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Mapping Of Groundwater Prospects Using GIS For The Sustainable Development Of Munugode And Chandurmandals, Nalgonda District, Telangana, India

Satish Jangam, Research Scholar, Department of Geoinformatics, Telangana University

Dr. KavitaToran, HOD, Assistant Professor, Department of Geoinformatics, Telangana University

Abstract

The continuous practice of rice cultivation extensively in huge proportion of land parcels, impervious granite rock portions, non-perennial nature of Halia River, increase in urbanization, soaring temperatures and irregular rainfall patterns all together caused the steep decline in groundwater levels in Munugode and ChandurMandals. As such this research problem is taken up to unveil the potential groundwater areas reliably using GIS technique in short period for their sustainable development.Inventory used are soil, geology, geomorphology, lineaments density, drainage density, land use land cover, slope and rainfall data layers extracted from NBSS & LUS, GSI and ISRO Bhuvan portals. The above layers are processed using ERDAS IMAGINE 2014 and ARCGIS 10.1 software which produced five types of groundwater prospective areas by weighted overlay analysis tool. The results show that the research unit has large area of moderate groundwater prospects encompassing 369.87 sq.km viz., 75.58%. Very low (4.88 sq.km) and low (81.81 sq.km) groundwater prospects together share (17.71%) of study area creating no scope for further groundwater development. High (6.08%) and very high (0.6%) groundwater prospects are the least portion and enclose an area of 32.74 sq.km.This facilitates in judicious planning of groundwater resources.

Keywords: Groundwaterprospects, Weighted overlay analysis, GIS,Telangana,Nalgonda

1. Introduction

Groundwater dynamics are temporal that are regulated by the intensity of rainfall, lithology composition, lineaments, soils type, geomorphic units distribution, slope of terrain, drainage pattern and land use land cover spatial factors (Das et al., 2019). In semi-arid regions of India especially in peninsular plateau groundwater is the immediate and alternate supply resource for irrigation, industrial and drinking purposes (Agarwal and Garg, 2016) upon severe stress on surface water caused due to seasonal precipitation patterns, burgeoning population, inappropriate and irregular water management.Likewise, in Chandur and MunugodeMandals of Nalgonda District the seasonal flow of Halia River do not meet the regular needs of surface water leading to the abrupt rise in borewells and thereby, pushing to the over-exploitation of groundwater. The usage of groundwater in these areas is > replenishment of aquifer.This alarming situation necessitated for the identification of groundwater prospects areas in regulating the demand and supply of water resources. The above research problem can be addressed effectively and efficiently by the use of GIS technology and remote sensing datain conjunction with the weighted overlay analysis that was already proven in other studies(Mageshkumar et al., 2019; Chilukuri et al., 2021; Chilukuri&Mohd, 2023).

2. Study Area

The study area shown in Figure 1 is part of semi-arid regions of India which issituated in the northwestern block of Nalgonda District, Telangana. It stretches in between the longitudes 78°59'13.183''E to 79°4'54.369''E and latitudes 16°56'22.007''N to 17°10'48.608''N. The tributary of Krishna River viz., Halia River drains across the Chandur and MunugodeMandals enabling for the production of rice, cotton, red gram and red chili. Both the Mandals together enclose 489.32 sq.km area. Climate is sub-tropical as it is located in a lower position of the tropic of cancer. Rainfall fluctuates in between 532.6 mm to 812.5 mm. The erratic rainfall, encroachment of water bodies, hard rocks like granites, gneisses, rise in urbanization, improper water management practices, reduction in rich soil cover and poor vegetation contributed for the decline in groundwater levels.

