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SITE SELECTION OF RAIN WATER HARVESTING STRUCTURES WITH THE HELP OF GEOPHYSICAL TECHNIQUE, REMOTE SENSING AND GIS IN BIRDHA BLOCK, LALITPUR DISTRICT, UTTAR PRADESH

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Abstract - *Water is a very important natural resource which has its use in every aspect of life and because of this it is exploiting at a very fast rate. Our country, India is also facing the problem of water scarcity as its population is more than 17% 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 Birdha block of Lalitpur, Uttar Pradesh. The hard terrain feature of Birdha 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, geomorphology, 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.*

Key Words: **Remote sensing, GIS, Geomorphology, DEM, Rainwater harvesting structures, VES.**

1. 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 Birdha 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.

1.1 Rain Water harvesting structures

Rain water harvesting structures helps in artificial recharge of groundwater by increasing the natural infiltration of rainwater into underground aquifers or formations by structures such as check dams, nala bunds etc. The choice of a particular method depends on the local geological and groundwater conditions.

1.2 Objectives

- To find the present situation of groundwater levels throughout the area and demarcate the locations with low groundwater levels to take necessary measures.
- To propose the suitable sites for Rainwater Harvesting Structures by studying the geology of hard rock terrain features.
- To maintain a record of Rainwater Harvesting Structures for help in future sustainable development aims in the area.

1.3 Study area

Birdha is a block in southern part of Lalitpur district which shares its boundary with the state of Madhya Pradesh. Lalitpur district is situated in south western part of Uttar Pradesh. It lies between east longitude $78^0 13'36''$ to $78^0 37'32''$ and between $24^0 16'09''$ to $25^0 47'03''$north latitude. Birdha comes under the toposheet numbers 54L2, 54L3, 54L5, 54L6, 54L7, 54L9, 54L10, and 54L11. The total area of this block is 1285.99 square km. It is situated 428km away from the state capital city Lucknow. The block has 159 villages. Some part of Rajghat reservoir and Sajnam reservoir comes under the Birdha block.

