Ground Water Prospect Mapping with the support of Geo-Spatial Technology- A case study of Pampawa Watershed Jhabua District Madhya Pradesh, India

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In a semi-arid country like India, surface water is not available throughout the year for various purposes. Due to insufficient surface water resource, most of the requirements for irrigation, industry and domestic purposes are being met from groundwater. It is therefore essential to ensure the availability of groundwater throughout the year **(Rajaveni, S. P. at el, 2015)**.

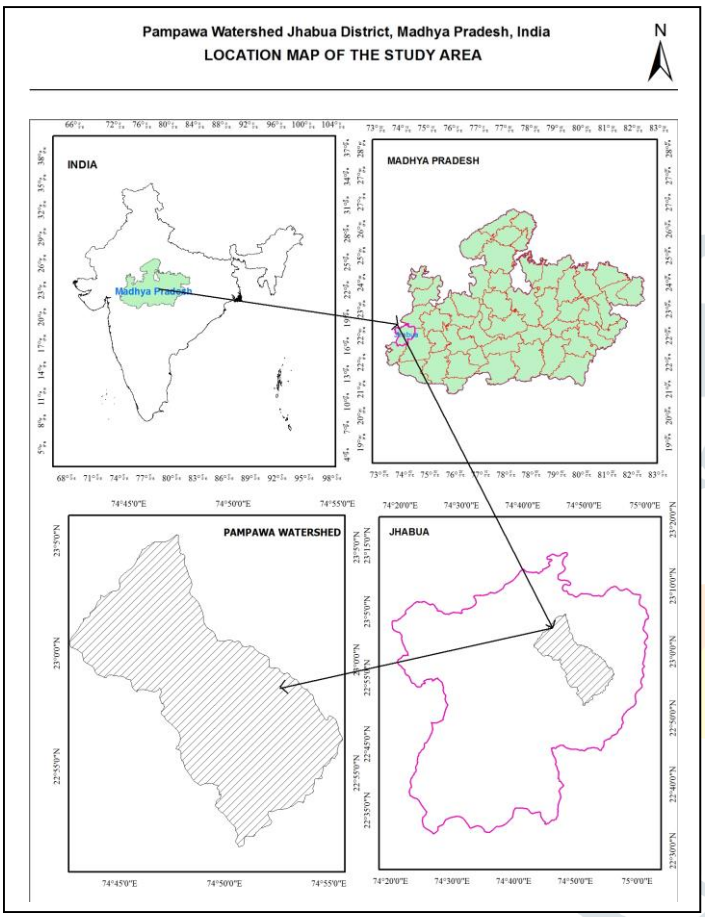
Groundwater is an important natural resource for the sustenance of both rural and urban population as well as all the flora and fauna. Groundwater is a vital fresh water resource and it contributes maximum of the total annual water supply for use. That is why an assessment of this valuable resource is extremely significant for the sustainable utilization and proper management of groundwater resources. GIS and remote sensing tools are widely used for the management of various natural resources **(Dar et al., 2010)** . Delineating the potential groundwater zones using remote sensing and GIS is an effective tool. In recent years, extensive use of satellite data along with conventional maps and rectified ground truth data has made it easier to establish the base line information for groundwater potential zones **(Tiwari and Rai, 1996)**.

Rapid population growth combined with increasing demand of water from multiple sectors such as municipal, agricultural, industries, and tourism becomes a major issue in the country, particularly in city **(Aurecon Ausralia 2012).** The population is continuously increasing in Pampawa Watershed therefore the water sources are not enough for the future utilization. Groundwater is the most needed resource for the existence of population. If the presence of groundwater in the area continues to remain at a desirable level then there would be no need to manage other resources, as they will be naturally sustained.

