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Selecting Sites for Artificial Recharge of Groundwater with the Help of GIS, Remote Sensing and Geophysical Investigations in Jakhaura Block, Lalitpur, Uttar Pradesh

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Abstract— Water is a type of natural resource which has its application in almost every aspect of life and due to this it's exploitation is observed at an increasingly fast rate. Our country is also suffering from water scarcity because its population is more than almost17% of the world's population with only 4% of the World's renewable water resources. In Indian sub-continent our dependency on Groundwater has increased very much. As a result, the Groundwater storage of our country is decreasing at very high rate and to address this we have thought to view the possibility of artificially recharging the Groundwater. This paper aims to find the suitable sites for building rainwater harvesting structures from combined use of Remote sensing, Geophysical technique and GIS in Jakhaura block of Lalitpur, Uttar Pradesh. The hard terrain feature of Jakhaura block makes the runoff very high and as a result infiltration of the rainwater to the groundwater is very low. For multi criteria evaluation, different thematic layers such as base map of area, drainage network, land use/ land cover, slope map, lineament, VES (Resistivity meter) data, pseudo section using Zohdy software are taken into account. The overlay analysis of thematic layers has helped to make ground water prospects map, which has helped to make a site suitability map of different rainwater harvesting structures including percolation tanks, nala bunds, distillation tank and check dams etc.
Keywords— Remote sensing, GIS, DEM, Rainwater harvesting structures, VES, Lineaments.

I. INTRODUCTION

Water being a noteworthy natural resource of nature supports both the human requirements and the socio-economic development. As we all know the surface water sources are very incapable to fulfill the necessity of water because of their uneven and inconsistent distribution. This results in increasing stress on the groundwater which has resulted in decline of the groundwater storage of the country. There is an immediate need of sustainably conserving the rainwater which flows off as runoff and using it to recharge the groundwater. Artificial recharge of groundwater is possible by using rainwater harvesting structures which can be selected according to their suitability at a location which is suggested with the help of Remote sensing, GIS and Geophysical investigation. The Jakhaura block of Lalitpur district is a hard rock area so most part of the rainfall flows as runoff. The infiltration of the rainwater is very less, so there is a need of increasing the groundwater storage with the help of RWH (Rain Water Harvesting) structures.

A. Rain Water Harvesting Structures

Rain water harvesting structures helps in artificially recharging the groundwater by increasing the natural infiltration of rainwater into groundwater (underground aquifers or formations) by constructing structures such as percolation tanks, check dams, nala bunds etc.

B. Objectives

1) To analyze current groundwater levels throughout the area and demarcate the locations with low groundwater levels to take necessary measures.
2) To suggest appropriate sites for Rainwater Harvesting Structures considering the geology of hard rock terrain features.
3) To maintain a record of Rainwater Harvesting Structures for help in future sustainable development aims in the area.

II. STUDY AREA

Jakhaura is a block which resides in western part of lalitpur district and shares its boundary with Madhya Pradesh. Lalitpur district is located in the south western part of Uttar Pradesh .It falls in east longitude $78^0 10' 14''$ to $78^0 30' 52''$ and between $24^0 33' 45''$ to $25^0 58' 07''$north latitude. Jakhaura comes under the topo sheet numbers 54L1, 54L2, 54L4, 54L5, 54L9, and 54L10.

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The total area of this block is 93202 hectare. It is situated approximately 420km away from the state capital. Some part of Rajghat reservoir and Gobindsagar reservoir comes under the Jakhaura block.

