2024 ENGINEERING INSTITUTION OF ZAMBIA SYMPOSIUM AND ANNUAL GENERAL MEETING,

MAPPING GROUND POTENTIAL ZONES USING GEOSPATIAL TECHNIQUES IN KIFUBWA, SOLWEZI DISTRICT IN ZAMBIA.

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DATE : Friday 19th April 2024

Avani Victoria Falls Resort,
Livingstone, Zambia

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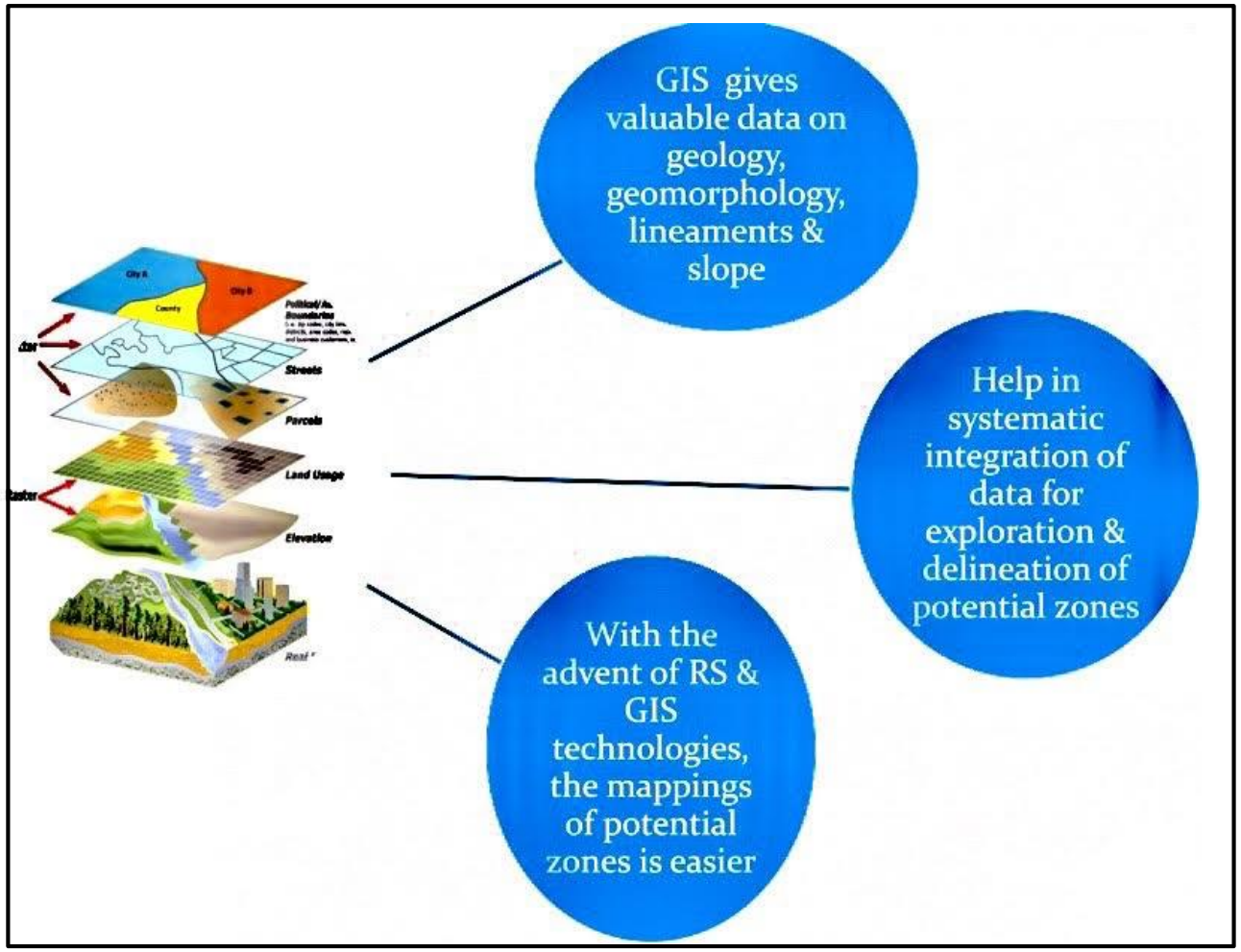
INTRODUCTION

INTRODUCTION

- Groundwater is a critical global water source.
- With over 2.5 billion people relying on it for various purposes.
- Water scarcity is a present-day reality.
- Affecting both developed and developing countries.
- Water stress conditions are increasing due to climate change
- And driving a shift towards groundwater use.

APPLICATIONS OF GIS & REMOTE SENSING

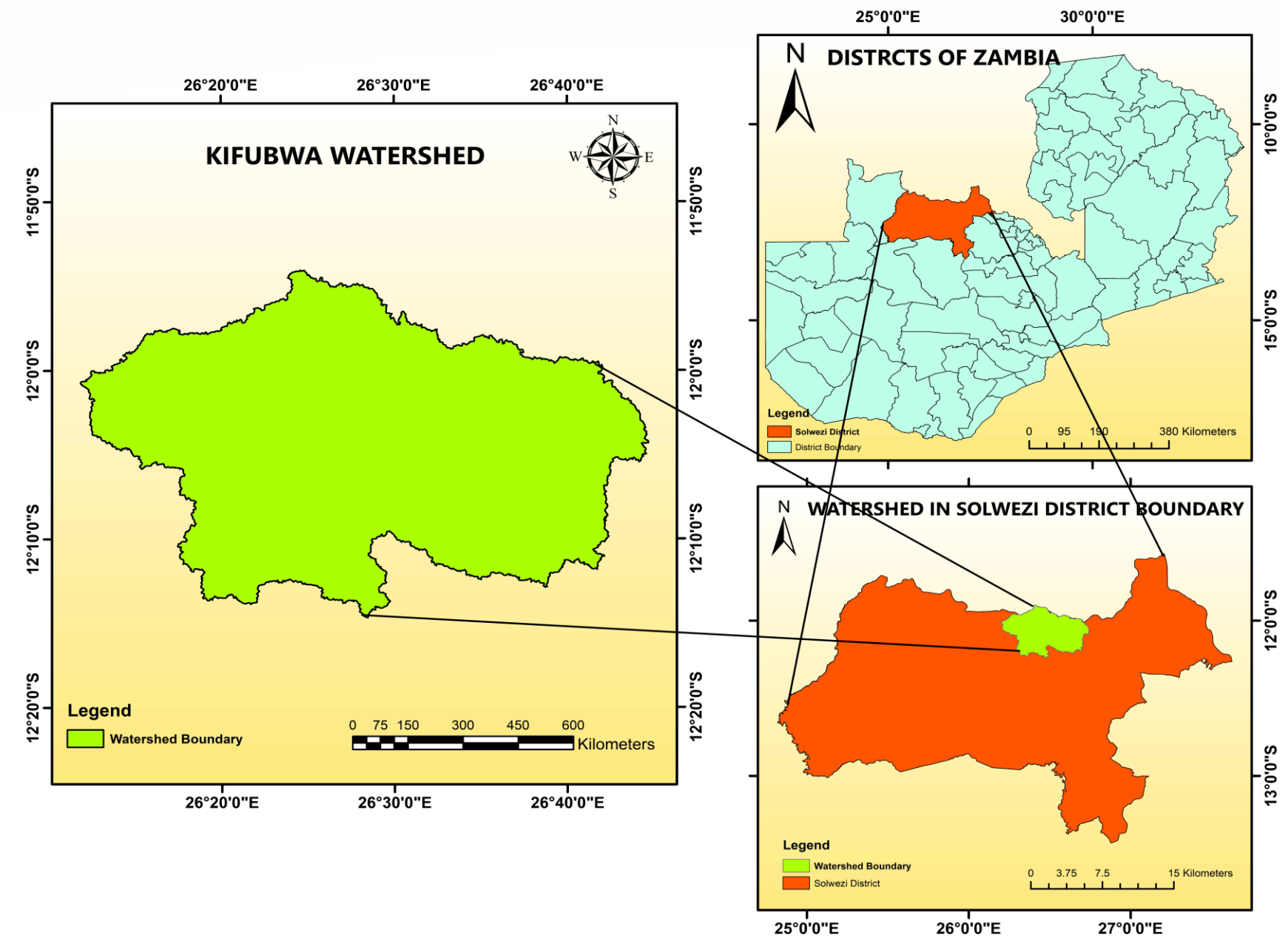


- GIS and Remote Sensing techniques have been increasingly used in groundwater potential mapping.
- Providing accurate and efficient methods for assessing and modeling groundwater sources.
- Integration of these techniques has been instrumental in delineating groundwater prospect zones
- To address water scarcity in different parts of the world.