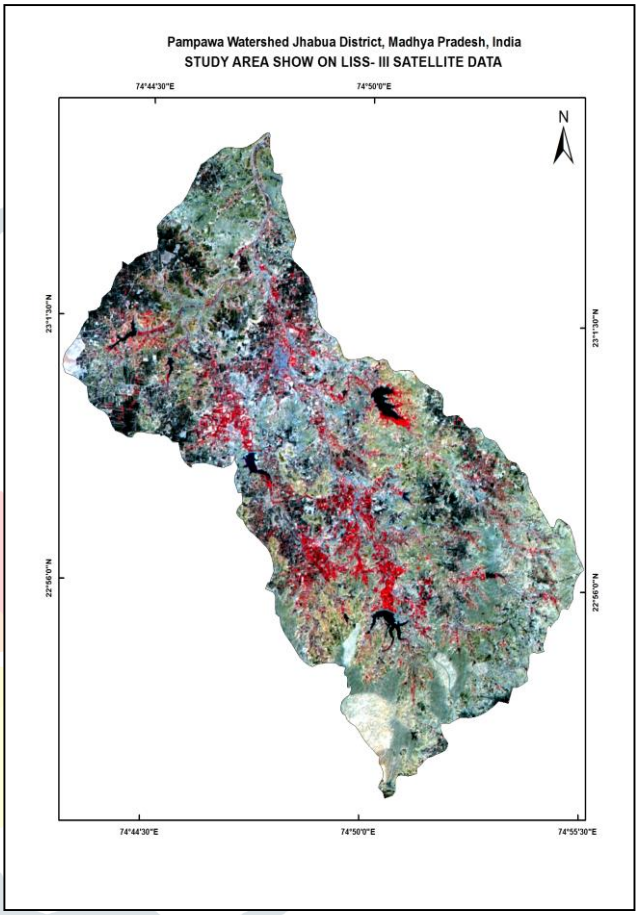
Study Area

The study area is Pampawa Watershed which is located in Petlawad tehsil of Jhabua district of Madhya Pradesh state, India. Pampawa Watershed located between Longitude 74°42'10.361" to 74°55'18.536"E and Latitude 22°51'24.406"N to 23°5'17.836" with covered an area 233.1178 Sq/km. The study area extends from North to South covering 25.5 km and east to West covering 22.5 km with covering of Survey of India toposheets No. 46J/13, 46J/9, 46I/16 and 46I/12. The study area is located to in the north and eastern part of Jhabua district, Jhabua district lies on the south-west corner of Madhya Pradesh. It is bounded by Alirajpur District of Madhya Pradesh on south, Dahod District of Gujrat in west, Ratlam District in north and Dhar district of Madhya Pradesh in east. Jhabua is one of the tribal dominated District of Madhya Pradesh. It's covered an area of 3596.00 Sq/km.

The northern and eastern boundaries of the study area are well defined by the rivers. The Mahi flows along the eastern boundary separating from Ratlam and Dhar District of Madhya Pradesh. Location Map of the study area is given in Map1 and Study area shown on Satellite data on Map2.