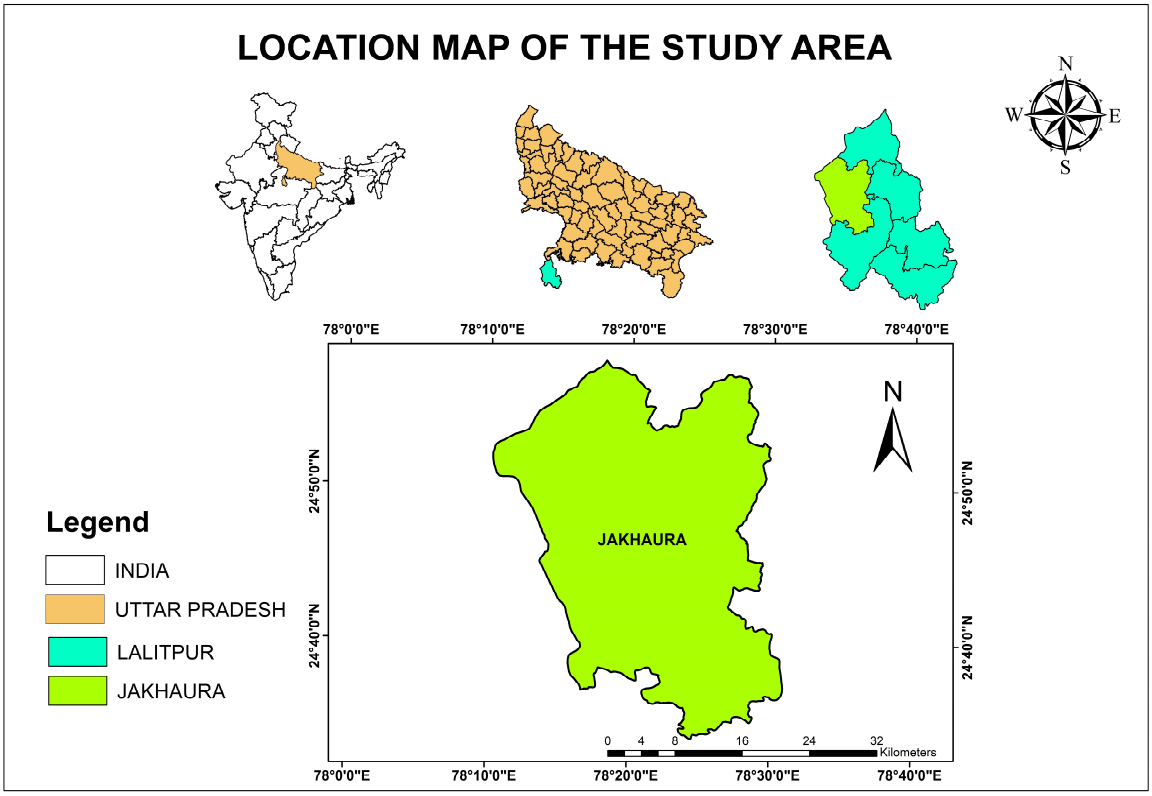


Fig. 1: Location map of Study Area

III.MATERIALS

A. Softwaret

- Zohdy software
- Arc GIS
- Erdas Imagine

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B. Equipments

- DDR 3 Resistivity meter
- GPS (Oregon 650)

C. DATA

- IRS Liss iv with Cartosat 1 pan merge data
- Survey of India toposheest.
- CARTOSAT-2

IV.METHODOLOGY

Overlay analysis of different thematic maps including drainage, base map, drainage density, DEM (Digital elevation model), slope map, lineament, land use/land cover, ground water prospect, top soil thickness etc. was done. All these maps were prepared using Remote sensing, GIS and Geophysical investigations. The software, satellite data and the steps which were followed are described in the form of a chart mentioned below.

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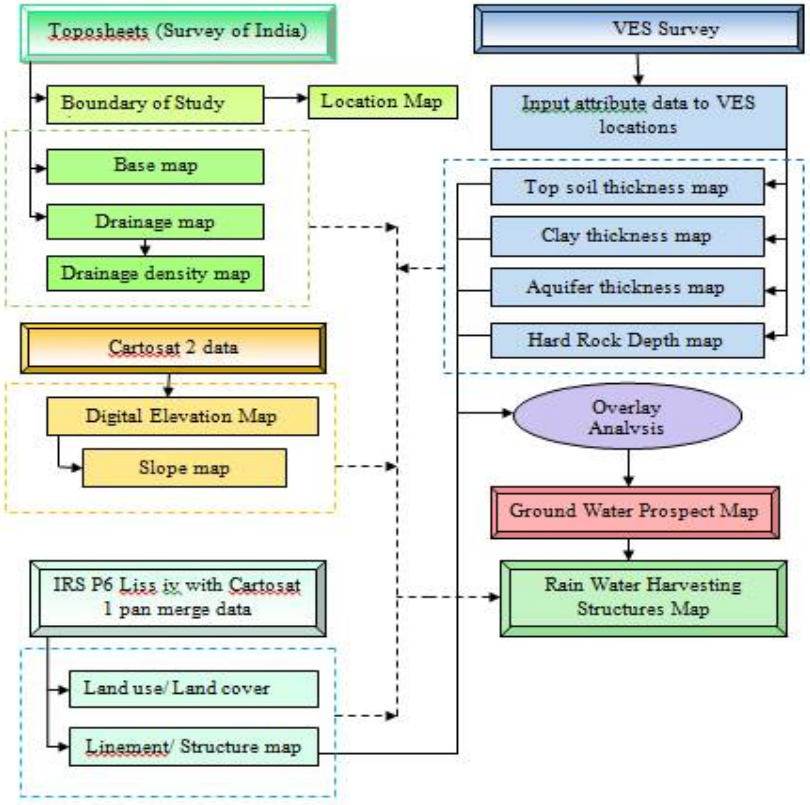


