REMOTE SENSING, GIS AND GEOPHYSICAL TECHNIQUES TO FIND SUITABLE SITES FOR RAIN WATER HARVESTING STRUCTURE

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Abstract-*Water is a natural resource which is a basis of life, livelihood and sustainable development is fluctuating very fast. India has more than 17 % of the world's population, but has only 4% of world's renewable water resources with 2.6% of world's land area. (Gaikwad, January-2015) Water scarcity is serious problem throughout the world for both urban & rural community. Groundwater has emerged as the preferred water source in India. Rapidly decrease in ground water is a serious problem and compelled us to think about some artificial recharge of ground water. The present paper envisage to use Remote Sensing, GIS and Geophysical technique(vertical electrical sounding) for identification of suitable sites for rain water harvesting structure as an alternative source of water on hard rock terrain area of Talbehat block of Lalitpur district, Uttar Pradesh. Runoff is very high as compare to infiltration because of hard terrain features in Talbehat. Different thematic layers such as drainage network, rainfall data (2013-2018) land use/cover, geomorphology, lineament/ structure, field data by VES(DDR 3 Resistivity meter), Zohdy software for pseudo section are taken into account for multi criteria evaluation. Overlay analysis of different thematic layers suggests suitable sites for rain water harvesting structure by the help of final ground water prospects map. Suitability map will help in selection of harvesting structures such as percolation tanks, nala bunds, check dams and disiltation tank etc.*

Key words- **Remote Sensing, GIS, VES by DDR3 Resistivity meter, DEM, Land use/cover, Geomorphology**.

1. INTRODUCTION

Water plays a vital role not only in fulfilling basic human need for life and health but in socio-economic development also. As the primary source of water is rainfall, so it becomes necessary for us to harvest it effectively we can maximize the storage and minimize the wastage of rain water. Surface water assets are deficient to meet the water necessity because of inconsistent appropriation of precipitation. So as to prevent the lackness of groundwater, artificial reviving of groundwater water is finished by using remote sensing, GIS and geophysical studies. Ground water is the world's biggest available stockpiling framework, which is the main substitute of surface water supply. The ground water asset constitutes a piece of the dynamic hydrological cycle. . In permeable surface material for example sand or rock 40 to 50 percent of the rain and snowmelt may penetrate into the ground. Invasion into less permeable surface material may go from 5 to 20 percent. Talbehat block comes under hard rock terrain which means runoff is very high as compare to infiltration. 85% population of this block belong to rural area and depend upon agriculture the water available is insufficient to fulfill their needs which leads to suggest some artificial recharge structure. According to IMD from 2007 rainfall pattern had been damaged.

1.1 Concept of Rain Water Harvesting Structure

Rain Water Harvesting is defined as the concentration; collection and in situ storage of rainwater at a different location, immediately or at a later time (: Nadhir Al-Ansari, April 18, 2014). RWH aims to improve the efficient use of rainfall by capturing it on the site where it falls, and capturing the runoff for irrigation, livestock and domestic purpose. The appropriate choice of water harvesting technique depends on rainfall and its distribution, topography, land use land cover (LULC), and soil.

1.2 Factor Consider For Rain Water Harvesting Structure

- Availability of runoff water.
- Depth to underground storage space.
- Quantity of source water available.

- Flow characteristics of the aquifer.
- Applicable methods (Injection or infiltration).
- Land cover /land use, DEM, Drainage pattern, Lineament, Geomorphology etc

1.3. Objectives

(1) To capture decline in ground water level and enhance availability of ground water at specific place and time and utilise rain water for sustainable development.
(2) To demarcate the artificial recharge potential zones using remote sensing, GIS and geophysical techniques.
(3) To create a digital database of artificial recharge structure for future development and planning

2. STUDY AREA

Talbehat is a block situated in Lalitpur district which is southern most part of Uttar Pradesh. It lies between $24^0 52'17''$ to $25^0 30'33''$north latitude and $78^0 18'05''$ to $78^0 40'26''$east longitude. It comes under the toposheet grid number 54L\5, 54L\9, 54K\8 and 54K\12. It is located 364.1Km via NH 27 from state capital Lucknow. There are about 165 villages and 47 gram panchayat. A very famous block of Lalitpur known for matatil DAM and Famous temples such as the Temple of Pawagir Ji Jain, Deva Mata Temple and some other tourist attractions such as Talbehat Fort, boat club, Mansrovar Lake etc. Talbehat is covered by rocky ridges that descend towards the river Betwa.