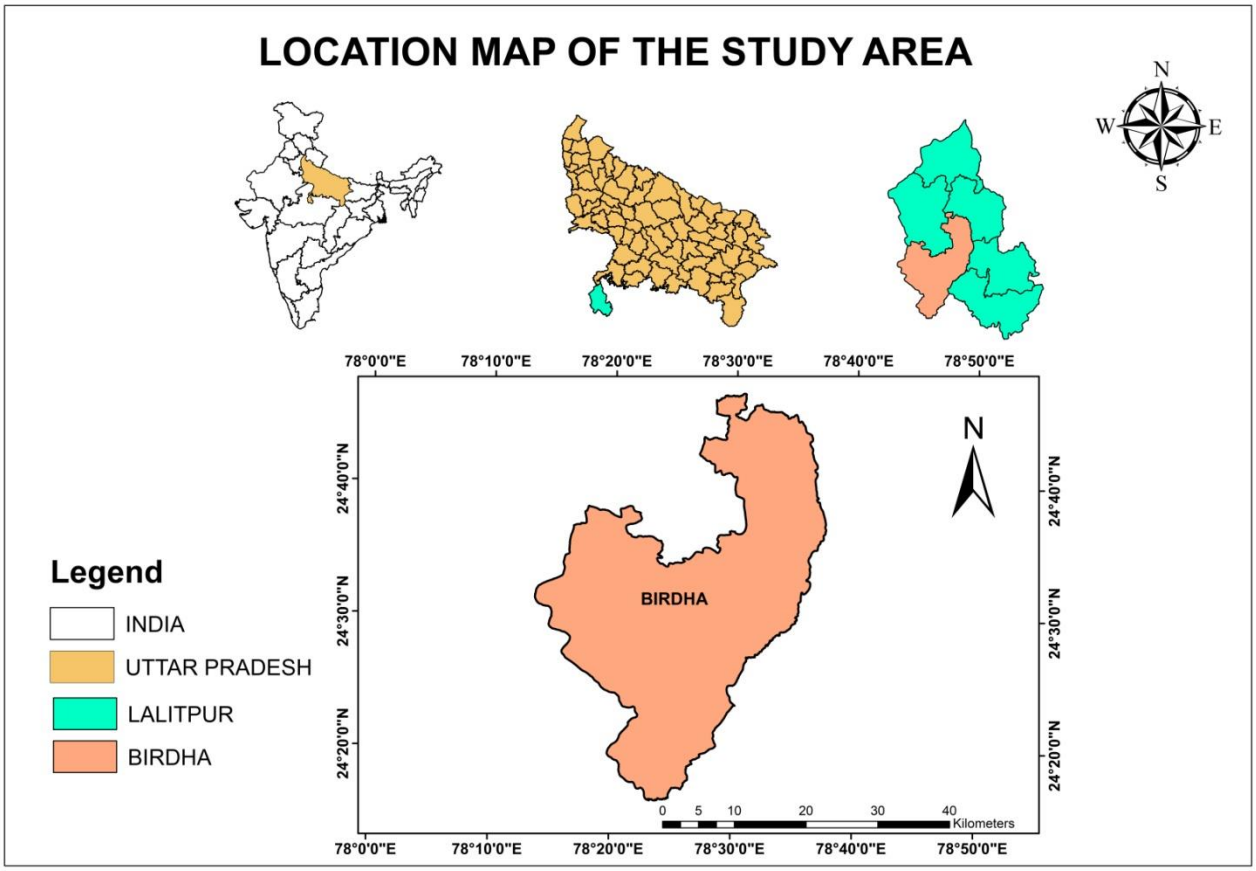

Fig – 1: Location map of Study Area

2. MATERIALS

2.1 Software

- Zohdy software
- Erdas Imagine
- Arc GIS

2.2 Equipments

- DDR 3 Resistivity meter
- GPS (Oregon 650)

2.3 Data

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

3. METHODOLOGY

Overlay analysis of different thematic maps including base map, drainage, drainage density, DEM (Digital elevation model), geomorphology, lineament, land use/land cover, slope, ground water prospect, aquifer 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 shown below.