Chart - 1: Methodology chart

V. MAPS USED

A. Base Map

The base map of an area tells us aboutnthe connectivity of it by roads and railway. This helped in our present study in finding the Rainwater harvesting structures and Ves locations both. The presence or absence of settlement and agricultural area also helps in site selection of the suitable area.

B. Drainage Map

Drainage map contains drainage flowing through the area, canals and the waterbodies present in the area. The drainage pattern in Jakhaura block as visible in the map is majorly dendritic. The drainage map when overlayed with the slope map and digital elevation map helps to find the order of the different drainage present by analyzing the direction of flow.

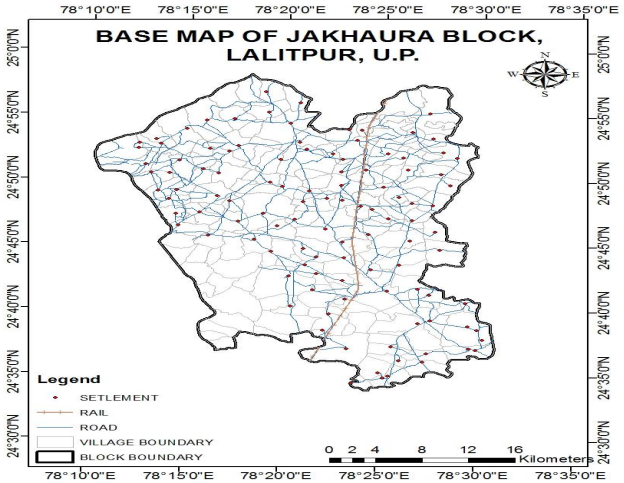


Fig – 2: Base map of Jakhaura

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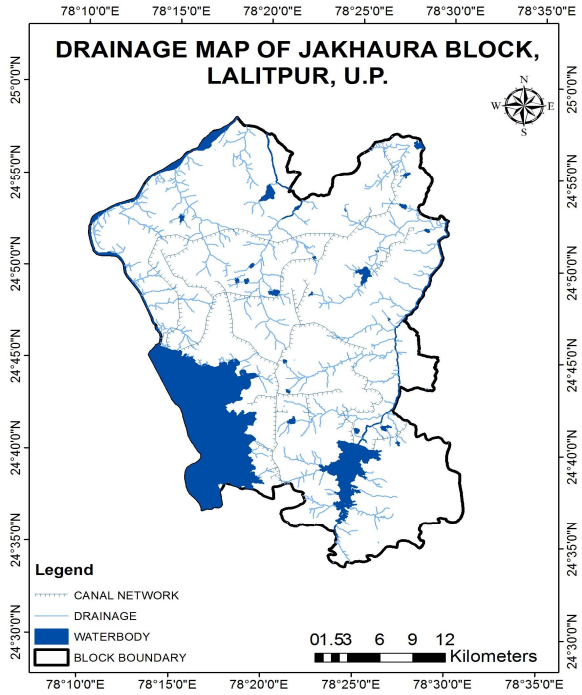


Fig – 3: Drainage map of Jakhaura

C. Digital Elevation Model Map

The digital elevation model map of the Jakhaura block was clipped from the Cartosat 2 digital elevation data downloaded from the bhuvan web portal. These maps are useful for depicting the viewpoint and other landscape traits which are useful to derive the stream order to the drainage present in the area. The highest elevation of the Jakhaura block is about 497 m whereas the lowest elevation point was 263m above the mean sea level.

