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Soil and landform Characteristics, in Some Part of Purna River Sub Basin Central, India

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ABSTRACT

The study has demonstrated the use of satellite data and Geographical Information Systems (GIS) in evaluation of morphometric parameters and to analyze their influence on the genesis and processes of landforms and characteristics of soil parameters like texture, drainage and land erosional conditions of the area. Visual interpretation of satellite imagery in analysis of geological, landforms and land erosion characteristics in combination with drainage pattern facilitates effective delineation of distinct features to evaluate the influence of drainage morphometry. Remote sensing and GIS techniques are an effective tool to analyze spatial and non-spatial data of drainage, geology, geomorphology, landforms and soil parameters to understand their inter-relationships. Remote sensing and GIS also provides a powerful mechanism not only to upgrade and monitor morphometric parameters but also to permit the spatial analysis of other associated resources database. Geo-rectified database generated through geology, geomorphology drainage, landforms and soil parameters in the of GIS environment provides an outstanding way of storing, retrieving and analyzing data of river basin level to find out their relationship. An attempt has been made to utilize the interpretation capabilities of remote sensing and GIS to find out the relationships geological, landforms and land erosion characteristics in combination with drainage patter.

Key words: Purna River basin, remote sensing and GIS

I.INTRODUCTION

Morphometry is the measurement and mathematical analysis of the configuration of the earth surface, shape and dimensions of its landforms (Clarke, 1966). The morphometric analysis is carried out through measurement of linear, areal and relief aspects of the basin and slope contribution (Nag and Chakraborty, 2003). River basins comprise a distinct morphologic region and have special relevance to drainage pattern and geomorphology (Doornkamp and Cuchlaine, 1971; Strahler, 1957). The stream lengths suggests a geometric relationship between the number of stream segments in successive stream orders and landforms (Horton, 1945).Quantitative description of the basin morphometry also requires the characterization of linear and areal features, gradient of channel network and contributing ground slopes of the drainage basin. Detailed analysis of drainage parameters is of great help in understanding the influence of drainage morphometry on landforms and their characteristics. Surface drainage characteristics of many river basins and sub basins in different parts of the globe have been studied using conventional methods (Horton, 1945; Strahler, 1952, 1957, 1964; Morisawa, 1959; Leopold and Miller, 1956; Krishnamurthy *et al*., 1996, Manjare et al., 2014, Shrivatra et al. 2021a Shrivatra et al. 2021b).

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The quantitative analysis of morphometric parameters is found to be of immense utility in river basin evaluation for soil and water conservation and natural resources management at micro level. The morphometric analysis carried out in the Kedar and Biswa river basin shows that the basin is having low relief of the terrain and elongated in shape. Drainage network of the basin exhibits as mainly dendritic type which indicates the homogeneity in texture and lack of structural control. In some parts of the basin, the dipping and jointing of the topography reveals parallel and radial pattern. The linear pattern of the graphical representation indicates the weathering erosional characteristics of the area under study. DEM's are now predominantly created using remote sensing techniques with observing the benefits that a large spatial area can be mapped by fewer people at a lower cost. Remotely sensing techniques include photogrammetry (Manjare et al. 2017).The morphometric parameters evaluated using GIS helped us to understand various terrain parameters such as nature of the bedrock, infiltration capacity, runoff, etc. Similar studies in conjunction with high resolution satellite data help in better understanding the landforms and their processes and drainage pattern demarcations for basin area planning and management (Manjare et al., 2014). The aim of the study was to demonstrate the potential use of remotely sensed data and Geographical Information Systems (GIS) in evaluation of linear, relief and areal morphometric parameters and to analyze their influence on the genesis and processes of landforms and characteristics of soil parameters like texture, drainage and land erosion conditions.

II.AREA OF STUDY

The study area between lies in between latitudes 20° 30' 00'' N to 21º 00' 00''N and longitudes 76°10' 00' E to 76°27' 00'' E, covering an area of 635.70 sq. km falls in Survey of India (SOI) toposheet No.55D/5, 55 D/6 with 1:50,000 scale The study area covers an area of 635.7 km2 and comprises two sub basins of Kedar and Biswa River draining in to Purna River basin in Buldhana District of Maharashtra state (Fig.1). Geologically, the area under study is occupied by Deccan trap upper cretaceous to lower Eocene formation and Purna alluvium Quaternary formation. The area is well represented by structural hills, denudational hills, and alluvial plains forming soil covers of silt clay and alluvium (Fig.2).

