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Identification of Groundwater Recharge Zones Through Geospatial Analysis

Dr. Arunima Mahapatra[1], B. Bhagath[2], B. Purna Prudhvi[3], M. Padma[4], T. L.V. Prasad[5], P. Karishma[6]
1Assistant Professor, [2, 3, 4, 5, 6]UG Students, Department of Civil Engineering, Dr. Lankapalli Bullayya College of Engineering, Visakhapatanam-530013, Andhra Pradesh, India

Abstract: As the population is increasing day by day the demand for groundwater resource is also increasing. Identification of groundwater potential zone in our study area is an essential assignment for sustainable groundwater resource management through geospatial techniques. For conserving, monitoring and evaluating various groundwater-related development plans Remote Sensing (RS) and Geographical Information System (GIS) will do a vital duty in it. Our current research incorporates RS, GIS and Hydrologic parameters for analysing ground water potential zones in the study area (Dr. Lankapalli Bullayya College of Engineering) with a total area is of 40,485.04m^2. LISS-111(Linear Image Self-Scanning Sensor) it is a multispectral sensor which is a part in the Indian remote sensing (IRS). We used LISS-111 data for our land use\land cover analysis, to generate hydro geomorphological thematic layers to delineate the ground water potential recharge zones. This layers were transformed into raster to analyse and overlaid to identify the recharge zone by weighted overlay method.

I. INTRODUCTION

We all now came to know that the groundwater is the most essential thing on our mother earth, which is a natural resource used in domains of works such as domestic, agriculture and industrial (Nagarajan et al.,2009). In the globe groundwater is the substitute to above ground water (Rezaie., Lombardo, et al.,2019) and also greater part of residents depends on groundwater (Mukherjee et al.,2010). Almost one third of fresh water comes from ground water & 36% used form household, 42% used for agricultural & 27% for industrial (Tayloretal.,2013).

Then Literature outlined the role of remote-sensing and geographical information system (GIS) based groundwater potential zones. As our assessment is on delineation of groundwater potential zones, the input data required is geology, geomorphology, soil map, land use\land cover (LCLU), lineaments, toposheet, slope, drainage (Lal, D., Sonkar et al..2019). Hence, our purpose of present study was delineating the ground water potential zones using weighted overlay method for our college campus located in Visakhapatnam, Andhra Pradesh, India.

In the present study SRTM DEM (Shuttle Radar Topography Mission Digital Elevation Model) of 30m resolution is obtained from Earth Explorer, http://eros.usgs.gov, and is projected using UTM (Universal Transverse Mercator) zone44, WGS 1984. In the present study area, the higher elevation observed from DEM is 1570m above MSL whereas the minimum elevation observed is 49m below the MSL. The Digital Elevation Model (DEM) is the main input used to extract various topographic and hydraulic parameters.

II. OBJECTIVES

1) Study of Geology, Geomorphology, Lineaments and Slope to understand the groundwater occurrence, movement and distribution in subsurface formations.
2) Map the detailed land use\land cover patterns.
3) Preparation of soil maps.
4) To identify the potential groundwater zones.
5) Display the recharge zones.
6) The study area using SketchUp.

III. STUDY AREA

The area under investigation lies between 17°43’54” N to 83°80’46” E and covers an area of 40,485.05m^2 it is located in National Highway 16, Near Rama Talkies, Visakhapatnam, Andhra Pradesh. The city is encircled by Simhachalam Hill Range to the west, the Yarada Hills to the Southeast, and Kamabalakonda Wildlife Sanctuary to the northwest.

The largest river flowing through the Visakhapatnam city is Gosthani river which rises in the Ananthagiri Hills of the Easter ghats and flows through the Borra Caves. The river basin displays a sub dendritic and dendritic pattern of drainage, most of the basin is covered by the Khondalite group of gneiss rocks. The average annual rainfall is 955mm in Visakhapatnam. The maximum and minimum temperature ranges between 20°C and 41°C respectively.

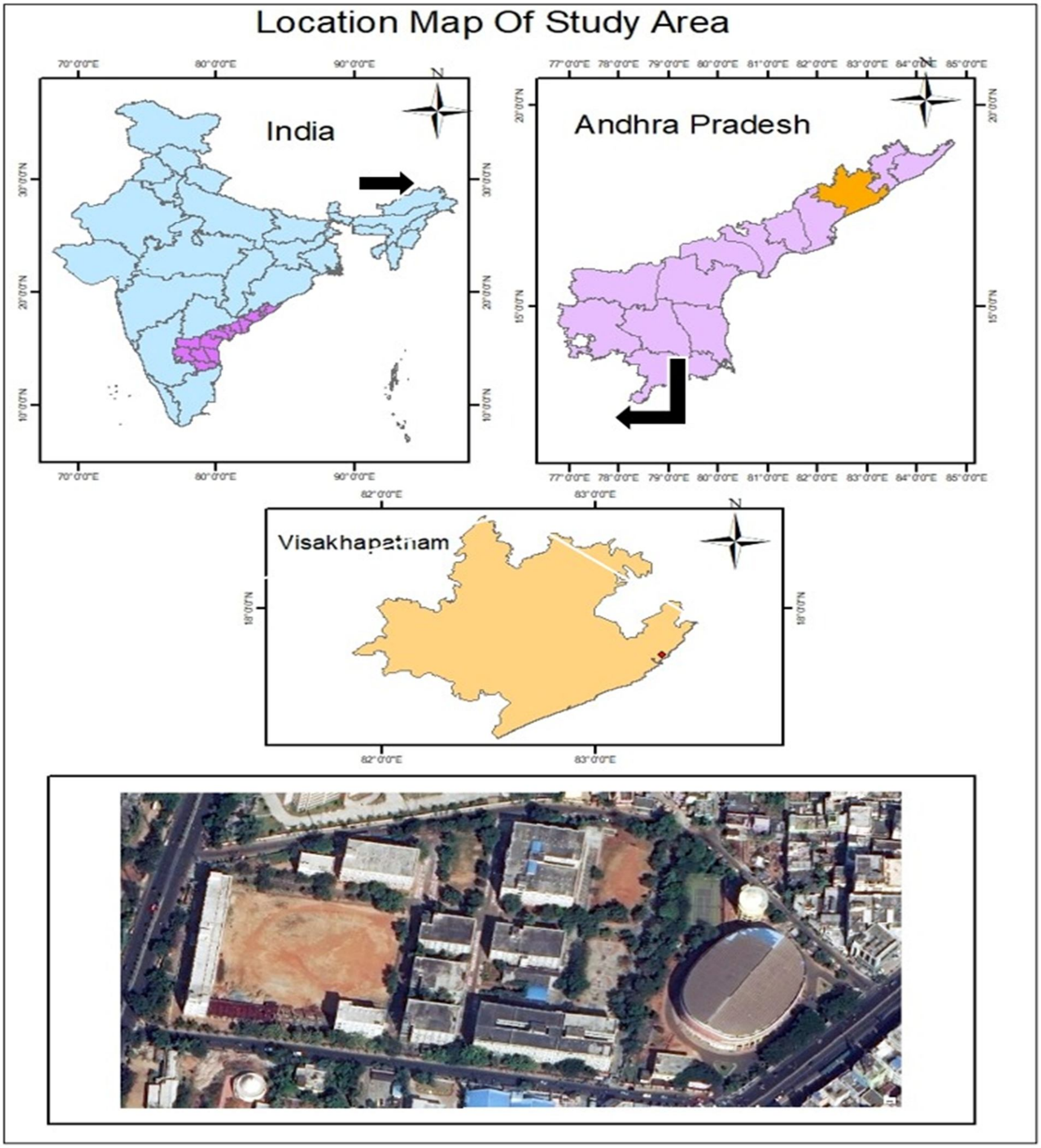

Fig: 3.1 Location map of the study Area

IV. METHODOLOGY

Our methodology of work starts with collecting various influential parameters viz. land use\land cover, soil map, slope map, geomorphology, geology, were taken from GVMC and SOI toposheets, LISS-111 satellite images, SRTM-30 and the supplementary data from websites and organizations. At first, the Digital Elevation Model (DEM) is the main input used to extract various topographic and hydraulic parameters.