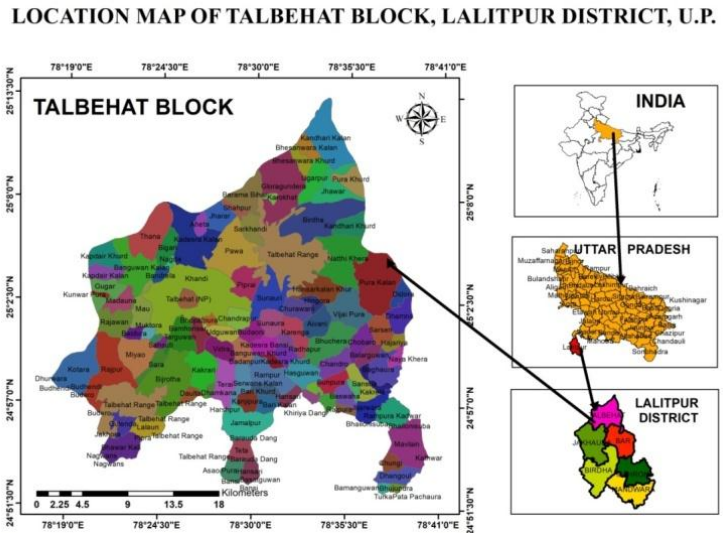


Fig-1: Location Map of Study Area

3. MATERIALS

3.1 Software

- Zohdy ware
- Arc GIS
- Erdas Imagine

3.2 Equipments

- GPS (Oregon 650)
- Geophysical instrument – DDR 3 Resistivity meter

3.3 Data

- Survey of India toposheet (1:50000 scale)

- Google earth (for real time verification)
- LISS iv +Cartosat 1 (PAN) merge data

4. METHODOLOGY

Thematic maps viz., geomorphology, ground water prospect, land use/land cover, soils Texture, contour, slope etc. have been prepared for the study area using Remote Sensing data ,GIS and Geophysical techniques. These thematic maps prepare using LISS IV and Cartosat 1 Pan merge satellite data, CartoDEM and other secondary data. Arc GIS software is also used during the whole course of work. The following steps were followed for identification of water harvesting structure in study area. A flow chart is also prepared for the support of Methodology.

