A Project Report on

Finding Ground Water Potential Zone Mapping of Mewat District of Haryana with the help of Rank based Weightage Analysis of GIS and Remote Sensing Technology

Submitted for the fulfillment of requirement for the award of Degree in Post Graduate Diploma in Geoinformatics from NIGMT Foundation, Dwarka Mor, New Delhi

By

Rhythem Kaushal

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Supervisors

Mr. Ravindra Nath Tiwari

(HOD Geoinformatics- NIGMT)

Mr. Deepak Pandey

(Senior Technical Instructor- NIGMT)

Dr. Sunil Kumar

(HOD- Department of Geography)

TO WHOM IT MAY CONCERN

This is to certify that the Project Report on "**Ground Water Potential Zone Mapping of Mewat District of Haryana**" has been submitted to Netra Institute of Geoinformatics Management and Technologies Foundation- Dwarka, New Delhi for the partial fulfillment of the Post Graduate Diploma in Geoinformatics by Rhythem Kaushal.

Supervisor	**Head of Department**
Mr. Deepak Pandey	Mr. Ravindra Nath Tiwari
(Senior Technical Instructor)	HOD- Geoinformatics
NIGMT Foundation	NIGMT Foundation

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I am grateful for getting immense guidance, support, valuable time and a great platform to work with the Technologies of Geographic Information System (GIS) and Remote Sensing. I learnt different GIS processes and tools during the project work which expand my knowledge and curiosity.

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Abstract

Groundwater is an important resource which contributes significantly to the total annual water supply. The purpose of present paper is to assess and delineate the groundwater potential zones in Mewat which is a southern district of Haryana. Satellite imageries and some other collateral data is used for the preparation of thematic layers. Factors for instance- geology, geomorphology, slope, drainage density, lineament density, land use/land cover, soil and Topographic Wetness Index are used. All thematic layers are integrated with a multicriteria evaluation technique. Weighted overlay index analysis is carried out to give rank for each parameter. Every thematic layer and their corresponding categories are assigned a priority-based ranking from 1 to 8 depending on their capacity to hold groundwater and their respective weightages are calculated. Raster calculator tool is used to integrate the different thematic maps to produce a composite ground water potential map of Mewat. The composite ground water potential map is divided into five categories which varies from – very low, low, moderate, high to very high ground water potential zones. The motivation for this project lies in identifying the areas where depleting ground water can be saved by finding out the low potential zones of ground water. The future scope of this project involves enhanced planning and management of important ground water resource to conserve ground water for future generations.

Introduction

Ground Water is the most reliable source of fresh water. Due to numerous factors for instance-industrialization, expansion in population and urbanization, sources of ground water are under severe menace. Therefore, it is necessary to delineate and identify the potential zones of ground water which can be used to identify the best location for aquifer zones to store the ground water.

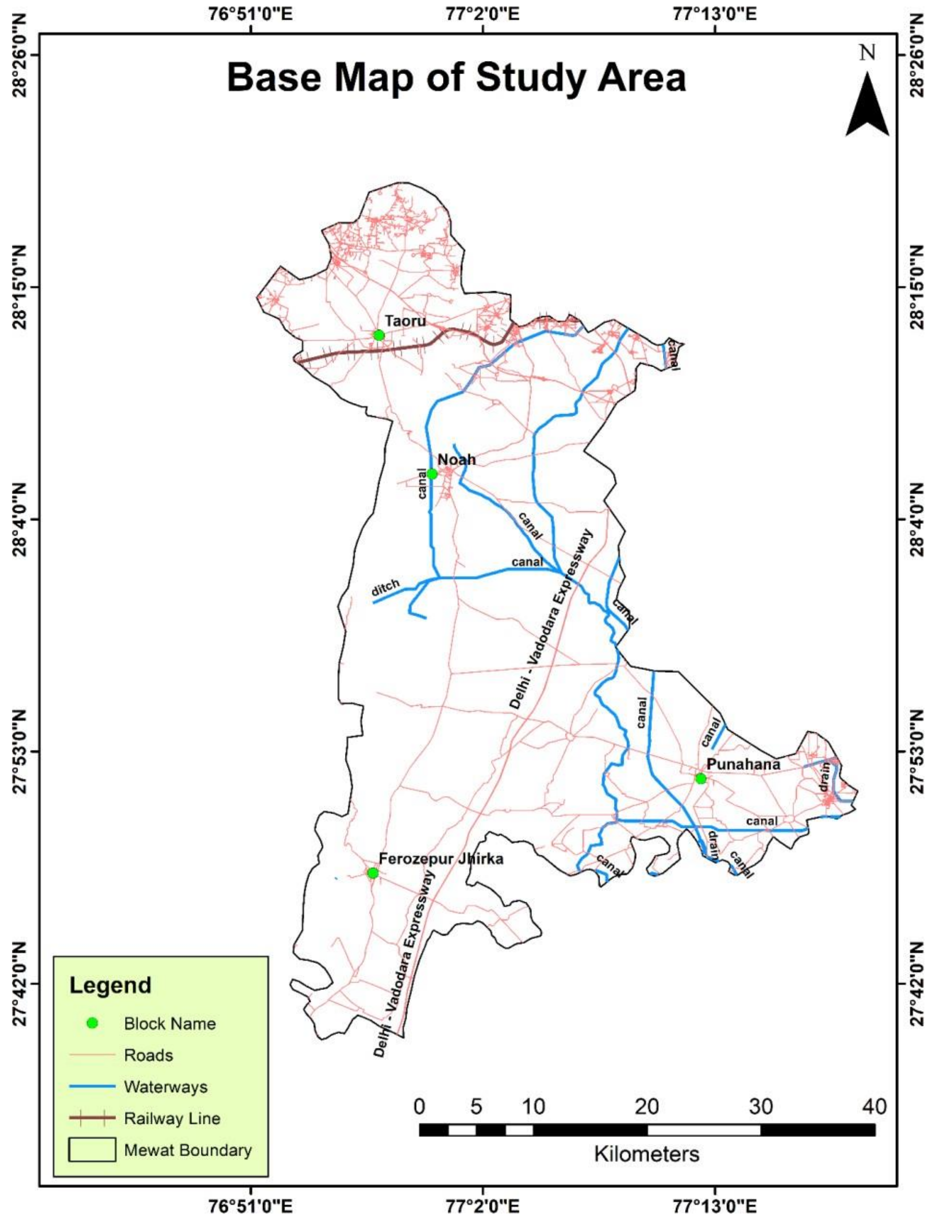
The present study is an attempt to delineate the potential zones of ground water and identifying the best location for aquifer zones with the help of an integrated approach of remote sensing technology and geographic information system for the better management of ground water.

There are several factors which regulate the location of ground water potential zones and movement of ground water such as geology, geomorphology, land use land cover, soil type, drainage density, lineament density and topographic wetness index of the study area.

The study area lacks water supply from canal systems. Unpredictable monsoon and semi-arid to hot climate fuelled the necessity to store the ground water. During most of the time of a year, Kotla and Ujina lakes remain dry. Hence, ground water becomes the crucial source of water for domestic, drinking and irrigation purposes.