The basic hydro geomorphological maps like drainage were taken from survey of India- toposheets, soil and geology maps were taken from Greater Visakhapatnam Municipal Corporation (GVMC) after these hydro geomorphological layers were digitized using a GIS and remotely sensed satellite image data. After considering the hydro geomorphological layers the layers were converted into raster using GIS platform then scaling the rank of each thematic map by the weight of the theme. We used UTM (Universal Transverse Mercator) which is geographic co-ordinate system which uses a map projection to assign co-ordinates to locations on Earth. We founded out the co-ordinates for the existing rain water harvesting pits in our study area and the co-ordinates for the sump tanks present in the study area.

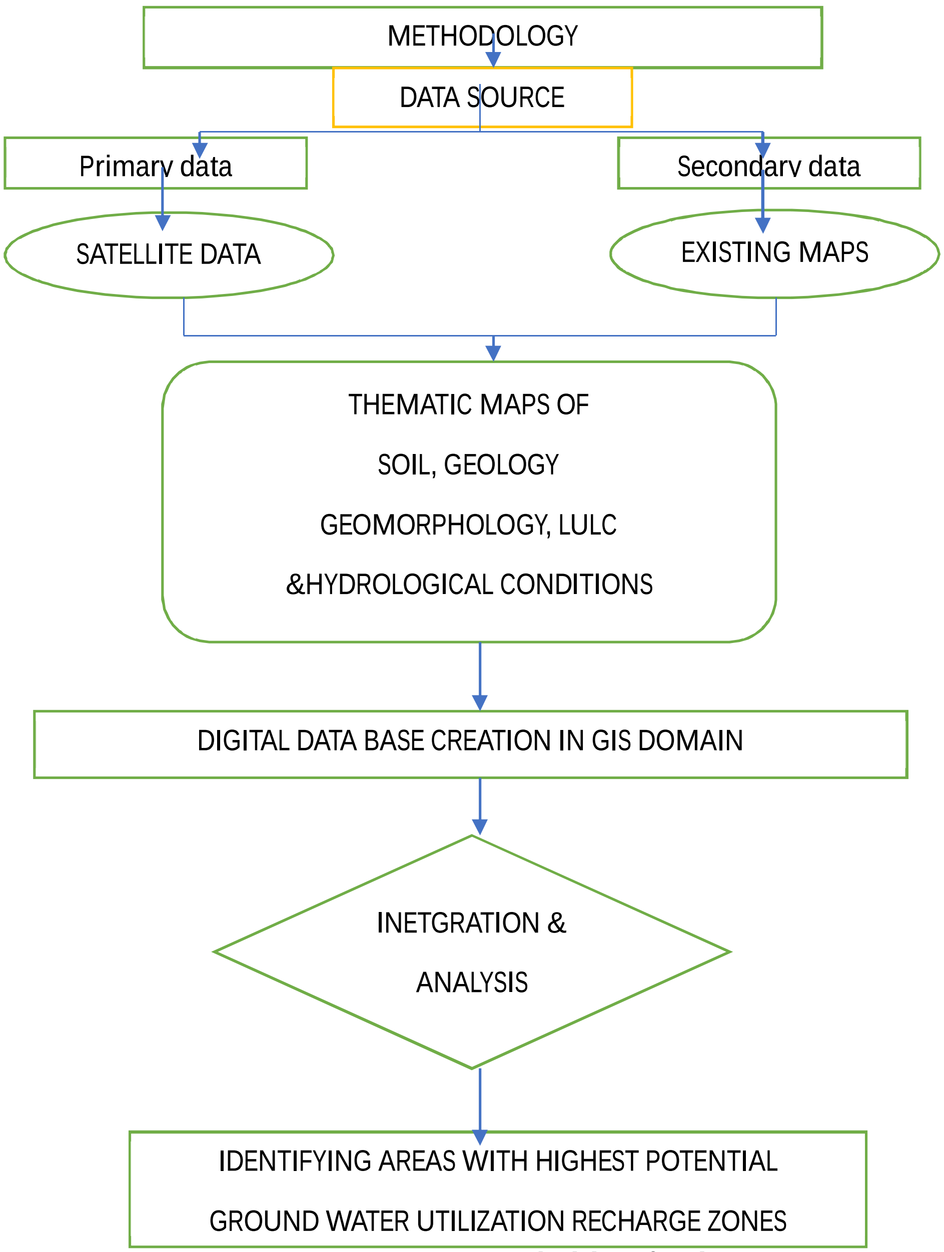

Fig: 4.1 Methodolgy of study area

V. RESULTS AND DISCUSSIONS

Advanced remote sensing and GIS techniques have been used to identify potential zones of groundwater in the selected twelve mandals of the Visakhapatnam district. For the present study, thematic maps such as LULC, geology, geomorphology, slope, and drainage are developed. The groundwater potential zones are obtained using the Arc GIS pro by overlaying geology, geomorphology, lineaments, slope, and LULC maps as part of the Index Overlay System with a Multi-Class map.

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A. Drainage Map

The stream ordering strategy is used to classify the specific stream segments into different orders based on their importance and contribution to the drainage pattern. The first-order stream is a single stream shown as 1. the second-order stream is formed by joining two first- order streams shown as 2. the third-order stream is formed by joining two second-order streams shown as 3. In the study area, the total length of the drainage network calculated using Arc GIS pro is 40,485.05m^2.