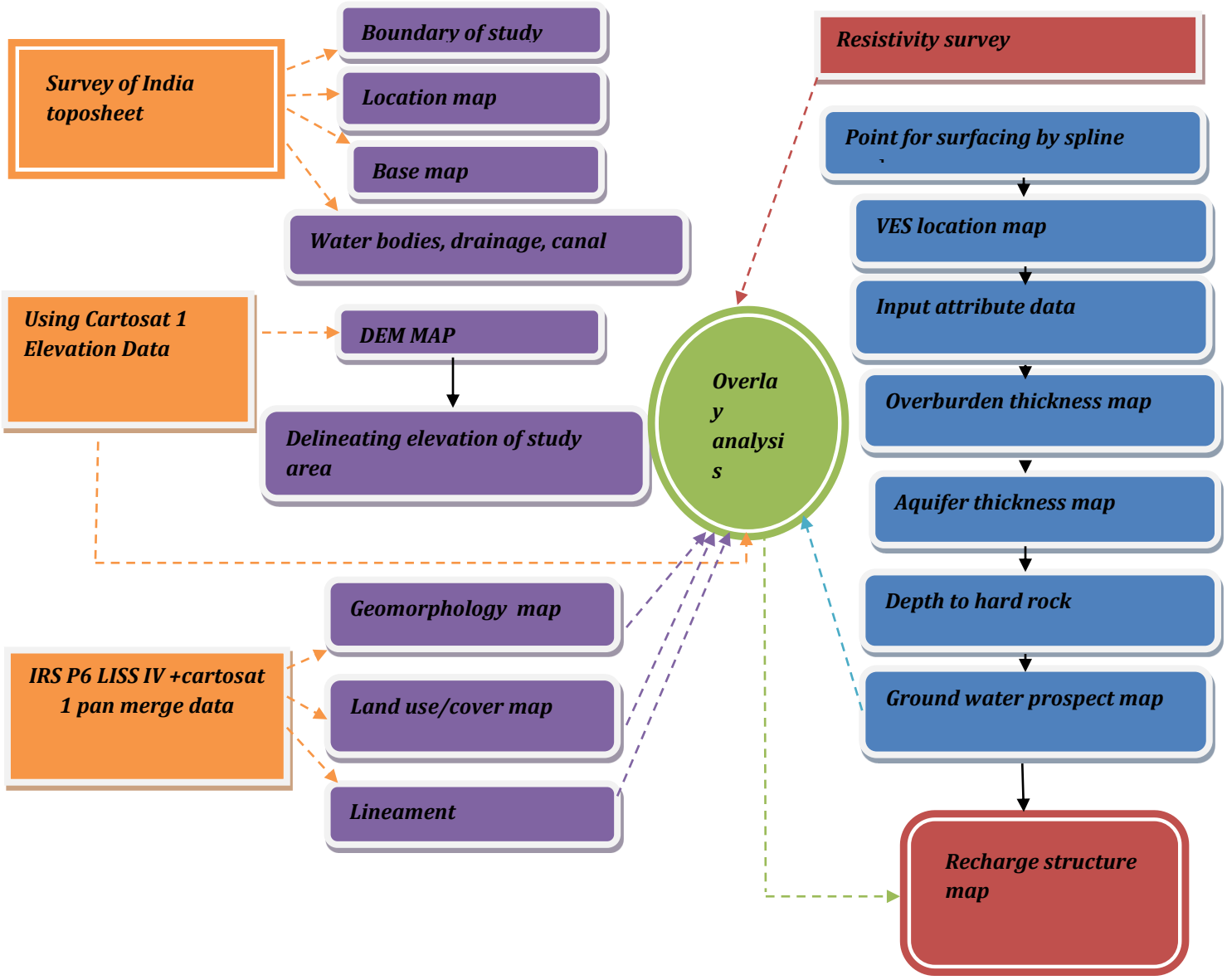


Fig-2: Process for Obtaining Objectives

4.1 Rainfall Data- Lalitpur district lies in between Indo-Gangetic plain to the north and Vindhya region to south. Normally rainy dayswas 52 days but from last 6 year the rainfall pattern is decreasing and is limited to 24 days only (As per IMD report). The present paper shows how rainfall pattern behaving between year 2012 to 2017(Data Source-Rainfall statics report from 2012-2017 presented by IMD)