Study Area

The geographical location of Mewat district lies between 27degrees 39' to 28 degrees 20' N latitude and 76degrees 31' to 77degrees 20' East longitude. It covers an area of 1,499 square kilometres. The climatic condition of Mewat is semi-arid and hot having an extreme dryness in air as a unique and important feature of the climate. The annual rainfall recorded in the district is 594 millimetres which is spread over 31 days. The depth of the ground water level in the study area lies between 5.03 to 24.46 mbgl. The majority of villages and towns in Mewat depend on tube wells for the supply of water for irrigation and domestic purposes.



Objective of the Study

The objective of this project is to identify the potential zones of ground water in Mewat District for the better management and future planning of ground water resources. Due to depleting ground water resources, it is becoming a dire need to identify the existing ground water resources and conserve them for future use so that, they would be available for future generation. Hence, rank based Weightage Analysis of Geographic Information System and Classification Techniques of Remote Sensing Technology helped to delineate the different zones of ground water.

The GIS and Remote Sensing Technology are used in this project.

The scope of GIS are as follows:

- To find out density of drainage and lineaments.
- To integrate different thematic layers of soil, slope, geology, geomorphology, land use land cover, drainage density, lineament density with the help of Multi- Criteria Weightage Analysis
- To assess the Topographic Wetness Index which determines accumulation of water.
- Scope of Remote Sensing is as follows:
- To classify various regions of study area into Agriculture Vegetation, Fallow Land, Rann, Urban Area, Deciduous Forest, Mining Area, Evergreen Forest.

Scope

The future scope of this project involves enhanced planning and management of important ground water resource to conserve ground water for future generation.

Ground water mapping project serves as a good input for aquifer mapping.

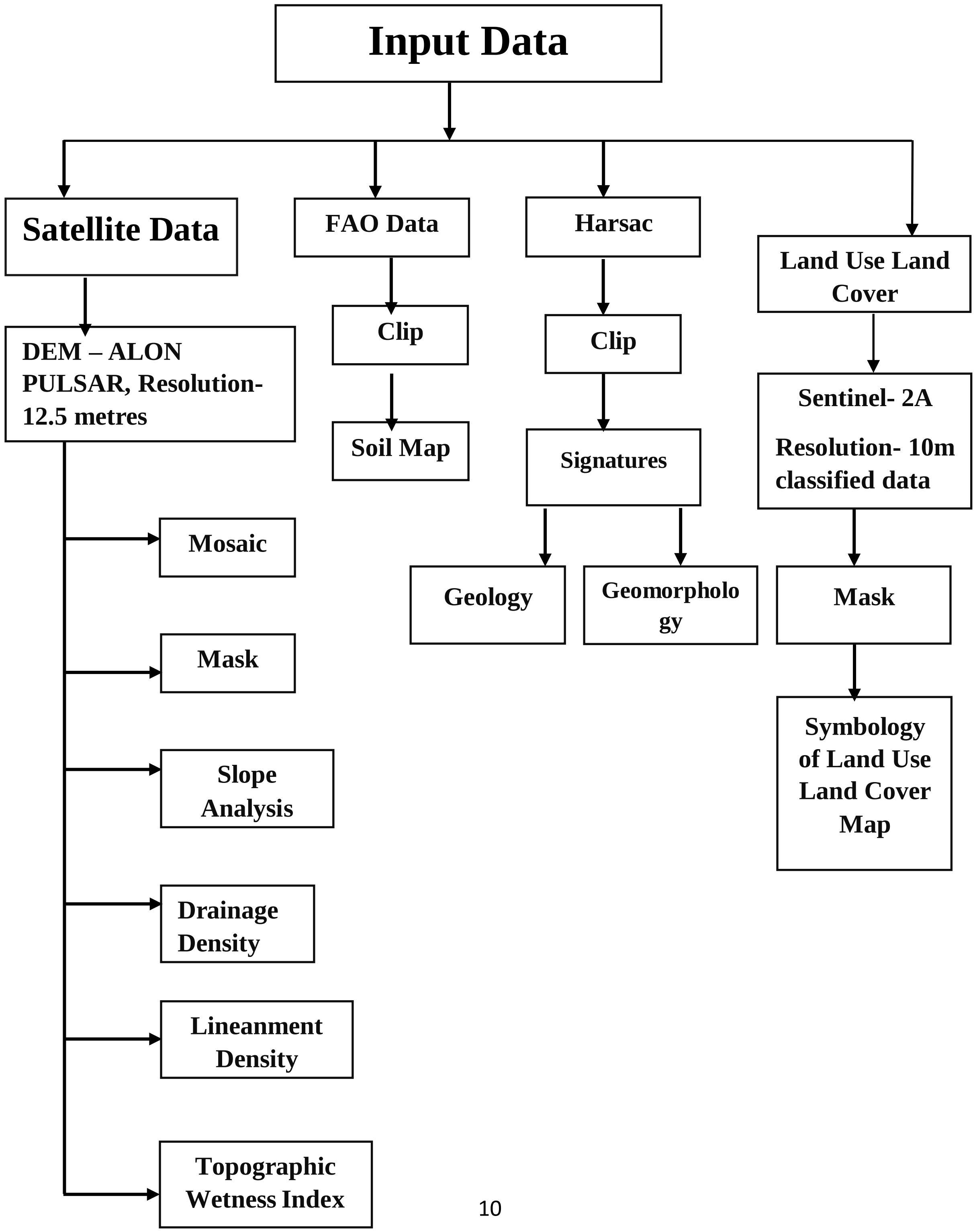
Ground water Mapping assist in identifying the ground water exploitation areas through ground water irrigated patches to address the suitable recharge structures for the betterment of ground water level.

One of the inputs for the resource estimation of future ground water development of Mewat District of Haryana.