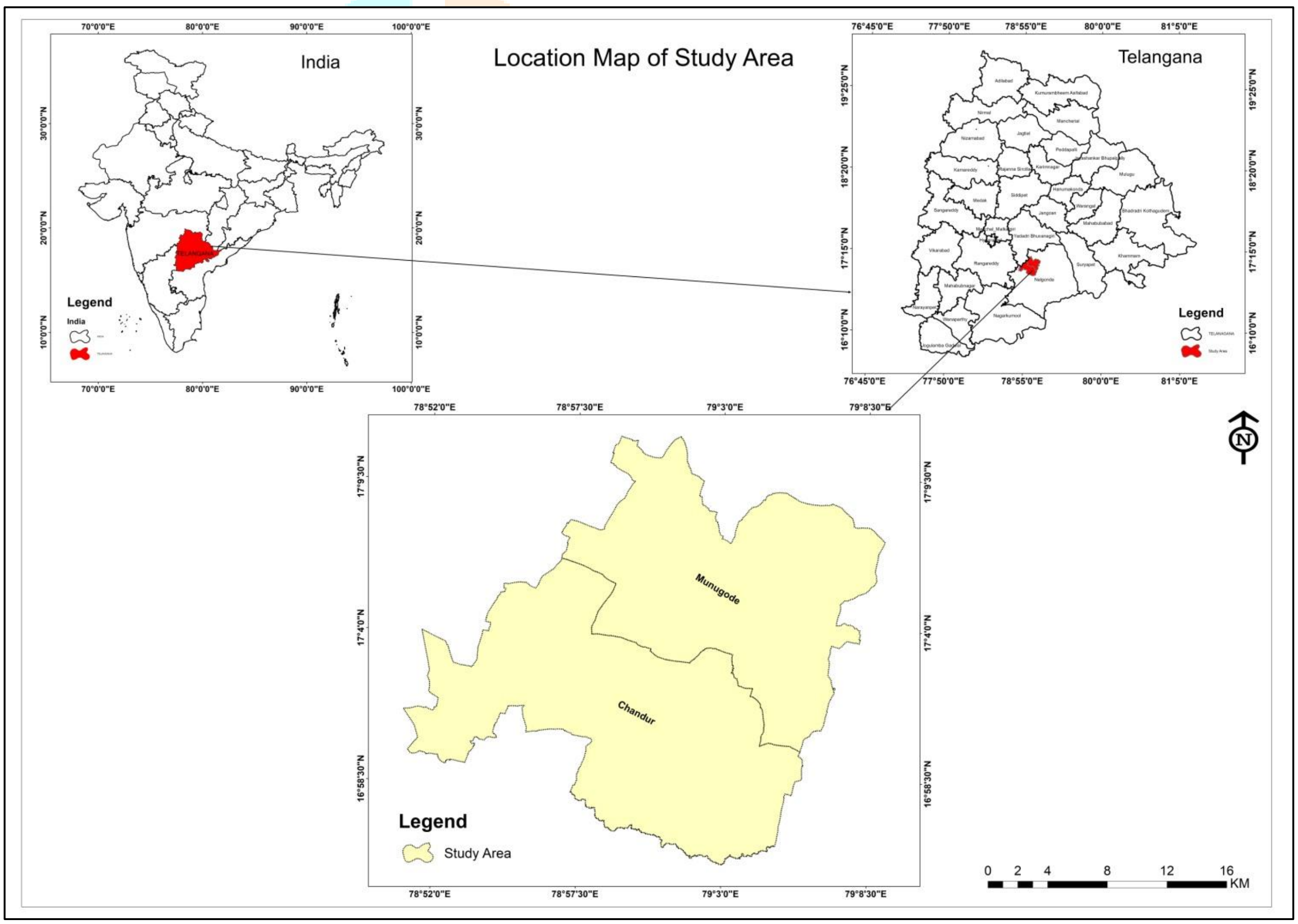

Figure.1. Location Map of Chandur and MunugodeMandals

3. Data used and Methodology

The groundwater prospects mapping requires satellite data and ancillary data. Sentinel-2A is chosen for preparing land use land cover map using ERDAS IMAGINE 2014 software likewise,CHRSrainfall satellite data for rainfall map and Cartosat-1 CartoDEM*v3* data for drainage network, slope and lineaments density maps using ArcGIS 10.1 software. Soil data was procured from National Bureau of Soil Survey and Land Use Planning. Geomorphology and geology data was extracted from Bhukosh Portal of Geological Survey of India. The relevant weights and ranks are assignedbased on their water retention capacity to the features of each map layer developed into raster. All the generated maps were superimposed and upon application of spatial analyst tool i.e., weighted overlay resulted into composite map of five classes (very low, moderate, low, very high and high) of groundwater prospects regions.

4. Results and Discussion

Delineation of varying groundwater prospects areas can be achieved using GIS only by understanding the geographical factors like rainfall, slope, drainage density, lineament density, soil, geology, geomorphology and land use land cover. It is because these factors determine the rate of groundwater recharge at a particular location.

4.1 Evaluation of Geographical factors

Slope

Slope is one of the crucial indicator in determining the rate of surface water percolation. As the elevation of slope decreases, the infiltration capacity increases ((Mondal et al., 2008; Kumar et al., 2016). It varies from <1 to >5 degrees as given in Figure 2 which indicates it contributes for very high to very low groundwater prospects. Slope is flat to gentle in most of the region as it is occupied by pediplain. Remaining area consists of moderate, moderately steep and steep slope giving moderate to very low groundwater potential and exists at hills and residual hills.

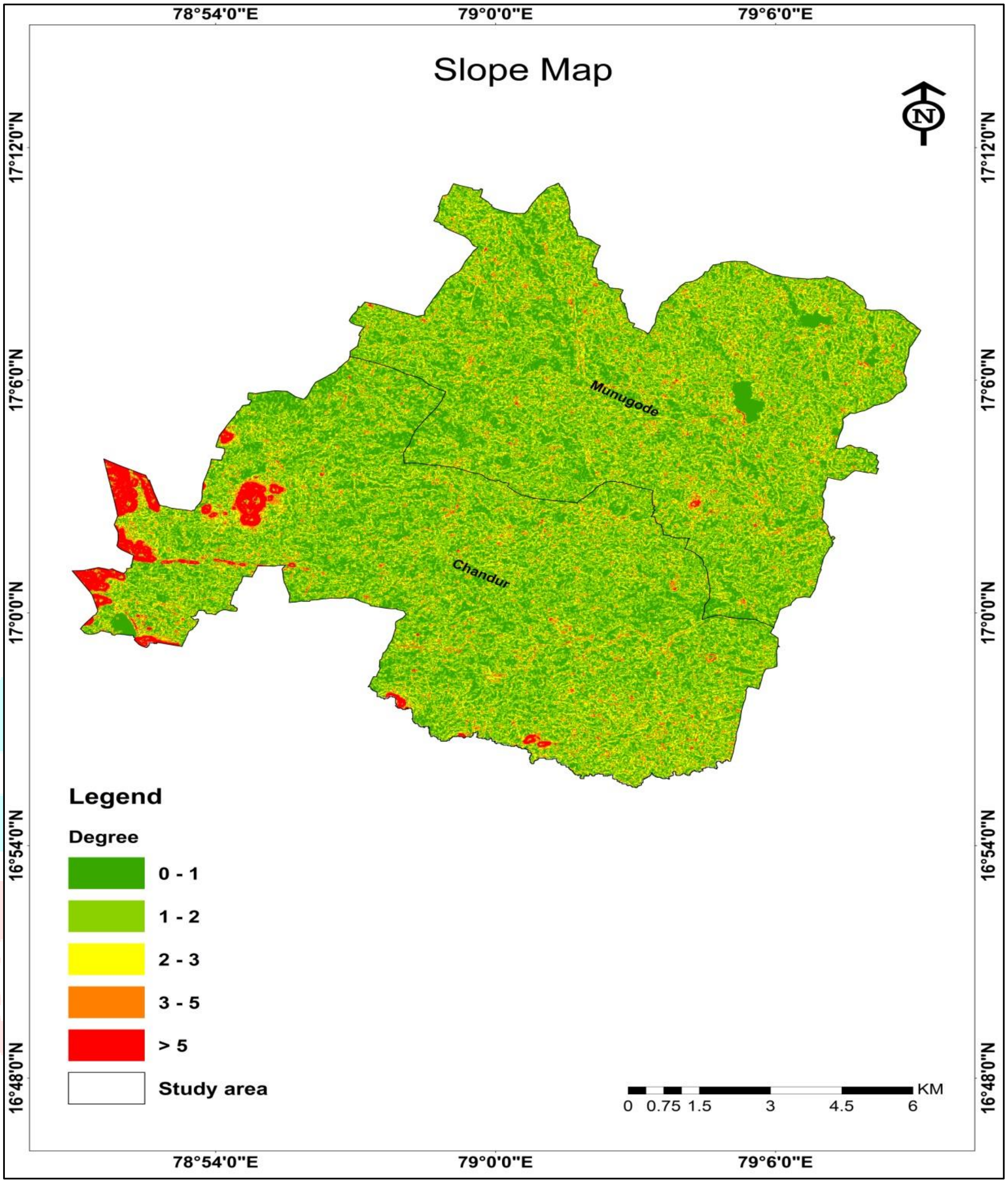

Figure.2. Slope Map of Chandur and MunugodeMandals

Geology

The underneath rocks forms the prime role in surface water percolation as it depends on the type of rock, the porosity and their orientation (Younger, 2007). Granites and gneisses rocks distributed in the study area belong to Peninsular Gneissic Complex super group of Archaean-Palaeoproterozoic age which are hard crystalline rocks that are impervious and in few sections it was prone to secondary weathering that caused fractures. Grey biotite granite in ChandurMandal as presented in Figure 3 and alkali feldspar granite in MunugodeMandal are the rocks distributed in the vast area.Migmatite gneiss are sparsely distributed in northeastern boundary and Leuco granite is in patches at southern boundary and northern section. Grey granite is in the northern tip of MunugodeMandal and grey hornblende biotite granite is distributed in SW crescent portion of ChandurMandal. These rocks contribute for low to very low groundwater potential in larger sections and high, very high and medium groundwater potential in secondary weathered pockets.