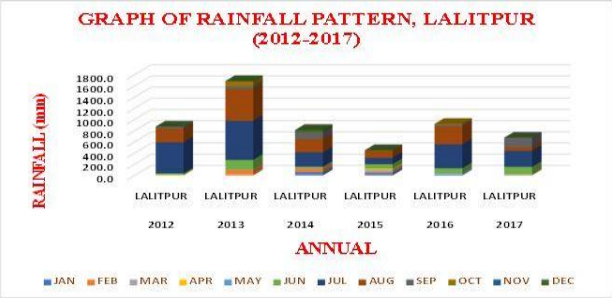


Fig-3: Annual Rainfall Data

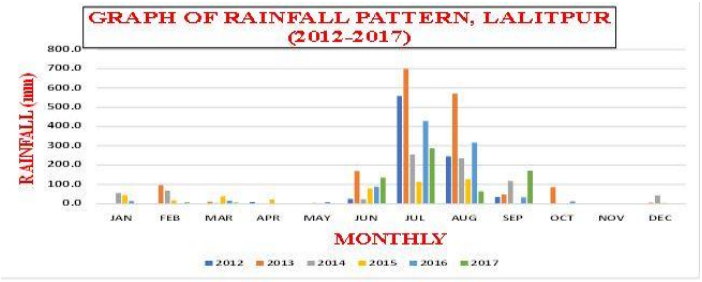


Fig-4: Monthly Rainfall Data

5. ANALYSIS OF DIFFERENT THEMATIC LAYERS

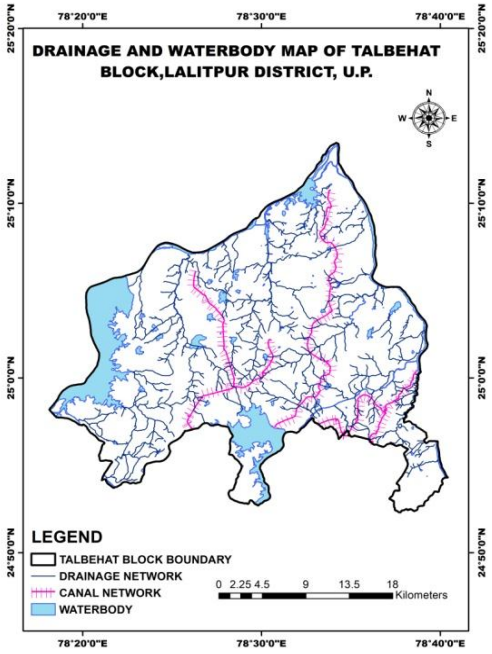


Fig-4: Drainage Map

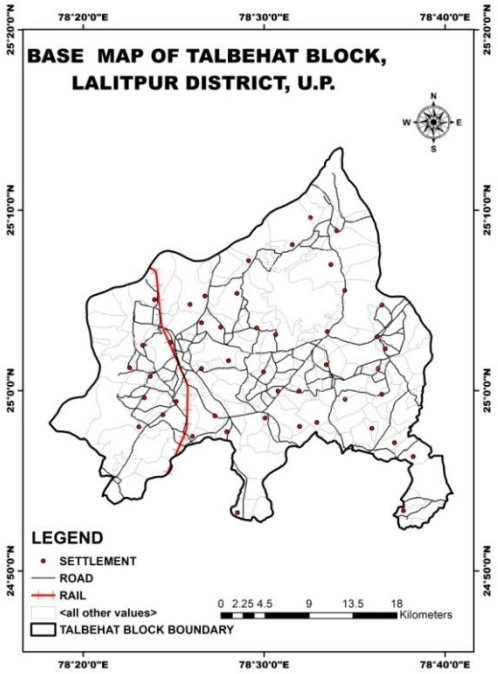


Fig-5: Base Map

Base Map- Base map basically gives an idea about the road features, settlement and railway track. In this block NH -26 passes from north to south. Rail network which passes from Talbehat station have been shown in Fig.4.

Drainage And Water Body- Drainage network helps in delineation of watersheds and for suggesting various water harvesting structures and soil conservation measures. Drainage map is being prepared by SOI toposheets on 1:50,000 scale and updated with satellite imagery like Google earth. This map provides basic information of drainages, watershed boundary and surface bodies. Drainage pattern is defined as the plan, which the individual stream courses collectively form. The Dendritic drainage pattern of Talbehat block has been observed (Fig.3) and some part pattern is radial.

Digital Elevation Model (DEM)- It is derived from Cartosat1digital elevation model available in Bhuvan App. The highest elevation 333m (from MSL) in south-west part and lowest elevation is 190(from MSL) meter in north east portion of study area. Digital Elevation Model, (DEM) is the computerized representation of the earth surface height concerning any reference datum. DEMs are utilized to decide landscape traits, for example, rise anytime, incline and viewpoint. Landscape highlights like seepage bowls and channel systems can likewise be distinguished from the DEMs. DEMs are broadly utilized in hydrologic and geologic investigations and so on. Hydrologic uses of the DEM incorporate groundwater demonstrating, estimation of the volume of proposed supplies and so forth Fig.5.