Methodology

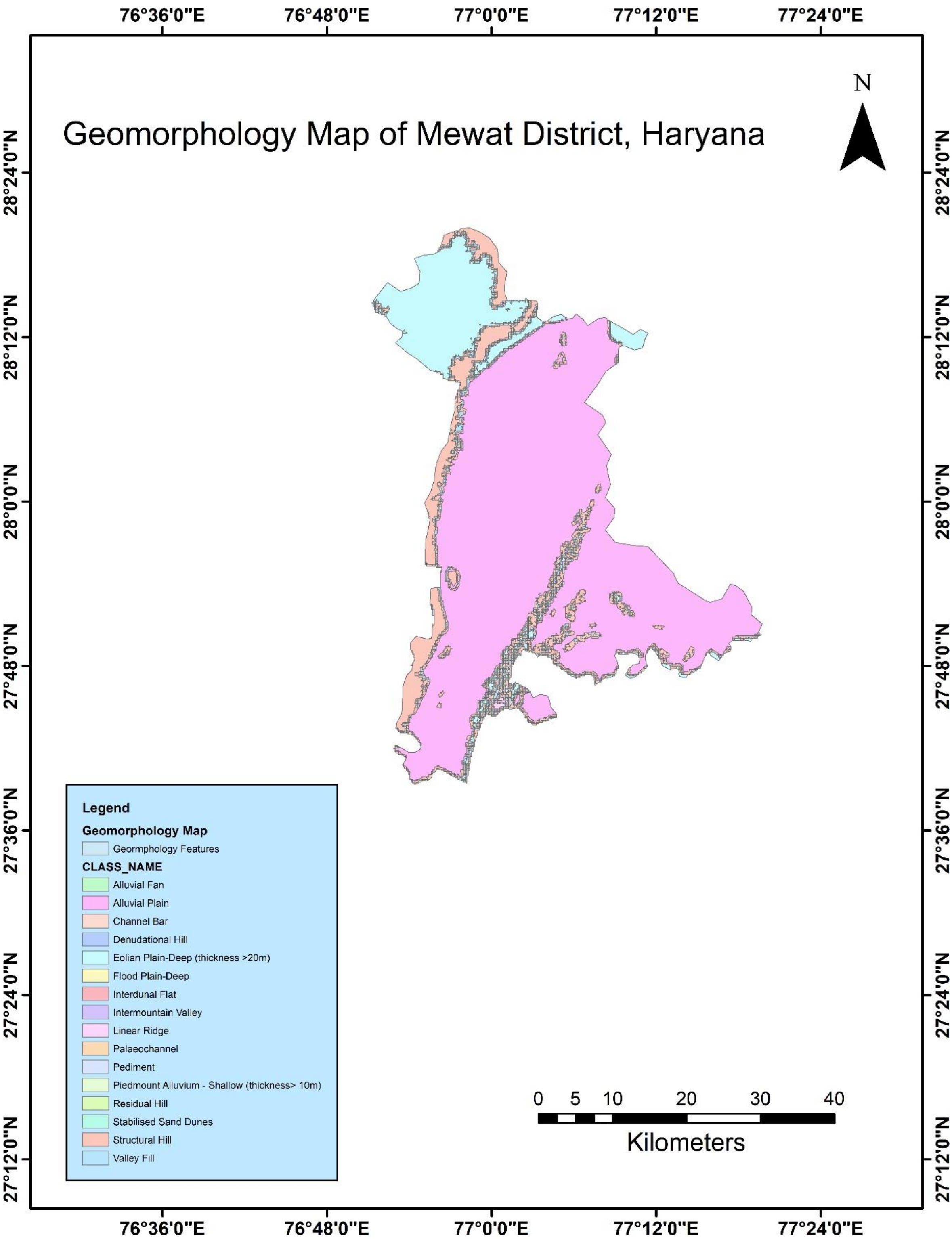
Digital Elevation Model of ALOS PALSAR having 12.5 resolution is used for Slope, drainage density, lineament density and topographic Wetness index Map. Twelve scenes of geocoded IRS P6 LISS IV satellite data covering the study area are visually interpreted for the preparation of geomorphology and land use/land cover maps. Geological map (1:2,50,000 scale), published by Geological Survey of India prepared by HARSAC, Hisar is used for the preparation of geology and, respectively. Eight thematic layers and their corresponding categories are assigned a knowledge-based priority ranking from 1 to 8 depending on their suitability to hold groundwater. The maximum value is given to the feature with highest groundwater potentiality and minimum being to the lowest potential feature. Based on these ranks their weightage are calculated and added to each layer. Eight parameters for instance geology, geomorphology, land use land cover, slope, soil, drainage density, Lineanment density and topographic wetness index were used and all by the composition through union tool ground water potential map is obtained.

Methodology of Delineation of potential zones of Ground Water



Geomorphology

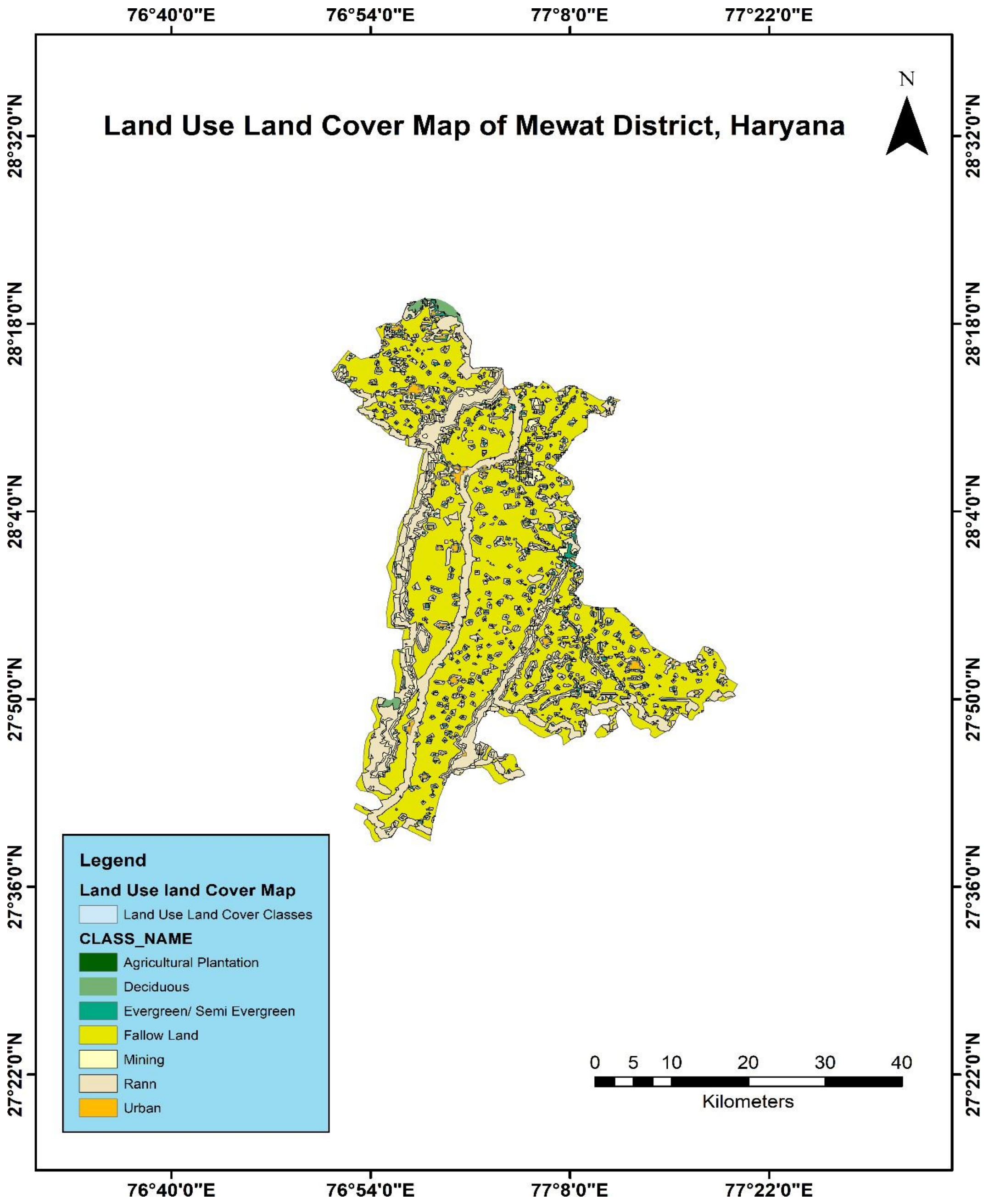
Geomorphology is a field of earth science to study the different landforms of earth, their description and genesis. Geomorphology of an area depends upon the structural evolution of geological formation. There are good number of features which are important and favourable for the occurrence of groundwater for instance- Alluvial Fan, Alluvial plain, Channel bar, Eolian plain, Flood Plain and Palaeo Channel.