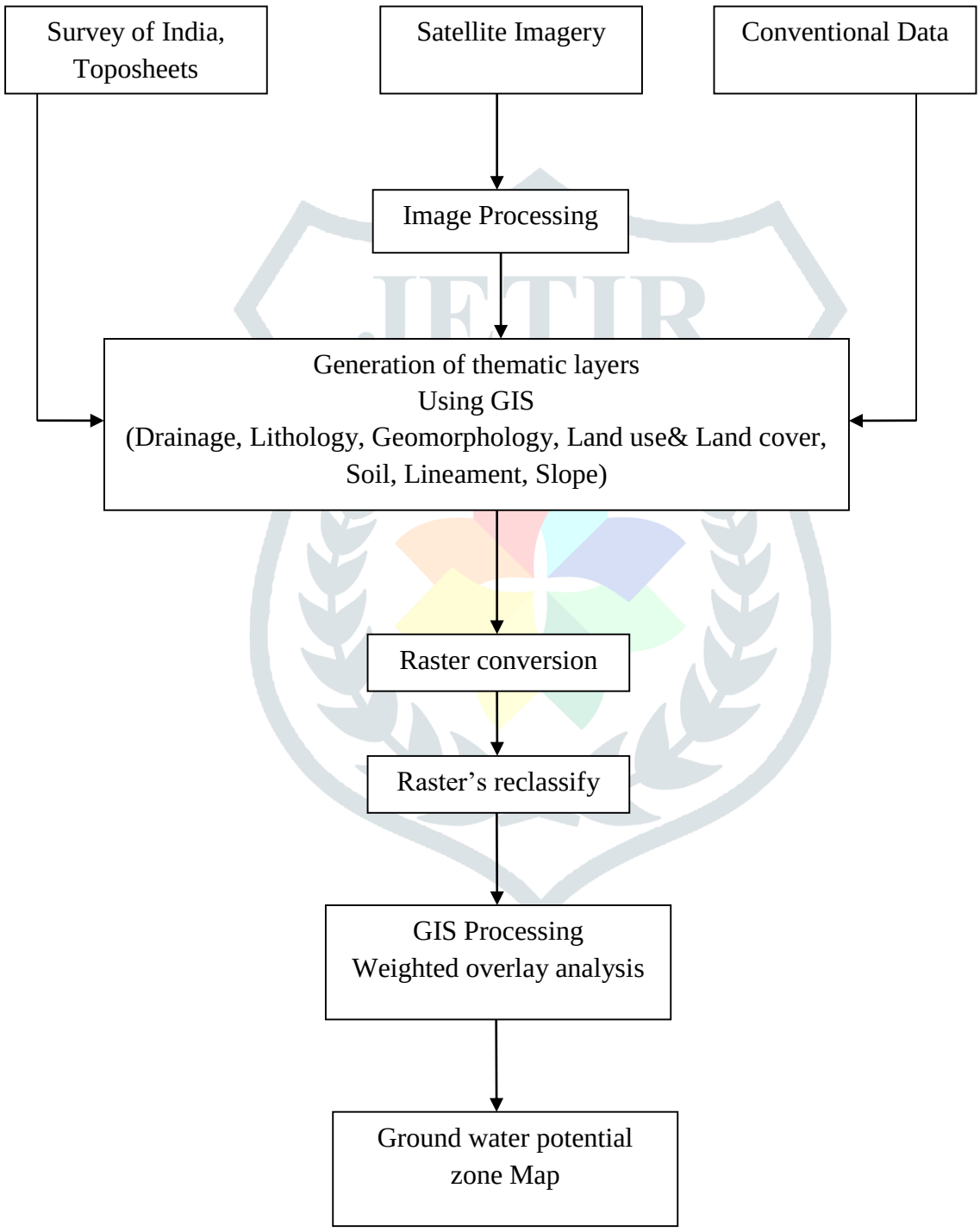
Map1 Location map of the study area



Map2 Study area shown on Satellite image

Methodology: - The Survey of India toposheets and satellite data are used for database creation purpose. Drainage has been digitized using toposheets on 1:50,000 scale. Geology, Geomorphology, Lineament, Landuse & land cover layers are generated using Satellite data (LISS-III) and slope is created using DEM with spatial resolution 30 m. After generating all these layers, raster data was created with the help of Arc GIS 10 software. For assigning the weightages the raster data was reclassified. On achieving the assigned weightages, Weightage overlay analysis was performed using Spatial Analysis tool. Thus, at the end Ground Water

Prospect Zone was obtained.



Flow chart of Ground water potential zone

Spatial Analysis: - Seven influencing factors, such as Geomorphology, Lithology, Land use & land cover, Soil, Drainage density and Lineament density have been identified to delineate the groundwater potential zones.

Ranks and weightages of parameters of Groundwater recharge potential zone			
LAYERS	**THEME WEIGHTAGE**	**DOMEN OF EFFECTS**	**LAYER WEIGHTAGE**
GEOMORPHOLOGY	10	Pediment	5
		Pediplan	7
		Plateau	3
		Waterbody	9
LAYERS		CLASS	LAYER WEIGHTAGE
LAND USE & LAND COVER	15	Agriculture	8
		Built-up	4
		Forest	6
		Wasteland	5
		Waterbody	9
LAYERS		CLASS	LAYER WEIGHTAGE
SOIL	15	Loamy	6
		Clay	7
		Fine	8
		Clayey	5
		ClayeySkeletal	4
		LoamySkeletal	3
		Laomy	2
LAYERS		CLASS	LAYER WEIGHTAGE
LITHOLOGY	15	Indore Formaion	
		Kakariya pirukheri Formation	
		Kalishingh formation	
LAYERS		CLASS	LAYER WEIGHTAGE
SLOPE	15	0-1	8
		1-3	8
		3-5	6
		5-10	4
		10-15	3
		15-35	1
LAYERS		CLASS	LAYER WEIGHTAGE
DRAINAGE DENSITY	10	Very low	3
		Low	4
		Moderate	8
		High	2
		Very High	1
LAYERS		CLASS	LAYER WEIGHTAGE
LINEAMENT DENSITY	20	Very low	1
		Low	3
		Moderate	5
		High	6
		Very High	8