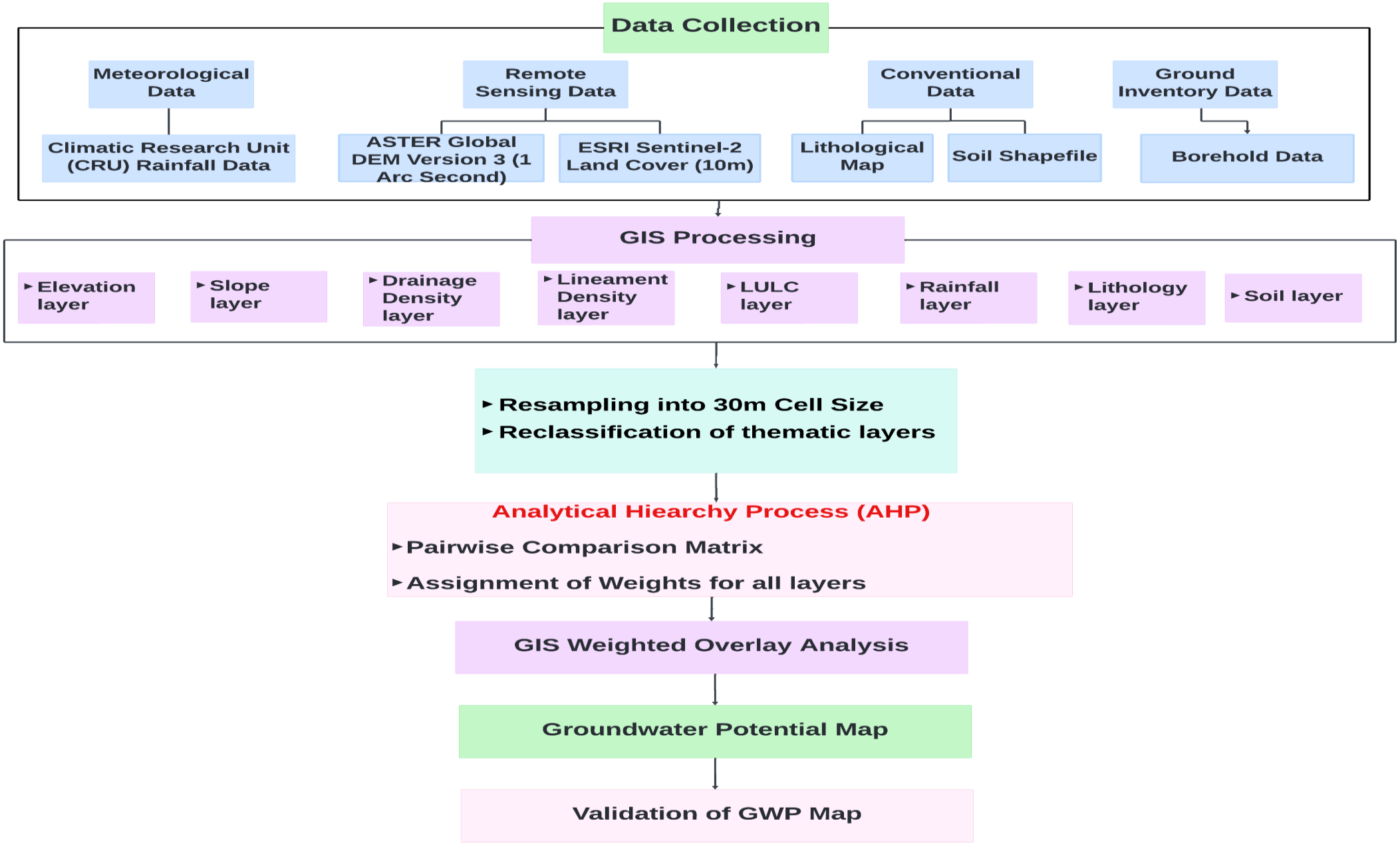
RELATED STUDIES

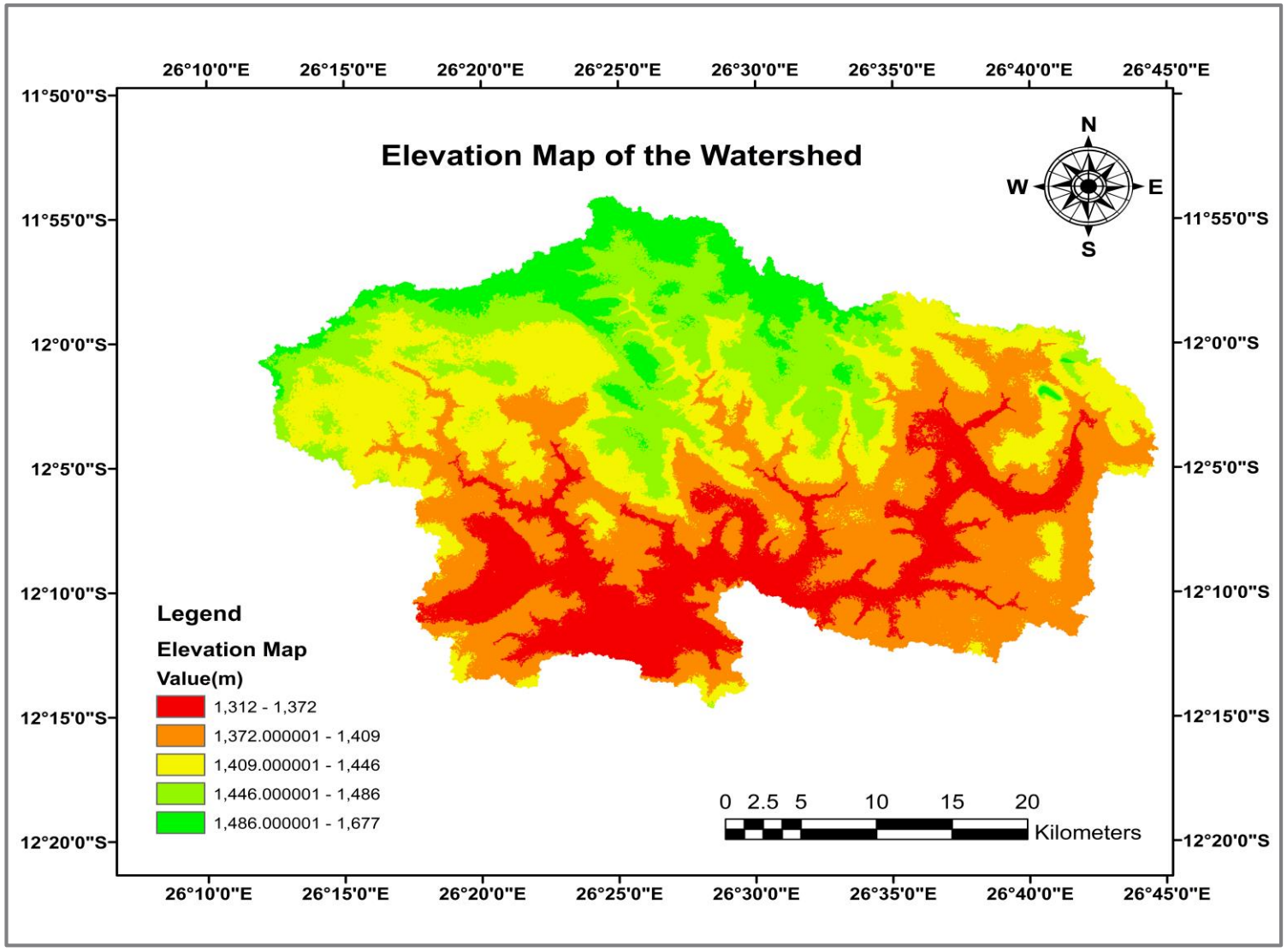
NO.	AUTHOR	METHODOLOGY	RESULTS
1	Ejepu, 2020	The study utilized publicly available datasets like geological, land-use, rainfall, soil maps, and SRTM DEM. These were digitized, georeferenced, and processed using GIS tools to assess groundwater potential zones through weighted overlay analysis.	The study integrated geospatial modeling and multicriteria decision analysis to delineate "very good," "good," "moderate," and "poor" groundwater potential zones, highlighting lithology, lineaments, and slope as key factors influencing groundwater flow and storage.
2	Kabeto *et* al., 2022	The methodology employed in the study included the use of Analytical Hierarchy Process (AHP) and weighted overlay analysis in GIS processing. used for preparing, normalizing, and fusing various groundwater-related factors, while the weighted overlay analysis was employed to delineate groundwater potential zones	Groundwater distribution in West Arsi Zone was classified into very high (2.47%), high (61.27%), moderate (35.46%), and low (0.79%) potential areas. The study achieved 87.61% agreement between the generated groundwater potential map and borehole yield data, confirming the accuracy of the assessment.