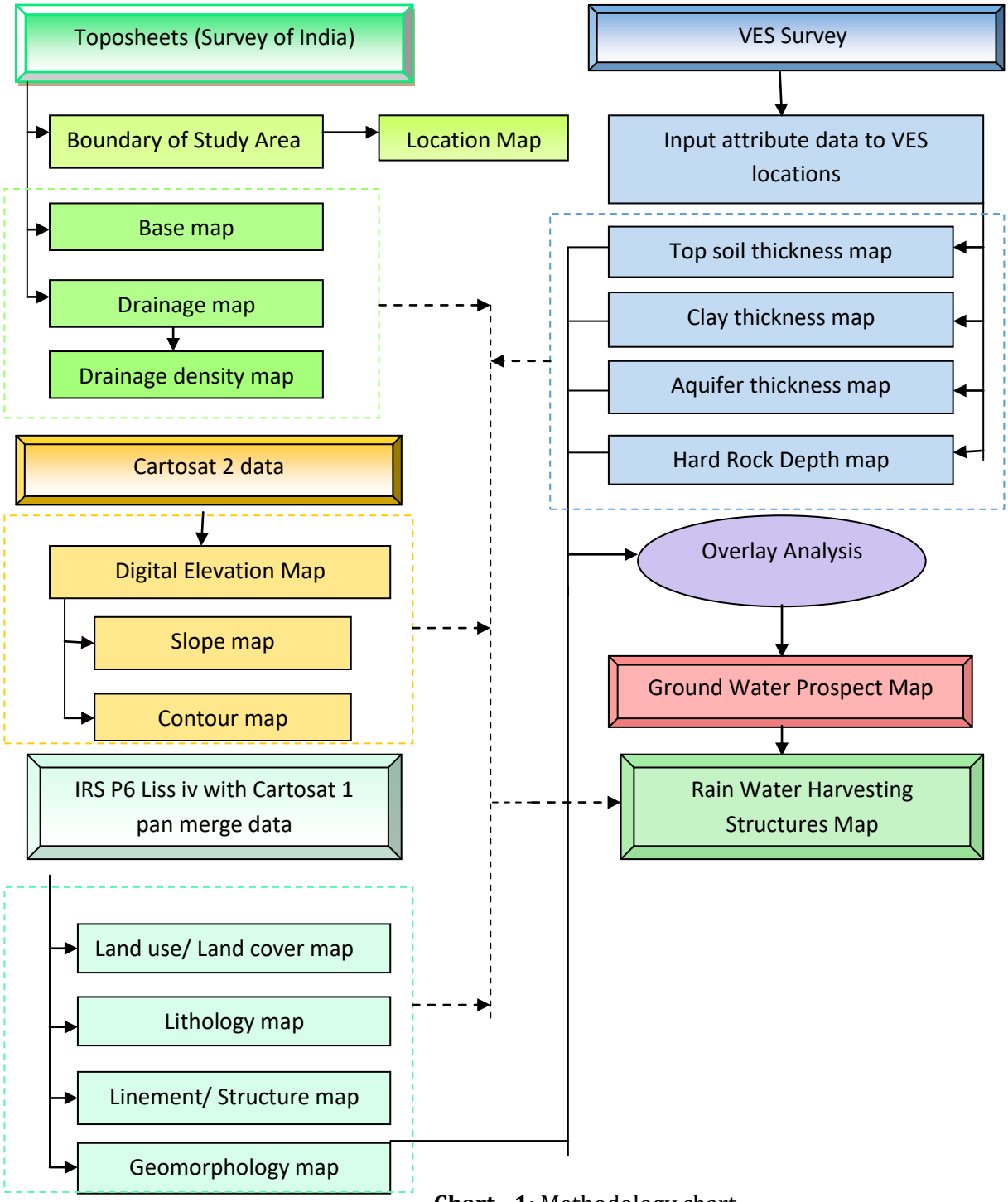

Chart - 1: Methodology chart

4. THEMATIC MAPS

Base map – The base map helps to check the connectivity of any area by road and railway. This helps in locating the Ves locations and Rainwater harvesting structures both. The presence of settlement also helps in selection of the suitable area.

Drainage map – Drainage map contains drainage flowing through the area, canals and the waterbodies present in the area. The drainage pattern in Birdha 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.