Table: - 1

The process of study of locations of geographic phenomena together with their dimensions and attributes, classification, polygon classification, rank and weightage assignment to individual class and feature class respectively, is significant and important. The various thematic maps, such as geomorphology, soil, slope and land use land cover map, Drainage density and lineament density have been prepared and duly assigned ranks for individual class and weightage to each theme depending upon its influence on groundwater occurrence and movement and also more importantly infiltration and runoff. For example slope plays prominent role in runoff process; as the slope is steeper more is the runoff. Similar is the case of geomorphology, which causes more holding capacity for groundwater than other factors once infiltration takes place. Further identification of groundwater recharge potential zones has been carried out with the prior knowledge of ranks and weightages assigned to the various features or themes . The thematic maps of (i) Slope, (ii) Geomorphology, (iii) Land Use and Land Cover, (iv) Soil, (v) Drainage density and (vi) Lineament density **(Patel, at el, 2014)** . Detail rank and weightages parameter shown in table 1.

Thematic layers: - These are seven thematic layers have been used for the mapping of Groundwater potential zone. Each layer has an important weightages on itself with their water holding capacity. Lithology and Geomorphology both are played significance roles to identify groundwater sites.

Lithology; - Pampawa watershed has 3 kinds of Stratigraphical setup which belongs to Lower Eocene to Upper Cretaceous Period. These Units are from the Deccan Trap Division. The lithology of these units is as follows:- First Stratigraphic Type is the Kalisindh Formation which has eleven highly vesicular compound pahoehoe lava. Second Stratigraphic Type belongs to Kankariya Pirukheri Formation which has six compound pahoehoe lava. The last one is Indore formation which has four compound pahoehoe lava **(DRM, GSI).** Shown on Map3.

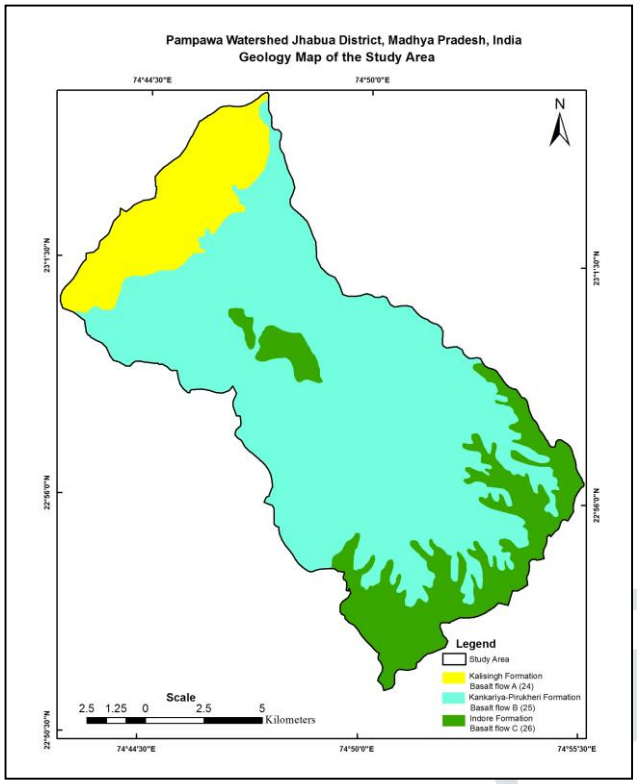
Geomorphology: - Geomorphology played a vital role in the formation of soil which has resulted from the physical and chemical weathering of the parent rock. Black cotton soil has been derived from the parent basaltic rock under semi-arid conditions. The soil of the pediplains comprises of largely the black soils derived from the Deccan trap and the red yellow lateritic soils derived from the granites, genisses etc. Pediments generally are not favorable for groundwater potential zones **(Verstappen, 1983)**. These two kinds of soils are found interspersed everywhere in the district. Shown in Map4.

Landuse & Landcover: - Land use is the area of land under utilization for various anthropogenic activities, while land cover means the coverage of natural features on land. The land use and land cover of the area under study has been done with the help of LISS III satellite image on 1: 50,000 scale using visual interpretation, unsupervised classification, and supervised classification. The land use classification is done according to NRSA, Hyderabad guidelines. For taking out the seasonal variation Kharif, Rabi and Zaid season's satellite data was used. Major landuse/Landcover classes identified in the study area are Built-up land, Agricultural Land, Wasteland, Forestland and Water body. Shown in Map 6.