Lineament - Lineament in this study is defined as a map able, linear feature of a surface (Fig.6), whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differ from the pattern of adjacent features and presumably reflect some subsurface phenomenon. As Lalitpur District comes under hard rock area so there are many lineament features. It is the finest geological cluster that helps to collect water and where water is stored at a very high capacity. It is the best geological unit which helps to collect the water and where the water is store at High capacity

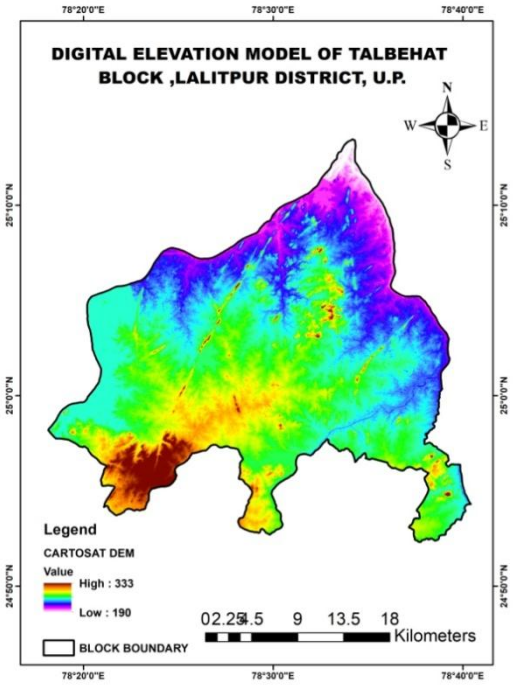


Fig-6: DEM Map

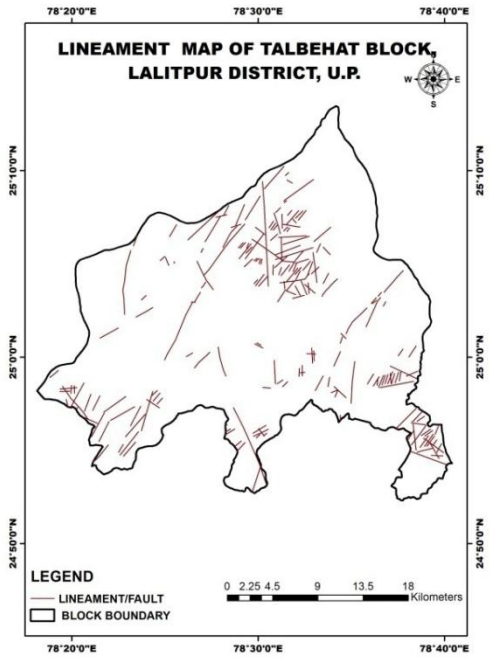


Fig-7: Lineament Map

Geomorphology- The geomorphic trademark can be considered as surface markers for recognizable proof of the states of the subsurface water. Geomorphic surface markers/landforms have been delegated basic and structural landforms. Different geomorphic highlights have been recognized in the satellite picture utilizing translation keys. Geomorphic unit of the investigation zone have been recognize based on satellite symbolism and ground truth confirmation. Geomorphological features of study area which have been categorized into five major classes (Fig.6) such as, Denundation hills, pediment inselberg complex, Pediplain moderate weathered, Pediplain shallow weathered water body, valley fill etc.

Land use/ Land cover- Land use/Land cover map is one of the most important inputs in action plan preparation. To suggest any development activity, it is imperative to know the existing use and spatial distribution of that particular land. Study area is categories in different classes of land (fig.7) such as agriculture, forest, waterbody, waste land etc.