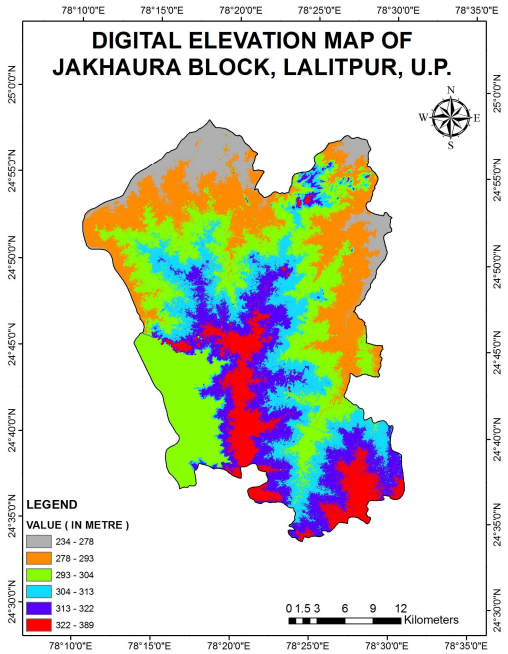


Fig – 4: Digital Elevation Model map of Jakhaura

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D. Slope Map

Slope map is helpful in finding suitability for the type of structures as slope is a necessary parameter in selection of the type of recharge structure to be built on a selected location.

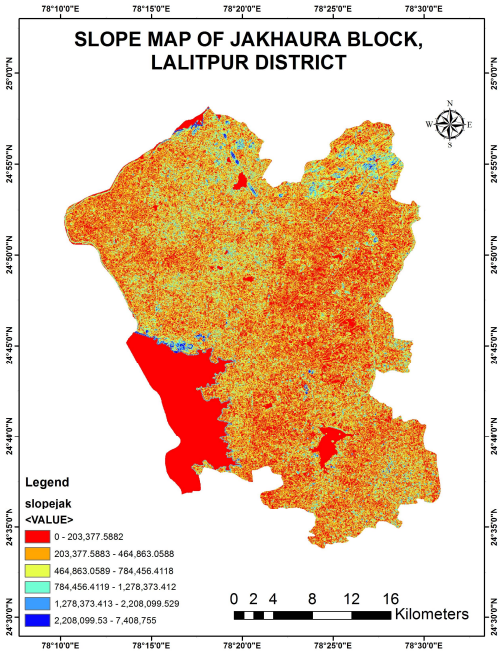


Fig – 5 Slope map of Jakhaura

E. Land Use/ Land Cover Map

This map is important as it is required for studies related to developmental activities. In this study it was used in locating the VES survey locations and in selecting the sites as well as the types for rainwater harvesting structures.

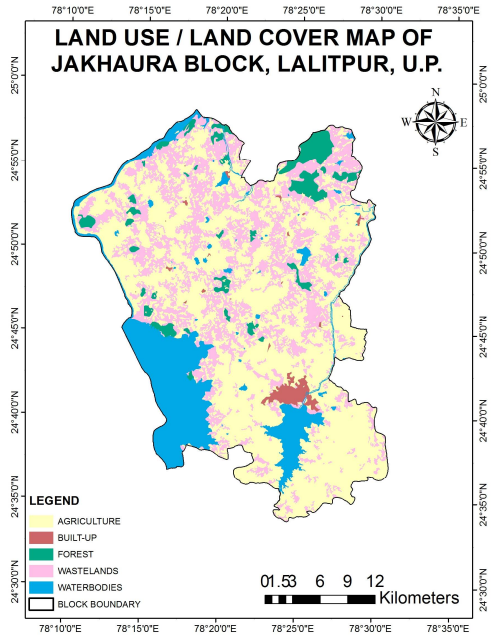


Fig – 6 : LU/LC map of Jakhaura

F. Lineaments Map

Lineaments map shows the faults and fractures situated in the area. Lineaments are those features of a surface that are aligned in a rectilinear and sometimes curvilinear relationships upto some extent. They are easily distinguishable as they are different from

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adjacent features in terms of their pattern and indicate subsurface phenomenon. The area in study has hard rock features primarily which is a reason for the lineament features to be present in large amounts. They help in collection and storage of water and at these places water is stored in large amounts.