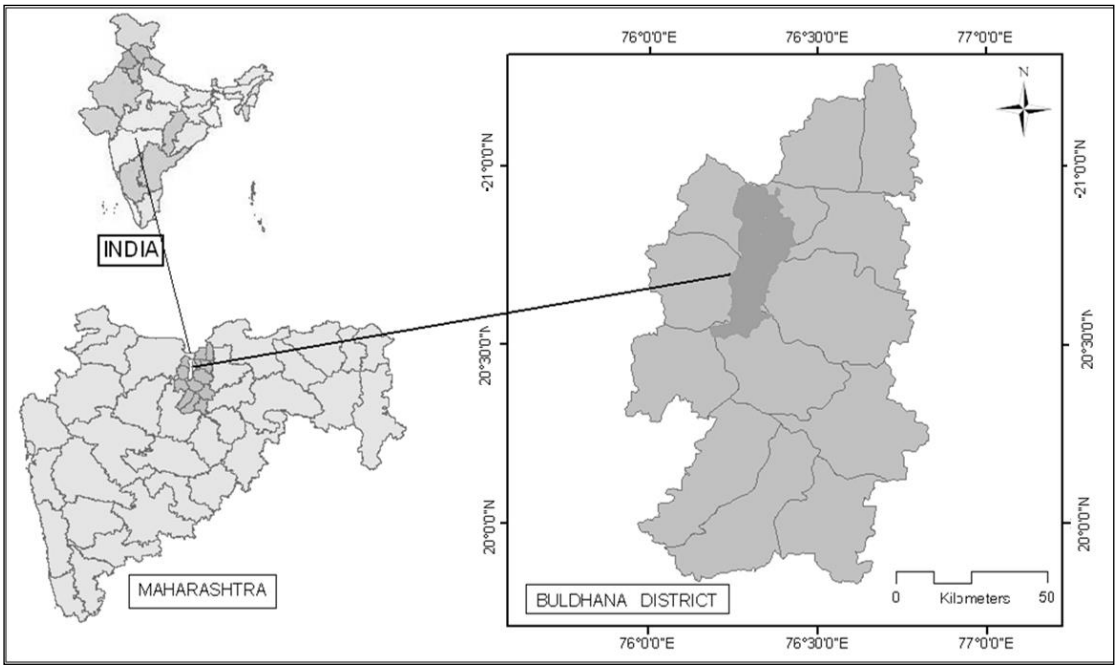

Fig.1: Location map of the study area

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III.DRAINAGE PATTERN

It refers to the orderly spatial arrangement of geologic, topographic or vegetation features. Drainage pattern is an important element in geologic interpretation of aerial photographs. The study area has dendritic to sub dendritic drainage type pattern. It is characterized by a tree like branching system in which tributaries join the gently curving main stream at acute angles. The occurrence of this drainage system indicates homogeneous, uniform soil and rock material (Fig.3).

IV.METHODOLOGY

In the given study, high resolution Indian Remote Sensing Satellite (IRS)-P6 Linear Image Self Scanning (LISS)-4 sensor, Survey of India (SOI) topographical sheets (1:50,000 scale) on superimposing with SRTM Dem of 90 mt. resolution and field verification data were used for systematic analysis of slope, various geomorphic processes, hydrological and landform characteristics of the study area. Drainage analysis was carried out at basin level using Spatial Analysis GIS System (Arc-GIS 10.2 Ver.) to identify the influence of drainage morphometry on landforms, drainage and land erosion characteristics. The elevation model was generated by using the SRTM DEM to generate height and slope maps (Fig.4). Visual interpretation techniques were followed for delineation of geology, geomorphology, landforms, and soil boundaries and degraded lands based on the tone, texture, shape, drainage pattern, color and differential erosion characteristics of the satellite data in combination with drainage morphometry.