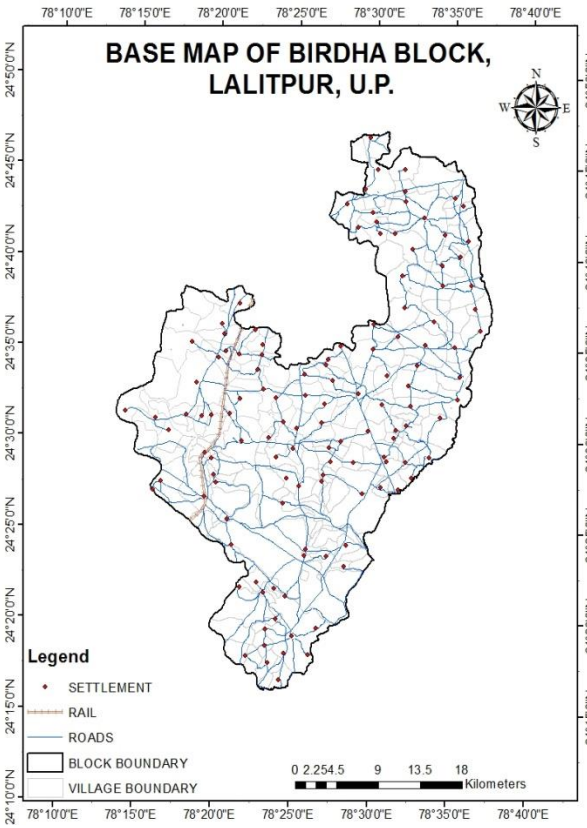

Fig – 2: Base map of Birdha

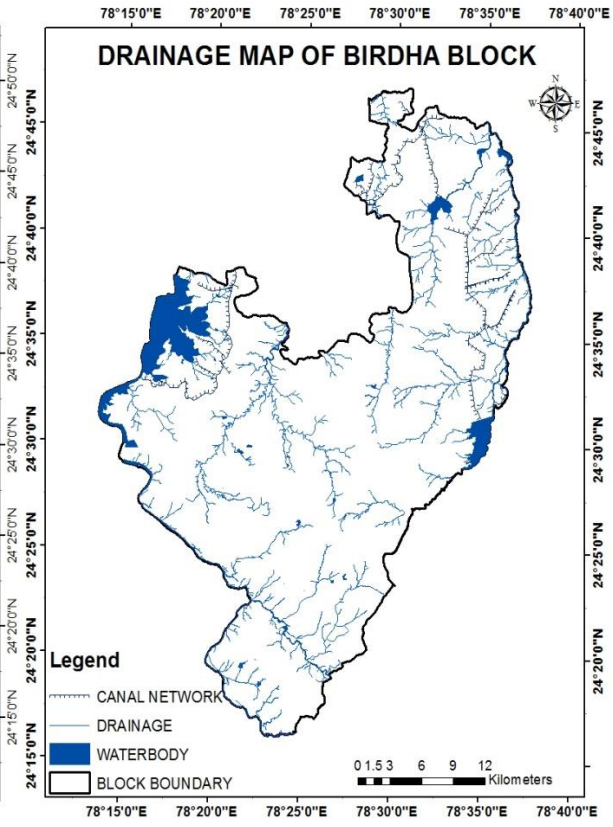

Fig – 3: Drainage map of Birdha

Digital elevation model map – The digital elevation model map of the Birdha 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 Birdha block is about 497 m whereas the lowest elevation point was 263m above the mean sea level.

Geomorphology map – The geomorphology of an area is helpful as it indicates the subsurface water conditions with the help of satellite images. The geomorphic features in this study are identified by both satellite imagery and ground truth conformation. Geomorphology of this area is categorized and shown in the map as Alluvial plain, Denudation hills, Flood plain, Habitation mask, Pediplain, Peidmont zone, Plateau and Structural hills.

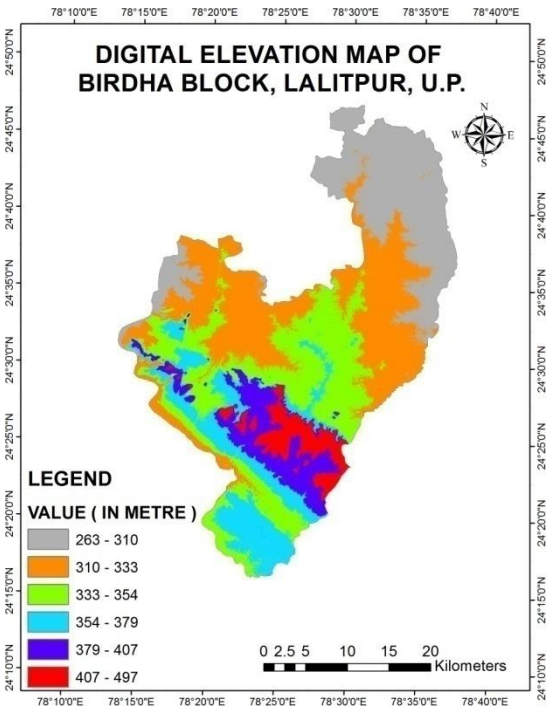

Fig – 4: Digital Elevation Model map of Birdha

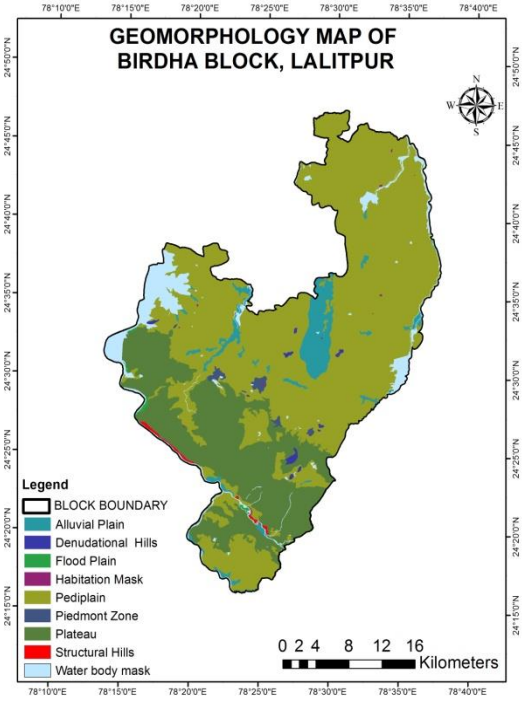

Fig – 5: Geomorphology map of Birdha

Land use/ Land cover map – Land use/ Land cover map is always required for the projects related to developmental activities. In this study also it was used in selection of VES survey locations and also in selecting the sites for rainwater harvesting structures.