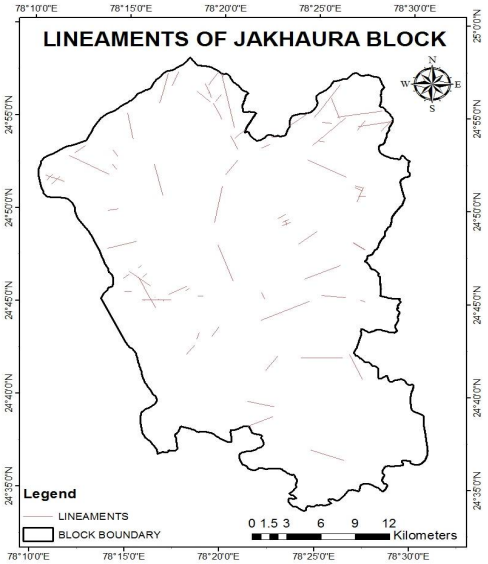


Fig –7 Lineaments map of Jakhaura

G. Geophysical Method Used

Geophysical technique is very widely used to collect the information of subsurface structures and helps in evaluating Clay thickness map, Aquifer thickness map, Top soil thickness map and Hard rock depth map etc.

This technique of Vertical electrical sounding uses the measurement of resistivity to find the subsurface variations. The ddr 3 resistivity meter was used for measuring the resistivity values and it helped for plotting of resistivity curve which further helped in preparation of Clay thickness map, Aquifer thickness map, Hard rock depth map and Top soil thickness map. These maps further helped in the preparing the Ground water prospects map.

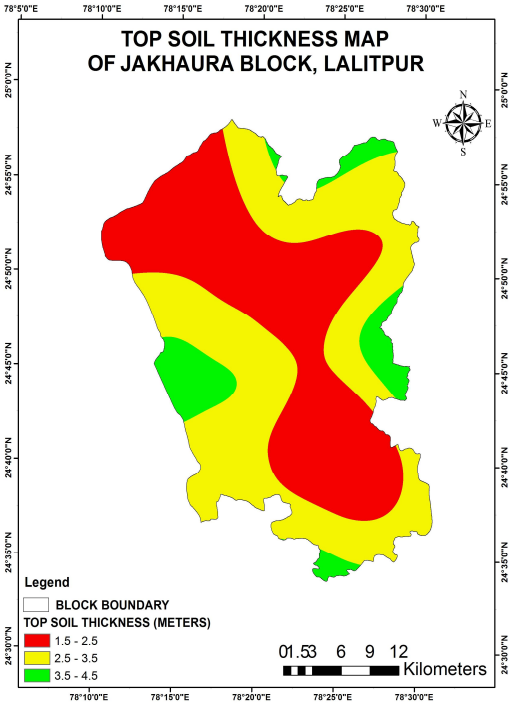


Fig – 8: Top soil map of Jakhaura

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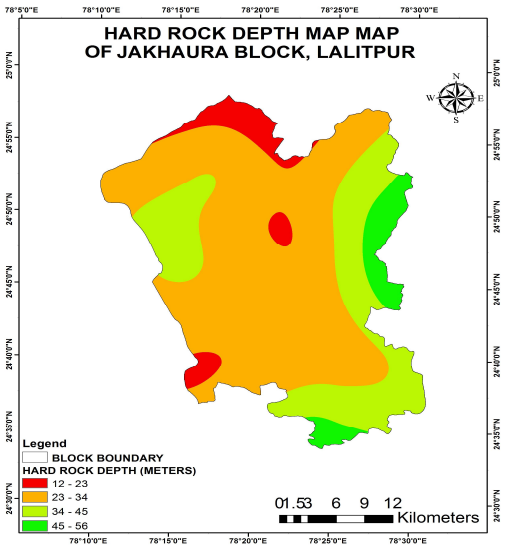