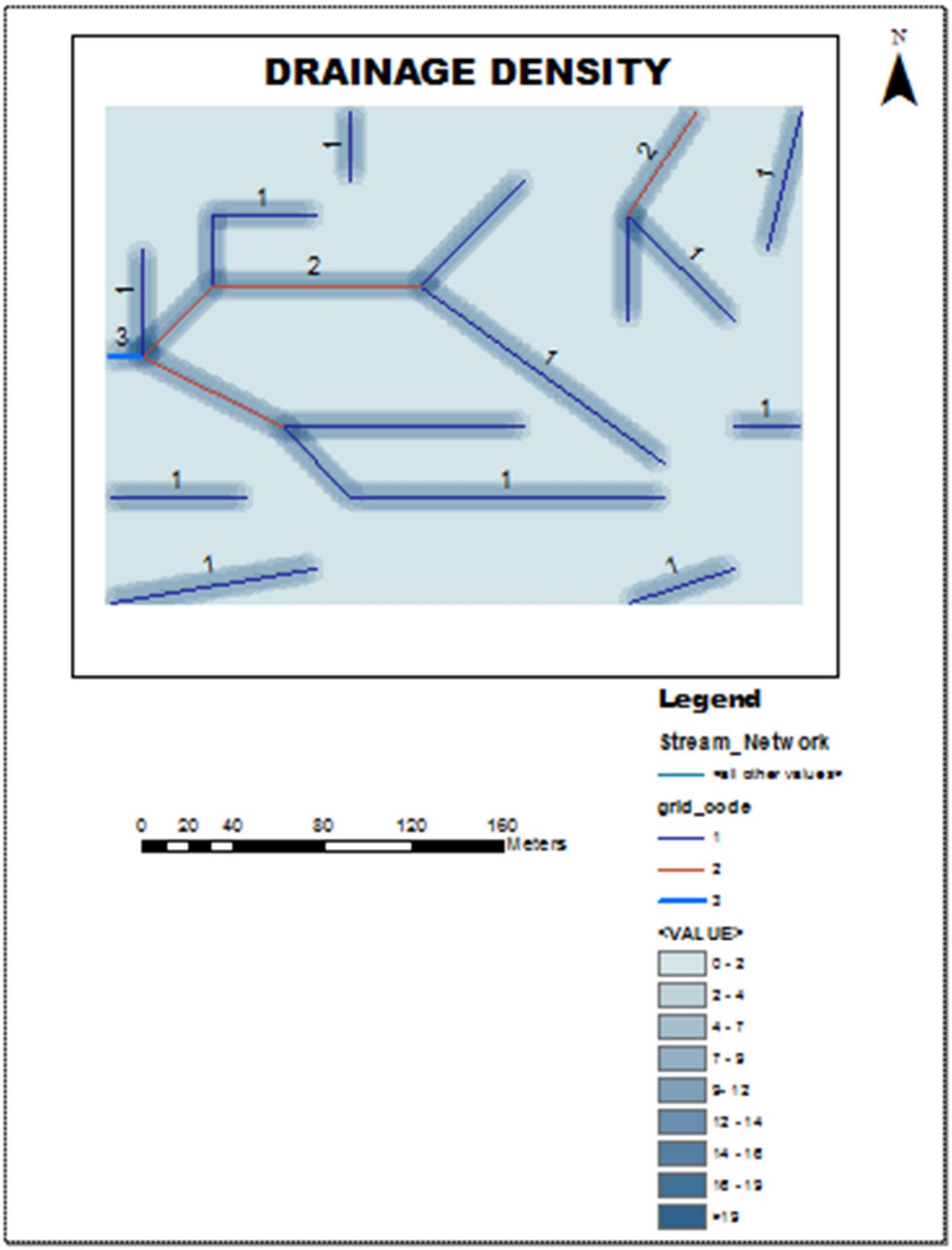

Fig: 5.1 Drainage density map of the study area

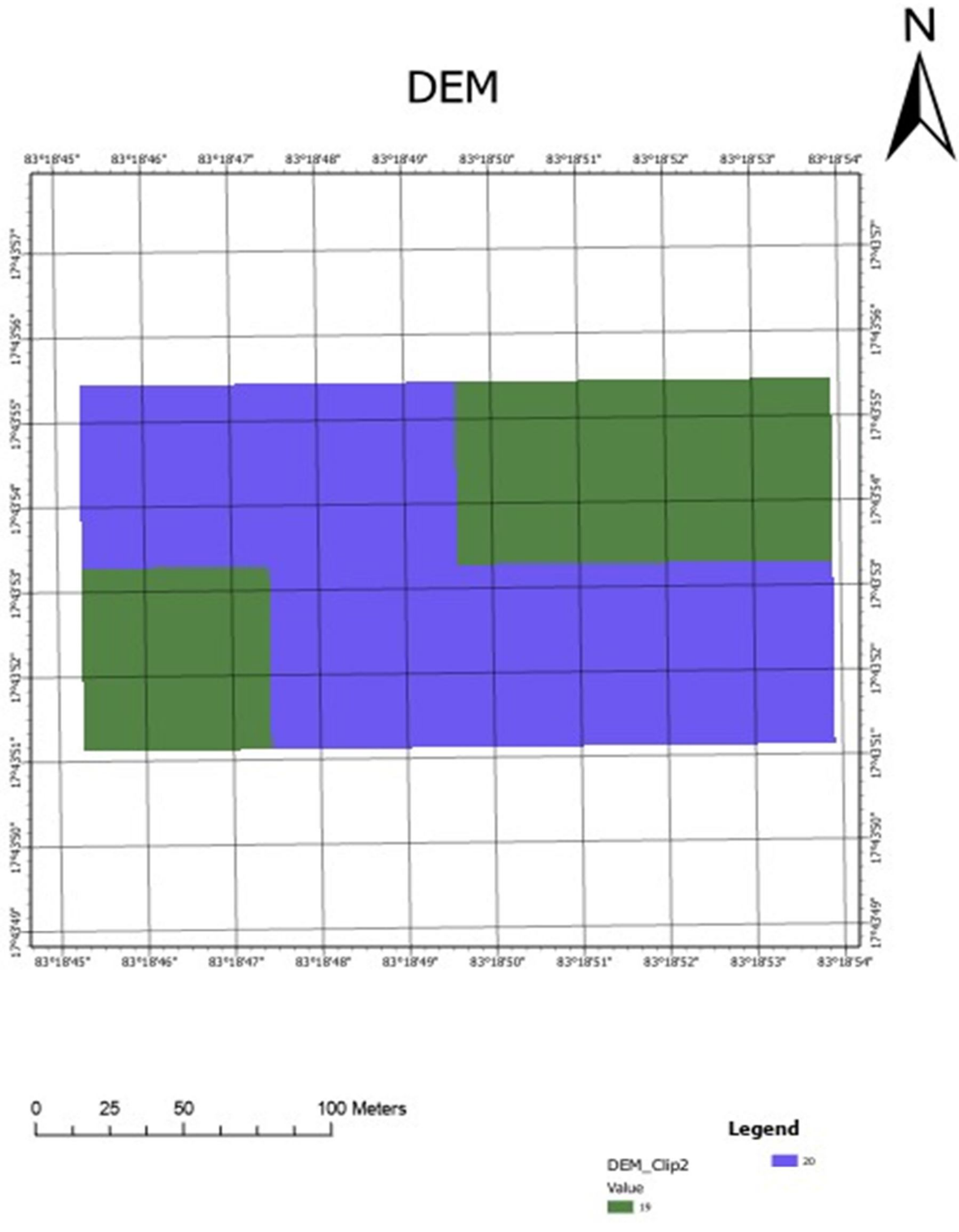

Fig:5.2 DEM of the study area

B. Geological Studies

In groundwater occurrence, distribution and consistency, geological research is essential. The field of research consists of abundant high-grade metamorphic and igneous rocks. The geology map is shown in Fig5.3. The major proportion in the study area is Khondalite than that of the other geological features. The Khondalite spread in the study area is 40,485.05m^2.