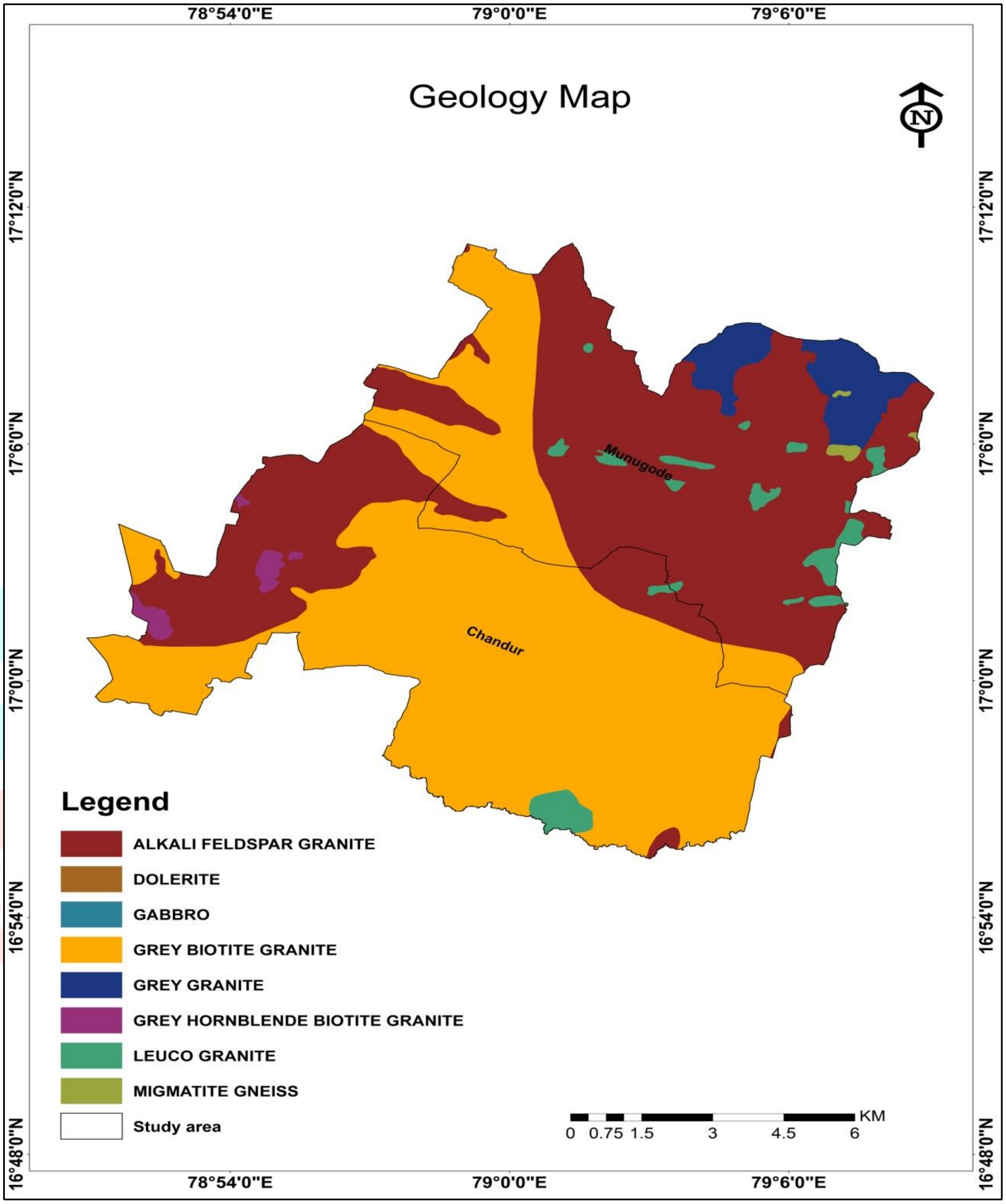

Figure.3. Geology Map of Chandur and MunugodeMandals

Lineament Density

Lineaments point to direct groundwater prospects. The size of the lineaments influence the extent of percolation of rain water and yield of groundwater (Varade et al., 2018). Major lineaments located in the MunugodeMandal trend in northwestern to southeastern directions and minor lineaments in Munugode and Chandur trend in NW-SE and north-south directions.Lineament density is a measure of groundwater potential. Larger portion is enclosed by very low lineament density as depicted in Figure 4. It is followed by low lineament density present in the central and SW portions and envelops a little portion of medium lineament density Very high and high lineaments density sections occupy very minor parts areas in SW of ChandurMandal which supply the highest surface water.