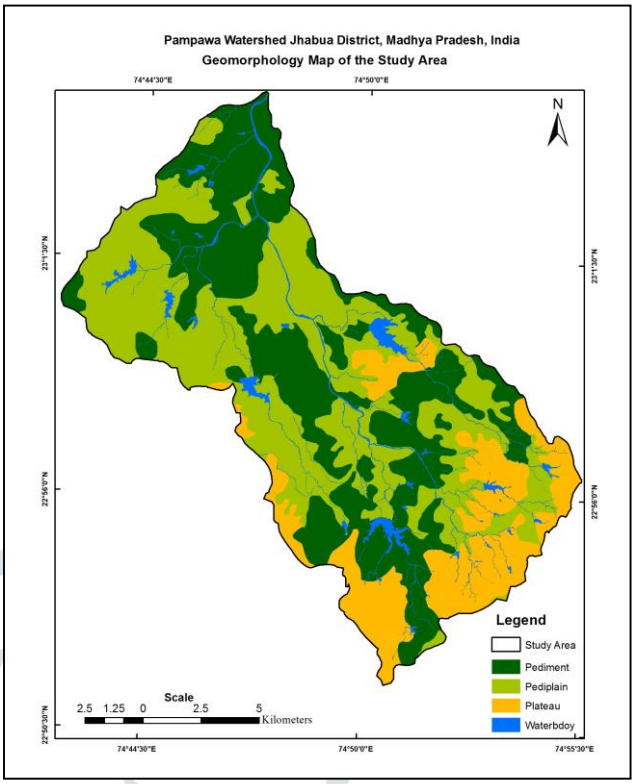
Soil: - The soil of Pampawa Watershed has its origin from Deccan traps basalts, granites, Gneisses. The topography controls different gradation of soil from clay, clayey skeletal, fine, loamy and loamy skeletal. The depth profile and fertility of soil largely depends on lateral differences. The soil map data has been collected from All India Soil and Land Use Planning Department **(AIS& LUS 1190) . S**oil distribution details are shown in Map 5.

Drainage density: - Drainage density is defined as the closeness of spacing of stream channels. It is a measure of the total length of the stream segment of all orders per unit area. The drainage density is an inverse function of permeability. The less permeable a rock is, the less the infiltration of rainfall, which conversely tends to be concentrated in surface runoff **(Magesh, at el 2011)**. Drainage density of the Pampawa Watershed has been calculated using line density analysis tool in ArcGIS software. The study area has been grouped into five classes. These classes have been assigned to Very low, Low, Moderate, High and Very High. High drainage density is recorded in the Southern parts of the study area because, the southern part has been comprises with hills and plateau along with very high altitude. While low drainage density is show that area is plain and water runoff is very slow, if water runoff does not fast it means that area has good water permeability along with high lineament density. Details are shown in Map7.

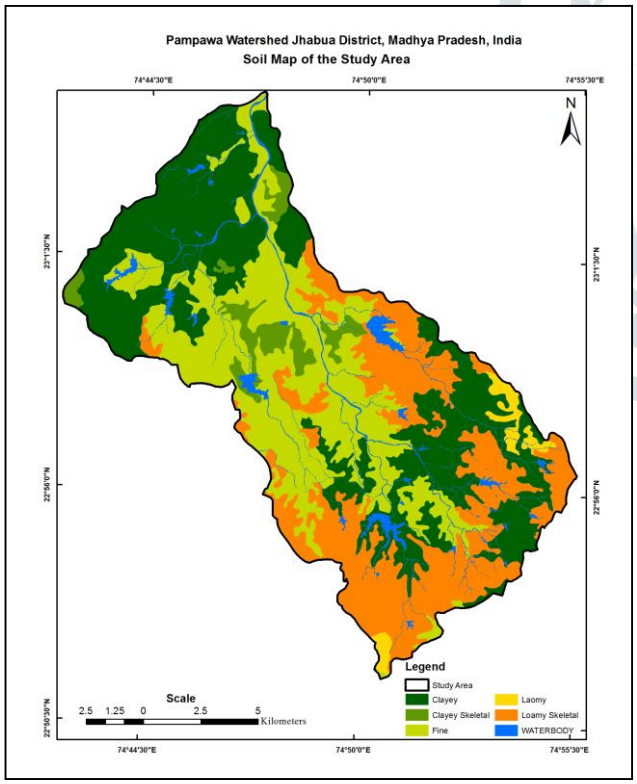
Lineament density: - A lineament is a linear feature in landscape which is an appearance of basic geological structure such as a fault. Naturally a lineament will comprise a fault-aligned valley, a series of fault or fold-aligned hills, a straight coastline or certainly a grouping of these features. Lineaments as significant lines of landscape caused by joins and faults, revealing the architecture of the rock basement **(Hobbs, 1904).** Lineament density shows that where groundwater recharge is good. If lineament density is high it means that area has a good recharge by runoff water. While low density is show that area has not good groundwater recharge, that is the basic different between them. All details are shown in Map9.