WATERSHED STUDY AREA



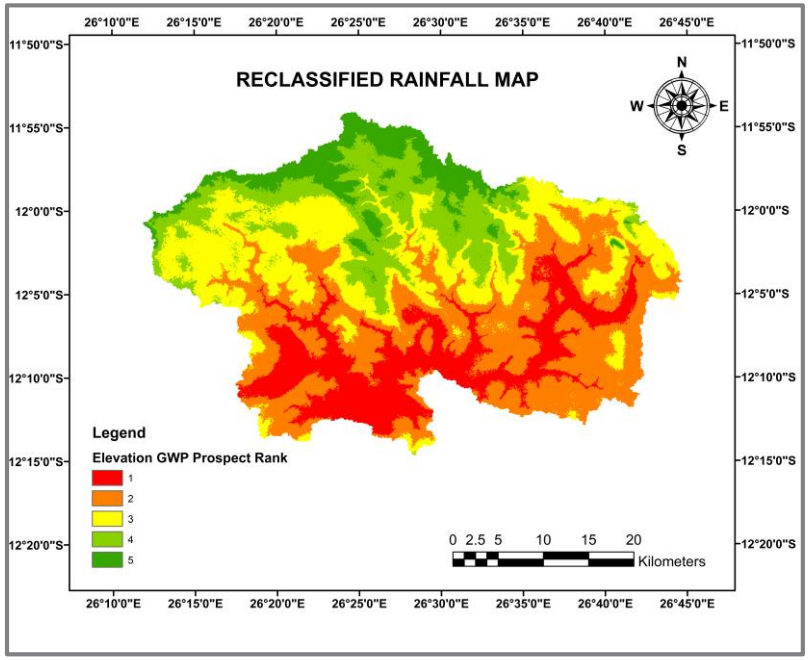
METHODOLOGICAL FLOW CHART

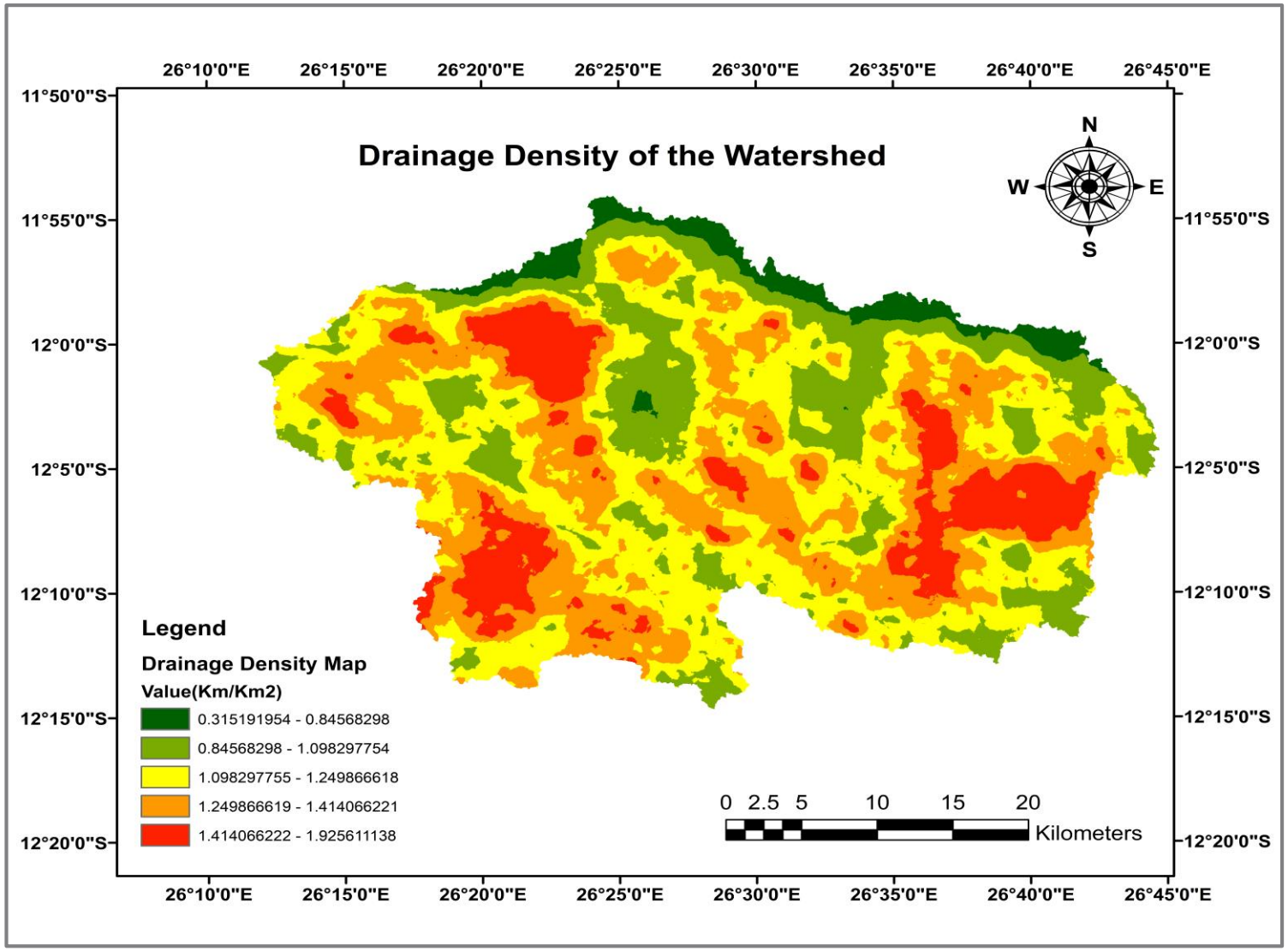




Elevation

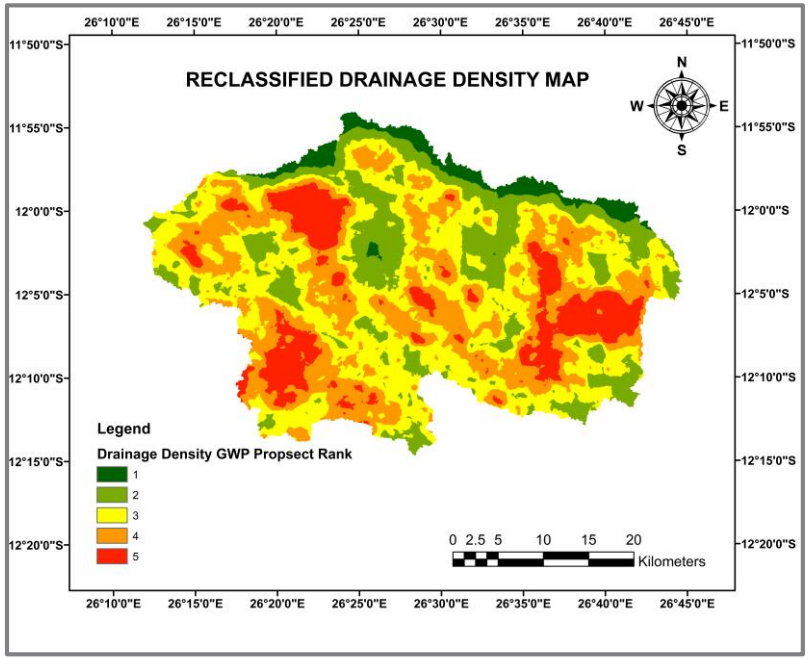
- Provides insights into the topographic characteristics.
- Higher elevations hinder recharge due to faster runoff.