Fig – 9: Hard rock depth map of Jakhaura

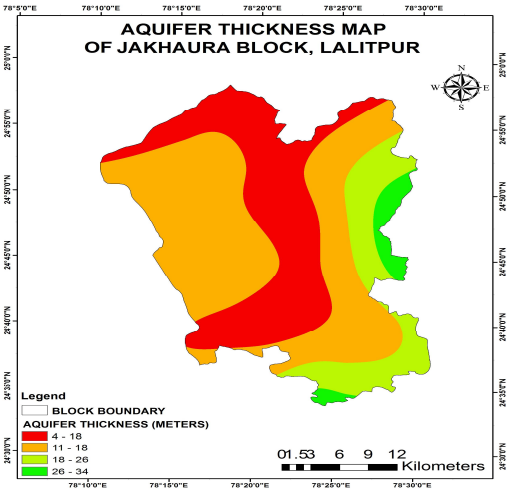


Fig – 10: Aquifer thickness map

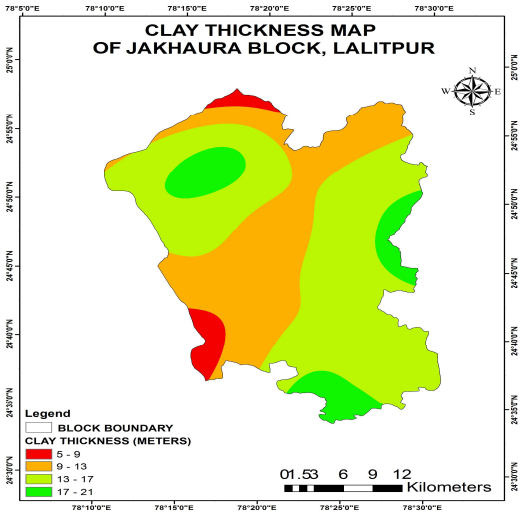


Fig. – 11: Clay thickness map

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VI. RESULTS

The Drainage map, Base map, Slope map, Lineaments map, Land use/ Land cover map, Aquifer thickness map, Hard rock depth map, Clay thickness map and Top soil thickness map were used for multi criteria evaluation to select suitable sites for Recharge structures such as check dams, nala bunds and desiltation tank. Weightage overlay index analysis was used for investigation of the thematic layers in Arc-GIS. The analysis in the Arc-GIS from different layers helped to make a map for suitable sites for various RWH structures.

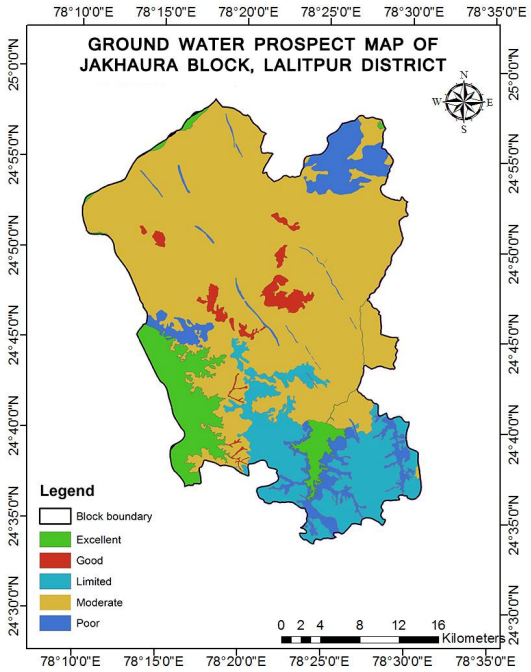


Fig – 12: Ground Water Prospect Map

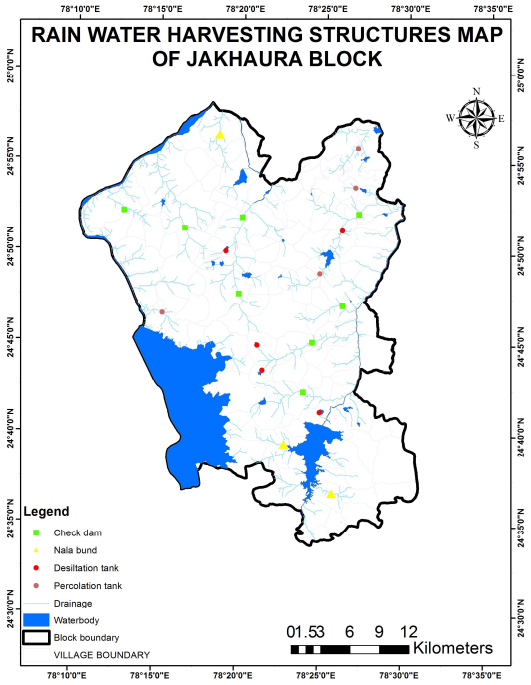


Fig – 13: Rain water harvesting structures map

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VII. CONCLUSION

Domestic needs and advanced agricultural methods demanding more water coupled with increasing population has created a surge in water demands of the area. The combined use of remote sensing, GIS and geophysical can prove to be effective in selection of RWH sites. Water table of the area has depleted significantly in recent times as depicted by few statistics. The water table of the area needs to be replenished using sustainable practices like rainwater harvesting. This work will help significantly as the high rainwater runoff in this area owing to hard rock features will be controlled by the suggested structures. Vegetation will be benefitted and specifically the ground water will get replenished resulting in increase in ground water storage.