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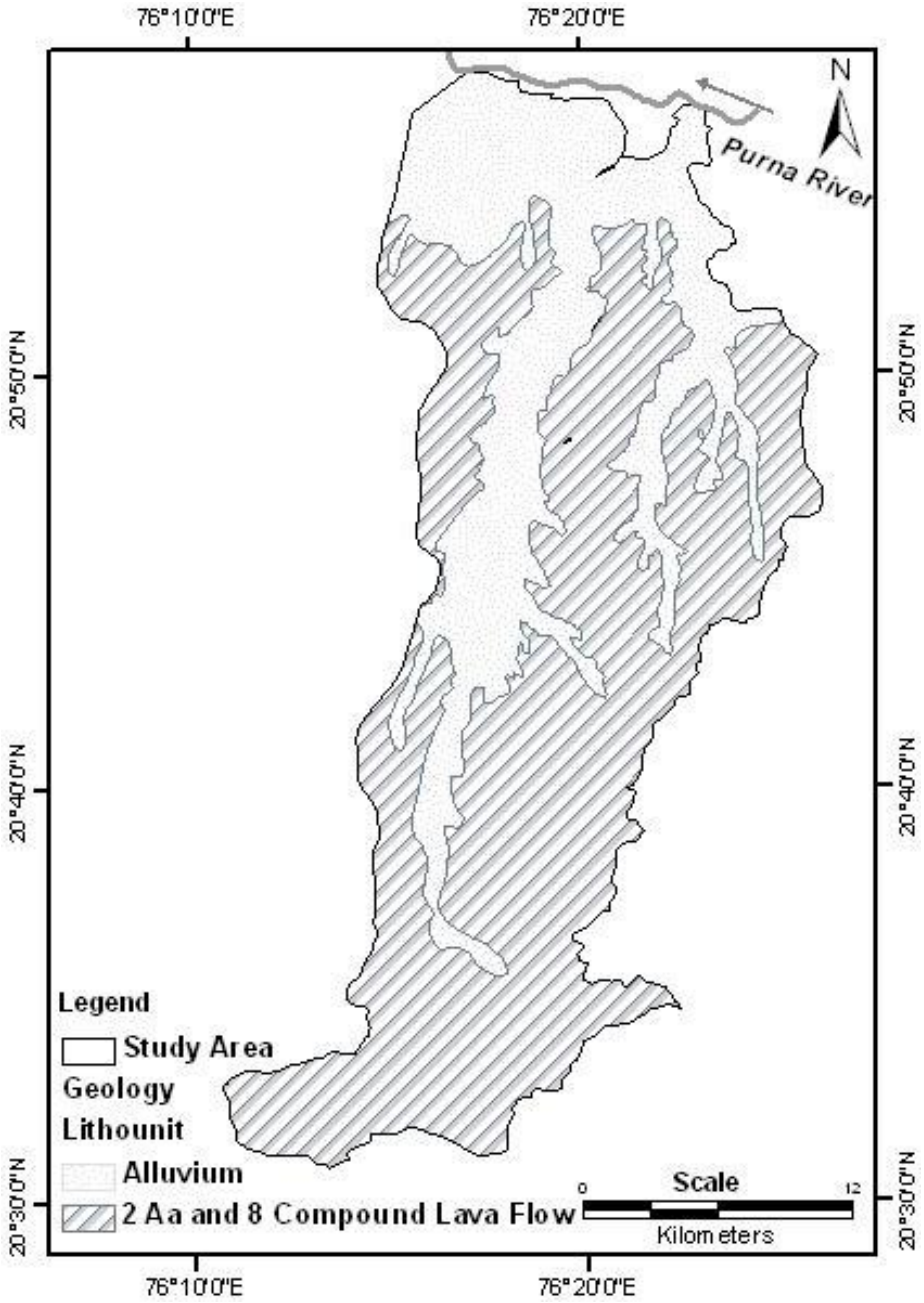