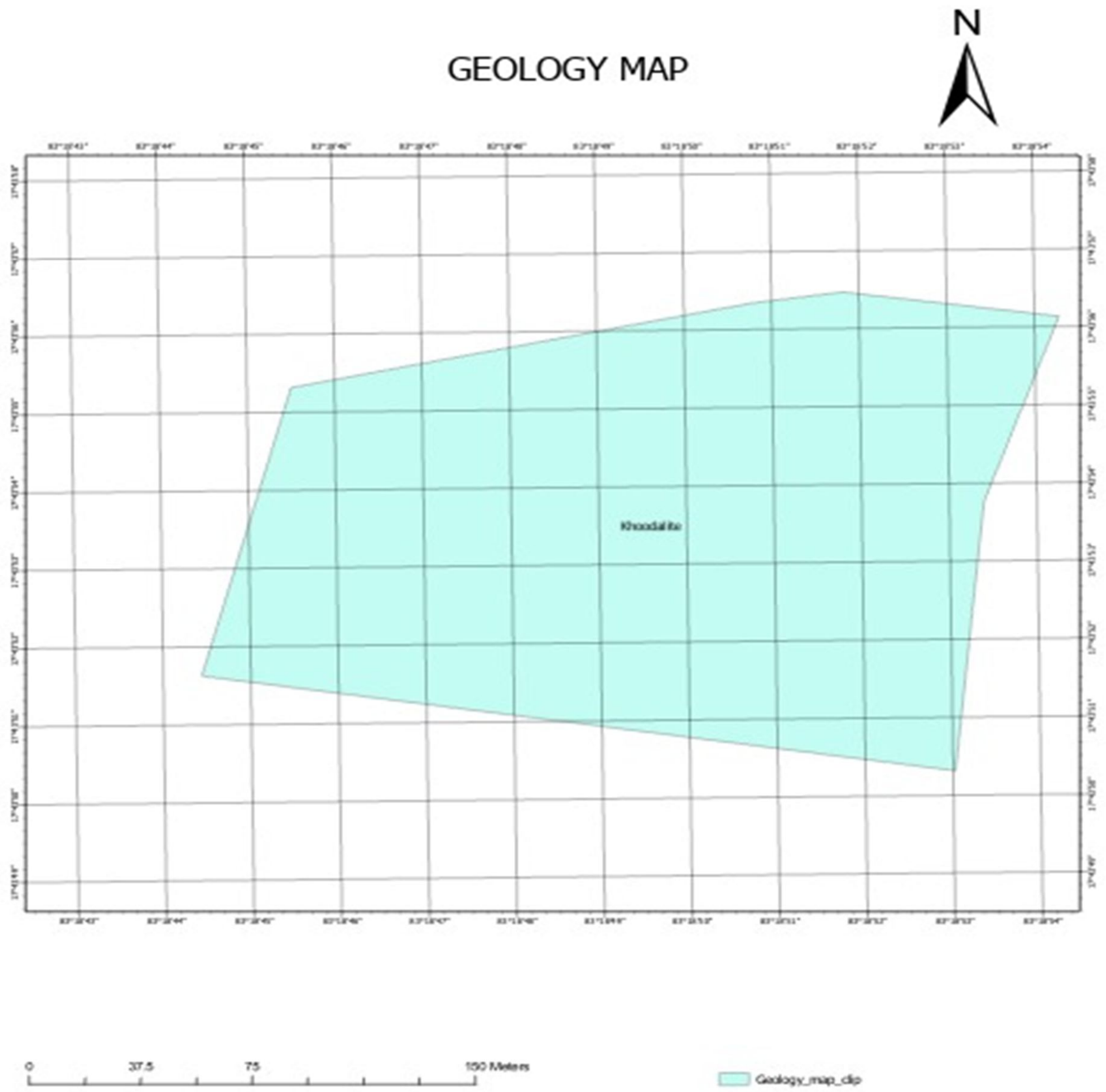

Fig:5.3 Geology map of the study area

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C. SOIL and LULC MAPS

Soil is a significant part of the soil structure and an essential aspect of the primary system of production. To consider their challenges, opportunities, and maintenance needs for their potential use, the soil map allows in understanding the nature and properties of soil in the research area. Advanced remote sensing and GIS methods were used in soil erosion assessment and watershed prioritization studies [22]. The study area contains brown clay soil with sandy and gravel. Fig5.4. shows the soil map of the research area. Built-up land, vegetation, plantation, current fallow, others are the LULC classes delineated in the research area. The LULC occupies a total area of 40,485.05m^2. in the study region. Area coming under built-up land is 10,109.323m^2. Fallow lands have coverage of 26,375.27m^2, vegetation has coverage of 4,000.45m^2. Fig.5.7. shows the LULC classification for the research area.