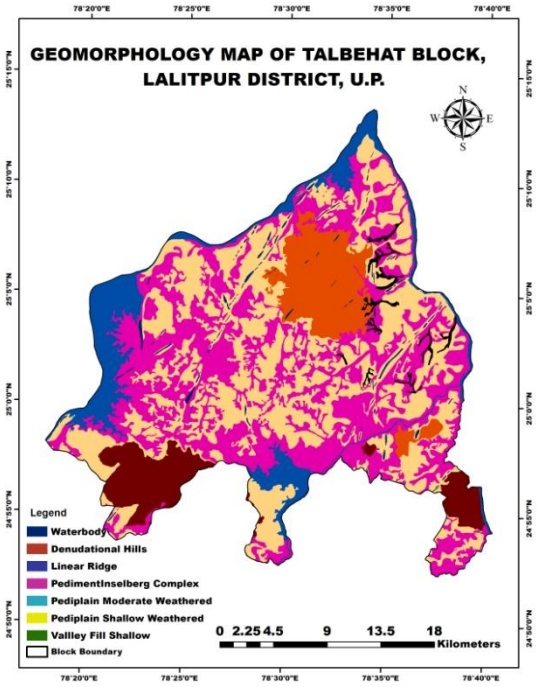


Fig-8: Geomorphology Map

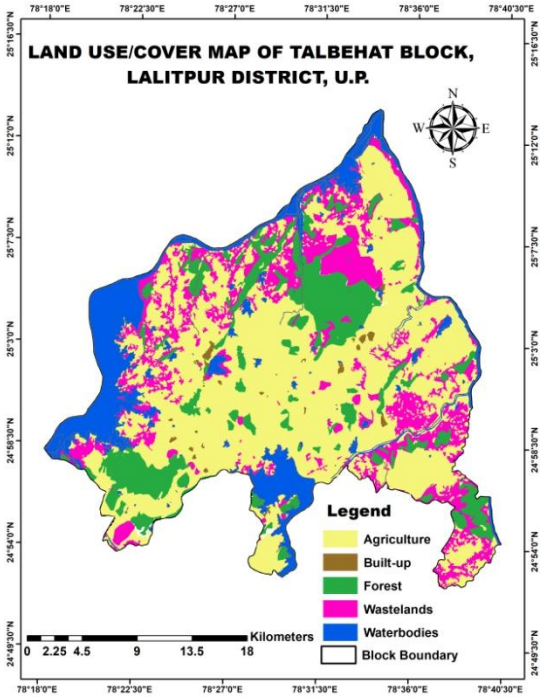
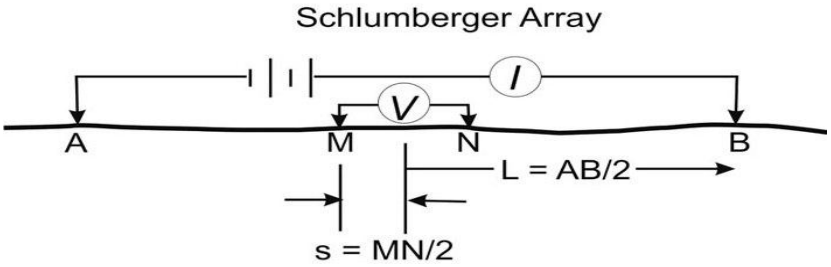


Fig-9: LULC Map

6. VERTICAL ELECTRICAL SOUNDING TECHNIQUE-

- DC electrical system also well known like vertical electrical sounding (VES) is one of the best known and most widely used geophysical techniques for trying to unravel subsurface structure for many geotechnical purposes, e.g. evaluating overburden thickness map, aquifer thickness map, hard rock thickness map etc.
- VES provides information about change in the lithology with depth by means of measured resistivity at surface.

$$\rho a = \frac{\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2}{MN} \pi \left(\frac{\Delta V}{I}\right)$$



Where AB = distance between the current electrodes ,

MN= distance between the potential electrodes.

Based on the above analysis of figures field location is set for VES survey of Talbehat block and resistivity curve is plotted by input of attribute data obtained by DDR 3 resistivity meter then after three major maps have been prepared named as overburden thickness map, aquifer thickness map and hard rock depth map. After preparing these maps interpolation is done and ground water prospects Fig.13 map has been created by overlay analysis of different thematic layers.