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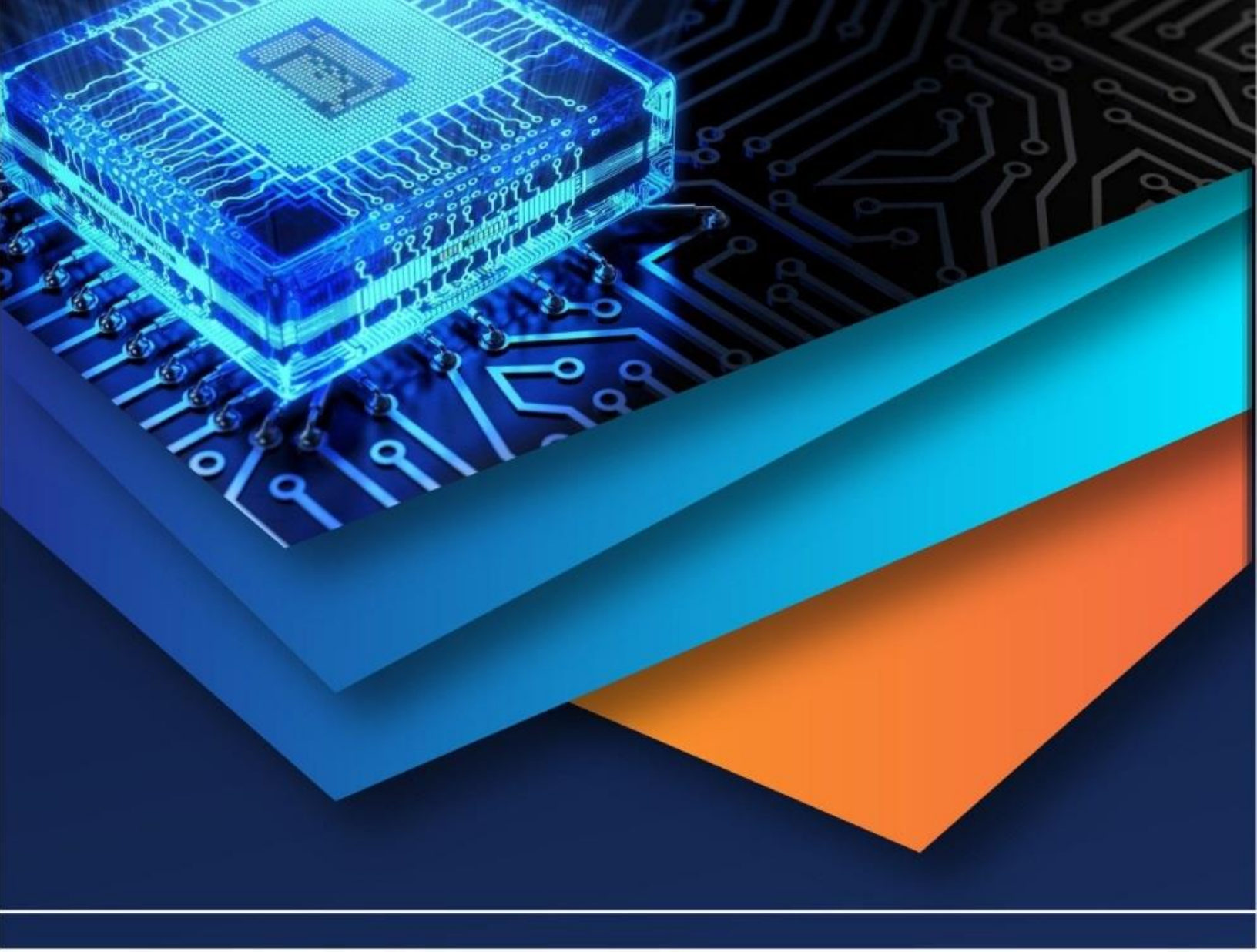
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