Land Use and Land Cover Map

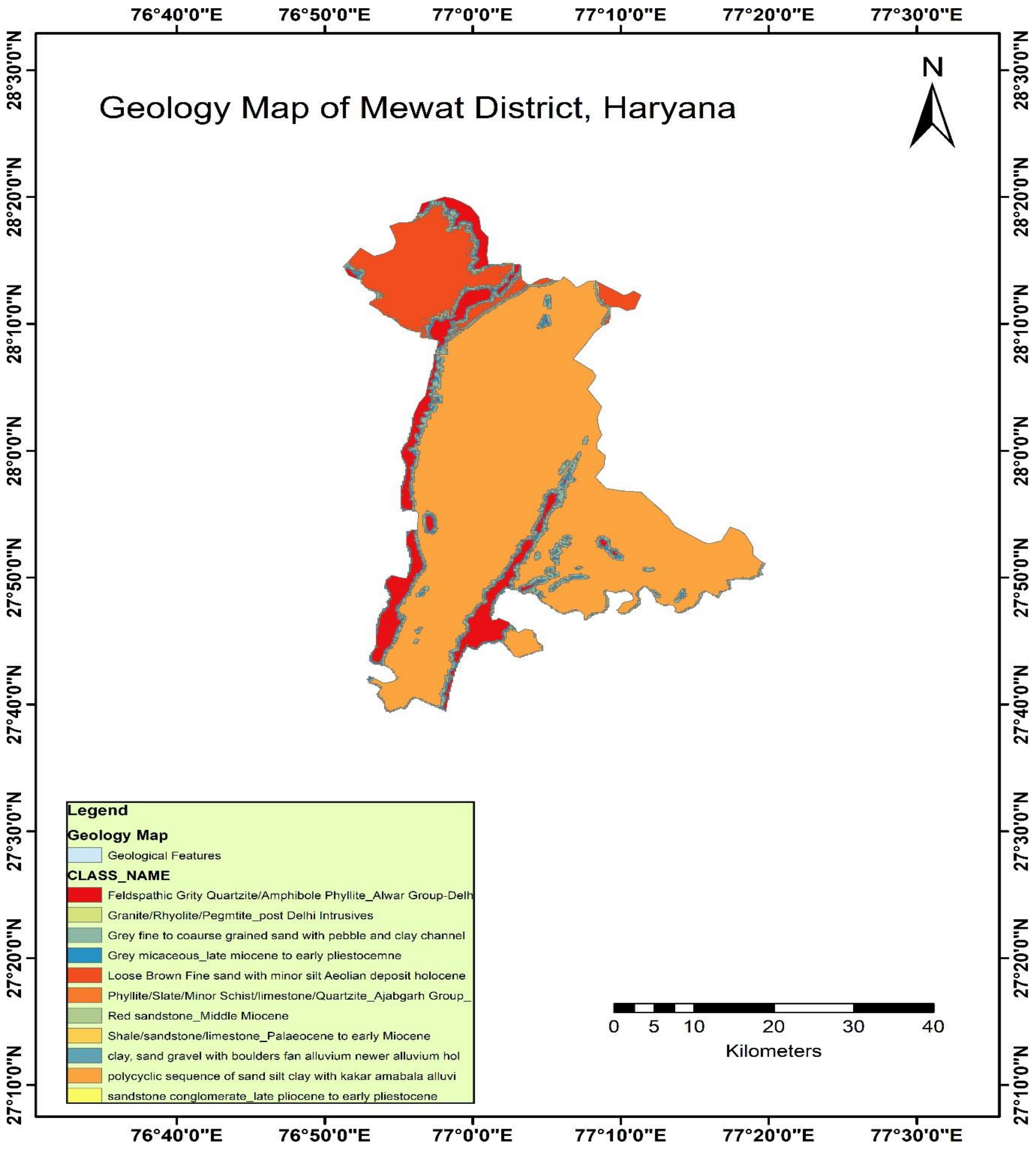
Land Use and Land Cover is an important parameter which affects the groundwater recharge, occurrence, and the availability of groundwater. Data for Land Use and Cover Map was derived from ESA Sentinel-2 imagery of 2020 having spatial resolution of 10 metres.

The study area consists of five different categories of land use and land cover namely- Water Bodies, Forest, Vegetation, Built-up Area and Bare Ground. Vegetation cover is the dominant factor among all the five Land use and Land Cover classes because it is considered to be the most suitable zone for the recharge of ground water as it helpful for the percolation of rainwater.