Lineaments - Lineaments shown in the map denotes the faults and fractures present in the area. Lineaments are those features of a surface that are aligned in a rectilinear and sometimes curvilinear relationships up to some extent. They are easily distinguishable as they are different from 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.

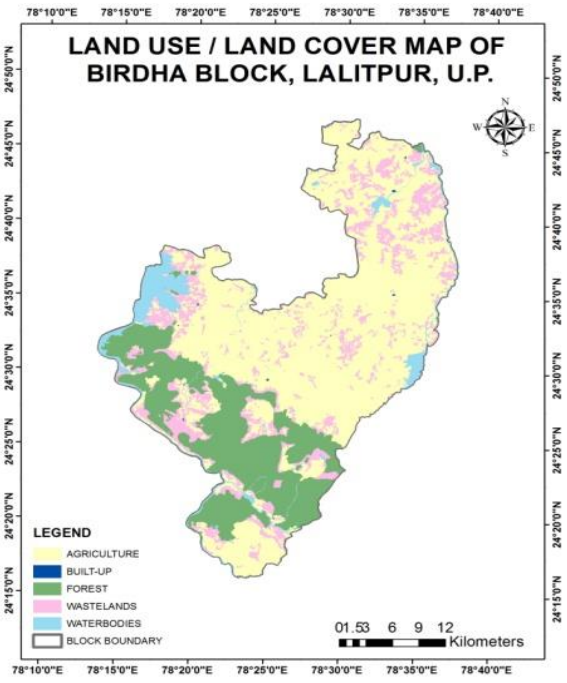

Fig – 6: LU/LC map of Birdha

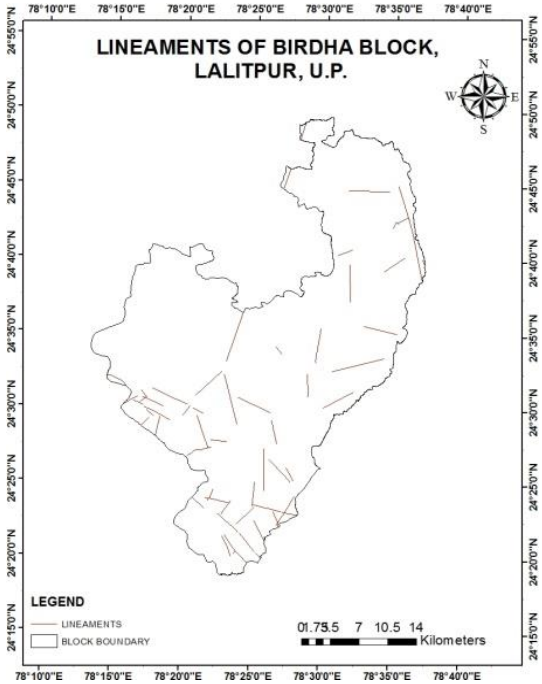

Fig – 7: Lineaments map of Birdha

5. GEOPHYSICAL METHOD USED

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

The VES technique uses the measurement of resistivity to find the changes in subsurface. The ddr 3 resistivity meter was used for taking the resistivity values and a resistivity curve was plotted which further helped in preparation of Aquifer thickness map, Clay thickness map, Hard rock depth map and Top soil thickness map. These maps have helped in the preparation of Ground water prospects map.