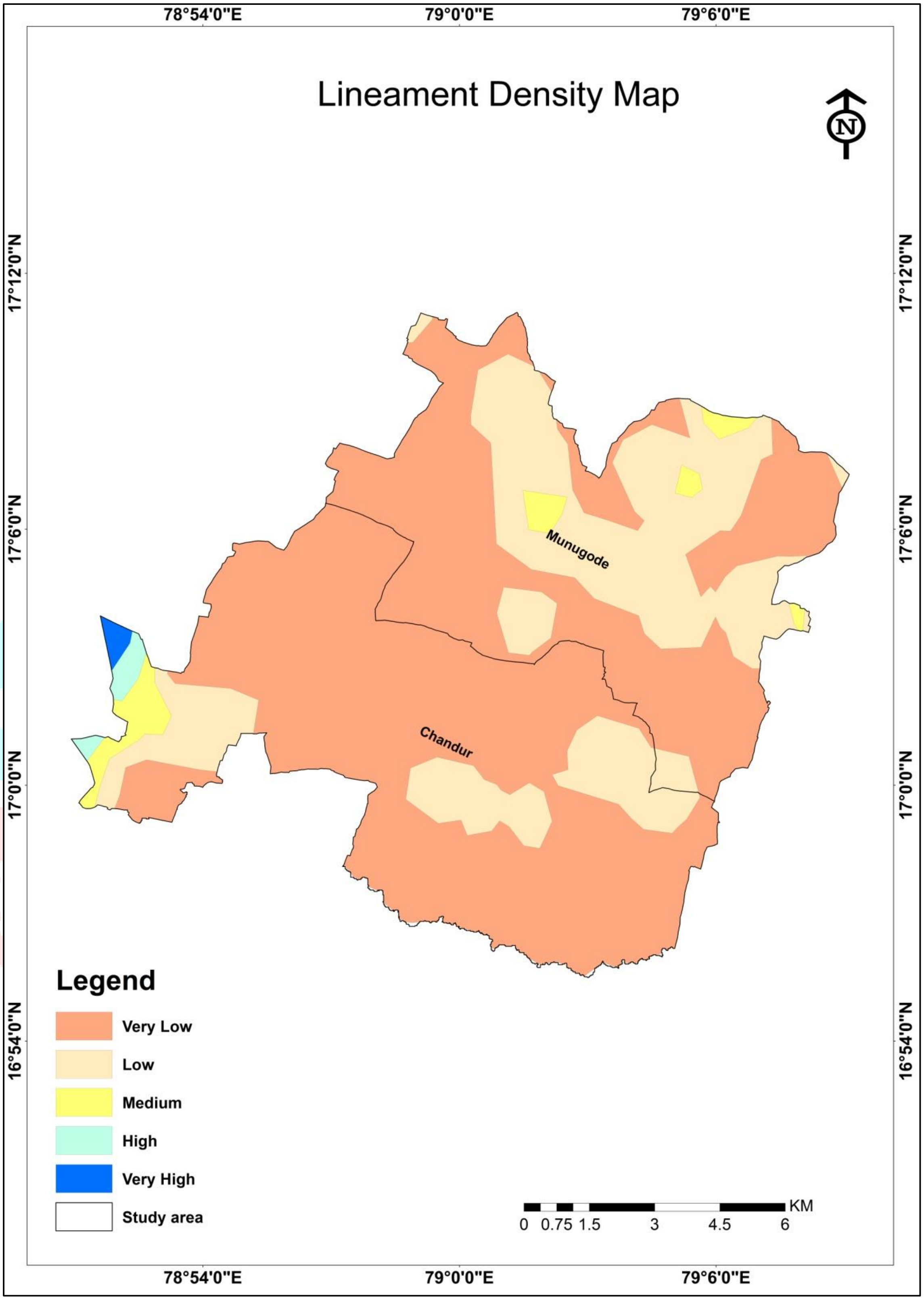

Figure.4. Lineament Density Map of Chandur and MunugodeMandals

Soil

The type of soil present on the ground surface regulate the amount of percolation of rain water into aquifers. Soil grain size impact the permeability of surface flow. The soil data procured from the NBSS & LUP reveal that the research area has five various soils. Clayey Calcareous and Gravelly Clay soil together share the highest portion of research area. Gravelly loam soil is spread in the ChandurMandal at western parts and southern edge whereas, clayey soil spatially extends from southern to southeastern portions. Loamy soil spread in the borders of

Munugode and ChandurMandals is distributed in a linear patch as shown in Figure 5.The diversity of soils show varied groundwater potentiality in the region.

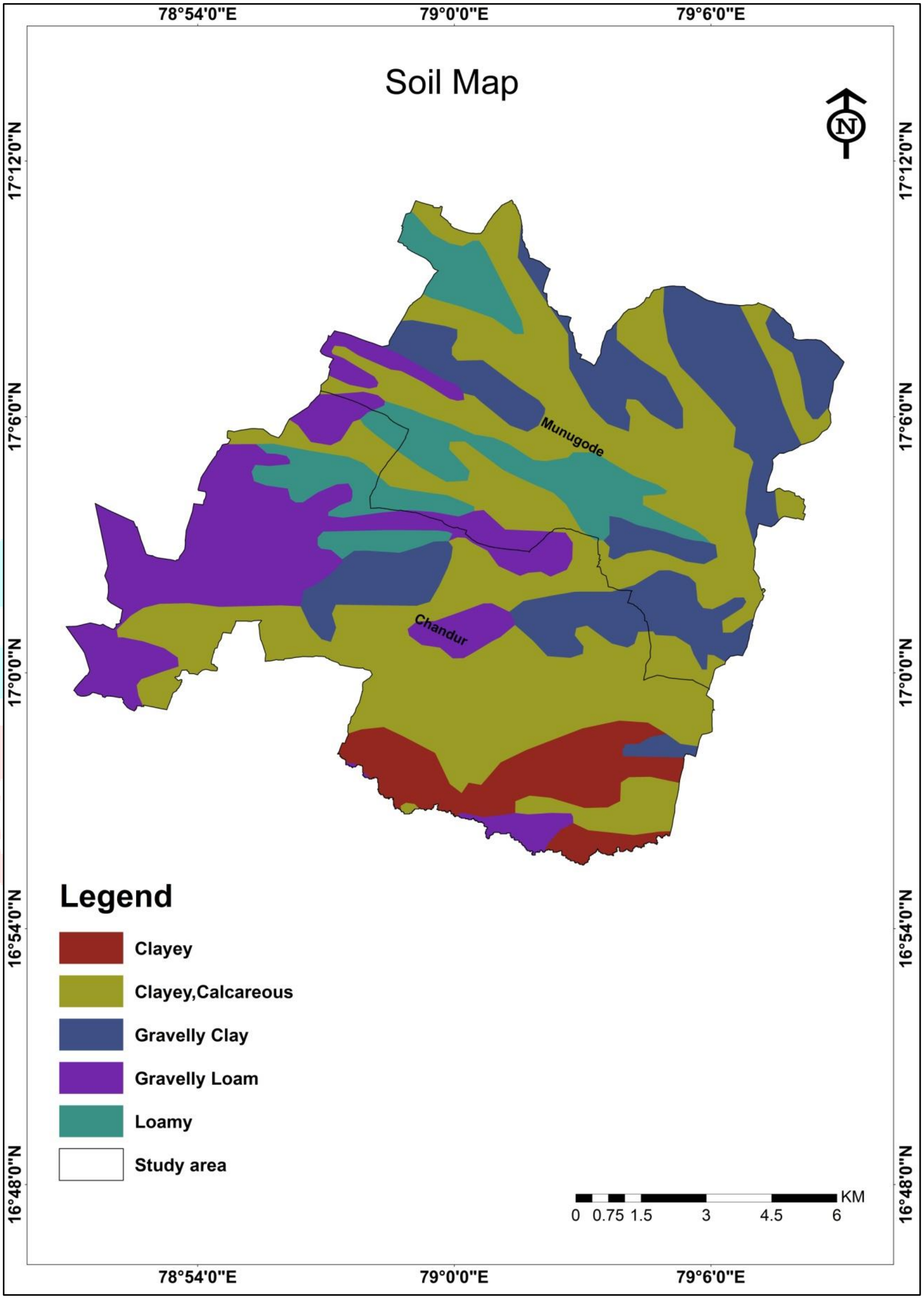

Figure.5. Soil Map of Chandur and MunugodeMandals

Geomorphology

Geographical landforms have a remarkable activity on replenishment of aquifers. Their origin, type and distribution have an effect on groundwater potential locally. Figure 6 uncovers there are twelve geomorphic units that can be grouped into denudational, structural, fluvial and anthropogenic origin genetic classes (NRSC, 2010).