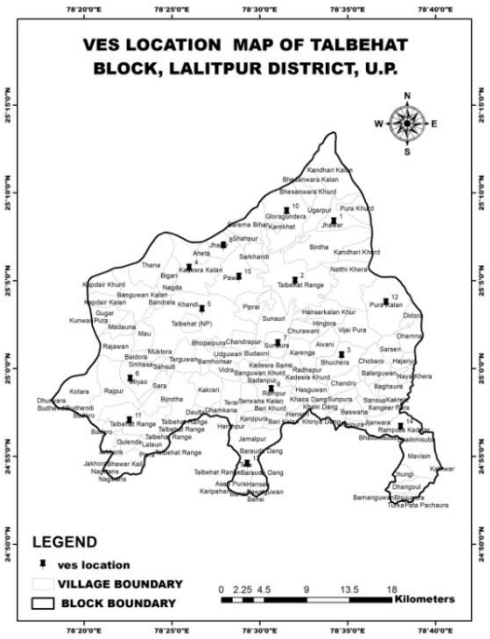


Fig-10: VES Location Map

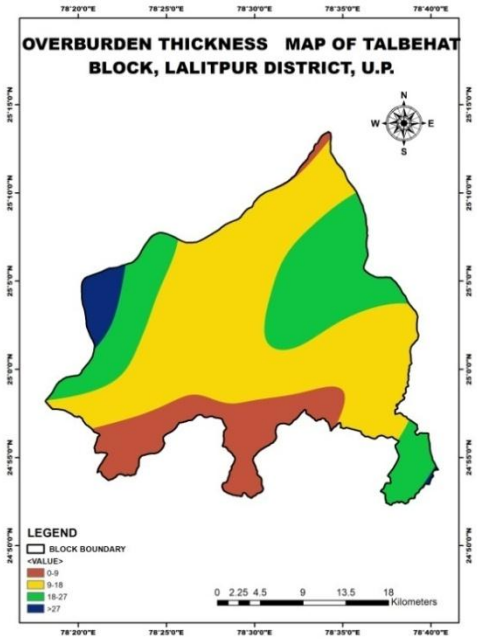


Fig-11: overburden thickness map

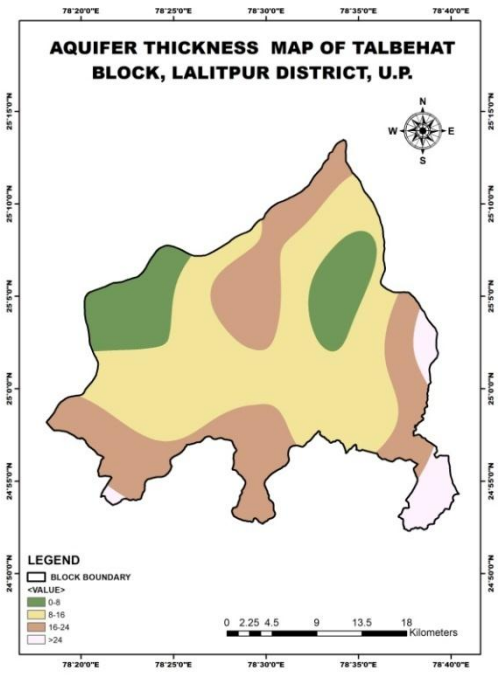


Fig-12: Aquifer thickness map

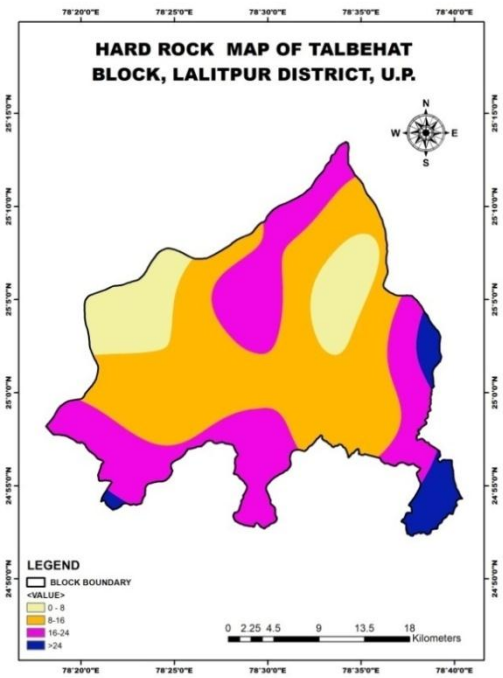


Fig-13: Hard Rock Map

7. RESULT

The multi criteria evaluation through Land use/cover, Slope, Flow direction, Drainage, Road, Geomorphology and Lineament etc gave the suitable sites for RWH such as nala bunds, check dam, and percolation tank. Factor layers (maps) were incorporated in Arc-GIS and analysis is done using Weightage Overlay index analysis. Finally a suitability map was developed Fig.13 that show the suitable sites for different Water Harvesting structures in study area. Nala bunds are provided to check the flow of water so that water infiltrate into the ground. Check dams are provided on drainage convergence points and on gentle slope. Percolation tank is located at highly fractured and weathered rock. . For successful implementation of this project participation of local people, government officers, and funding agencies is must. As these techniques are eco-friendly, the development due to this in future will be sustainable (Gaikwad, January-2015)