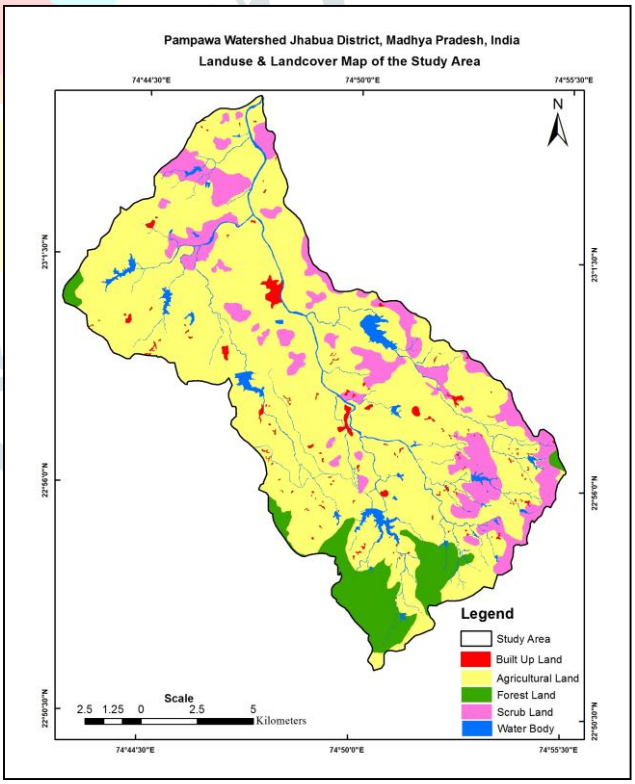
Map3- Lithology Map



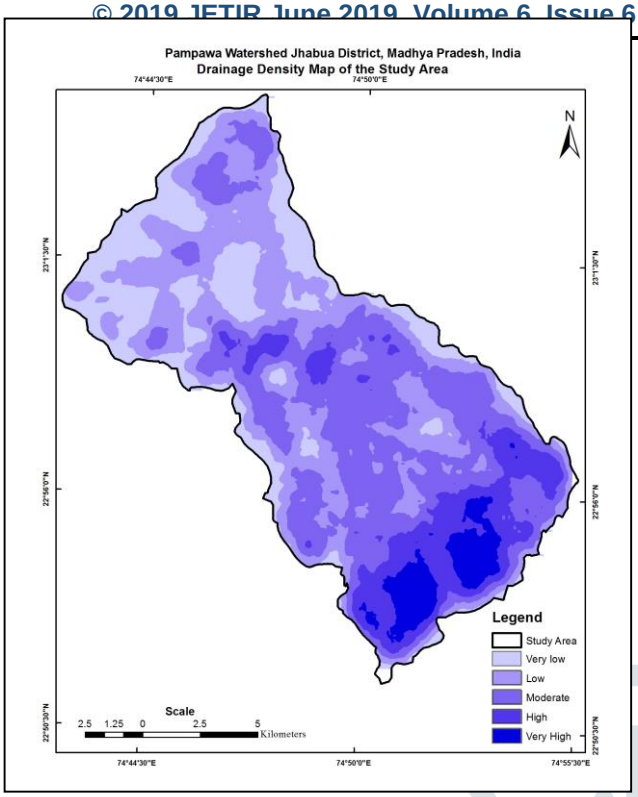
Map4-Geomorphology Map



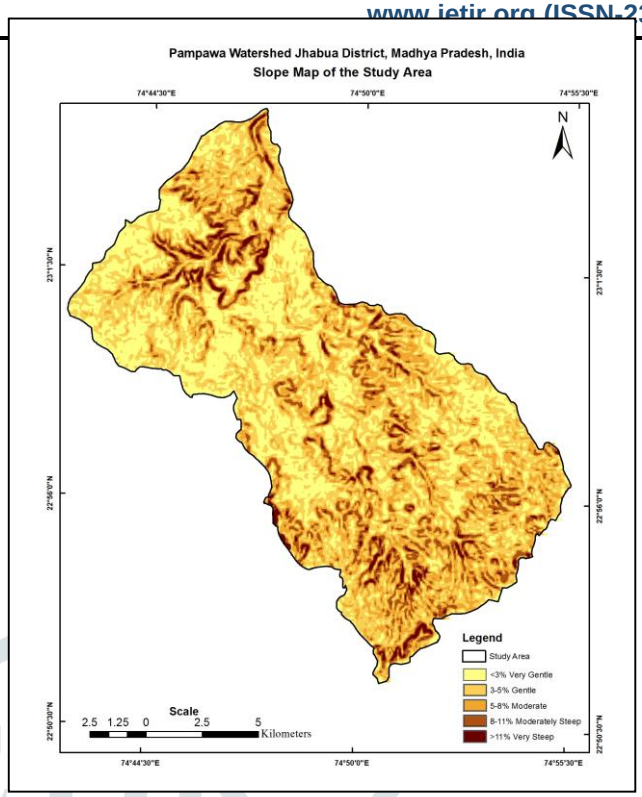
Map5- Soil Map



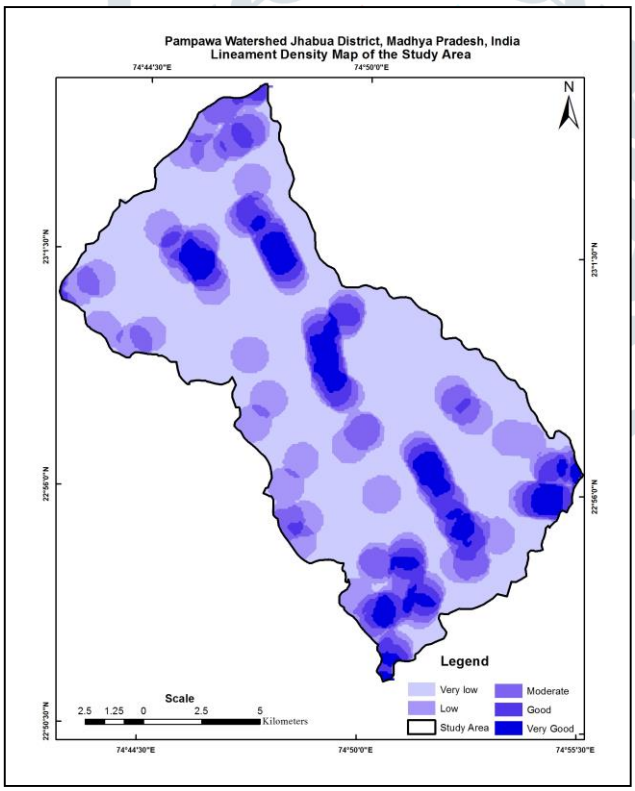
Map6-Landuse & Land cover Map



Map7- Drainage Density Map



Map8- Slope Map



Map9- Lineament density Map

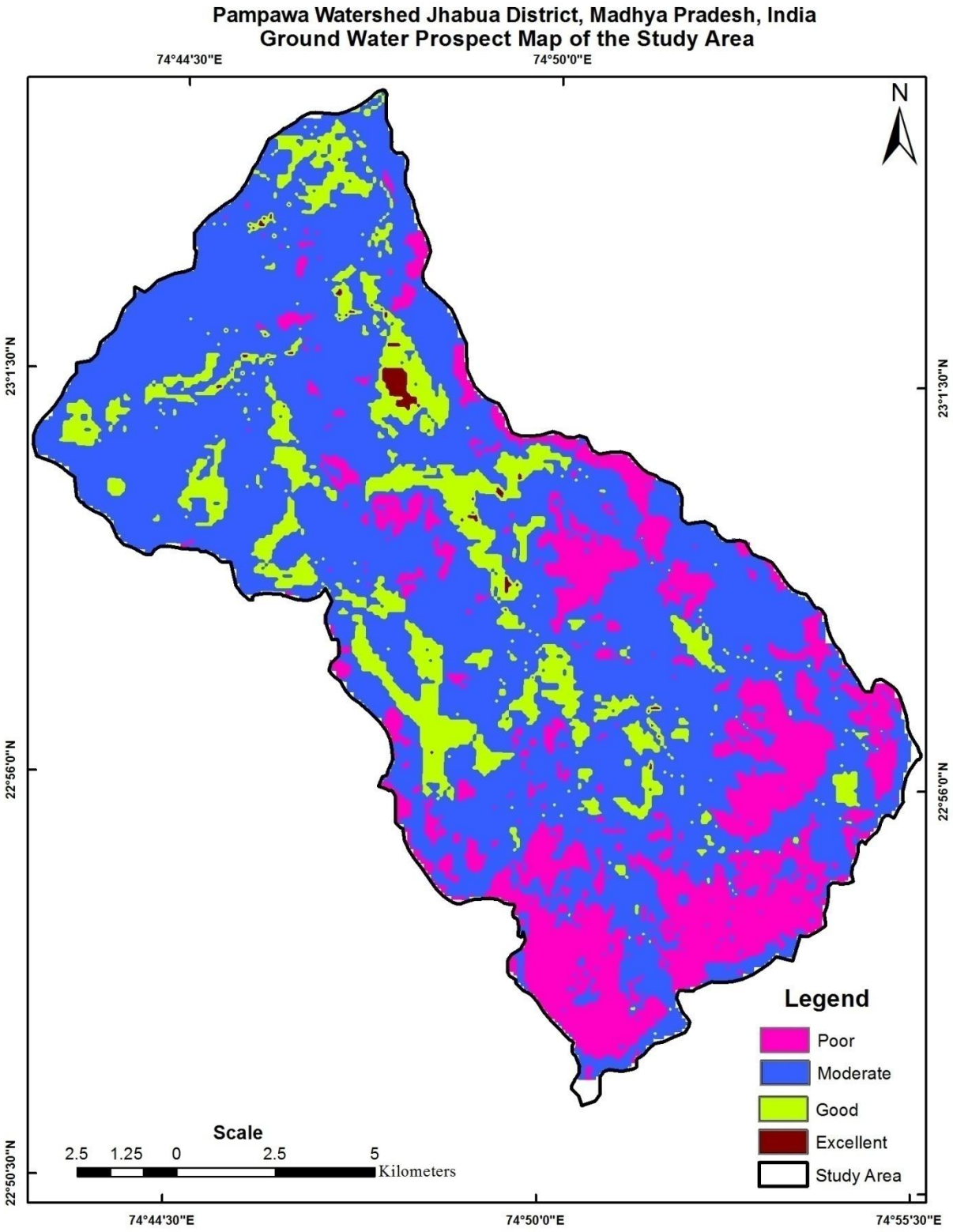
Delineating the groundwater potential zone:-

The groundwater potential zones for the study area were generated through the integration of various thematic maps viz., drainage, slope, lithology, soil, lineament, rainfall and land-use using remote sensing and GIS techniques. The demarcation of groundwater potential zones for the study area was made by grouping of the interpreted layers through weighted multi influencing factor and finally assigned different potential zones. The

groundwater potential zone of this study area has been divided into four grades, namely poor, moderate, good and excellent. The groundwater potential map demonstrates that the excellent groundwater potential zone is concentrated in the north-eastern due to the distribution of alluvial plains and agricultural land with high infiltration ability. Similar results are reported by Shankar and Mohan (2006) **6**. Poor concentration in shouth-east and some patches are found in whole study area. While moderate groundwater condition occurred 70% and good groundwater zone in north-western part of the Pampawa watershed. This indicates that, soil type and slope plays a vital role in groundwater augmentation. Moreover, the concentration of drainage density and lineament density also helps the infiltration ability of the groundwater system. Finally, the cumulative effect of the weighted multi influencing factors through overlay analysis in GIS platform revealed the mapping of groundwater potential zones in the study area Groundwater prospect map of the study area. Arial distribution shown in table no 2 and thematic map shown on Mp 10.

Sr. No.	Class	Area in Hectare (ha)	Area in Percentage
I	Poor	5083.48	21.80
II	Moderate	15164.77	65.05
II	Good	2951.43	12.66
IV	Excellent	112.10	0.49
	Total	**23311.78**	**100**

Table: - 2 Spatial distribution of Groundwater potential zone



Map10- Groundwater prospect map of the study area

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