Geology

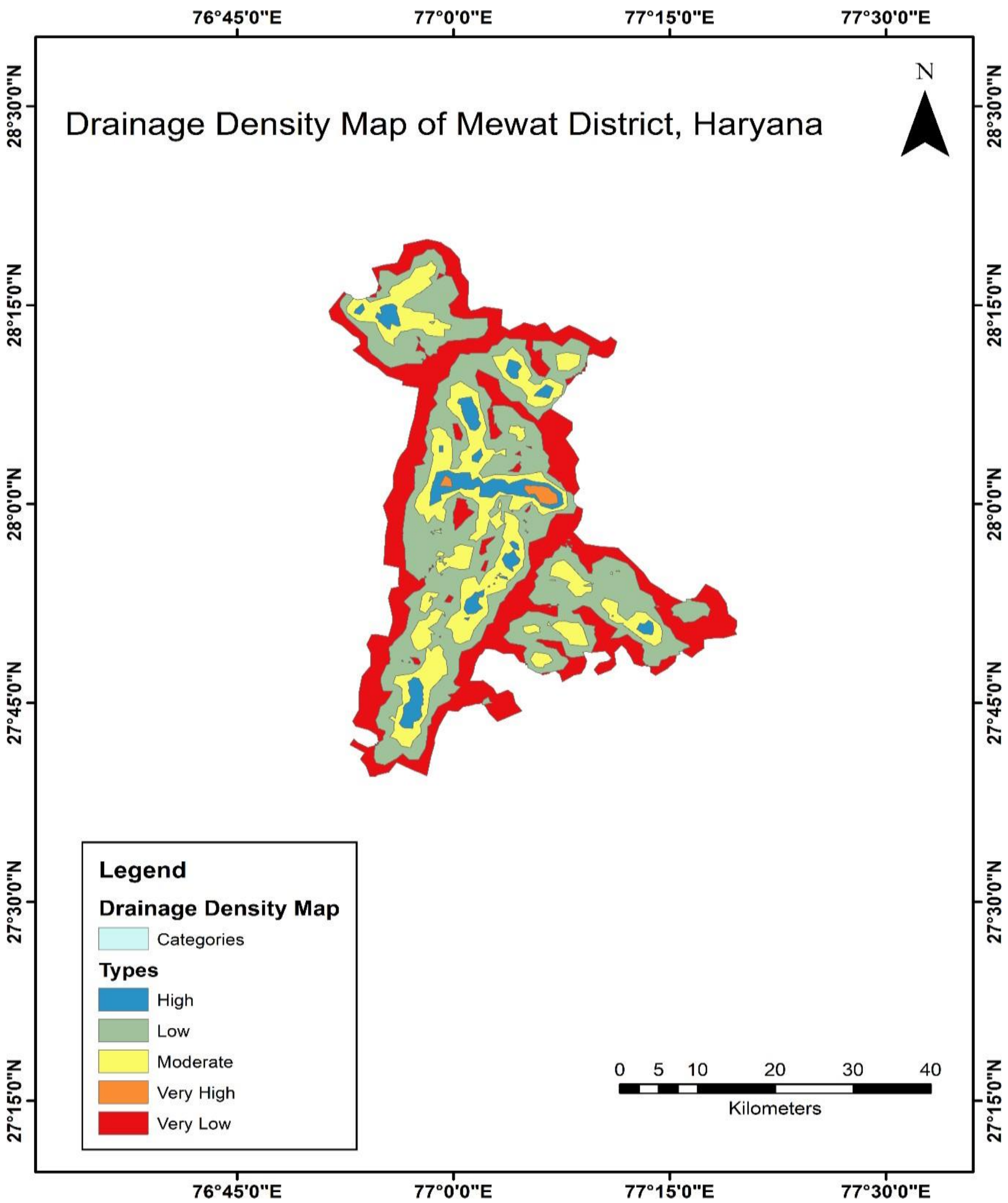
Geology plays a significant role in the occurrence and movement of ground water. The study area contains the following rocks- Feldspathic Grity Quartzite, Granite, Grey fine to coaurse grained sand with pebble, Grey micaceous, Loose Brown fine sand, Phyllite, Red Sandstone, shale sandstone, clay, sand gravels, polycyclic sequence of sand, silt and clay and sandstone conglomerate. The Geological feature of the district is characterized by the majority of Quaternary sediments and Delhi supergroup of rock formations. Quaternary sediments consist of alluvium deposits with a sequence of inter layered clay/silt and sand with occasional kankar formations in case of older alluvium formations having coarse to fine aeolian sand in case of aeolian deposits.



Drainage Density

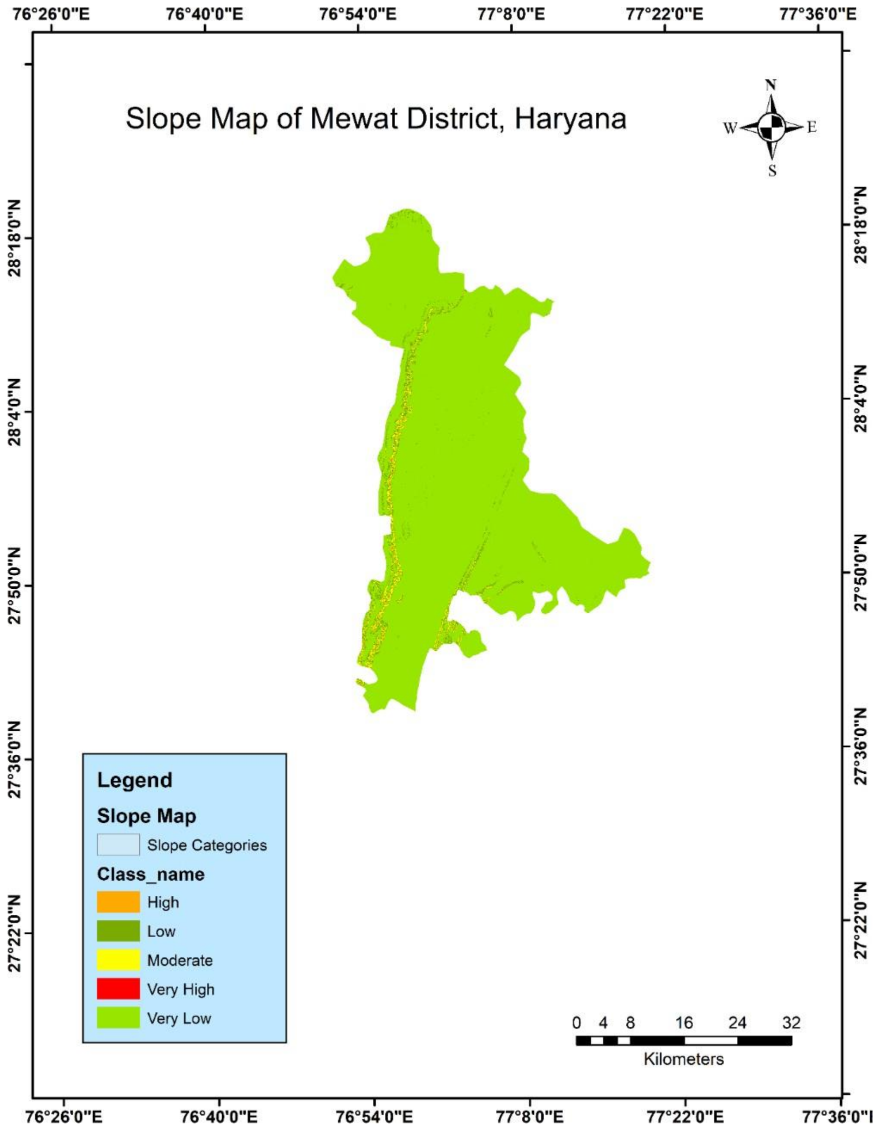
Drainage Density follows an inverse relationship with groundwater occurrence. Higher the drainage density, lower is the probability of groundwater potential zone. The input for Drainage density map was Digital Elevation Model obtained from ALOS PALSAR having 12.5 metres resolution. Flow direction and Flow accumulation were determined using Arc GIS software for obtaining Drainage Density. The Drainage Density of the study Area is grouped into five different classes ranging from very low, low, medium, high upto very high.

Groundwater potential is poor in the areas of high drainage density as major part of the water poured over them during rainfall is lost as surface runoff with little infiltration to meet groundwater. On the contrary, groundwater potential is high in the areas having low drainage density as they permit more infiltration and recharge of the groundwater.