Structural landforms viz., dykes and ridges covered in little portions create a notable role in groundwater storage and are present in the MunugodeMandal. Denudational origin landforms are spatially distributed majorly among them pediplain contributing for moderate groundwater potential extends most of the area followed by pediments, residual hills, hills, pediment-corestone-tor-composite, tor and inselberg. Fluvial landforms giving excellent groundwater recharge are older flood plain present across the course of Halia River and minute portion of channel bars in the main stream. Few active quarries of anthropogenic origin are also at the southern boundary of research area.

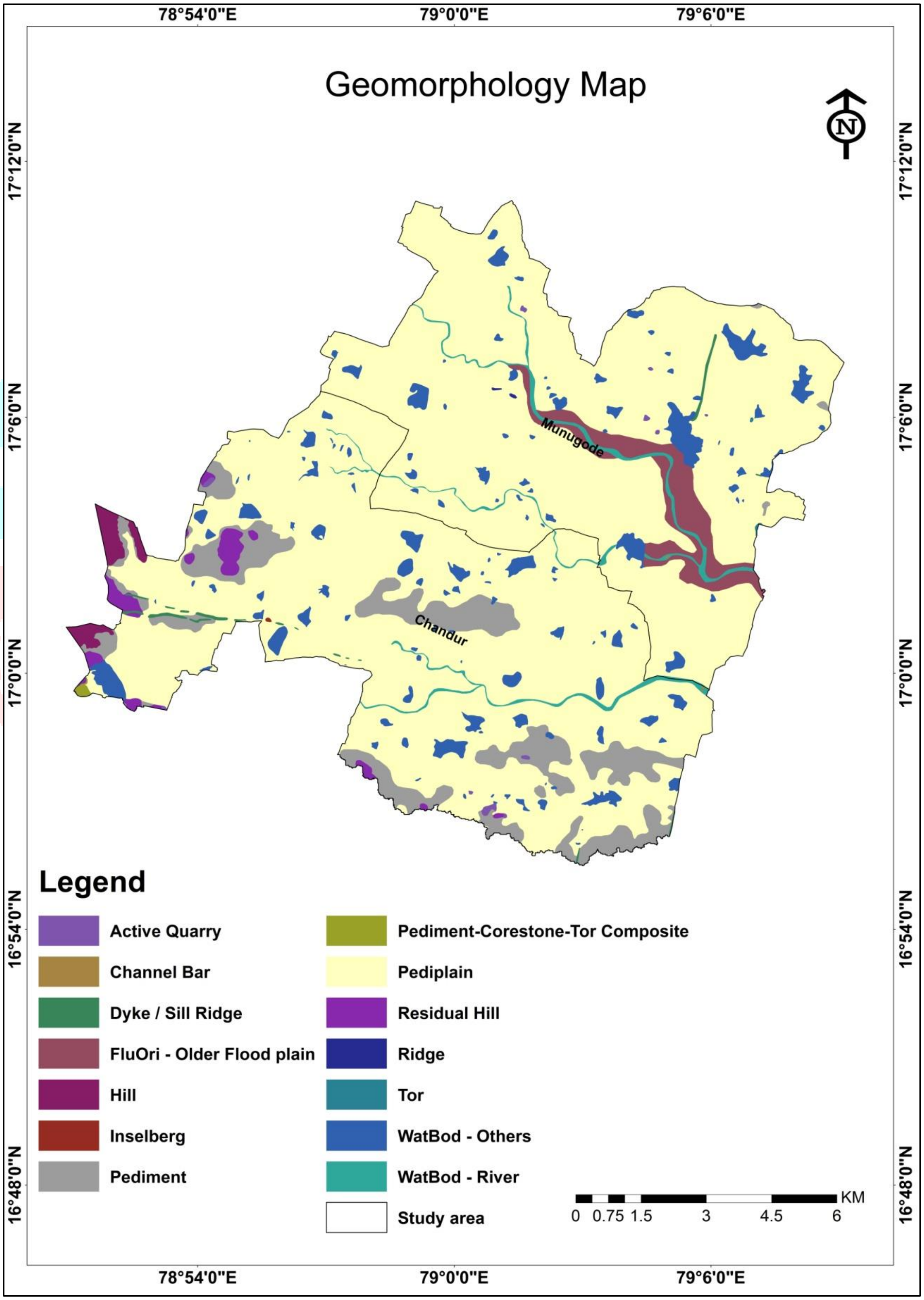

Figure.6. Geomorphology Map of Chandur and MunugodeMandals

Rainfall

Rainfall is the weighty factor that shows direct influence on the availability of groundwater in a given area (Thapa et al., 2017). Rainfall map of Figure 7 developed by interpolation of satellite rainfall grid data of CHRS shows there is fluctuation in rainfall distribution thereby, creating four precipitation patterns. The amount of rainfall decreased as it traversed from north to south directions of research unit.Scanty rainfall was at MunugodeMandalsignaling high and very high groundwater prospects and medium to very low rainfall was in ChandurMandal implying moderate to poor groundwater potential.