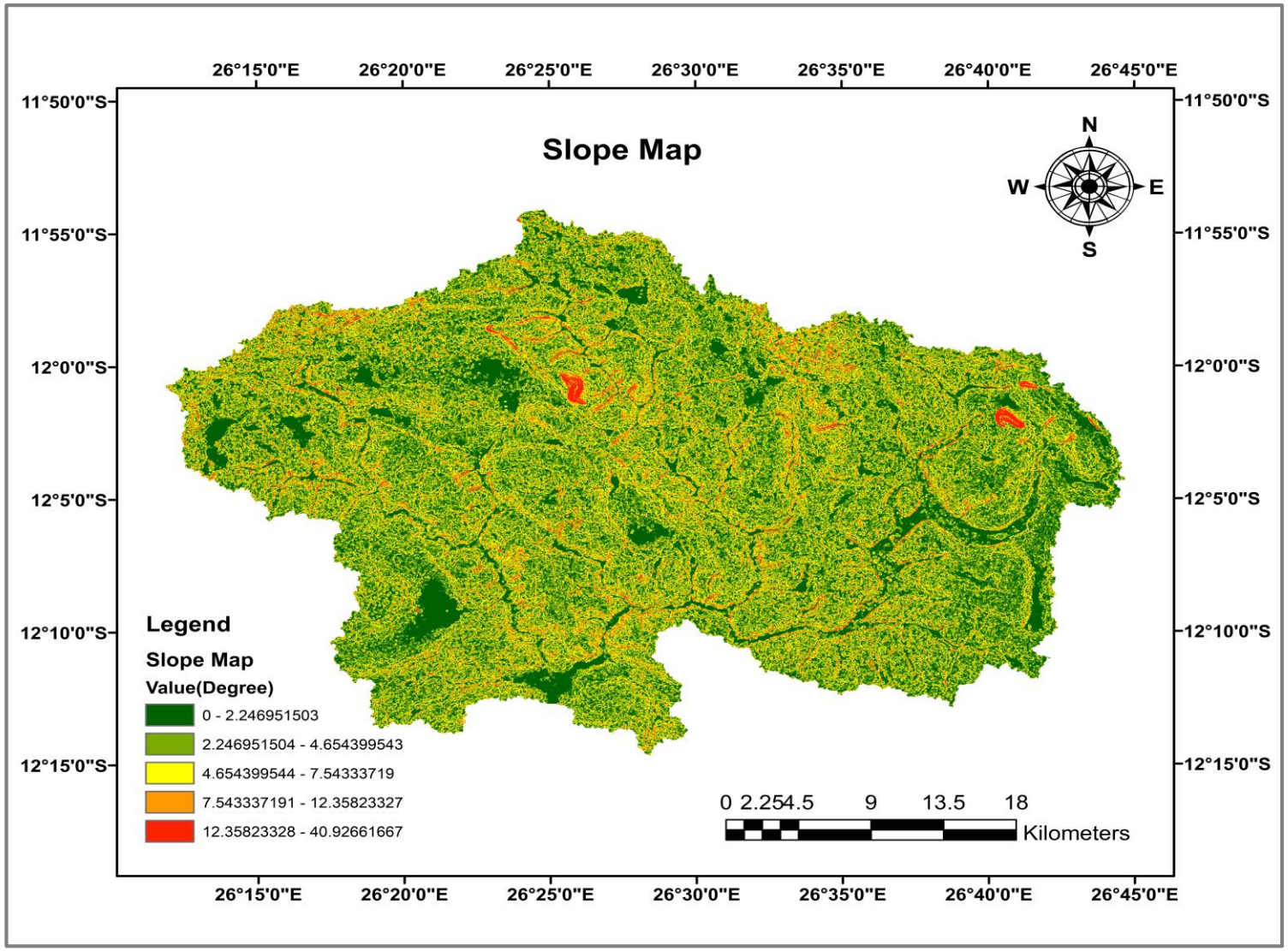




Drainage Density

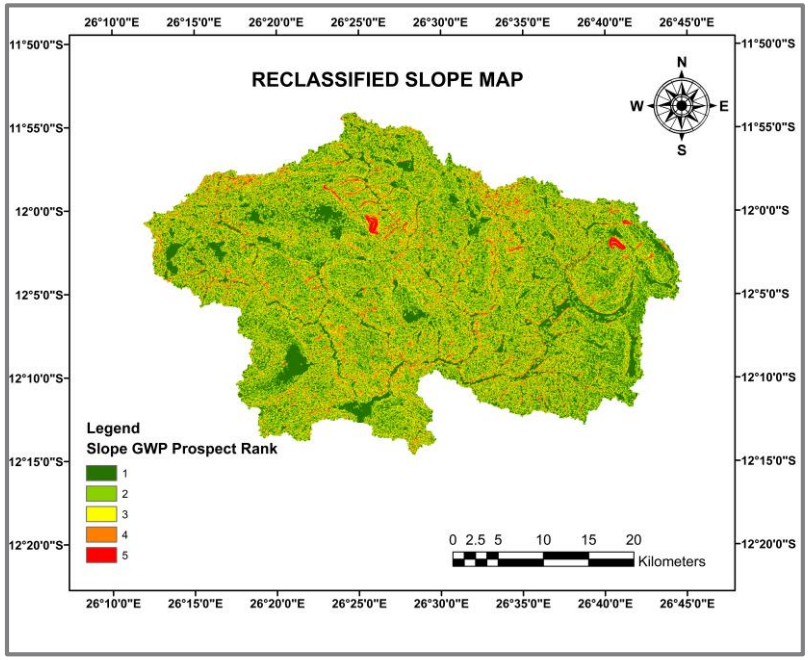
- Drainage density varies across regions impacting recharge.
- Drainage density inversely affects groundwater infiltration.

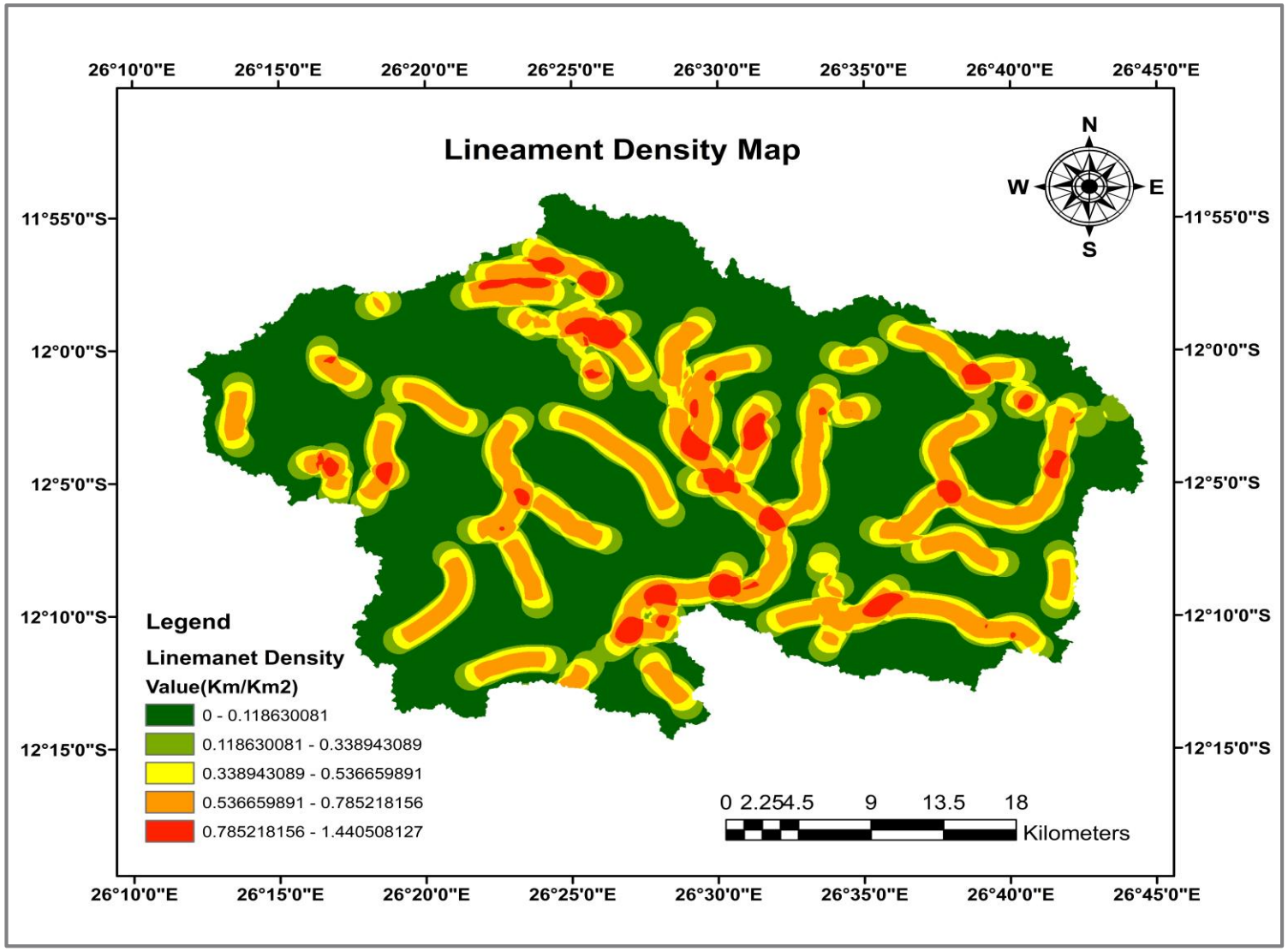




Slope

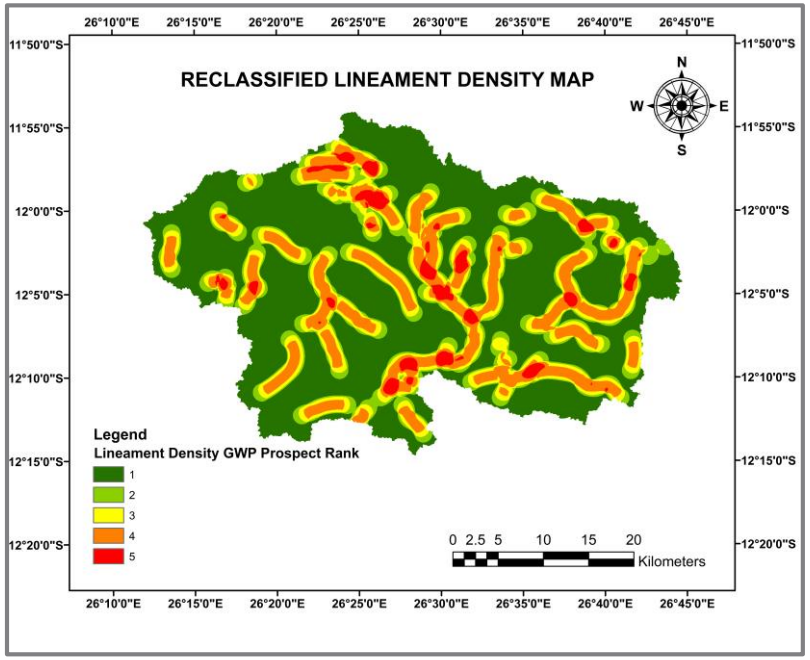
- High slopes reduce recharge due to rapid runoff.
- Gentle slopes enhance recharge with high infiltration rates.

