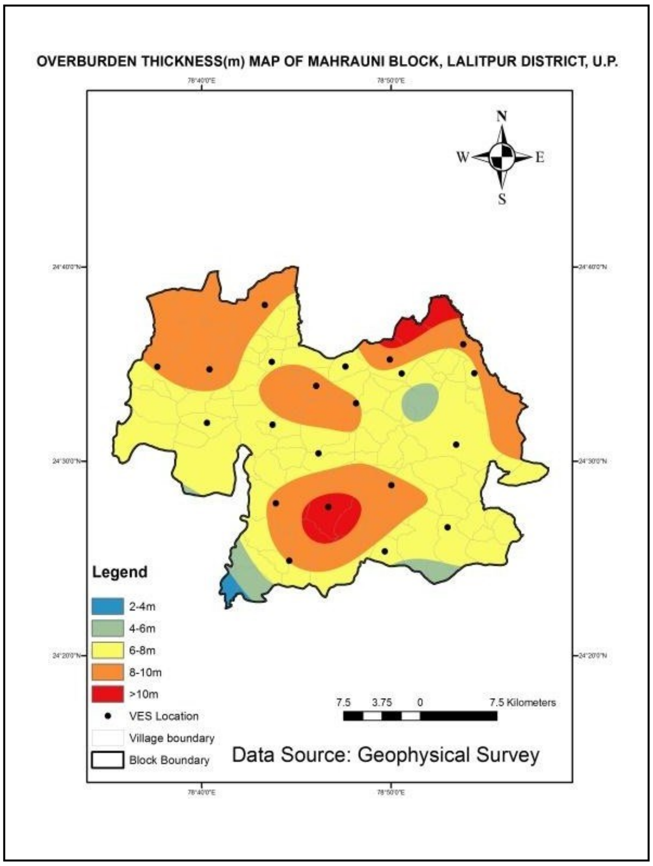


**Figure 5:** Overburden thickness Map

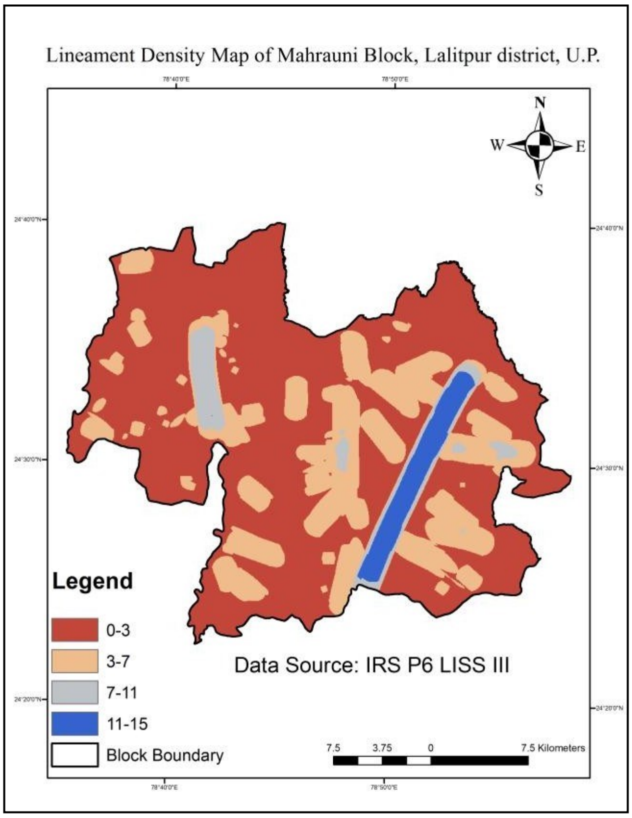


**Figure 4:** Lineament density Map

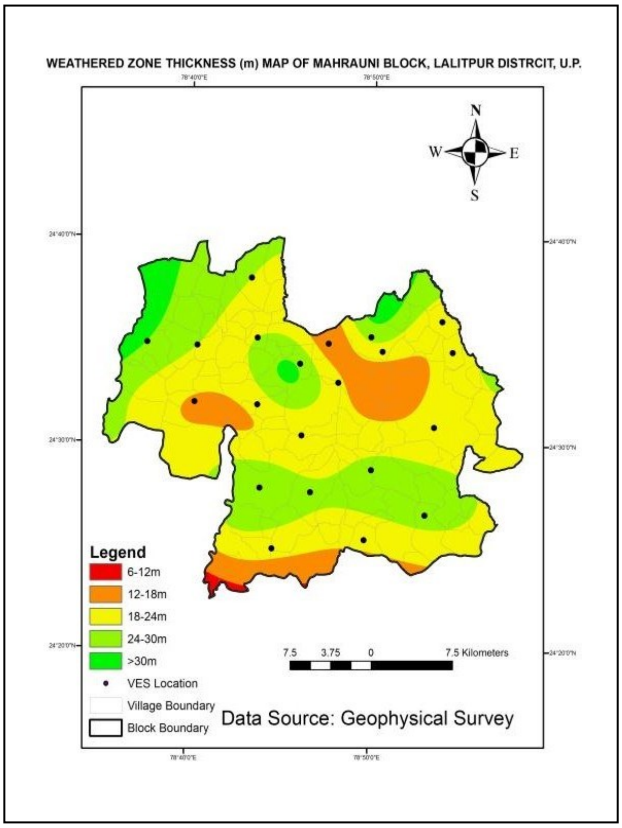


**Figure 6:** Weathered zone thickness Map

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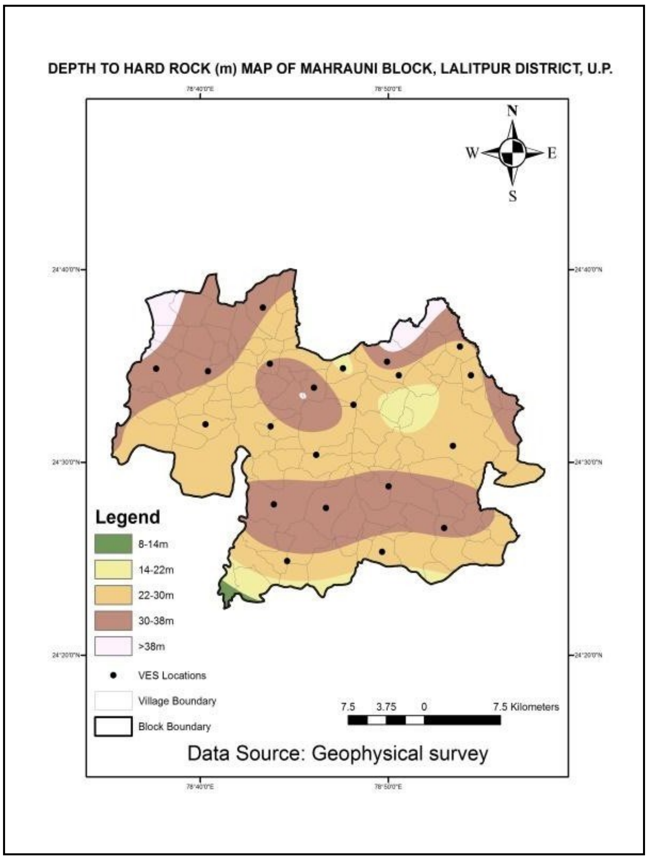


Figure 8: Depth to hard rock Map

4. WEIGHTAGE OF DIFFERENT THEMATIC LAYERS

| S.No | CRITERIA | CLASS | WEIGHT |
|---|---|---|---|
| 1. | Hydro geomorphology | Buried Pediplains | 5 |
| | | Pediments Inselberg complex | 4 |
| | | Residual Hills | 3 |
| | | Terraces | 1 |
| 2. | Slope(in degrees) | 0-5 | 5 |
| | | 5-10 | 4 |
| | | 10-15 | 3 |
| | | >15 | 1 |
| 3. | Lineament density | 0-3 | 1 |
| | | 3-7 | 3 |
| | | 7-11 | 4 |
| | | 11-15 | 5 |
| 4. | Overburden Thickness | 2-4m | 1 |
| | | 4-6m | 2 |
| | | 6-8m | 3 |
| | | 8-10m | 4 |
| | | >10m | 5 |
| 5. | Weathered Zone thickness | 6-12m | 1 |
| | | 12-18m | 2 |
| | | 18-24m | 3 |
| | | 24-30m | 4 |
| | | >30m | 5 |
| 6. | Depth to hard rock thickness | 8-14m | 1 |
| | | 14-22m | 2 |
| | | 22-30m | 3 |
| | | 30-38m | 4 |
| | | >38m | 5 |

Chart 2: Weightage chart

