DELINEATION OF GROUNDWATER POTENTIAL ZONES IN HARD ROCK TERRAIN AREA USING GEOSPATIAL AND VERTICAL ELECTRICAL RESISTIVITY TECHNIQUE

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Abstract - *Present study is carried out to delineate groundwater potential zones in Mahrauni block of Lalitpur district, Uttar Pradesh. This area is characterized by hard rock terrain, and the groundwater in this region is limited in buried pediplains within the weathered and fracture zone. Groundwater potential zone is found in weathered and fractured zone thickness. As most of the surface water in this region dries up in summer season, so ground water resources needs to be developed. Survey of India toposheets and satellite imagery along with other data and field observation data have been utilized to prepare various thematic layers viz. slope, lineament, hydro-geomorphological units. With the help of VES technique overburden thickness map, weathered zone thickness map and depth to hard rock map are prepared. Schlumberger setup is used to study physical properties and also to identify vertical and horizontal variations of sub surface features on earth. All the thematic map that influences groundwater occurrence has been analyzed and integrated based on weight assignment in ArcGIS. To delineate possible groundwater potential zones, the weighted index overlay approach was applied. The result shows that the area can be classified into different zones of groundwater potential, i.e., very good, good, moderate and poor. The map prepared for potential groundwater zones also help in detailed ground-based hydrogeological surveys which ultimately lead to the selection of suitable Tube well sites. Thus, the above analysis clearly demonstrated the capabilities of Remote Sensing, Geophysics and GIS technique in demarcating the potential groundwater zones.*

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

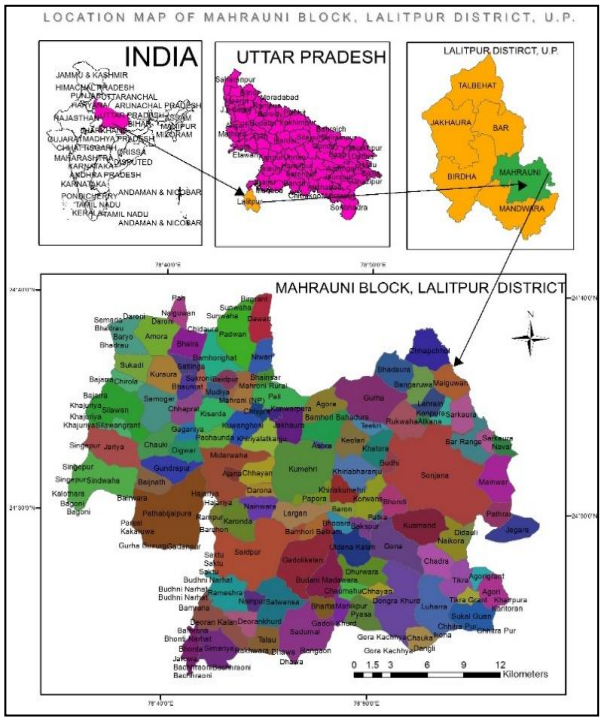
1. INTRODUCTION

Generally ground water in hard rock terrain region is found at secondary porosity zone, weathered zone and fractured zones. In recent times, many researchers such as **Chaudhary et al. (1996), Dr. Jyoti Sarup et al. (2011)** have used the approach of remote sensing and GIS for demarcating groundwater potential zones. Groundwater exploration is gaining more and more importance in our country owning to the ever increasing demand for water supplies, especially in areas with inadequate surface water supplies. Remote sensing and GIS play a vital role in identification of groundwater potential zones **[7].** The analysis of satellite data along with adequate ground truth knowledge makes it possible to define and outline various characteristics such as geological structure, geomorphic characteristics and their hydraulic character, which can serve as direct or indirect indicators of groundwater presence.

The study area is characterized by hard rock terrain and the groundwater in this region is confined within the weathered and fractured zone **[2].** Also, unplanned excessive pumping of ground water add up to the misery of the farmers and their domestic needs as it is an agricultural area.