Fig.2: Geological map of the study area

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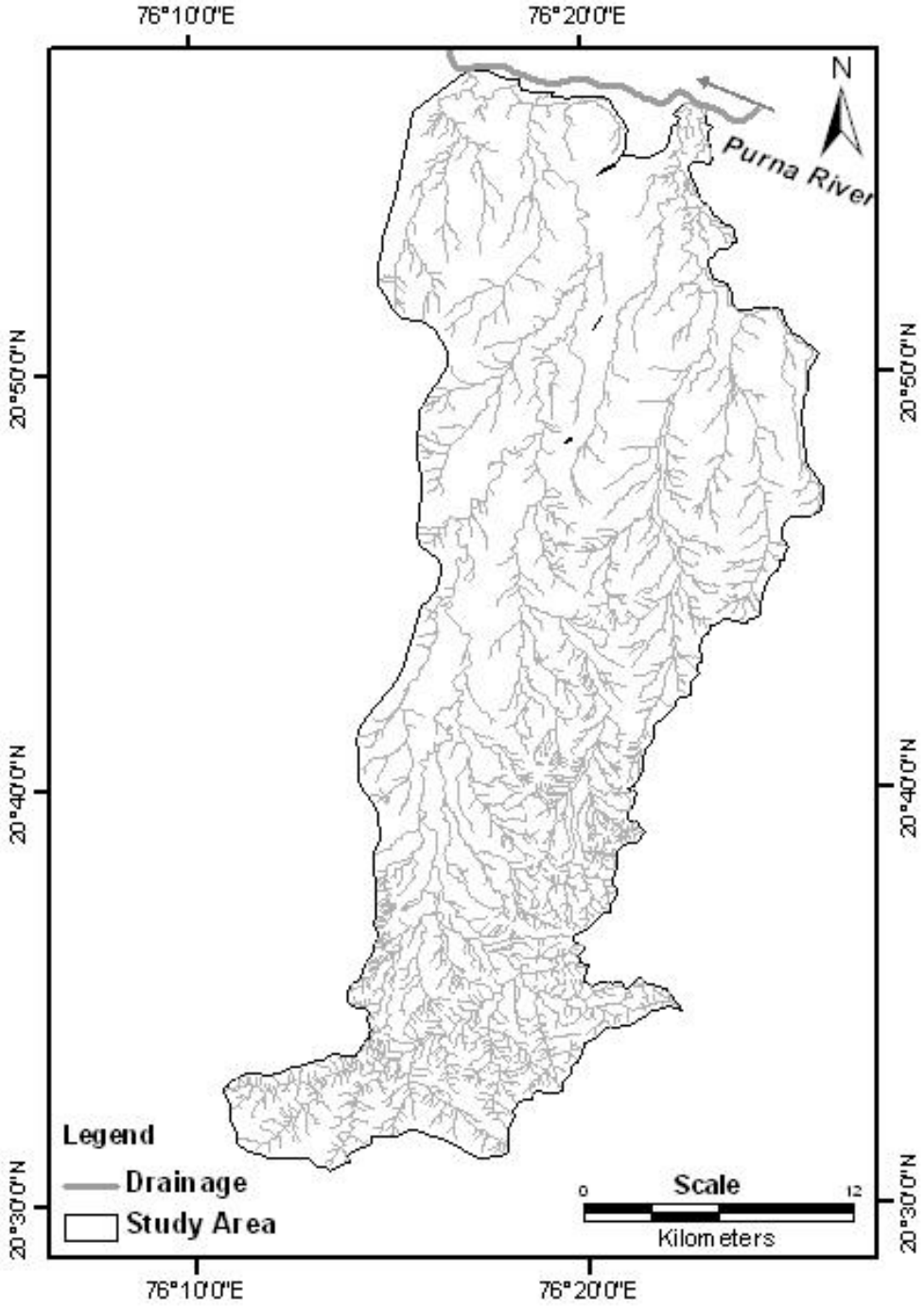

Fig.3: Drainage map of the study area

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V.RESULTS AND DISCUSSION

SLOPE

Slope analysis is an important parameter in geomorphic studies. The slope elements, in turn are controlled by the climatomorphogenic processes in the area having the rock of varying resistance. An understanding of slope distribution is essential as a slope map provides data for planning, settlement, mechanization of agriculture, deforestation, planning of engineering structures, morphoconservation practices etc. (Sreedevi et al. 2005, Manjare 2014). In the study area slope map was prepared based on SRTM DEM data were converted into slope using Arcview method (ESRI, 2000). Slope grid is identified as “the maximum rate of change in value from each cell to its neighbors, using methodology described in Burrough (1986).The calculated slope in degree are gentle (1 to 2), Gentle (3^0-5^0), Moderate (5^0-10^0), Moderately steep (10^0-15^0) and steep to very steep (15^0-35^0). In study area slope varies from 0° to 35° with a mean slope of 3.17° and Slope Standard Deviation 5.23°. A high degree of slope is noticed in the north western and northwestern parts of the basin (Fig.5). The elevation ranging from lowest 216 t659 m above MSL The highest elevation is mainly confined to Hill top plains/Dissected plateau and structural hill. The elevation ranging from 0 to 216 m above MSL is mainly associated with lower parts of foot slopes, structural hill and pediments. Gradient ratio is an indication of channel slope from which the runoff volume could be evaluated. The basins has a gradient ratio of 0.005, varies from low to moderate.