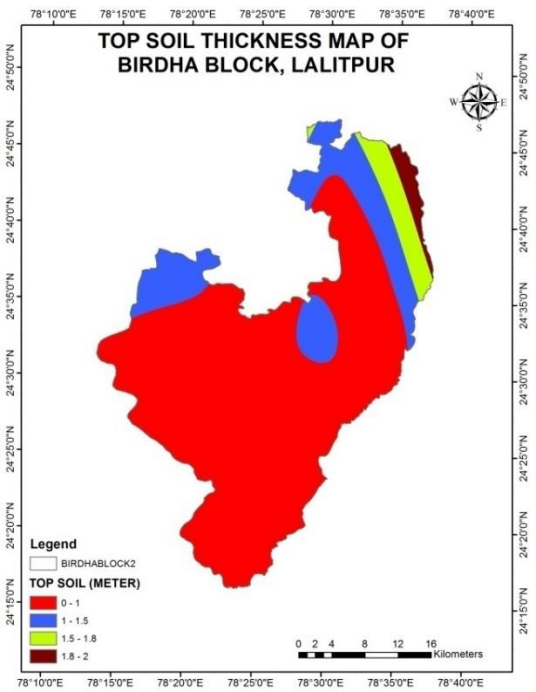

Fig – 8: Top soil map of Birdha

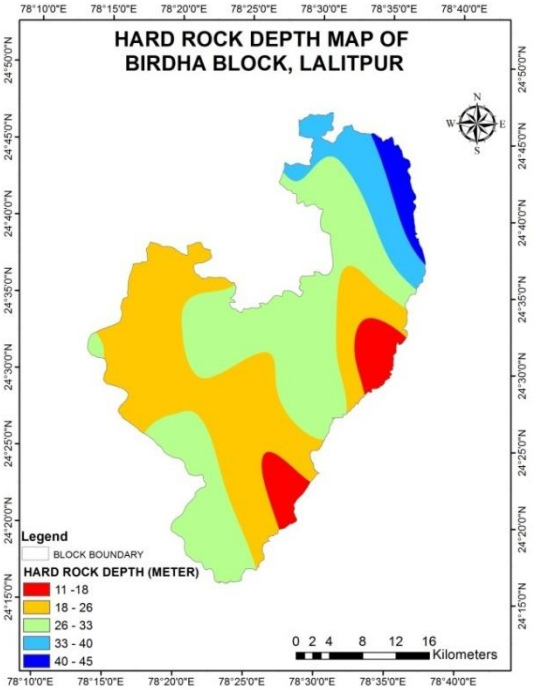

Fig – 9: Hard rock depth map of Birdha

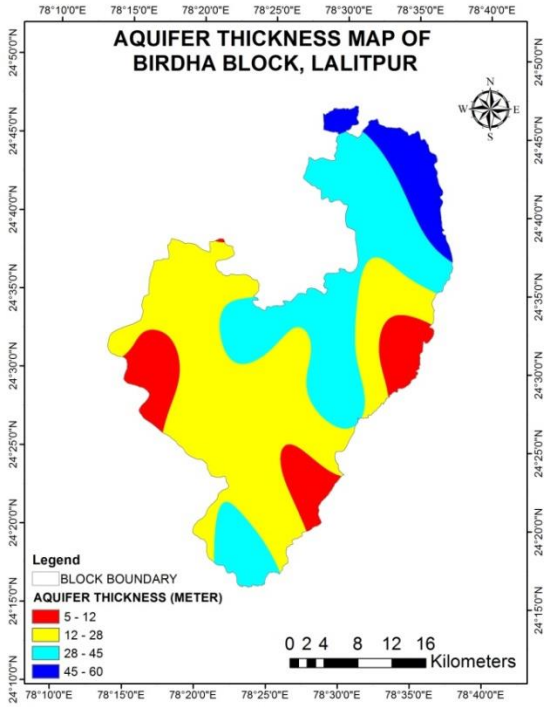

Fig – 10: Aquifer thickness map

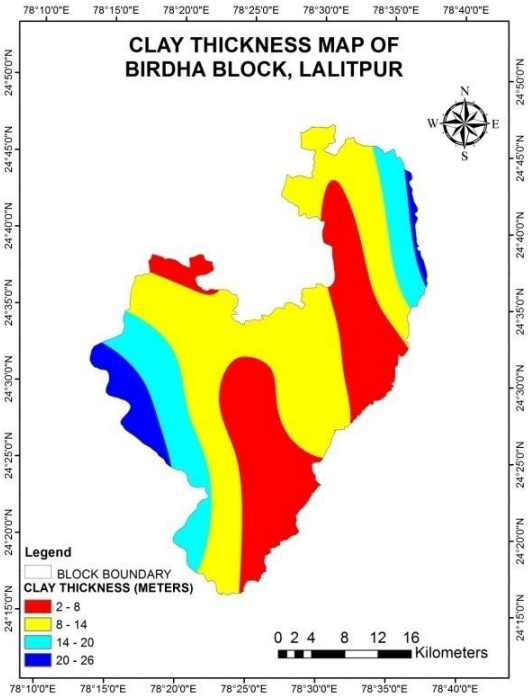

Fig. – 11: Clay thickness map

6. RESULTS AND CONCLUSION

The Base map, Drainage map, Geomorphology map, Land use/ Land cover map, Lineament, Aquifer thickness map, clay thickness map, Hard rock depth map and top soil thickness map were used for multi criteria evaluation for selection of suitable sites for RWH structures such as check dams, nala bunds and percolation 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.

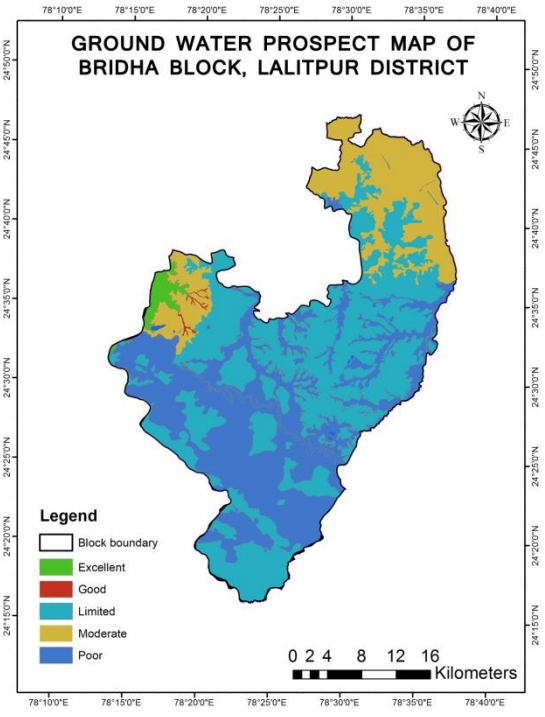

Fig – 12: Ground Water Prospect Map

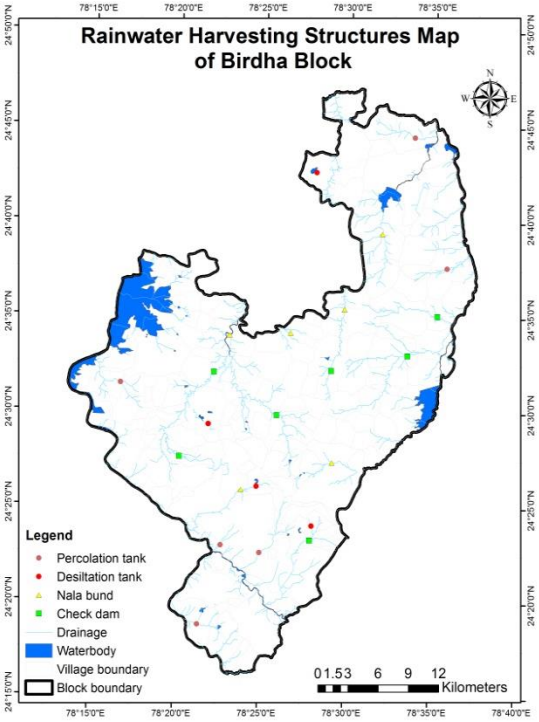

Fig – 13: Rain water harvesting structures map

CONCLUSION

The demand of water in this area is increasing day by day due to increase in its consumption through agricultural and domestic needs due to increment of population and new agricultural techniques and practices. The combined use of remote sensing, gis and geophysical method is a very efficient method for selection of RWH sites. The water table of this area is decreasing significantly during past few years according to the statistics. The water table of this area needs to be improved by using suitable practices like rain water harvesting. The result of this work will be very beneficial in multiple ways such as the high runoff in this area due to hard rock features will be regulated by the suggested structures, the vegetation will get benefit and most importantly the ground water will get recharged resulting in increase in ground water storage.

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