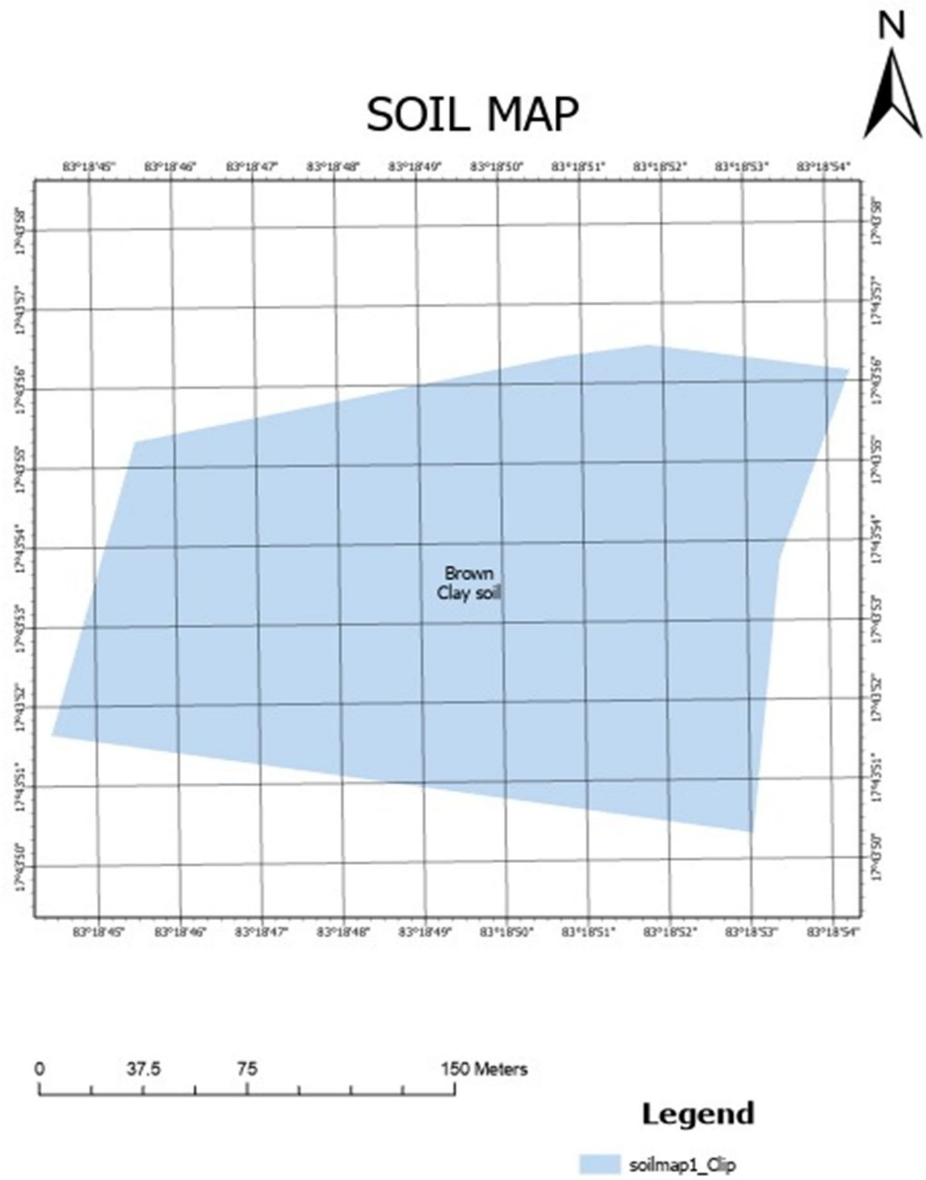

Fig:5.4 Soil map of the study area

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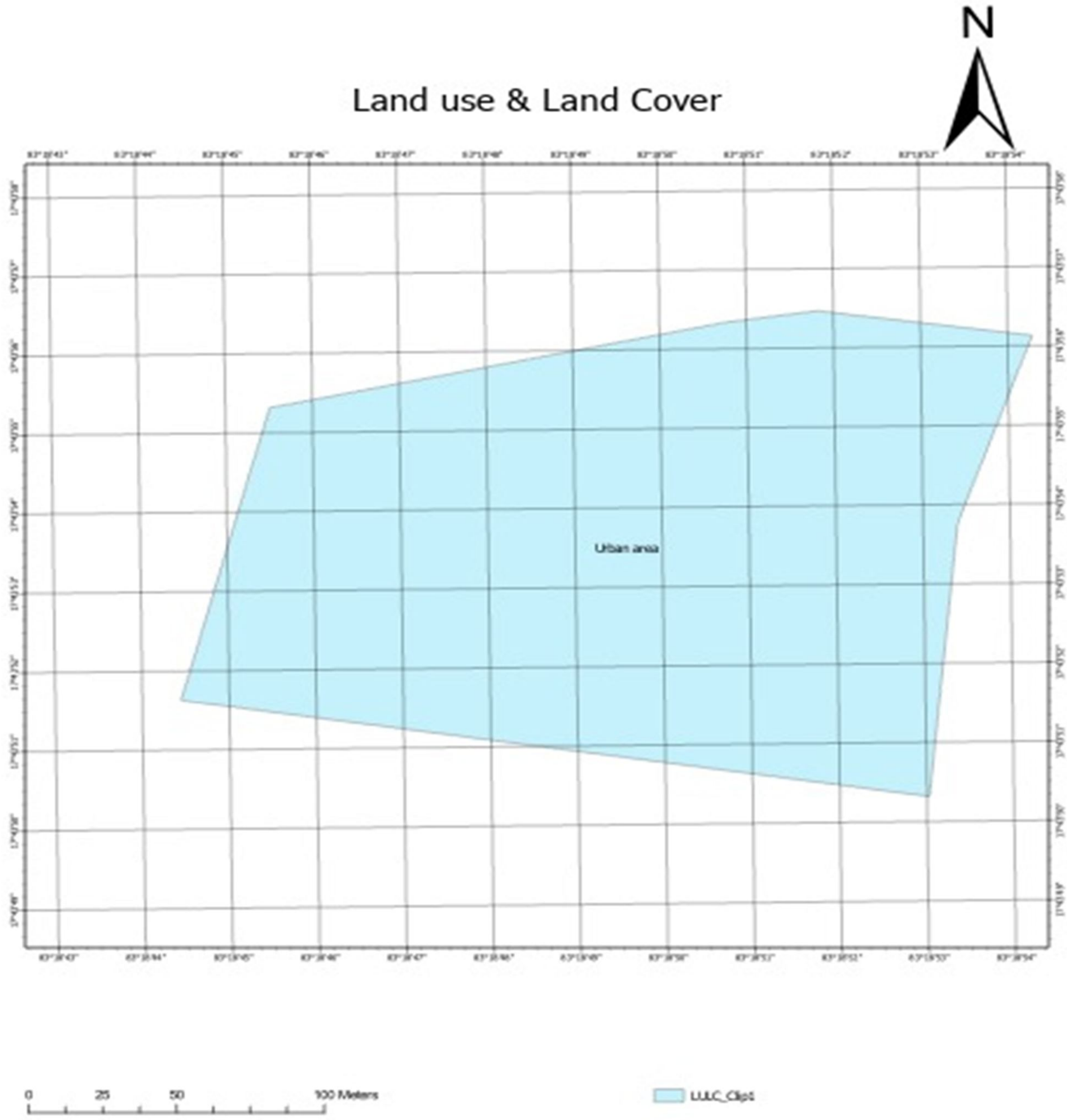

Fig:5.5 LULC of the study area

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D. Geomorphological Studies

Geomorphological landform features found in the current research is pediment slope as represented in Fig.5.6. It is a gently sloping bedrock surface that can be concave or waning slope.