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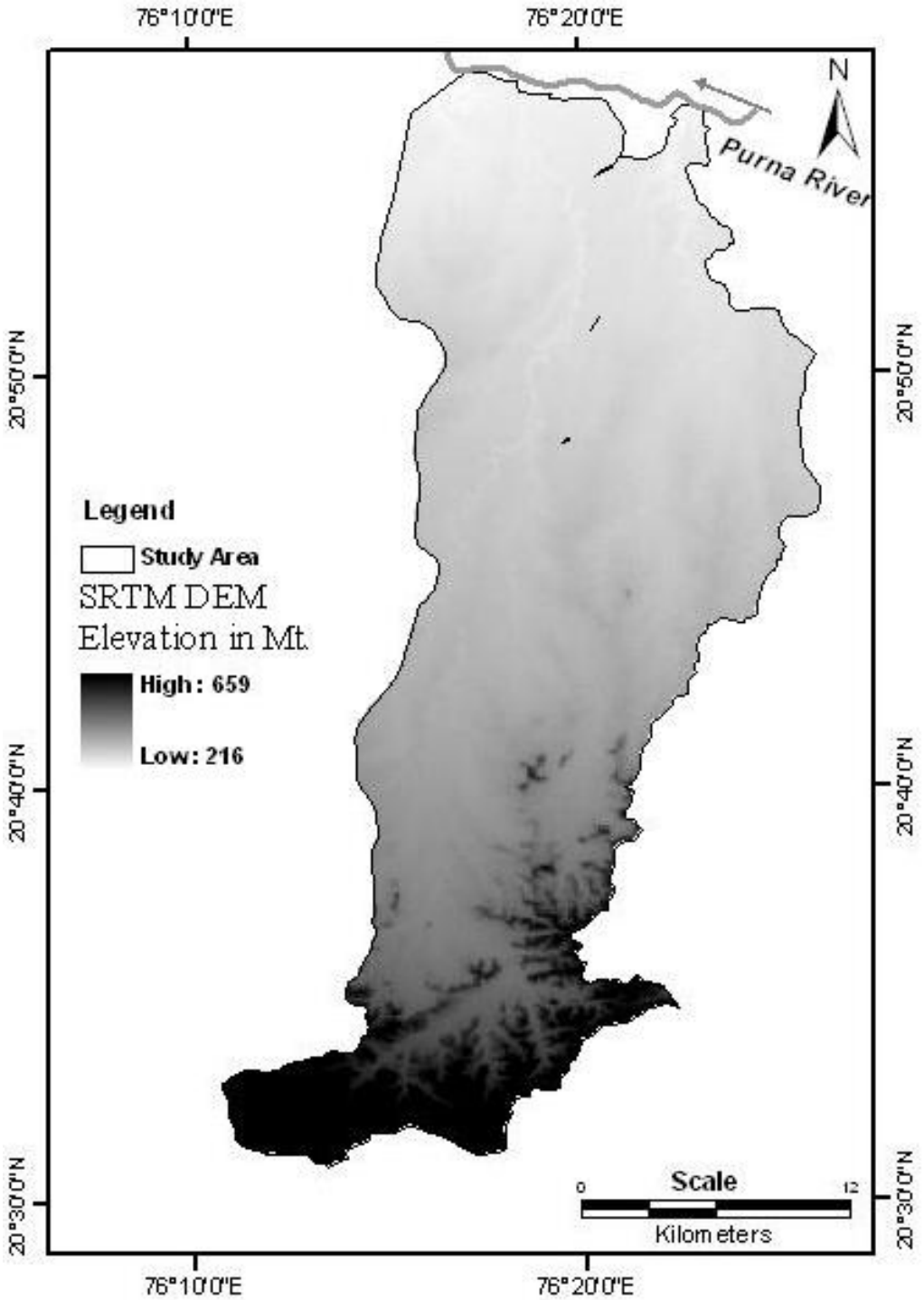