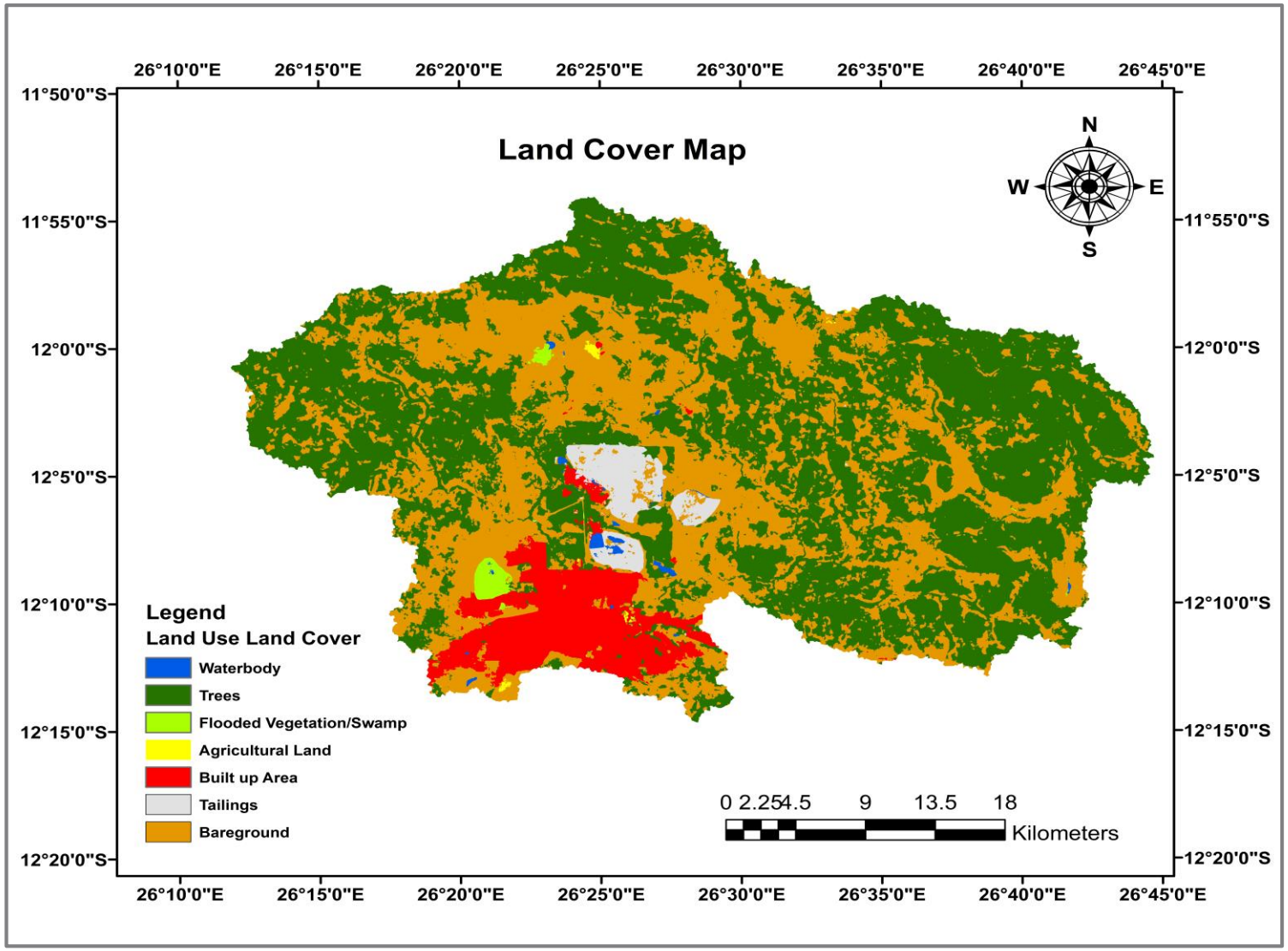




Lineament Density

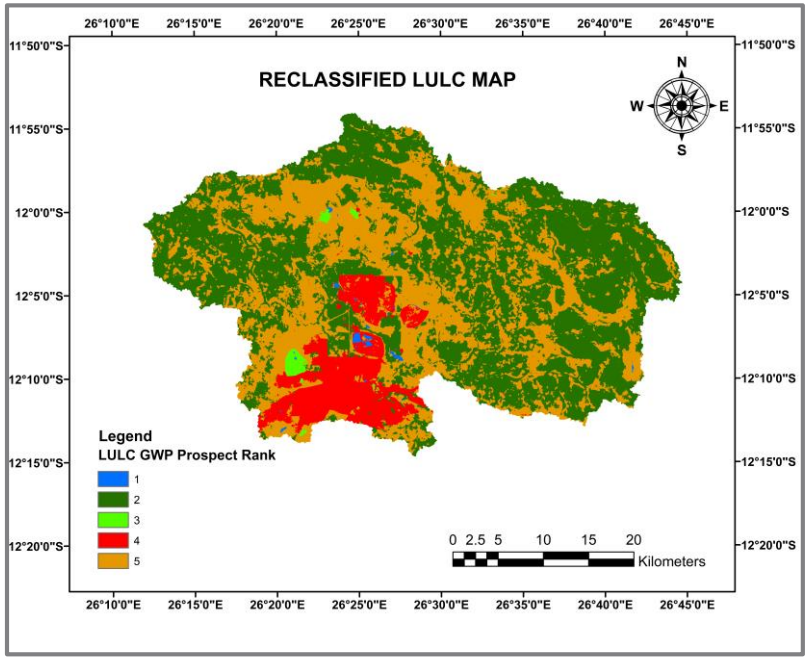
- Lineaments guide water flow paths underground.
- High lineament density indicates potential recharge zones.

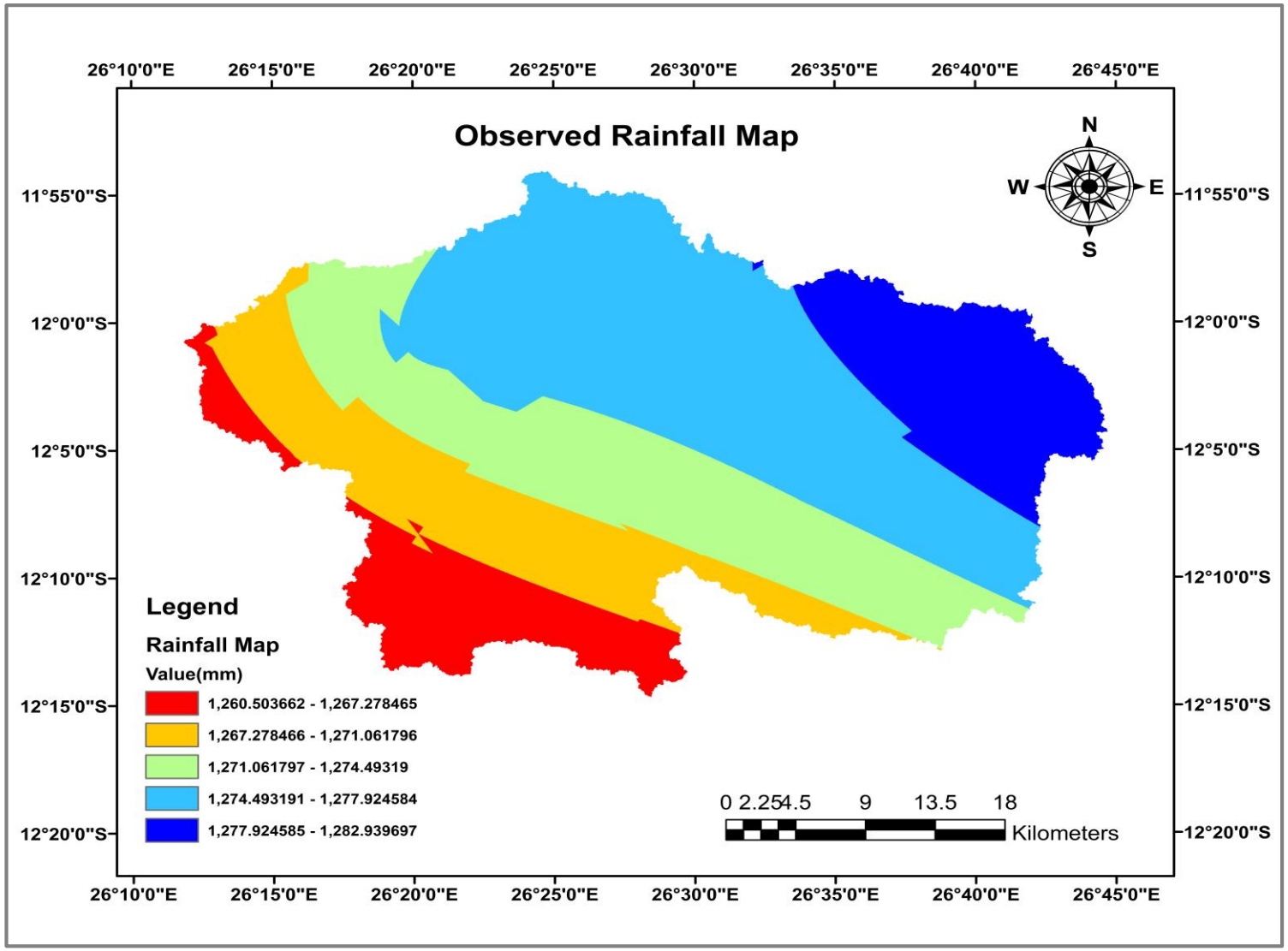




Land Use Land Cover

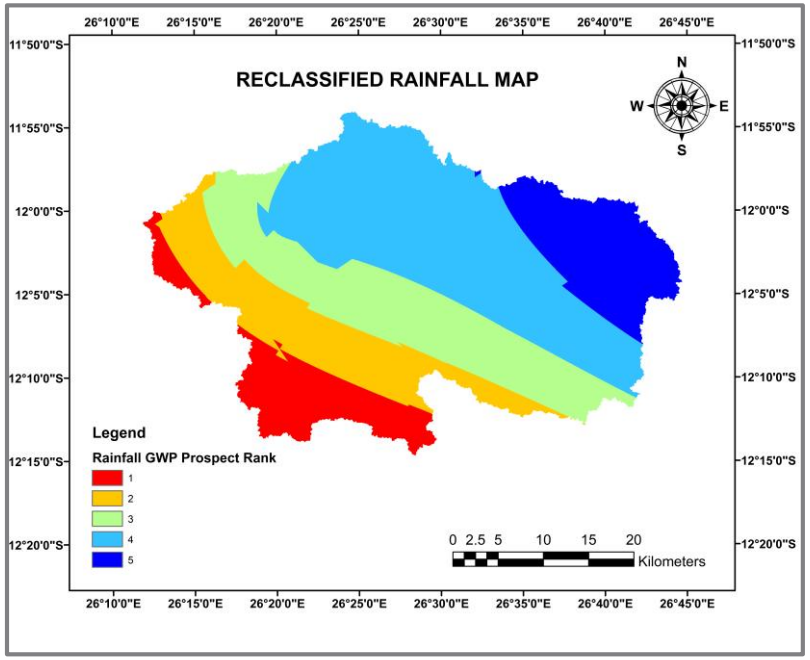
- Changes in land use impact groundwater recharge dynamics.
- E.g. vegetative cover removal enhances groundwater infiltration.