2. STUDY AREA

Mahrauni block is in Lalitpur District of Uttar Pradesh, India as depicted in Figure No.1. The location coordinates are: Top: 78°44′ 57″E, 24°39′ 51″N, Bottom: 78°41′ 23″E, 24°22′ 16″N, Left: 78°35′ 26″E, 24°30′ 14″N, Right: 78°58′ 27″E, 24°29′ 29″N. The total geographical area is 725 square kilometres. Geologically the block is predominantly hard rock terrain underlain by Bundelkhand granitic and gneissic complex **[1]**. It is mainly an agricultural area and has least forest cover in terms of area. The climate is sub-humid and it is characterized by a hot dry summer and cold winter. The slope is towards north and northeast. The study area of Mahrauni block, Lalitpur district is selected because it is a hard rock terrain area and a problematic area and is mostly dependent upon ground water as surface water dries up in summer season in this region. Crop production and livestock rearing provide more than 90 percent of rural income in this region.



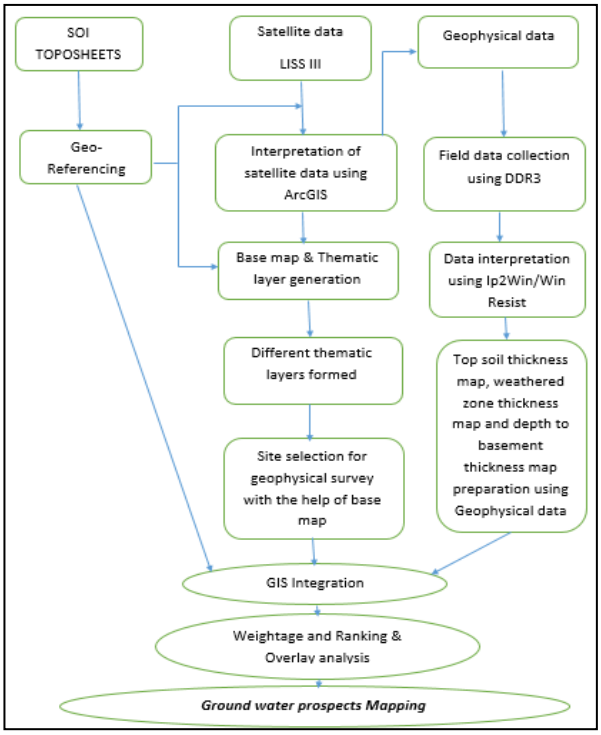


Chart 1: Methodology used for the research work

Survey of India (SOI) topographical map (54 L/10, 54 L/11, 54 L/14, 54 L/15, at 1:50,000 scale) are geo referenced using the known ground control points (GCP) on it. Satellite imagery from IRS P6 LISS-III on a scale of 1:50,000 are later geo referenced with respect to SOI topographical maps. Slope map has been prepared from SRTM DEM 30m imagery using spatial analyst tool in ArcGIS. Also, Lineament density and hydro geomorphology have been prepared using satellite data and proper ground truth. Geophysical instrument DDR3 resistivity meter and Oregon 650 GPS are used for field survey. Vertical change in resistivity is secured by performing vertical electrical soundings (VES) utilizing Schlumberger electrode setup. The overburden thickness map, weathered zone thickness map and depth to hard rock map were prepared after analysing field data using Ip2Win software. After preparing all maps, we use weighted index overlay study. This method allows combining, weight and ranking several different types of information and visualizing it so we can evaluate multiple factors at once. During weighted overlay analysis, weightage has been given for each individual parameter of each thematic map,