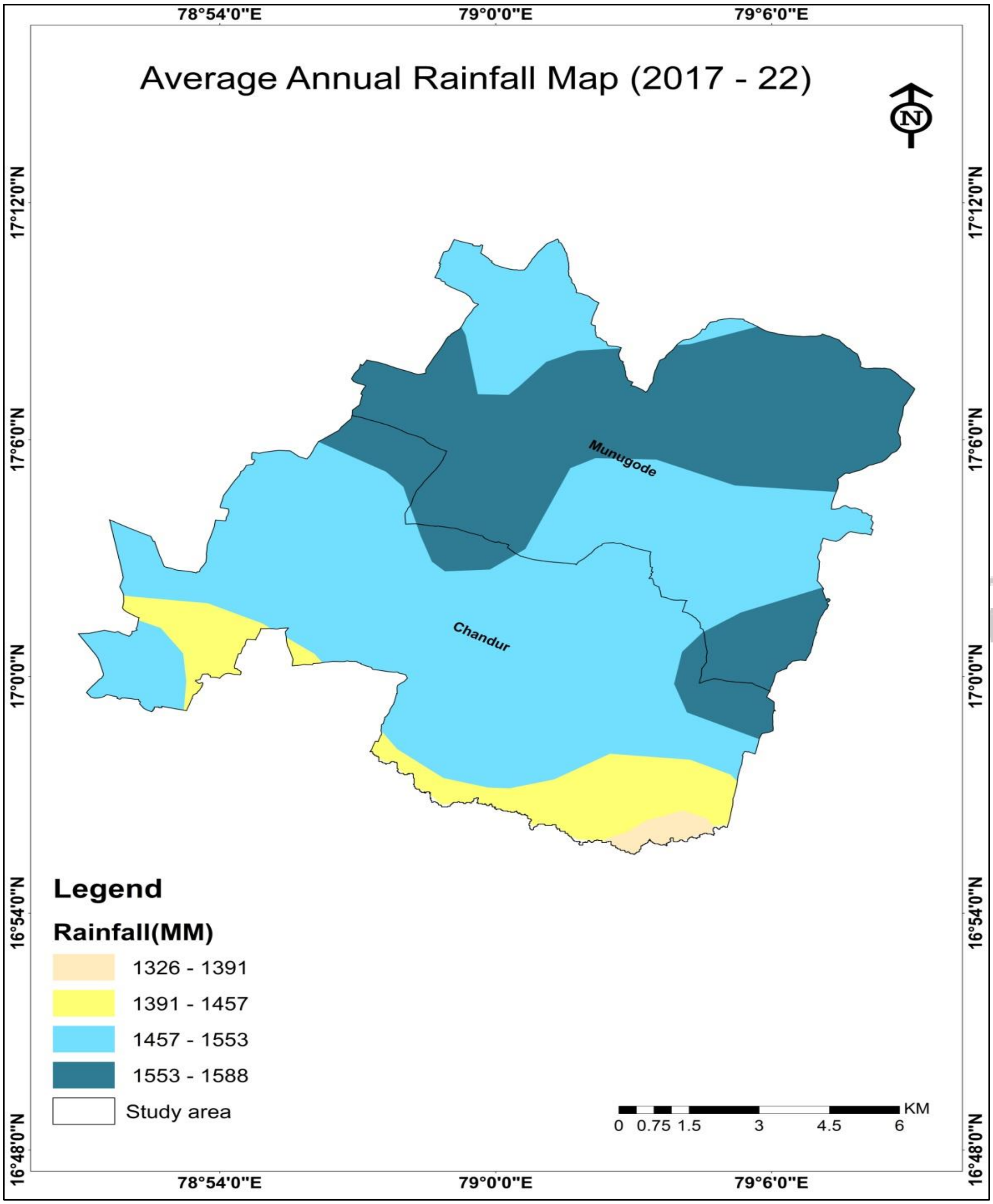

Figure.7. Rainfall Map of Chandur and MunugodeMandals

Drainage Density

Drainage network channels spacing has a leading and great roleon infiltration rate of groundwater. Drainage density is inversely proportional to augmentation of groundwater resources (Magesh et al., 2012). Figure 8 displays the drainage density ofChandur and MunugodeMandals. It is decreasing as theStream order increases from left to right periphery of study area which also signifies the increase in groundwater potential from high to low similarly. A small linear patch ofVery low drainage density is at southern edge of ChandurMandal.

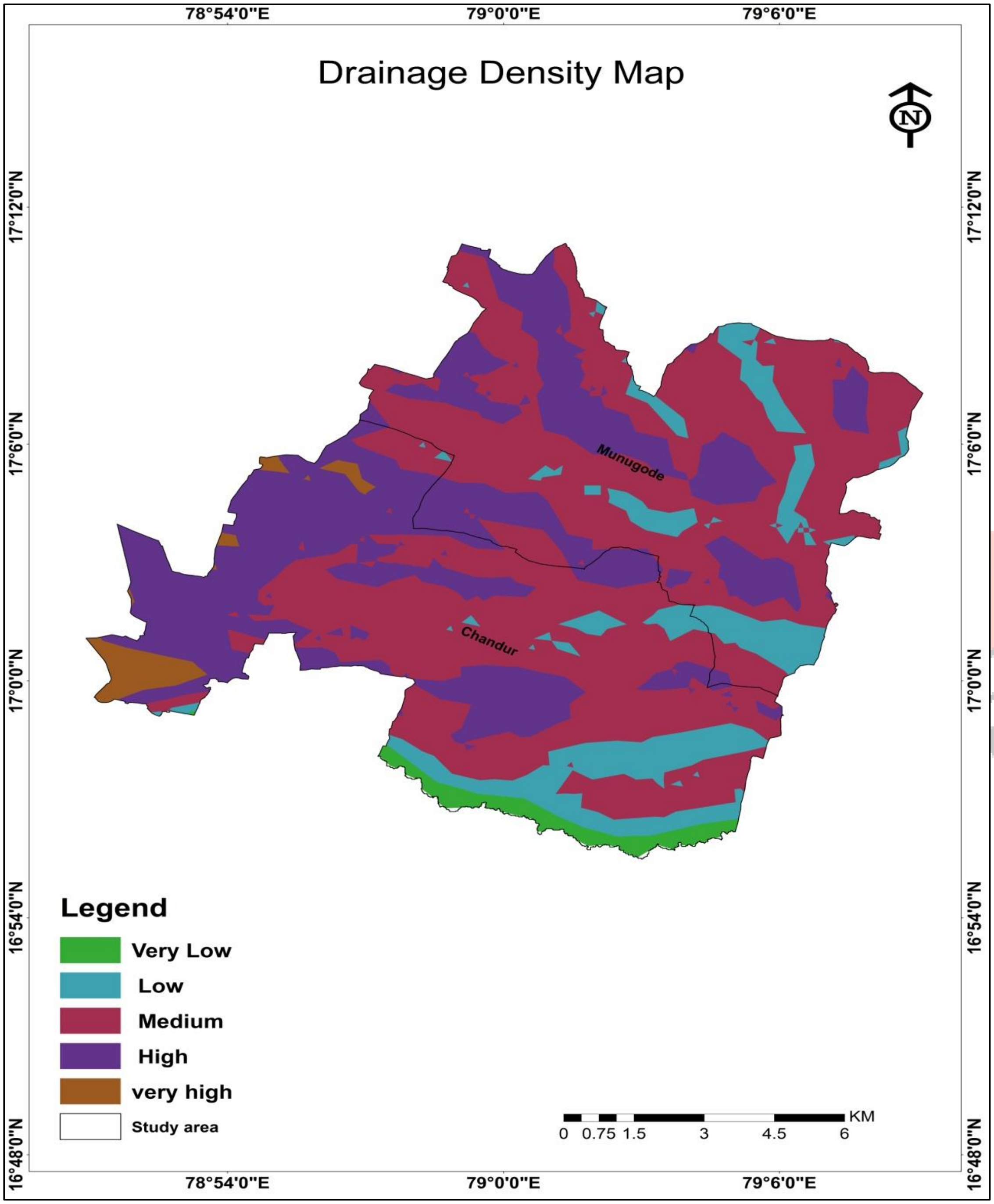

Figure.8. Drainage Density Map of Chandur and MunugodeMandals

Land Use Land Cover

Land use land cover gives considerable value to groundwater recharge (Yegizaw et al., 2022). Land use land cover is segregated into five categories as exhibited in Figure 9 which are agriculture, built-up, forest, barren/scrub land and waterbodies by digital image processingtechnique. The larger extension of pediplain and flat-gentle slope allowed for agriculture practice making it the highest share of land use and adding good to moderate groundwater potential. Least section of land use is barren/scrub land located at eastern zone of study area. Water bodies and built-up areas are present wide across the research territory but in medium portion and dispense very high to very low groundwater prospects. Forest is spread in slight patches of SW part of ChandurMandal.