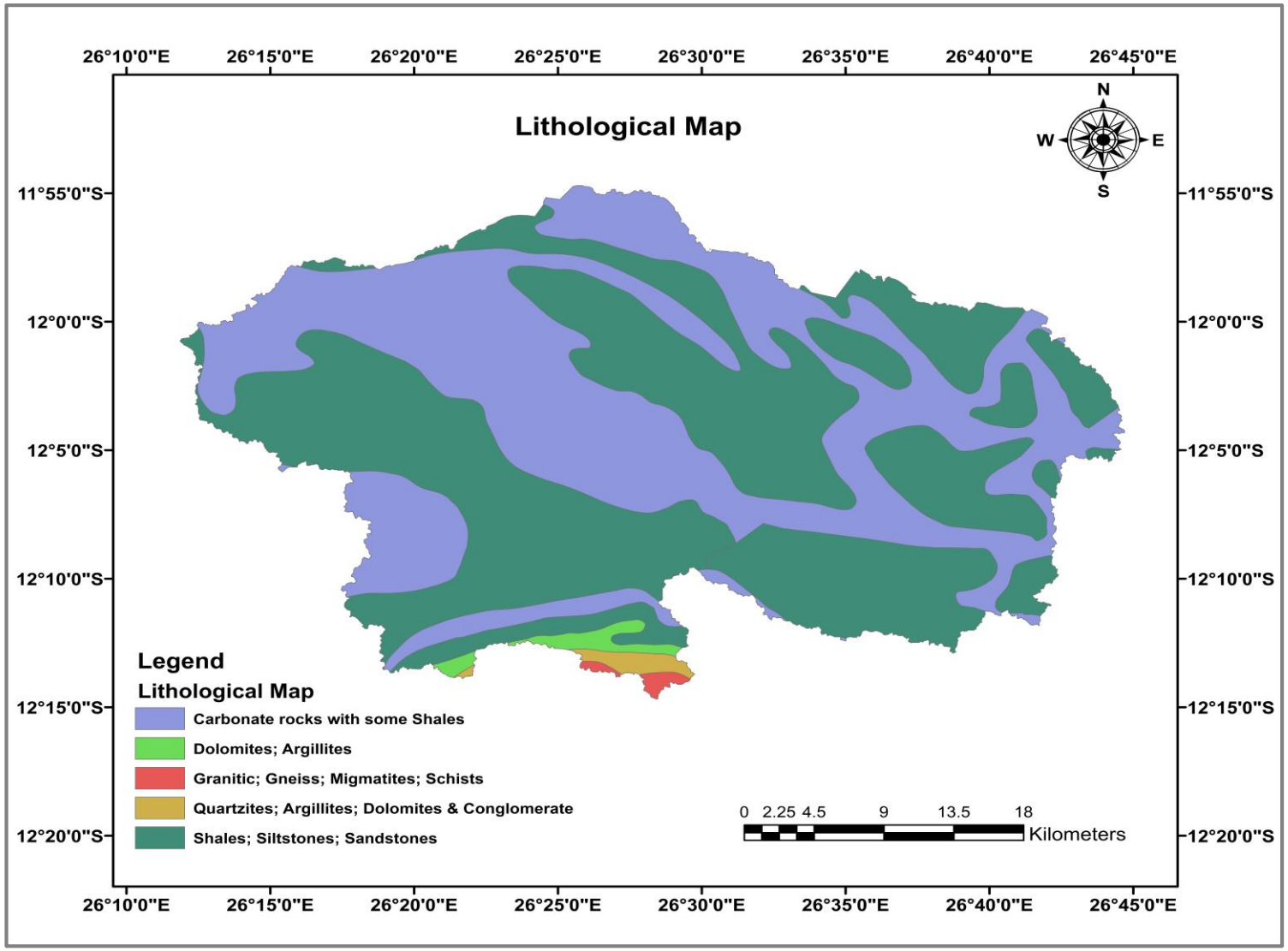




Rainfall

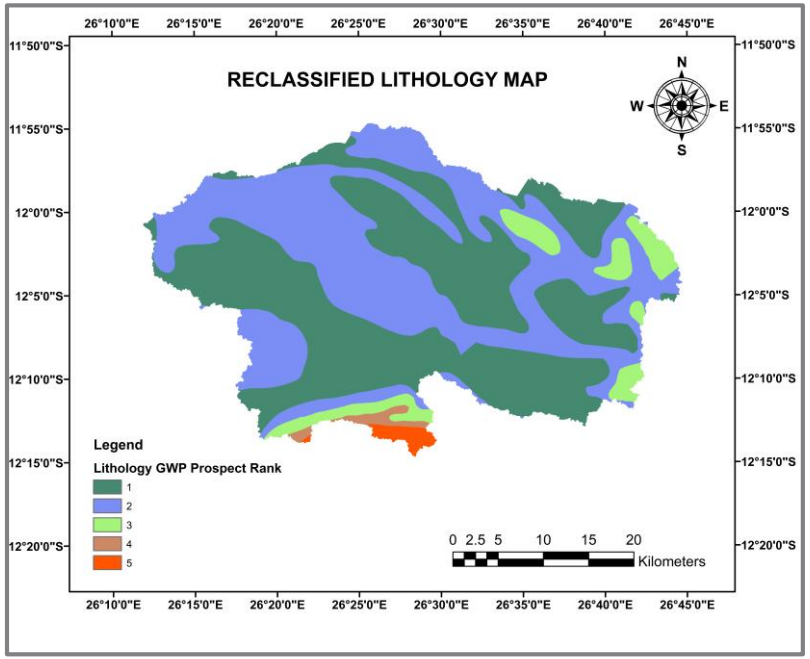
- Seasonal rainfall patterns impact groundwater replenishment.
- Rainfall distribution influences groundwater recharge dynamics.