## 5. SUMMARY

Different thematic laters, such as hydrogeomorphology, lineament density, and slope, have generally been utilized to integrate without taking the subsurface lithology into consideration in order to identify the groundwater potential zones. This gives a general notion of the region's potential for groundwater. Groundwater potential zones are currently defined using GIS technique by integrating the overburden thickness and weathered zone thickness, which are obtained from vertical electrical resistivity surveys with the aforementioned thematic layers.

In order to confirm the validity of the study, the groundwater potential map created using this method was compared to the yield data, and it was discovered that the two sets of data agree. This shows that the suggested strategy has advantages and can be applied successfully with the right adjustments. The aforementioned work has shown that remote sensing, geoelectrical data, and GIS may be used to demarcate distinct zones of groundwater potential, particularly in geologically heterogeneous settings. This provides a more accurate picture of an area's groundwater potential, which may be utilized for any groundwater management and development project.

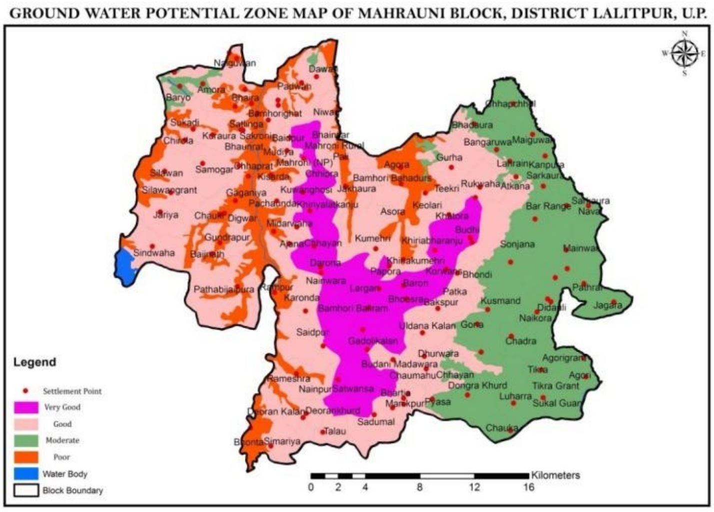


Figure 9: Groundwater potential Map

## 6. GRATUITY

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