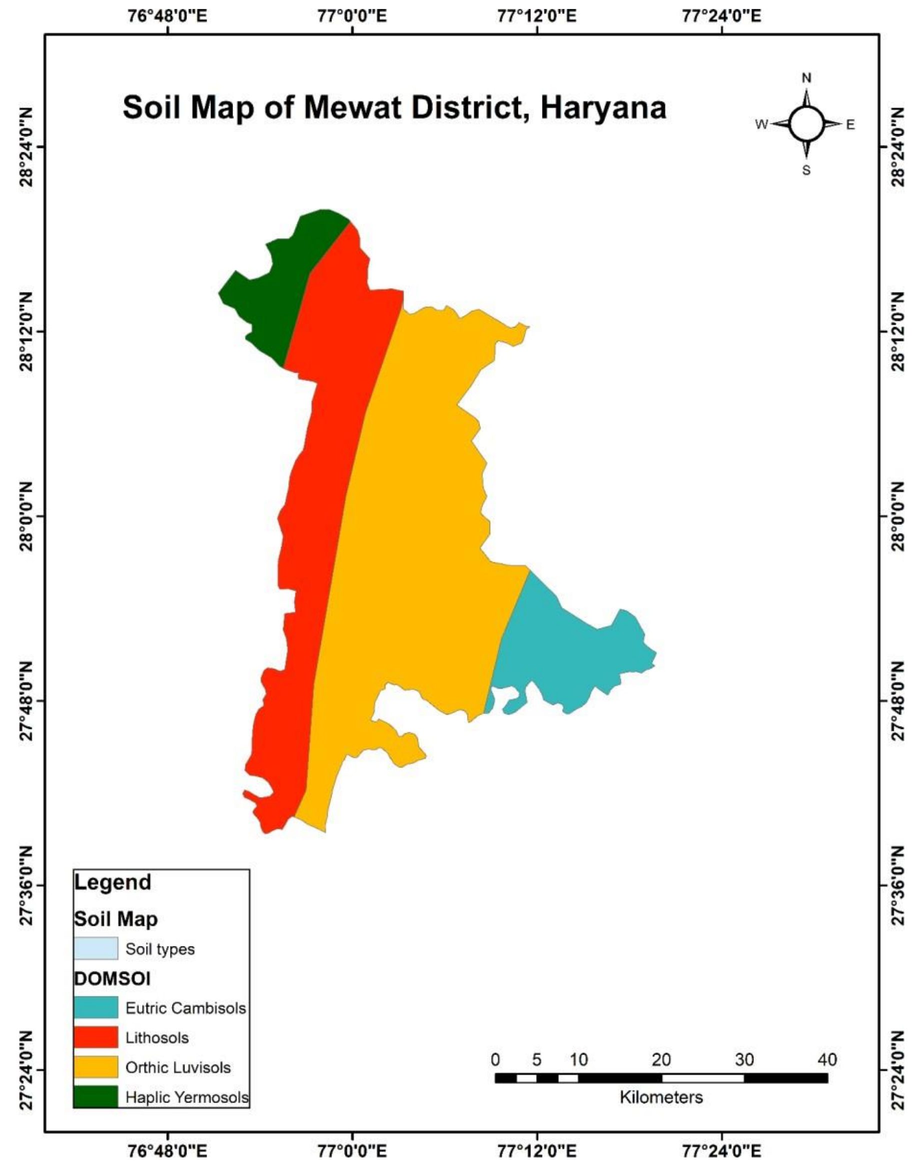
Slope Analysis

Slope is one of the important parameters for delineation of potential zones of groundwater because it regulates the infiltration of groundwater into subsurface. Gentle slope favors slow surface runoff thereby increasing the time for groundwater to percolate. Steep slope favors high surface runoff thereby decreasing the time for groundwater to percolate. Hence, infiltration of groundwater is more in the areas of gentle slopes and less in the areas of steep slope. The data for slope map was obtained from ALOS PALSAR with 12.5 metres resolution. Surface slope was categorized into five distinct classes from very low slope, low, moderate, high to very high slope.



Soil Map

Soil plays a significant role in recharge of ground water by its water holding capacity therefore, it should be considered as an important parameter for delineation of ground water potential zones. The study area consists of four different types of soil namely- Eutic Cambisols, Lithosols, Orthic Luvosols and Haplic Yermosols. Data for Soil Map is based on the FAO-UNESCO Soil Map of the World at 1:5.000.000 scale with projection of Geographic Coordinate System.



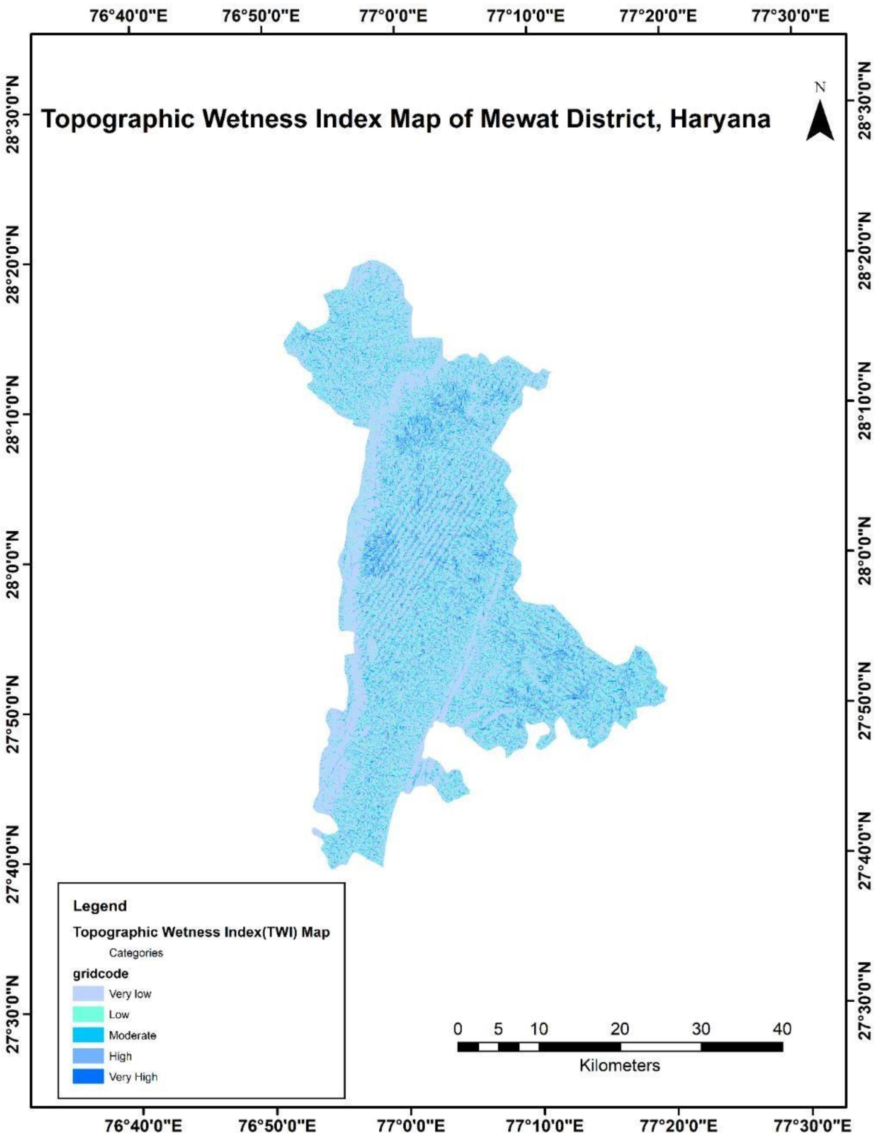
Topographic Wetness Index (TWI)

Topographic Wetness Index (TWI) is used to determine the topographic control on hydrological processes. TWI indicates the effect of topographic conditions on the potential groundwater infiltration. Topographic Wetness Index can be expressed as Ln (a/tanB) based on the idea of Beven and Kirkby in 1979, here a is the specific catchment area obtained by dividing catchment area with contour length.

a=A/L here, A= catchment area and L= contour length.