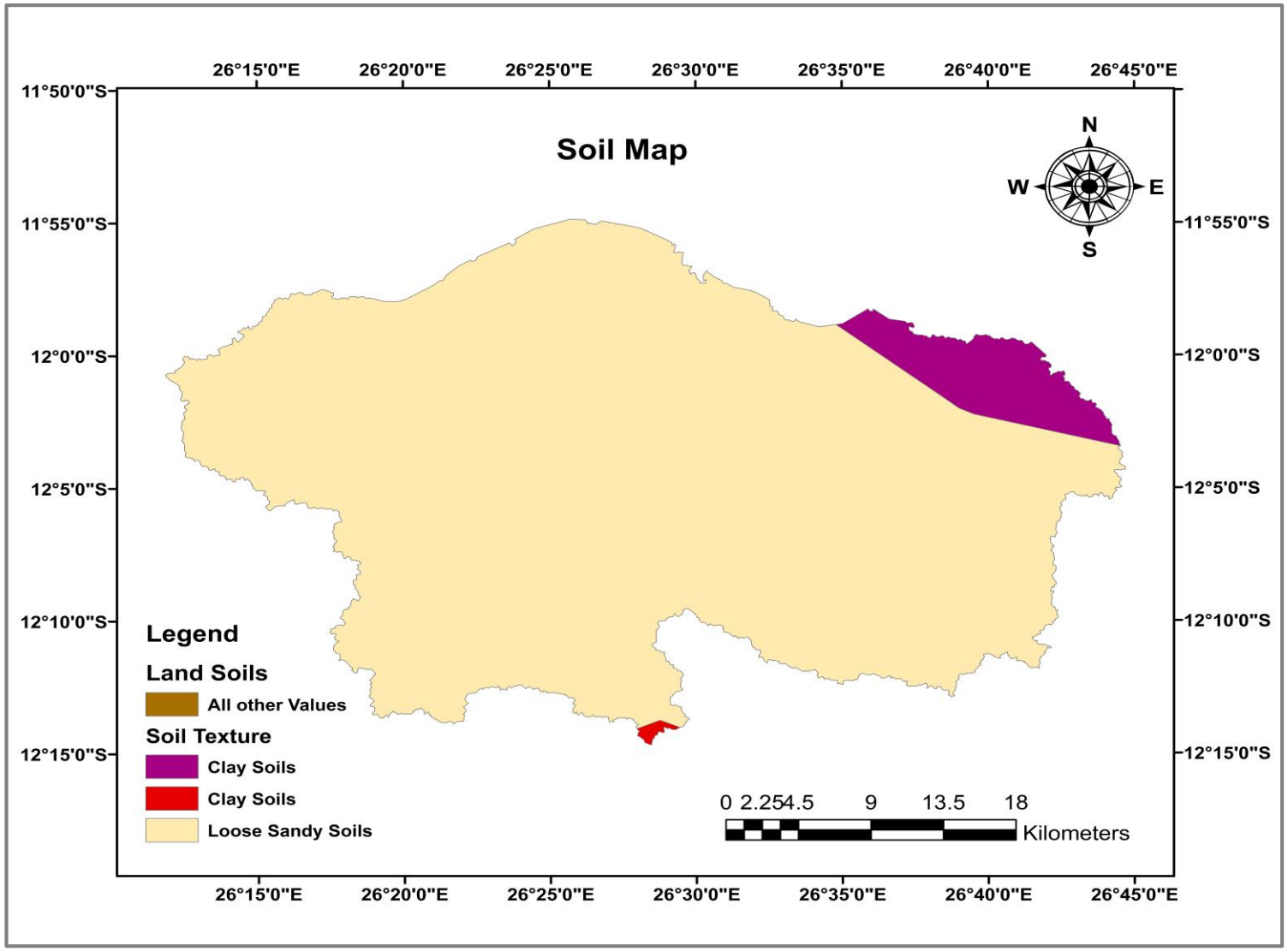




Lithology

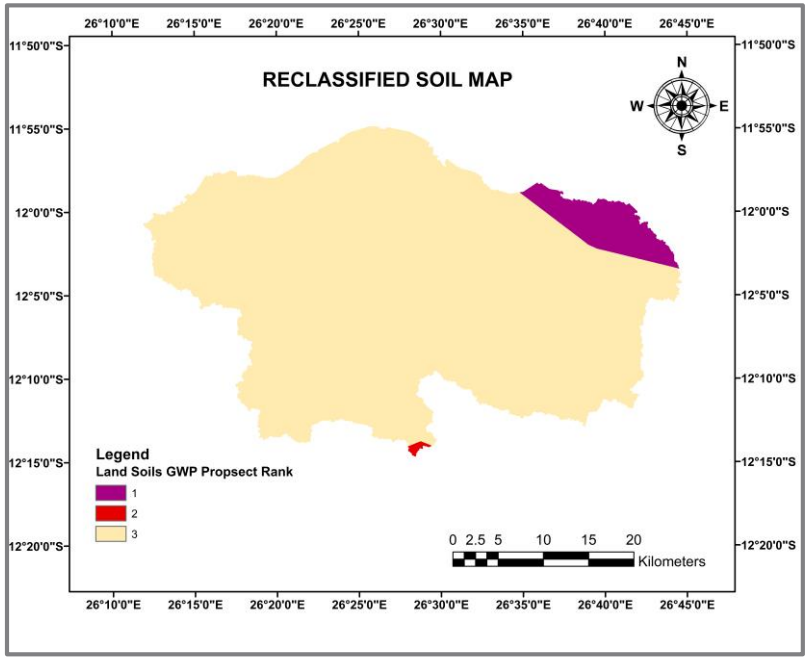
- Lithologic influences on recharge vary based on rock type and structure.
- Lithology affects recharge by controlling percolation and infiltration.



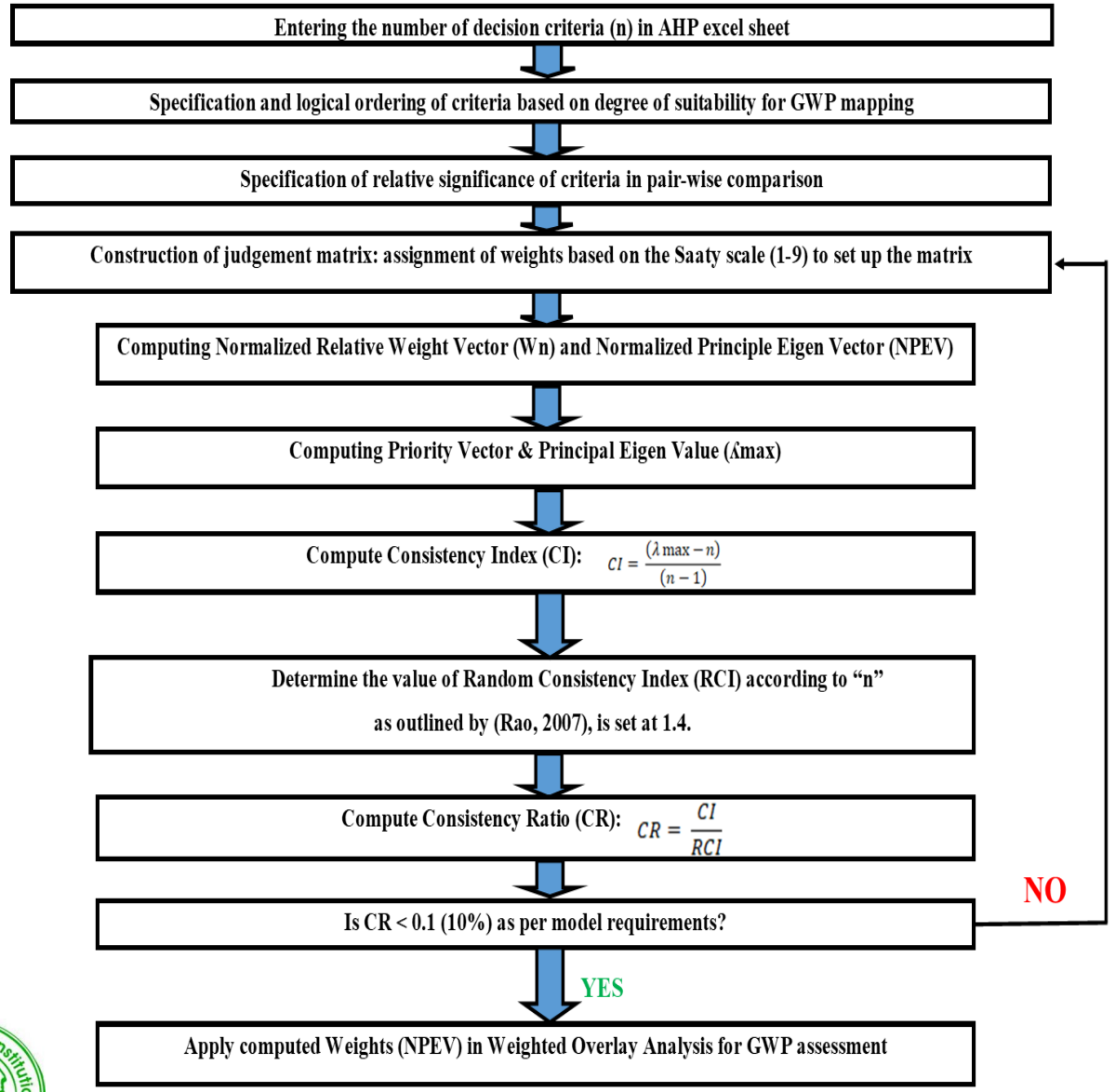


Soil

- Soil type influences the occurrence and distribution of recharge.
- Porosity and permeability of soil affect water movement underground.



ANALYTICAL HIEARCHY PROCESS (AHP)