3. DIFFERENT THEMATIC LAYERS PREPARED

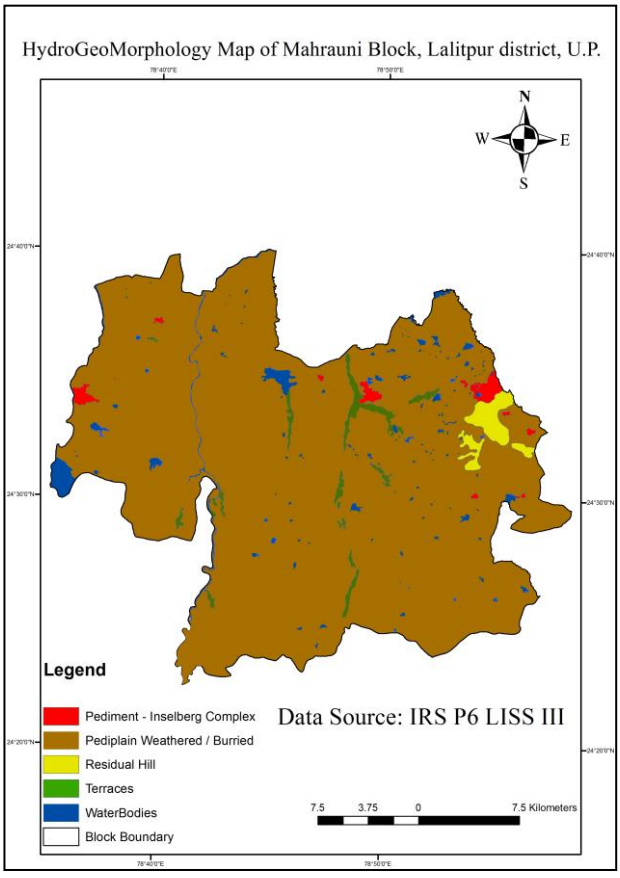


Figure 2: Hydro-geomorphology Map

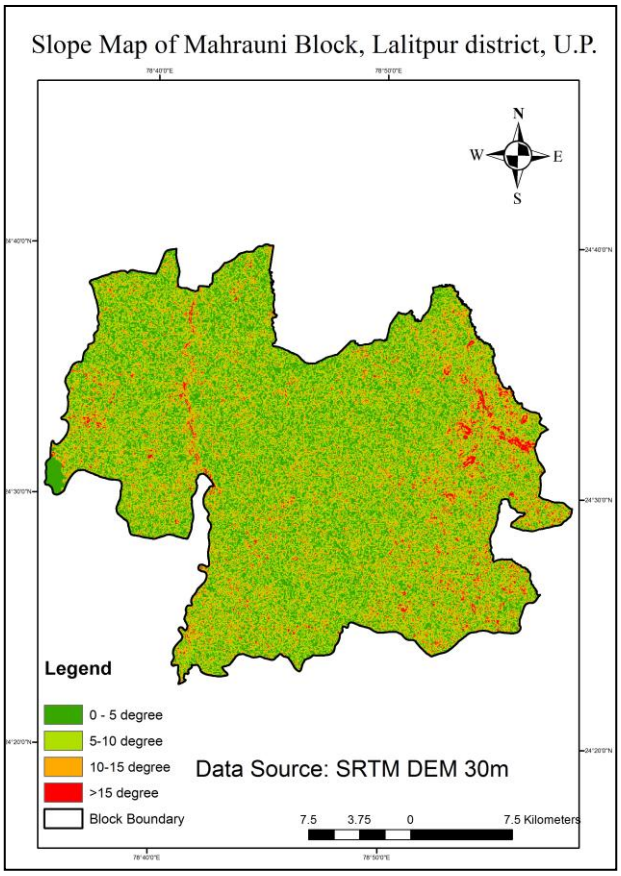


Figure 3: Slope Map

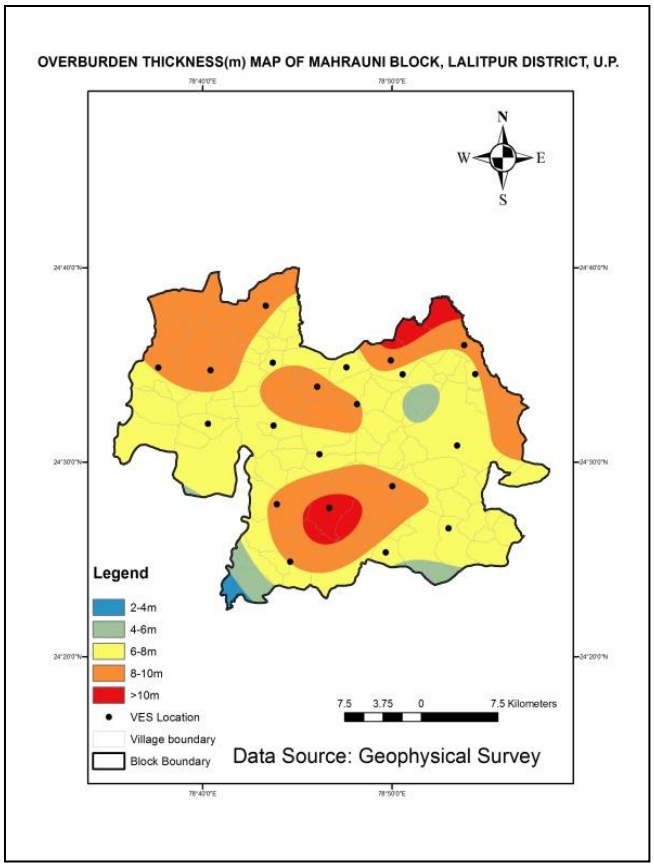


Figure 5: Overburden thickness Map

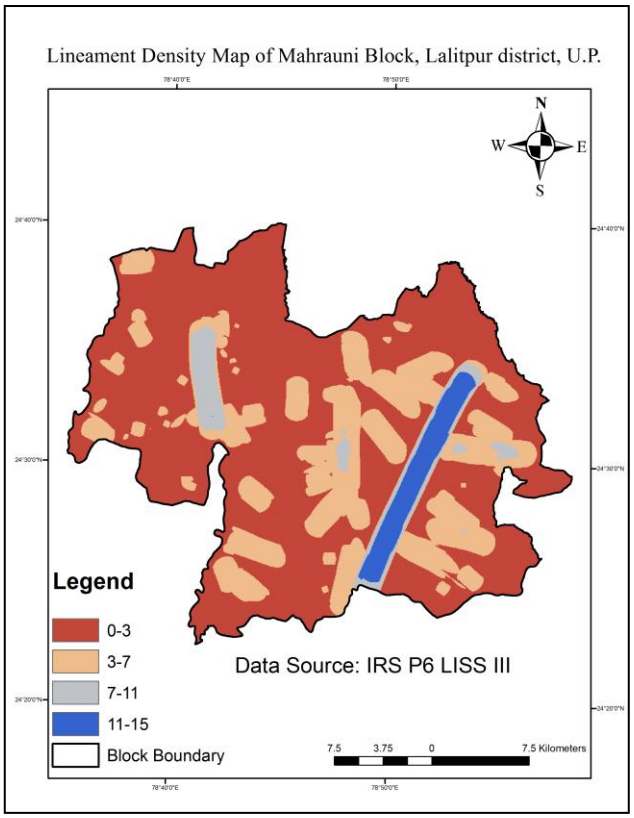


Figure 4: Lineament density Map

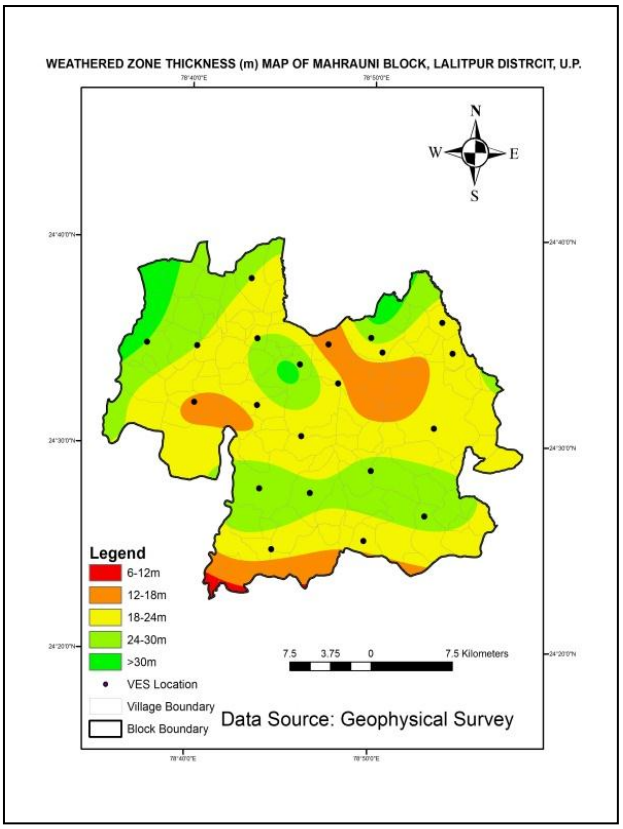


Figure 6: Weathered zone thickness Map

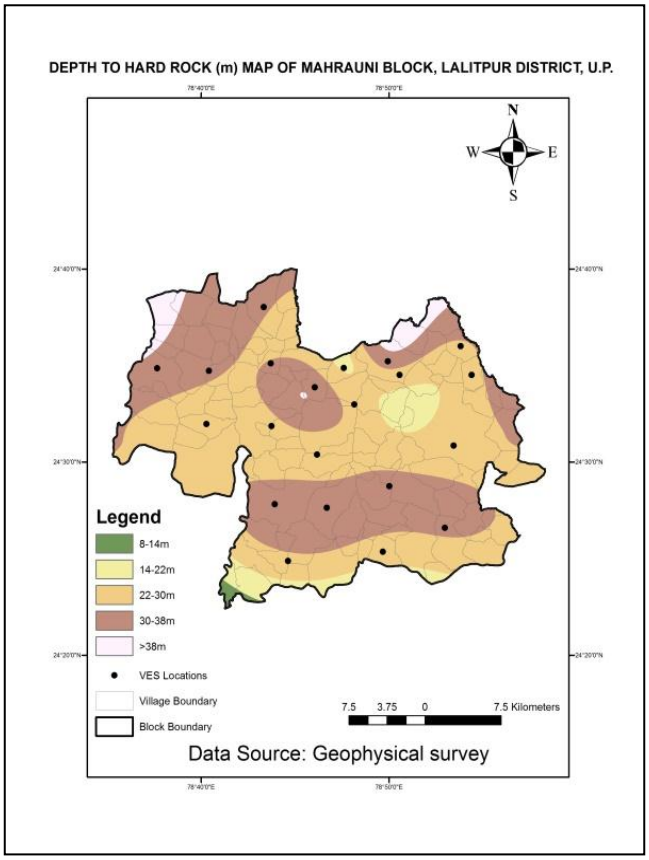


Figure 8: Depth to hard rock Map

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. CONCLUSION

In order to delineate the groundwater potential zones, in general, different thematic laters viz: hydrogeomorphology, lineament density, slope have been used to integrate without considering the subsurface lithology. This provides a broad idea about the groundwater potential of the area. Presently groundwater potential zones have been demarcated by integration of weathered zone thickness and overburden thickness derived by vertical electrical resistivity survey with above thematic layers, through GIS techique.

The groundwater potential map generated through this technique was verified with the yield data to acertain the validity of the study and found that is is in agreement with yield data. This illustrates that the approach outlined has merits and can be succesfully used with appropriate modifications. The above study has demonstrated the capability of using remote sensing, geoelectrical data and GIS for demarcation of different groundwater potential zones, especially in diverse geological setup. This gives more realistic groundwater potential map of an area, which may be used for any groundwater development and management programme.