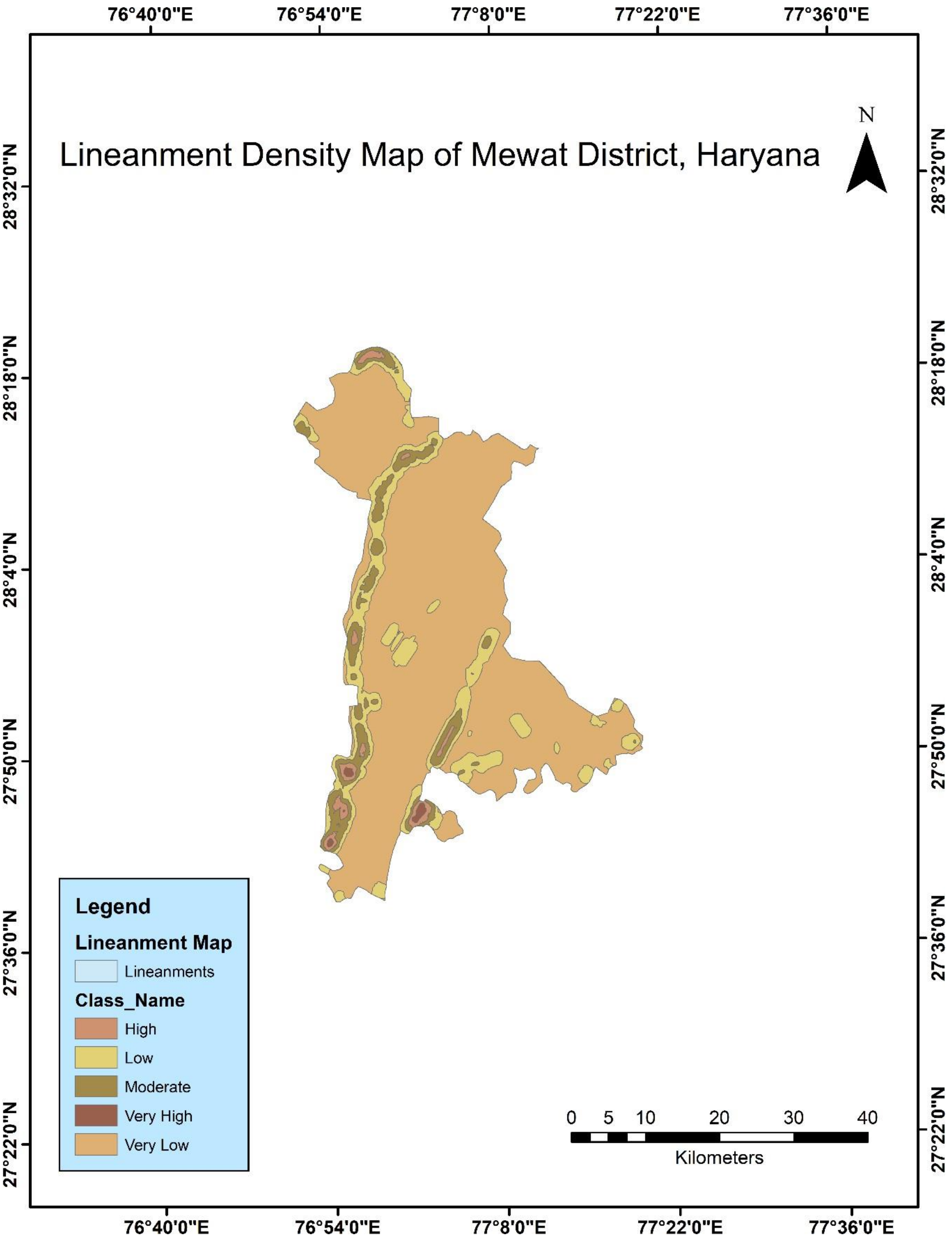
The input for TWI was Digital Elevation Model obtained from having 12.5 metres resolution. The study area consists of five distinct classes of Topographic Wetness Index ranging from very low, low, moderate, high to very high TWI.

Areas of high Topographic Wetness Index facilitates the identification of areas of soil moisture, accumulation and infiltration potential of groundwater.



Lineament Density

Lineaments are structurally controlled linear and curvilinear features in a landscape which are the expressions of underlying geological structures such as faults, joints and fractures and provide a route for the percolated water. The input for lineament density map was Digital Elevation Model obtained from ALOS PALSAR having 12.5 metres resolution. Lineament Density of the study area varies from very low, low, medium, high upto very high density. Lineament Density is an important parameter for ground water potential zone mapping because lineaments act as a channel for the flow of groundwater which leads to rise in secondary porosity and hence denote as potential ground water zone. Therefore, highest value of lineament density indicates the highest potential for ground water recharge whereas, lowest value of lineament density indicates lowest potential for ground water recharge.



Weightage Analysis

Factors	Geomorphology	LULC	Geology	Drainage Density	Slope	Soil types	pographich Wetness Ind	Lineaments	Weight	Overall 100%
Geomorphology	8	7	6	5	4	3	2	1	0.37	37
LULC	8\2	7\2	6\2	5\2	4\2	3\2	2\2	1\2	0.186	19
Geology	8\3	7\3	6\3	5\3	4\3	3\3	2\3	1\3	0.123	12
Drainage Density	8\4	7\4	6\4	5\4	4\4	3\4	2\4	1\4	0.089	10
Slope	8\5	7\5	6\5	5\5	4\5	3\5	2\5	1\5	0.074	7
Soil Types	8\6	7\6	6\6	5\6	4\6	3\6	2\6	1\6	0.062	6
Topographich Wetness Index	8\7	7\7	6\7	5\7	4\7	3\7	2\7	1\7	0.057	5
Lineaments	8\8	7\8	6\8	5\8	4\8	3\8	2\8	1\8	0.04	4
Total	21.6	18.8	16.2	13.4	10.7	8	5.2	2.5		

Geomorphology			
Factors	**weight**	**ranks**	**overall**
Alluvial Plain	37	16	592
Alluvial Fan	37	15	555
Flood Plain-Deep	37	14	518
Piedmount Alluvium - Shallow (thickness> 10m)	37	13	481
Pediment	37	12	444
Palaeochannel	37	11	407
Channel Bar	37	10	370
Eolian Plain-Deep	37	9	333
Interdunal Flat	37	8	296
Linear Ridge	37	7	259
Intermountain Valley	37	6	222
Stabilised Sand Dunes	37	5	185
Denudational Hill	37	4	148
Valley Fill	37	3	111
Structural Hill	37	2	74
Residual Hill	37	1	37

LULC			
Agricultural Plantation	19	7	133
Evergreen/ Semi Evergreen	19	6	114
Deciduous	19	5	95
Mining	19	4	76
Urban	19	3	57
Fallow Land	19	2	38
Rann	19	1	19