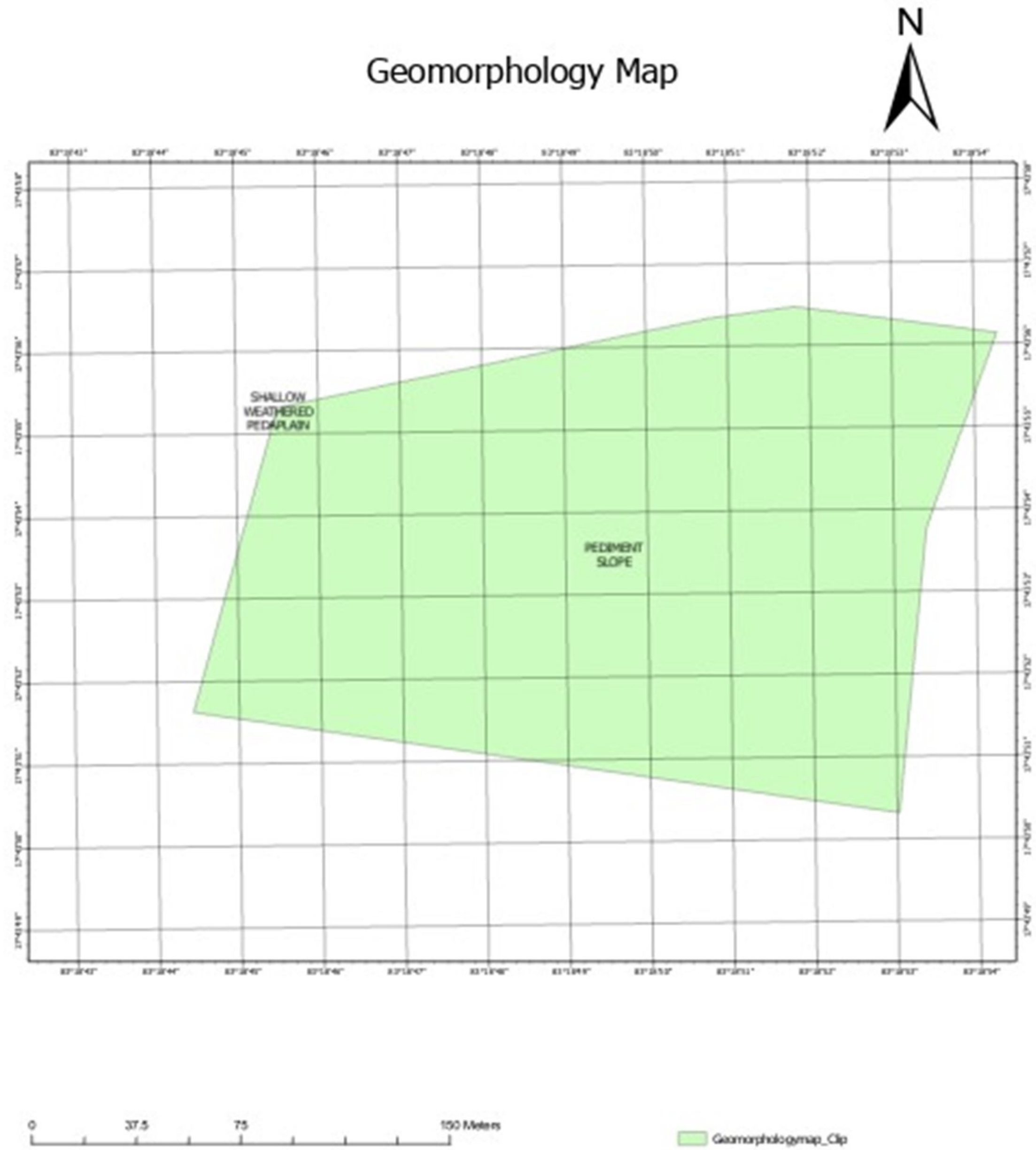


Fig:5.6 Geomorphology map of the study area

E. Slope Studies

The slope has a major part in predicting infiltration and surface runoff. Conversely, infiltration is correlated to the slope, i.e. a milder slope, more infiltration and less runoff, and vice-versa. Using DEM, a degree slope map was developed. The degree of the slope affects flow velocity. run-off, infiltration rate, and other facets of soil transportation. The infiltration potential is poor when the flow velocity is high, and more soil erosion occurs when the slope is steep. In the gentle slope area, surface runoff is slow, allowing rainwater to percolate longer and thus penetrate more effectively. The study region has been categorized into gentle slope, moderate slope and steep slope. The slope map of the research area is shown in Fig5.7. and Table 1 represents the degree of slope category

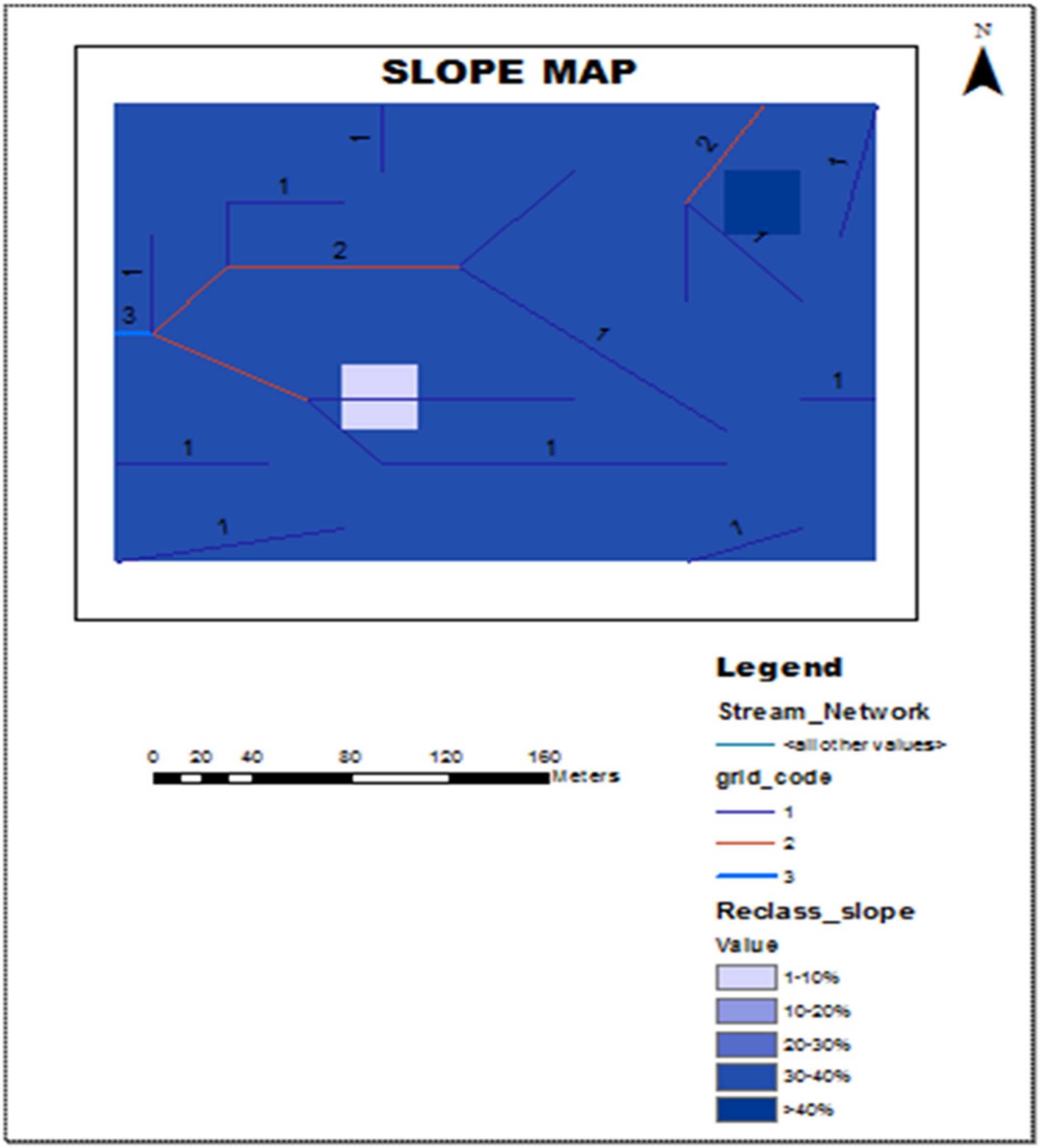


Fig:5.7 Slope map of the study area

Table 1 Degree of slope with slope category

S.No.	Percentage of slope	Type of slope category
1	0-3%	Nearly level
2	3-5%	Gentle slope
3	5-10%	Moderate slope
4	10-15%	Steep slope

F. Groundwater Potential Zones

A spatial operation in which a thematic layer is superimposed over another to create a new layer is known as index overlay. Geology, geomorphology, soils, slope, land use, land cover, and drainage pattern are some of the input layers used in the study of potential groundwater zones. The final phase of the GIS framework in this study is to analyse all data layers using the "Overlay" technique. To obtain a final vulnerability map, the score values for all individual classes for each map are allocated, along with the map weightages. Following are the list of weightages assigned to the classes:
M1(10%) =weightage [class (Geology)]. M2(5%) =weightage [class (Geomorphology)]. M3(20%) =weightage [class (Slope)]. M4(25%) = weightage [class (Soils)]. M5(25%) =weightage [class (LULC)]. M6(15%) =weightage [class (Drainage density15)].