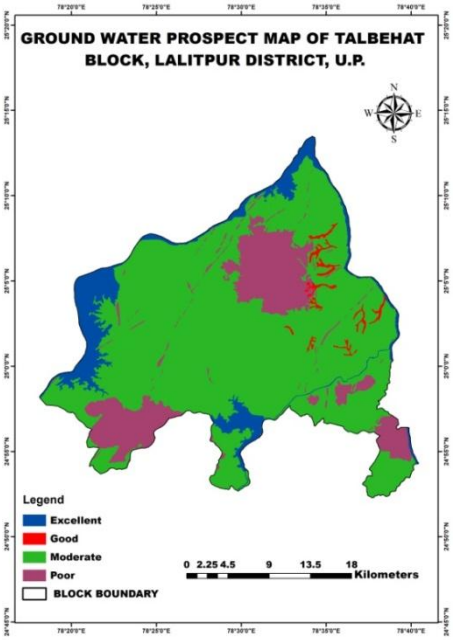


Fig-14: Ground Water Prospect Map

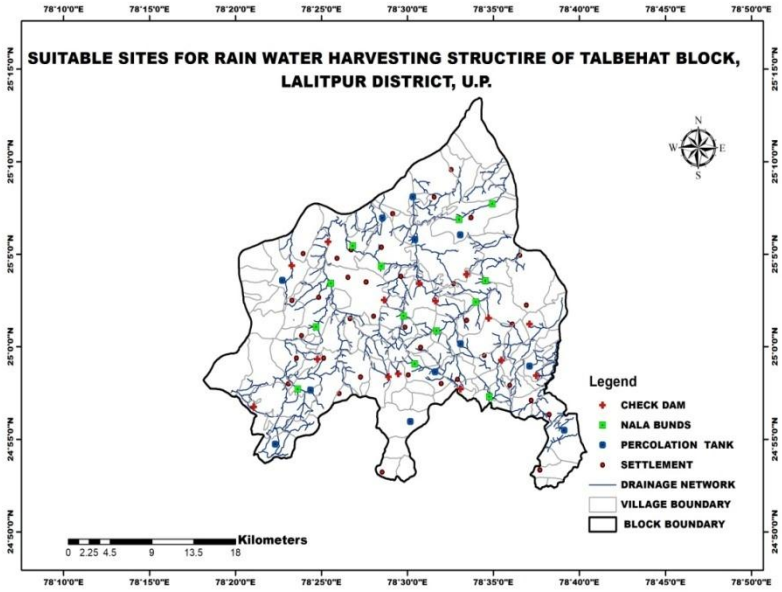


Fig-15: Recharge Map

7.1CONCLUSION

Due to increase in agriculture practices and domestic use in the study area, demand for water Consumption has increased at an unprecedented rate. Statistics on water availability in the study area has already revealed that water table has gone down remarkably in last one decade. To fulfill this demand watershed management technique need to be implemented. Socio- economic survey shows that 85% of people having agricultural land. Living standard of people is poor. Runoff is very important factor and it is very high in study area due to hard rock terrain features In study area Artificial recharge structure will only way to increase the ground water level and long term solution for water scarcity in the study area.

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