Soil types			
Eutric Cambisols	6	4	24
Orthic Luvisols	6	3	18
Haplic Yermosols	6	2	12
Lithosols	6	1	6
Topographic Wetness Index			
Very High	5	5	25
High	5	4	20
Moderate	5	3	15
Low	5	2	10
Very Low	5	1	5
Lineaments			
Very High	4	5	20
High	4	4	16
Moderate	4	3	12
Low	4	2	8
Very Low	4	1	4

Geology			
polycyclic sequence of sand silt clay with kakar amabala alluvi	12	11	132
clay, sand gravel with boulders fan alluvium newer alluvium hol	12	10	120
Grey fine to coaurse grained sand with pebble and clay channel	12	9	108
Loose Brown Fine sand with minor silt Aeolian deposit holocene	12	8	96
sandstone conglomerate_late pliocene to early pliestocene	12	7	84
Shale/sandstone/limestone_Palaeocene to early Miocene	12	6	72
Red sandstone_Middle Miocene	12	5	60
Grey micaceous_late miocene to early pliestocemne	12	4	48
Feldspathic Grity Quartzite/Amphibole Phyllite_Alwar Group-Delh	12	3	36
Granite/Rhyolite/Pegmtite_post Delhi Intrusives	12	2	24
Phyllite/Slate/Minor Schist/limestone/Quartzite_Ajabgarh Group_	12	1	12
Drainage Density			
Very Low	10	5	50
Low	10	4	40
Moderate	10	3	30
High	10	2	20
Very High	10	1	10
Slope			
Very Low	7	5	35
Low	7	4	28
Moderate	7	3	21
High	7	2	14
Very High	7	1	7

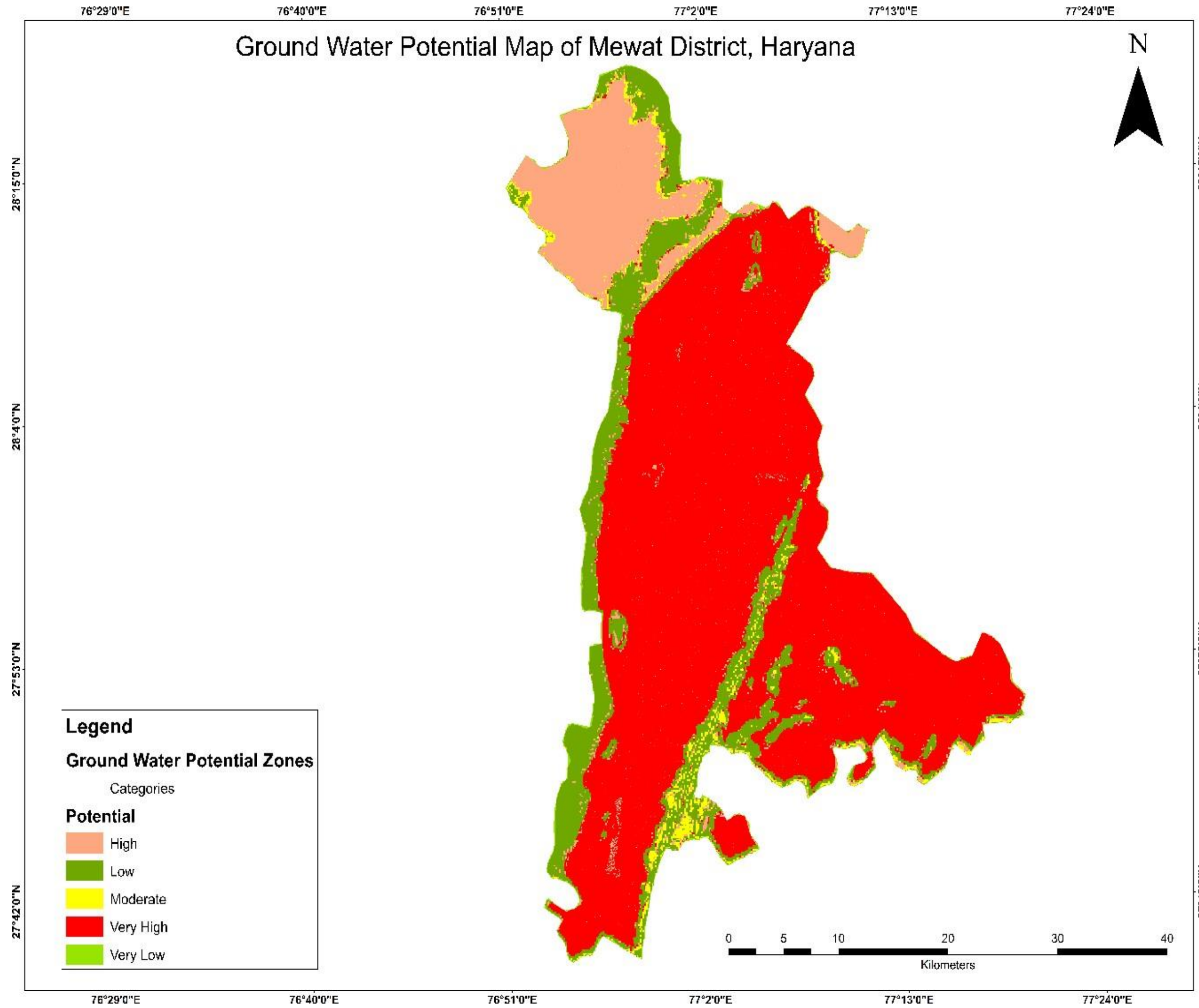
About Weightage Analysis

Weightage Analysis is an important process where weights or rank is given to different parameters depending on their significance to calculate or determine a defined output. In an attempt to delineate the potential zones of ground water, we have considered eight different factors for instance- Geomorphology, geology, land use land cover, slope, soil types, drainage density, Lineanment density and Topographic Wetness Index. Highest weight is given to Geomorphology and lowest weight is given to Lineanment Density to calculate potential zones of ground water in Mewat district of Haryana. Within a particular parameter of Geomorphology, different sub parameters are taken into account for analysis for instance, Alluvial Plain, Alluvial Fan, Flood Plain-Deep, Piedmont Alluvium upto Structural Hill and Residual hill. Individual weight or rank is provided within the geomorphology parameter. Alluvial Plain is given maximum weight whereas, residual hill is given lowest weight.

All the parameters are given percentage as per their weights and overall weight is calculated of all the parameters considered. In this way, Weightage Analysis is done.

Ground Water Potential Map

Ground Water Potential Map is a composite map of eight thematic maps namely-Geomorphology, Geology, Land use land cover, slope, soil, topographic wetness index, drainage density and Lineanment density. By combining these eight parameters we find out areas of very low, low, moderate, high, very high potential to find ground water which can be understand by combining the total effects of all eight parameters which are considered.



Conclusion

Assessment of groundwater potential is a vital step to use and manage water resources effectively and efficiently. In the present study Geographic Information System, Remote sensing Technology and Weightage Analysis assist in identifying ground water potential zones by integrating different thematic layers for instance geology, geomorphology, slope, soil, topography wetness index, drainage density, land use land cover and lineament density of Mewat district of Haryana, India. In conclusion, the result of the groundwater potential map can serve as a base for planners in water resource management and land use planning.

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