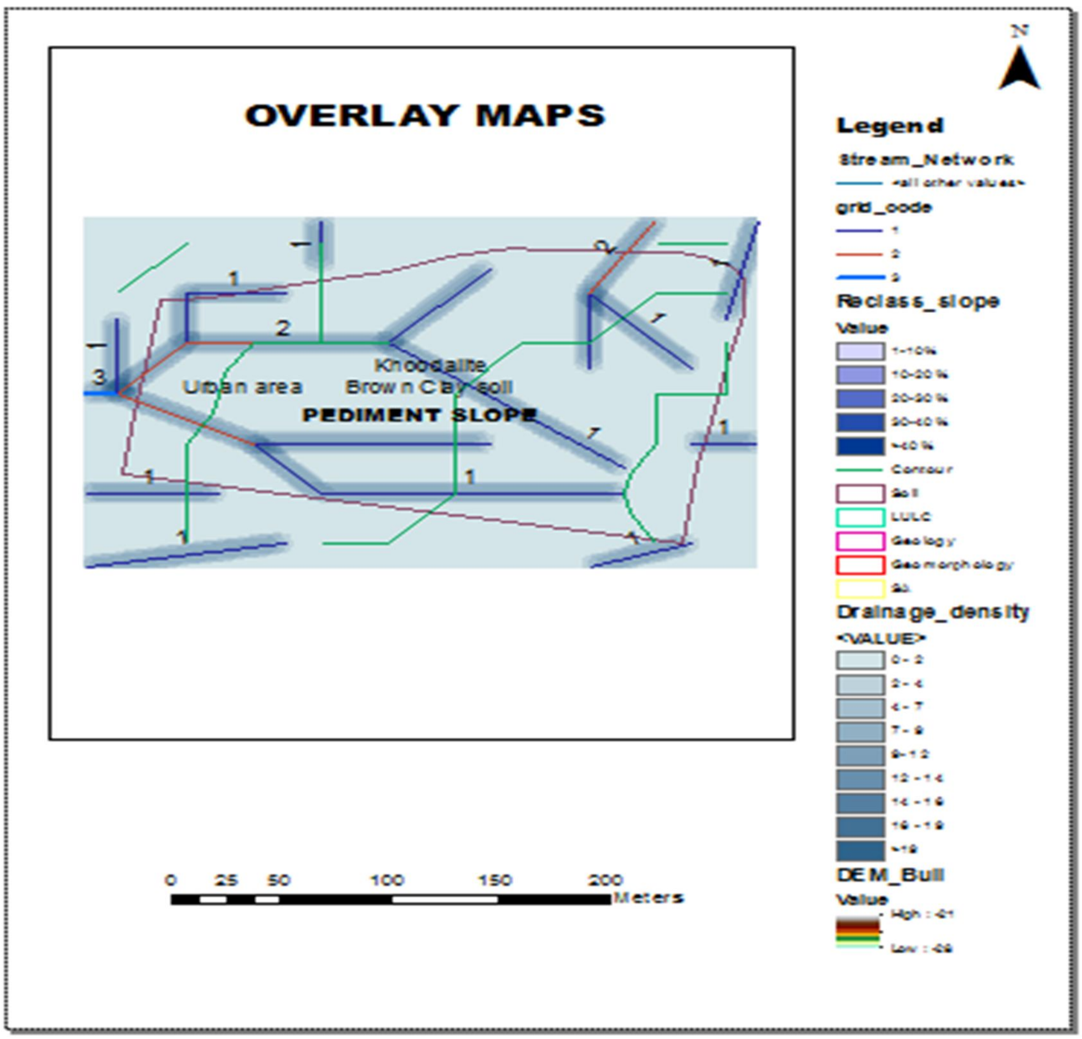


Fig:5.8 Overlay map of the study area

The data from each grid cell is then calculated and shown as a map representing possible groundwater areas. It is identified that very good groundwater zones in the central region of the study area, good groundwater zones in the south- eastern part, moderate groundwater zones in the south-western part of the study area. As shown in Fig.5.9