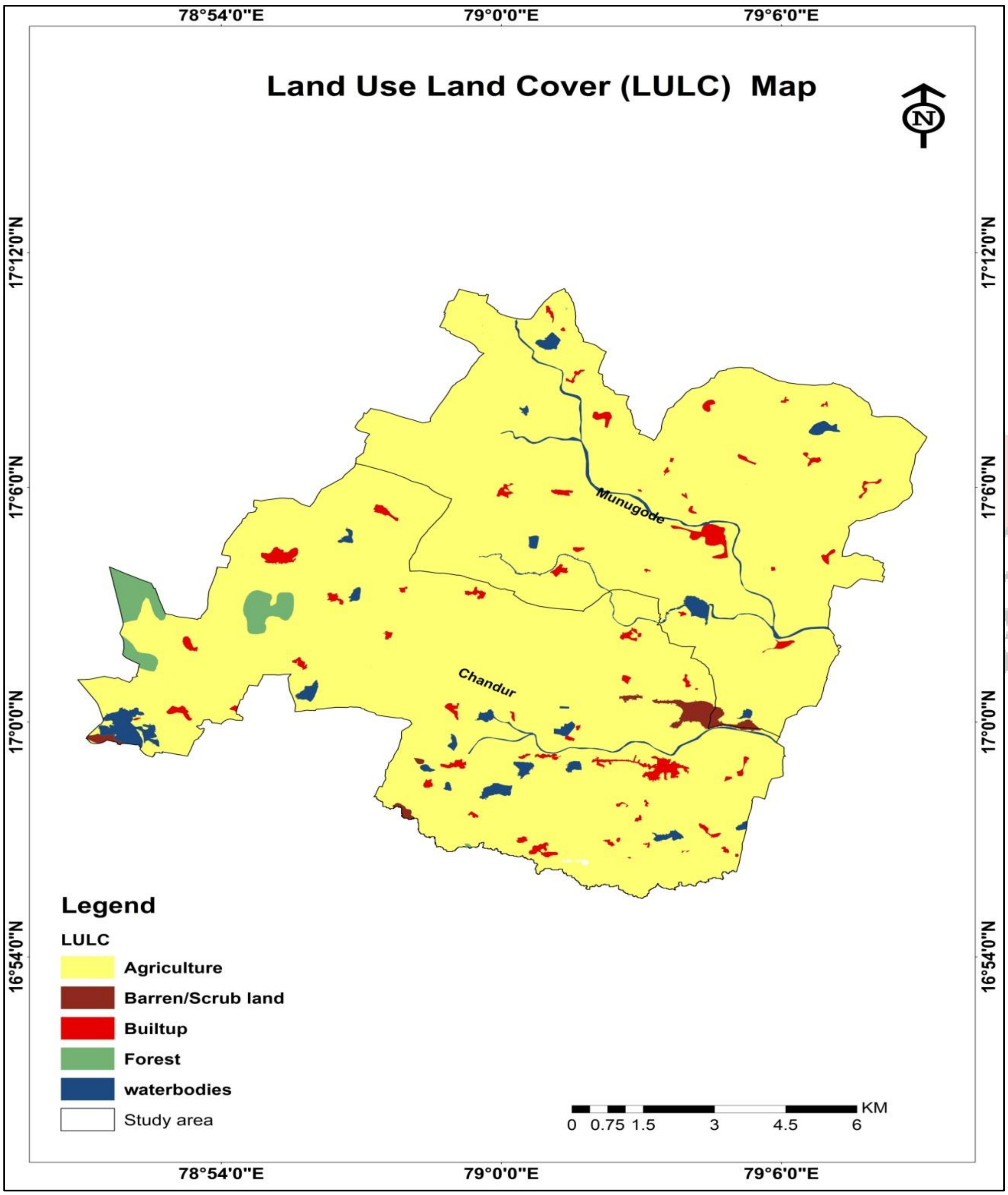

Figure.9. Land Use Land Cover Map of Chandur and MunugodeMandals

4.2 Mapping andAnalysis of Spatial Distribution of Groundwater Prospects

The allocation of weights and ranks to the parameters of geographical factorsandapplication of weighted overlay analysis tool generated the varied groundwater probable areas of Chandur and MunugodeMandals in ArcGIS 10.1 software.

The groundwater potential zones are derived using below formulain weighted overlay analysis:

$$S = \sum_{i-1}^{n} (wi.xi)$$

Where, S is total GWPZ score, *wi* is weight of GWPZ criterion, *xi* is feature/class score of *i* GWPZ criterion and *n* indicates total number of GWPZ criterion (Doke et al., 2021).