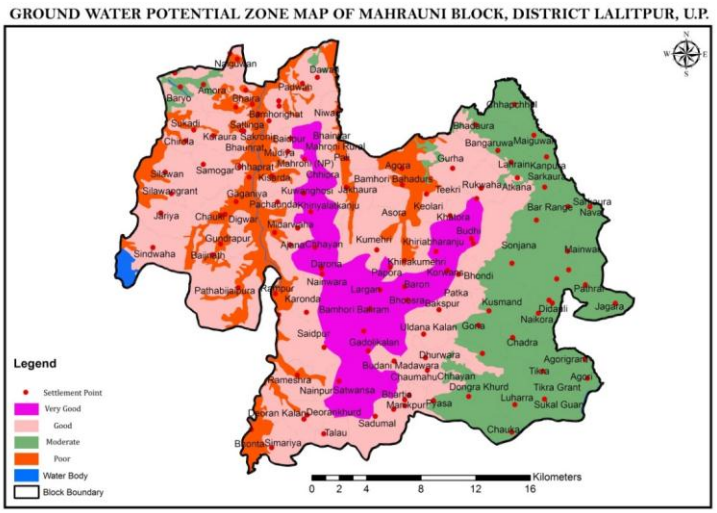


Figure 9: Groundwater potential Map

6. ACKNOWLEDGEMENT

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7. REFERENCES

[1] Aquifer mapping and Ground water management report of Lalitpur district, U.P. by Central Ground Water Board, 2017.

[2] Das Sujit. "Delineation of groundwater potential zone in hard rock terrain in Gangajalghati block, Bankura district, India using remote sensing and GIS techniques". Modeling Earth Systems and Environment December 2017, Volume 3, Issue 4, pp 1589–1599.

[3] Dr. S. Vidhya Lakshmi Y. Vinay Kumar Reddy. "Identification of Groundwater Potential Zones Using GIS and Remote Sensing". International Journal of Pure and Applied Mathematics Volume 119 No. 17 2018, 3195-3210.

[4] Ganvir V.J., Singh Arjun, Kumar Pushpesh, Singh Amaresh Kr, Kumar Vineet. "Analysis of Electrical resistivity data for the delineation of ground water prospective zones at Karchana block of Allahabad district. U.P. India". International Journal of Advanced Multidisciplinary Scientific Research (IJAMSR) ISSN:2581-4281 Volume 1, Issue 7, September, 2018.

[5] Ganvir V.J., Amaresh kr singh, Pushpesh kumar, Miss Nandita Singh. "Groundwater Potential zones Investigation in hard rock terrain using integrated study of Remote Sensing, Geoelectrical and GIS Techniques - A case study of Mandwara block, Lalitpur district U.P. India". ISRS Geomatics Shillong chapter North Eastern Applications Centre Union, Shillong, Innovation in Geospatial Technology to sustainable development with special emphasis on NER 20-22 Nov 2019.

[6] Nag S.K. and Anindita Kundu. "Delineation of Groundwater Potential Zones in Hard Rock Terrain in Kashipur Block, Purulia District, West Bengal, using Geospatial Techniques". International Journal Water Resources 2016, 6:1

[7] Partha C R, Swetharani V J , Dipa Malik, Prashanth V, Mallika P. "Identification of Groundwater Potential Zone in Southern Part of Bangalore East Taluk using Remote Sensing and GIS". International Journal of Research and Innovation in Applied Science (IJRIAS) | Volume III, Issue I, January 2018|ISSN 2454-6194.

[8] Saraf A, Choudhary PR (1998). "Integrated remote sensing and GIS for ground water exploration and identification of artificial recharge site". International Journal of Remote Sensing 19: 1825-1841.

[9] Sarup Dr. Jyoti, Tiwari Manish K, Khatediya Vardichand.

"DELINEATE GROUNDWATER PROSPECT ZONES AND IDENTIFICATION OF ARTIFICIAL RECHARGE

SITES USING GEOSPATIAL TECHNIQUE". International Journal of advance technology and engineering research 1(1), pp 6-20.

[10] Shivaji Govind P, Nitin Mahadeo M. "Identification of groundwater recharge potential zones for a watershed using remote sensing and GIS". International Journal of Geomatics and Geosciences Volume 4, No3 2014.