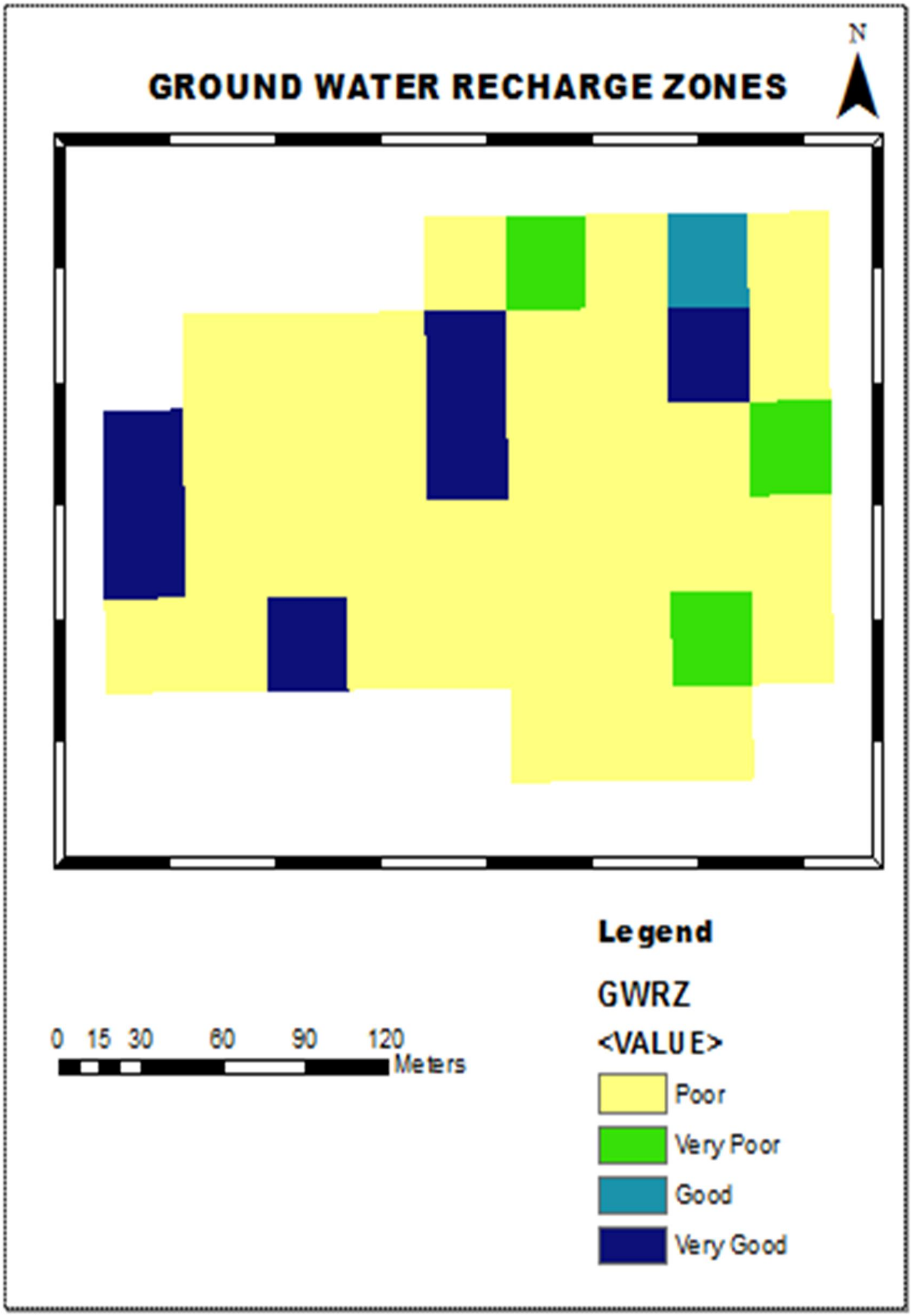


Fig:5.9 Groundwater recharge zones of the study area

VI. CONCLUSION

Groundwater is a precious, restricted resource. Over the years, growing population, urbanization, and growth of agriculture have contributed to the development of a water stress condition through unscientific use of groundwater. A wide amount of data from different sources is required for groundwater research. The index overlay method is incredibly useful in the categorization of groundwater potential zones. As effectively shown in the current study. advanced remote sensing and GIS will provide the required forum for convergent analysis of vast quantities of interdisciplinary information and decision-making for groundwater exploration. Four groundwater potential zones are identified in the integrated region. From the research study, wetlands in the near level zone slope were found to be especially good for groundwater exploration, Pediment zones of more than 10 degrees sloping scrubland are categorized as moderate potential groundwater areas. A slope greater than 20 degrees surrounded extensively by the structural hills was observed as poor potential areas. The present work also revealed the potential for using remote sensing and GIS methods for groundwater exploration analysis to enliance field monitoring.

VII. ACKNOWLEDGEMENT

I am profoundly thankful to Dr Arunima Mahapatra, Assistant Professor in the Department of Civil Engineering, Dr Lankapalli Bullayya College of Engineering, Visakhapatnam, India, who has served as my mentor and guide, advising me on how to accomplish my goals.

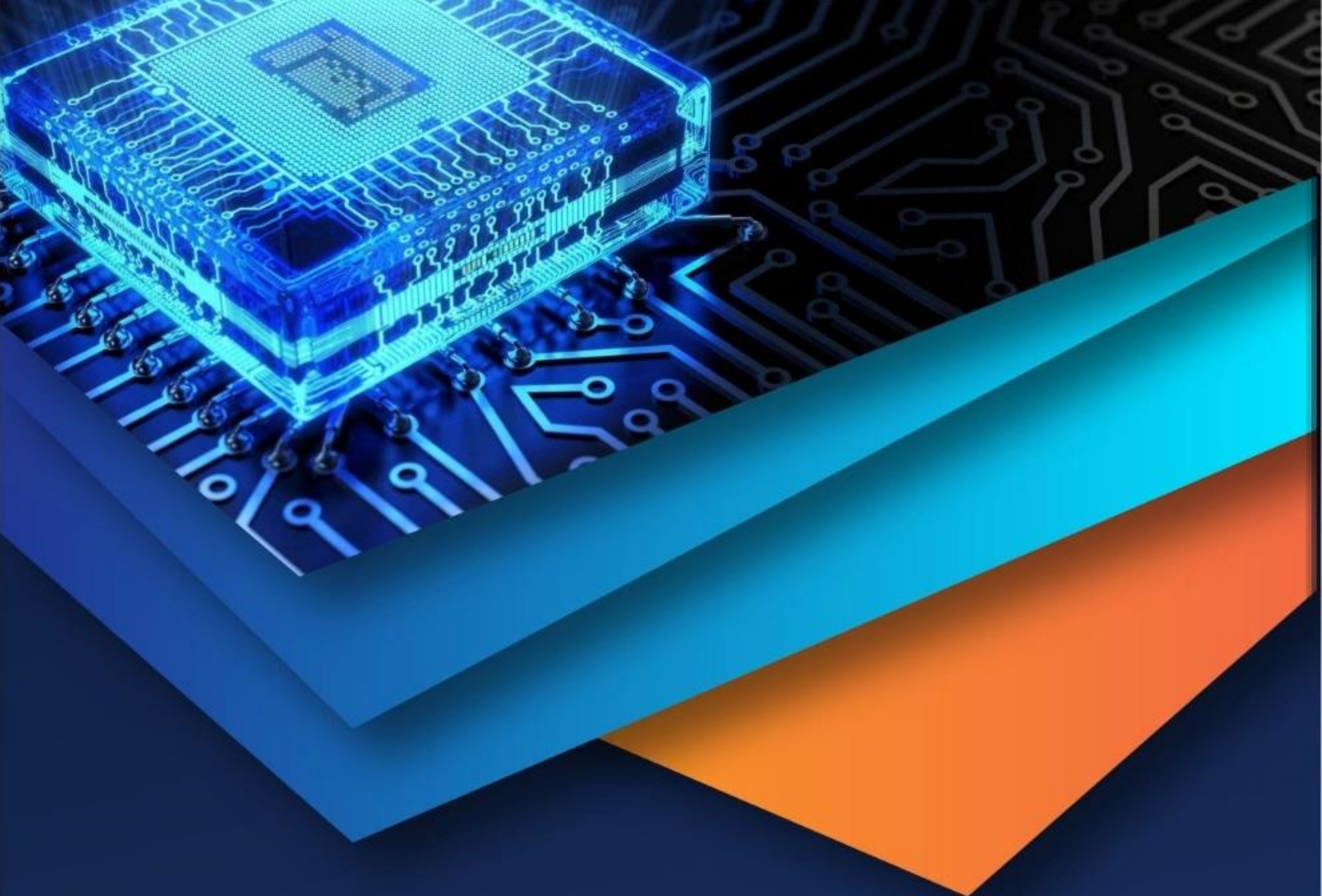
REFERENCES

[1] Tanveer Dar, Nachiketa Rai & Aadil Bhat et al.2021 conducted tests on groundwater recharge zones using analytical hierarchy process (AHP)

[2] Devanantham Abijitha, Subbarayan Saravanan a, ∗, Leelambar Singha et al.2020 conducted tests on groundwater recharge zones. This study adopts the Analytical Hierarchy Process (AHP) and Multi influence factor (MIF), multicriteria decision-making approaches to determine the weights for the influencing factors.

[3] Sarkawt Ghazi Salar, Arsalan A. Othma, Syed E. Hasan et al.2018 Groundwater is a valuable natural resource for drinking, domestic, livestock use, and irrigation, especially in arid and semi-arid regions like the Garmiyan belt in Kurdistan region.

[4] Dima Al Atawneh a, Nick Cartwright a d, Edoardo Bertone a b c et al.2021 They researched about Groundwater is a critical source of freshwater that meets the demand of a large portion of the Earth’s population, industries and ecosystems (Döll, 2009, Okkonen et al., 2010).



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