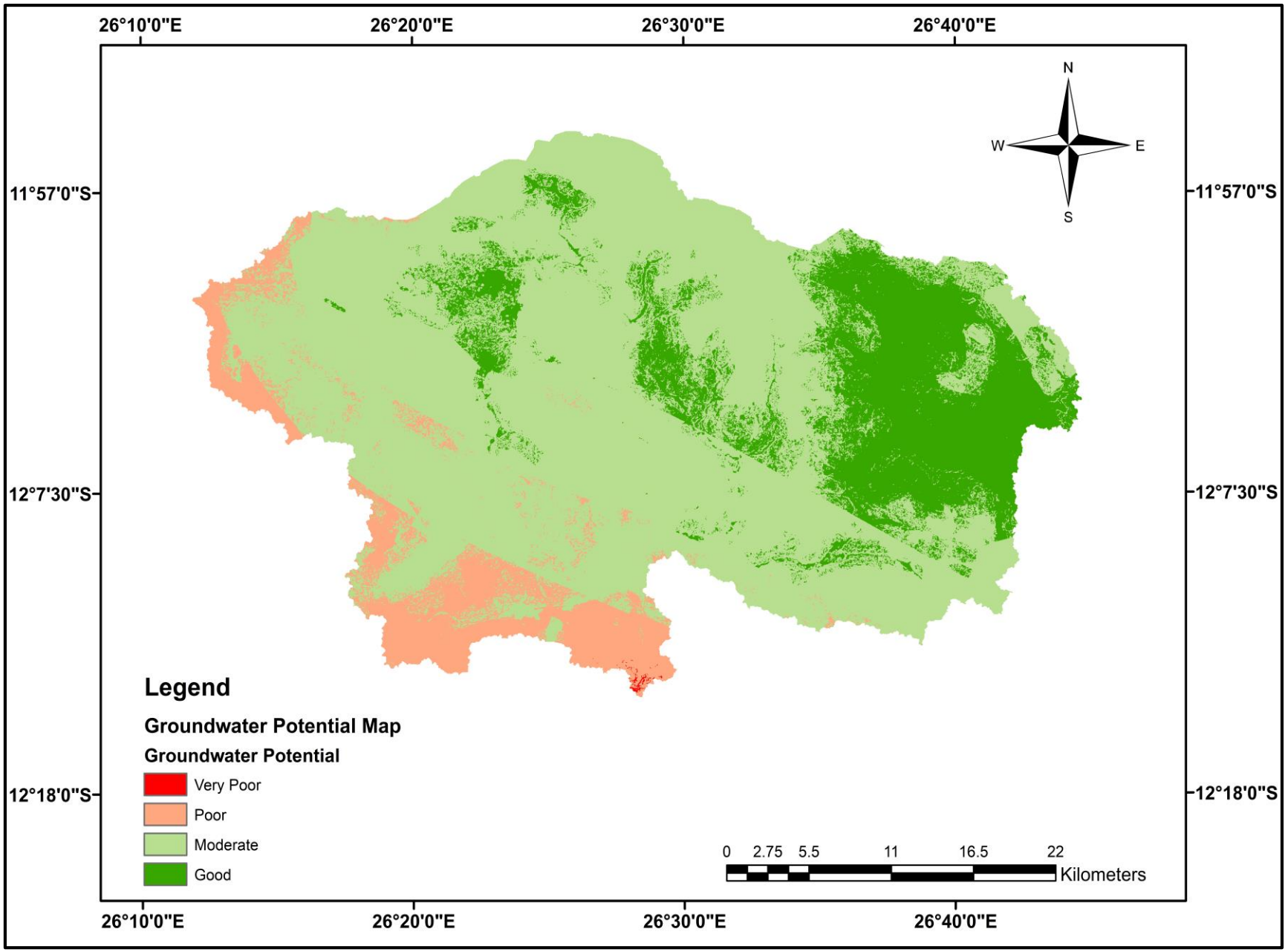


- AHP is a decision-making tool.
- It allows for the consideration of multiple factors.
- And considers factor significance in groundwater mapping.
- AHP enables the weighting of multiple factors for mapping accuracy.
- The consistency of the AHP model is ensured by validating the consistency ratio (CR).

COMPUTED NORMALIZED WEIGHTS

Factors	Rf	Lith	Sl	Dd	El	ST	LULC	Ld	Weight
Rf	1	3	5	5	5	7	3	4	34.93%
Lith	1/3	1	3	3	5	5	5	4	22.27%
Sl	1/5	1/3	1	2	1	5	3	1	10.09%
Dd	1/5	1/3	1/2	1	3	4	3	2	10.50%
El	1/5	1/5	1	1/3	1	5	3	1	7.74%
ST	1/7	1/5	1/5	1/4	1/5	1	1	1/3	2.90%
LULC	1/3	1/5	1/3	1/3	1/3	1	1	1	4.54%
Ld	1/4	1/4	1	½	1	3	1	1	6.57%
Sum	2.7	5.5	12.03	12.42	16.53	31	20	14.33	
Total									100%

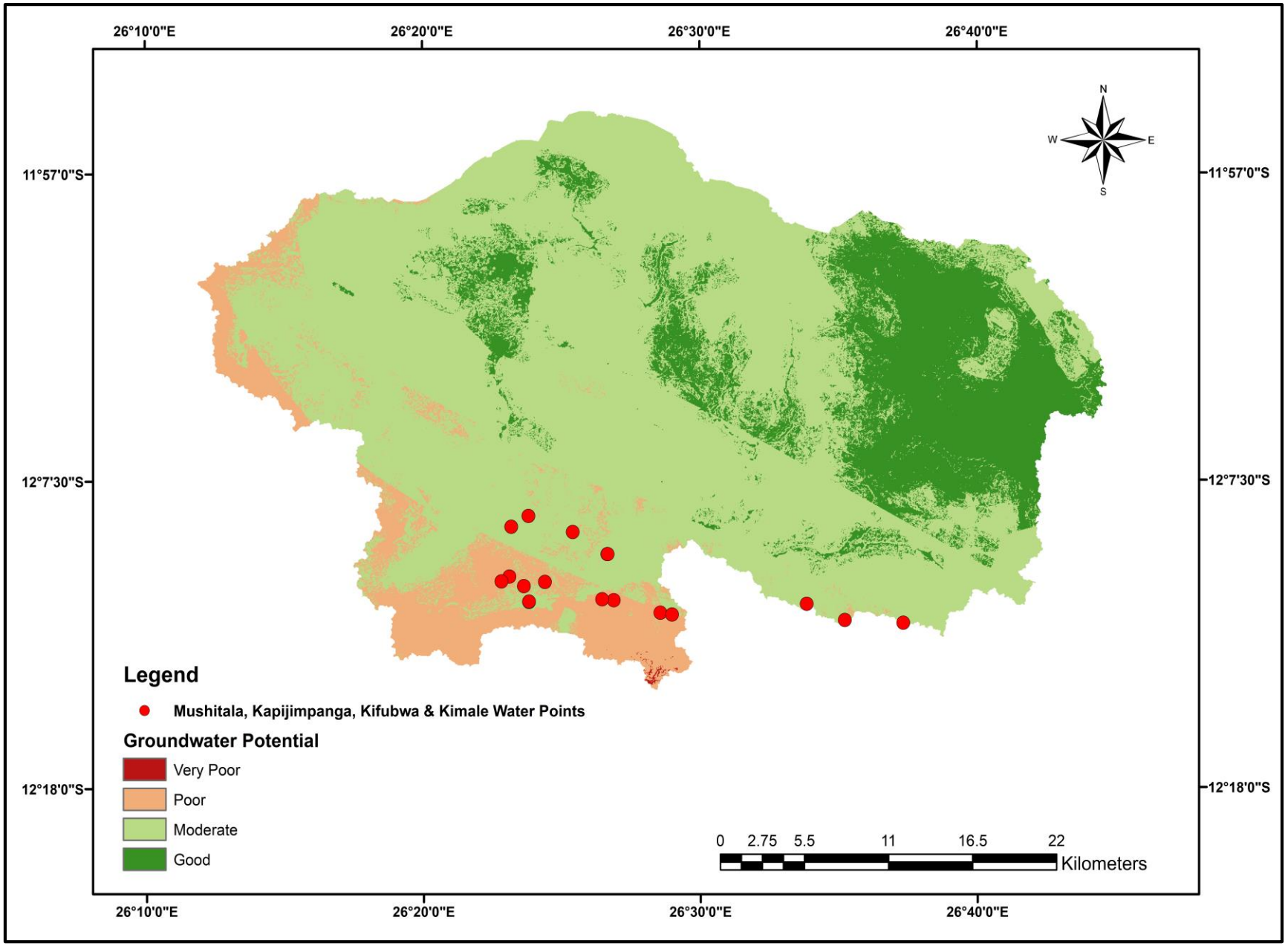
GROUNDWATER POTENTIAL MAP



BOREHOLE DATA

NO	SITE NAME	Depth (m)	SWL (m)	CASING LENGTH		YIELD (L/sec)
				Plain (m)	Screen (m)	
1	Zambia Army	70.00	3.50	46.00	24.00	1.5
2	Mushitala Clinic	50.00	3.50	26.00	24.00	1.50
3	DCs Residence	17.00	1.00	5.00	12.00	2.50
4	Rodwel Mwepu school	70.00	4.20	40.00	30.00	1.50
5	Kyawama school	55.00	3.30	37.00	18.00	3.50
6	Kampitubwanga village	50.00	6.55	26.00	24.00	2.00
7	Kakombe Community	50.00	12.50	26.00	24.00	0.50
8	Kakombe clinic	60.00	15.00	30.00	30.00	0.50
9	Dowson community	55.00	3.50	25.00	30.00	2.00
10	Kimasala Clinic	75.00	2.10	45.00	30.00	0.75
11	Correctional service	60.00	3.20	30.00	30.00	1.50
12	Solwezi Mortuary	70.00	14.00	40.00	30.00	0.80
13	Private	55.00	3.00	31.00	24.00	1.0
14	Private	60.00	19.60	48.00	12.00	1.0
15	Private	47.00	8.00	29.00	18.00	1.50
16	Private	66.00				
17	Private	55.00	6.00	31.00	24.00	2.50
18	Private	66.00	18.00	42.00	24.00	1.00
19	Private	55.00	15.00	31.00	24.00	0.75
20	Private	55.00	17.00	31.00	24.00	2.00
21	Private	55.00	20.00	25.00	30.00	1.00
22	Private	70.00	3.00			0.20
23	Private	55.00	3.00			0.20
24	Private	55.00	0.75			0.25

GROUNDWATER POTENTIAL MAP WITH BOREHOLE POINTS



CONCLUSION

- Weighted overlay analysis classifies groundwater potential into distinct categories.
- Borehole data validates mapped groundwater potential zones effectively.
- Classification system defines poor to good potential based on yields.
- Correlation between mapped zones and field conditions is evident.
- Achieved 79.2% agreement, delineating zones with varying potential.

CONCLUSION

- Groundwater potential influenced by multiple factors.
- Eastern part of the watershed exhibits good potential.
- Contrasting with a small portion of very poor potential in the south.
- Low drainage density, gentle slopes, and low lineament density favorable for groundwater recharge.
- GIS, Remote Sensing, and AHP tool practical for groundwater potential assessment in a watershed.

END OF PRESENTATION

THANK YOU!