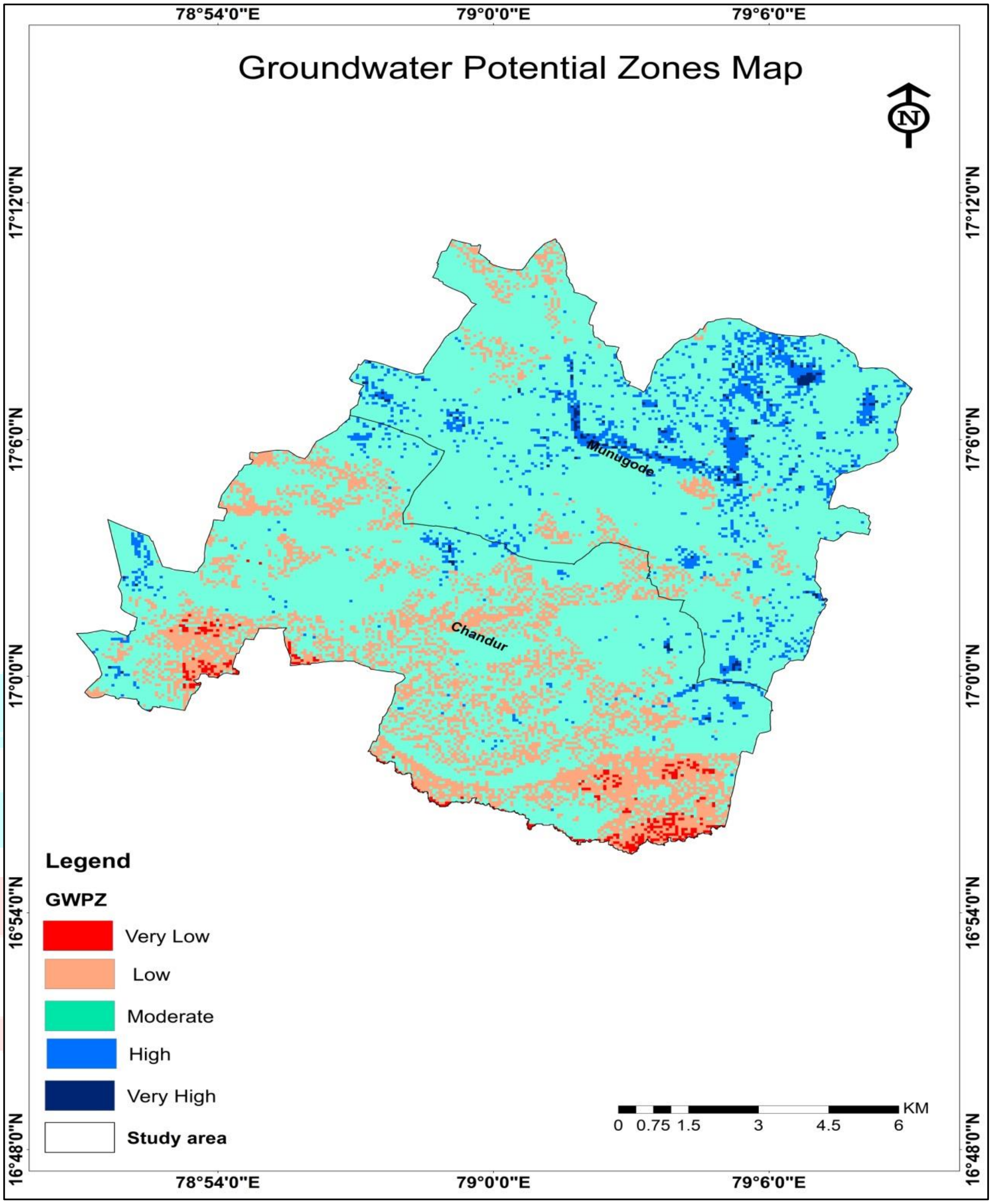

Figure.10. Groundwater Potential Zones Map of Chandur and MunugodeMandals

Figure 10 unveils the groundwater prospects decreases from northern sections of research area to southern sections. Very high and high groundwater pockets are concentrated in larger extent in northwestern portions because of gentle-flat slope of pediplain compensated with higher precipitation. Very low and low groundwater prospects occupying moderate section areat hills, built-up areas, and impervious granites and gneisses sections. Rest of the area which is of about nearly 75% consists of moderate groundwater prospects denoting the larger practice of rice cultivation.

5. Conclusion

The systematic processing of rainfall, lineaments density, drainage density, slope, land use land cover, soil, geology and geomorphology layers unfolded the groundwater scenario of Chandur and MunugodeMandals. Thus, allowing for the identification of vulnerable areas and drafting the suitable framework for optimal development of groundwater resources. The output of groundwater prospects areas becomes the input in locating accurate yielding borewell points by geophysical techniques and in the study of groundwater quality.

References

Agarwal, R., &Garg, P.K. (2016). Remote sensing and GIS based groundwater potential & recharge zones mapping using multi-criteria decision-making technique. Water Resources Management, 30(1), 243-260. https://doi.org/10.1007/s11269-015-1159-8

Chilukuri, L. K., Vasa, S. K., &Mohd, A. A. (2021). The Hierarchical Segregation of Groundwater Potential Zones Using Weighted Overlay Technique for the Discernment of Site Suitable Artificial Recharge Structures in the Development of Avunoor Watershed. In R.K. Mishra, R.B. Singh & A. Dubey (Eds.), Sustainable Climate Action and Water Management (pp. 73-86). Singapore: Springer Singapore

Chilukuri, L.K., &Mohd, A.A. (2023). Deciphering the groundwater potential of Madnur and JukkalMandals of Kamareddy District: A multi-criteria analysis approach. International Journal of Creative Research Thoughts, 11(7), 713-730

Das, B., Pal, S.C., Malik, S., &Chakrabortty, R. (2019). Modeling groundwater potential zones of Puruliya district, West Bengal, India using remote sensing and GIS techniques. Geology, Ecology, and Landscapes, 3(3), 223-237. doi: 10.1080/24749508.2018.1555740

Doke, A.B., Zolekar, R.B., Patel, H., & Das, S. (2021). Geospatial mapping of groundwater potential zones using multi-criteria decision-making AHP approach in a hardrock basaltic terrain in India. Ecological Indicators, 127. doi: 10.1016/j.ecolind.2021.107685

Magesh, N.S., Chandrasekar, N., Soundranayagam, J.P. (2012). Delineation of groundwater potential zones in Theni district, Tamil Nadu, using remote sensing, GIS and MIF techniques. Geoscience Frontiers, 3(2), 198–196. doi: 10.1016/j.gsf.2011.10.007

Mageshkumar, P., Subbaiyan, A., Lakshmanan, E.,Thirumoorthy, P. (2019). Application of geospatial techniques in delineating groundwater potential zones: a case study from South India. Arabian Journal of Geosciences, 12(5). doi: 10.1007/s12517-019-4289-0

Mondal, M.S., Pandey, A.C., &Garg, R.D. (2008). Groundwater prospects evaluation based on hydrogeomorphological mapping using high resolution satellite images – A case study in Uttarakhand. Journal of the Indian Society of Remote Sensing, 36, 69-76. doi: 10.1007/s12524-008-0007-1

Kumar, P., Herath, S., Avtar, R., & Takeuchi, K. (2016). Mapping of groundwater potential zones in Killinochi area, Sri Lanka, using GIS and remote sensing techniques. Sustainable Water Resources Management, 2, 419–430. doi: 10.1007/s40899-016-0072-5

National Remote Sensing Centre. (2010). Manual for Geomorphology and Lineament Mapping. Technical Report No: NRSC-RSAA-ERG-G&GD-SEP' 12-TR-445, Geosciences Division, ISRO-GSI, Government of India: Hyderabad, India, p. 28

Thapa, R., Gupta, S., Guin, S., Kaur, H. (2017). Assessment of groundwater potential zones using multi-influencing factor (MIF) and GIS: a case study from Birbhum district, West Bengal. Applied Water Science, 7 (7), 4117-4131. doi: 10.1007/s13201-017-0571-z

Varade, A.M., Khare, Y.D., Yadav, P., Doad, A.P., Das, S., Kanetkar, M., &Golekar, R.D. (2018). 'Lineaments' the potential groundwater zones in hard rock area: a case study of basaltic terrain of WGKKC-2 watershed from Kalmeswar Tehsil of Nagpur District, Central India. Journal of the Indian Society of Remote Sensing, 46(4), 539–549. doi: 10.1007/s12524-017-0716-4

Yegizaw, E.S., Ejegu, M.A., Tolossa, A.T., Teka, A.H., Andualem, T.G., Tegegne, M.A., &Dirar, T.M. (2022). Geospatial and AHP Approach Rainwater Harvesting Site Identification in Drought-Prone Areas, South Gonder Zone, Northwest Ethiopia. Journal of the Indian Society of Remote Sensing, 50, 1321–1331. doi: 10.1007/s12524-022-01528-5

Younger, P. (2007). Groundwater in the environment: an introduction. Oxford: Blackwell publishers, p. 318