Fig.4: SRTM DEM map of the study area

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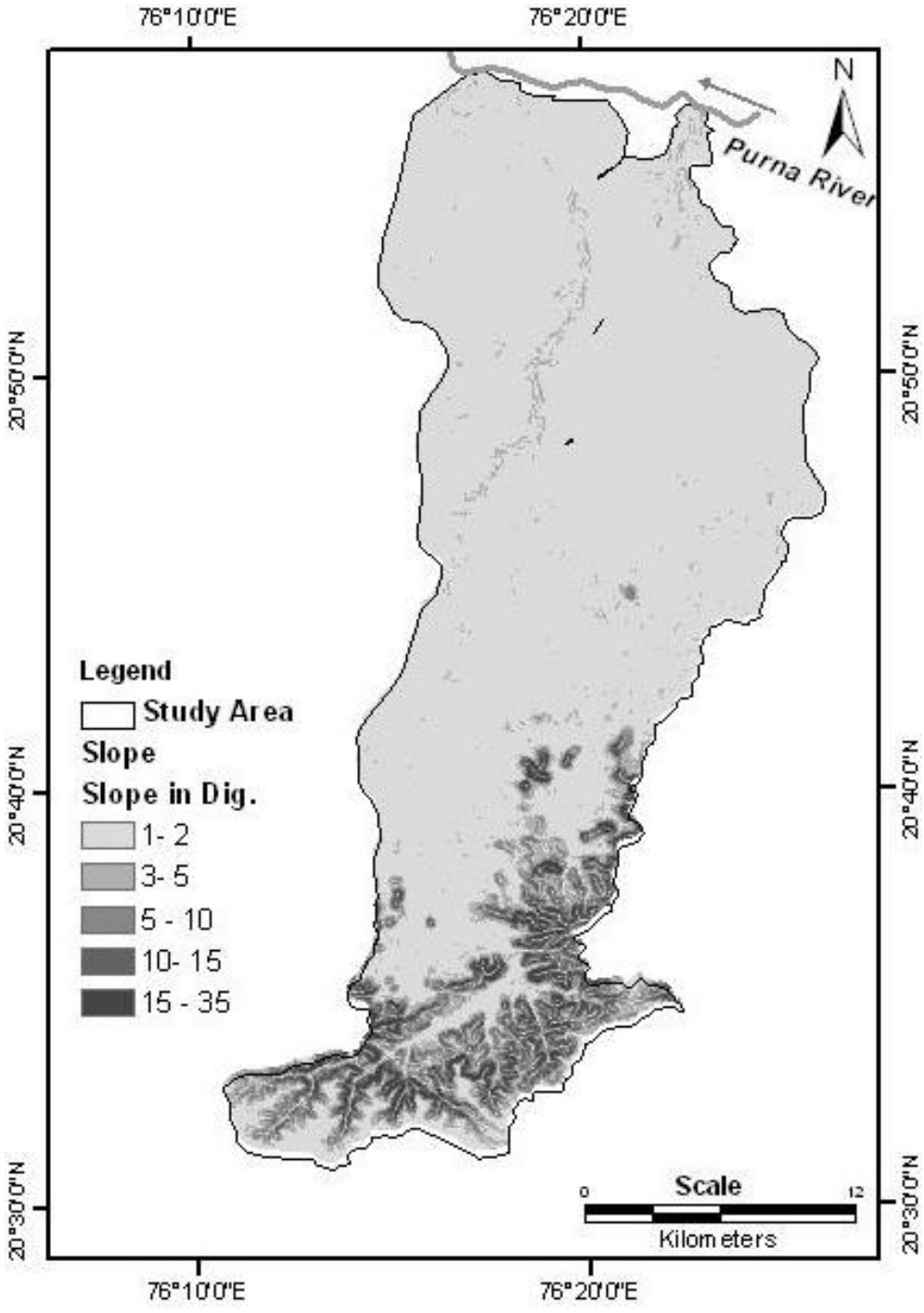

Fig.5: Slope map of the study area

LANDFORMS CHARACTERISTICS IN THE BASIN

Dissected Plateau composed of basaltic rocks gives crested radiating eroded ridges along the down slopes. The cluster of hills is characterized by rill and gully erosion, smooth and rounded hilltop. The height of the ridges was found to decrease progressively on the northern side of the study area, signifying intense linear headward stream erosion and slope retreat under high hydraulic gradients of streams. Pediments

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are broad gently sloping erosion surface and of plain or low relief, in an arid or semiarid region at the base of an abrupt and receding mountain front; it is underlain by bedrock this pediment. Residual and structural hills have been identified in peripheral part of the sub basins and are delineated based on the image characteristics viz. valley fills are delineated with the help of satellite image (Fig.6).

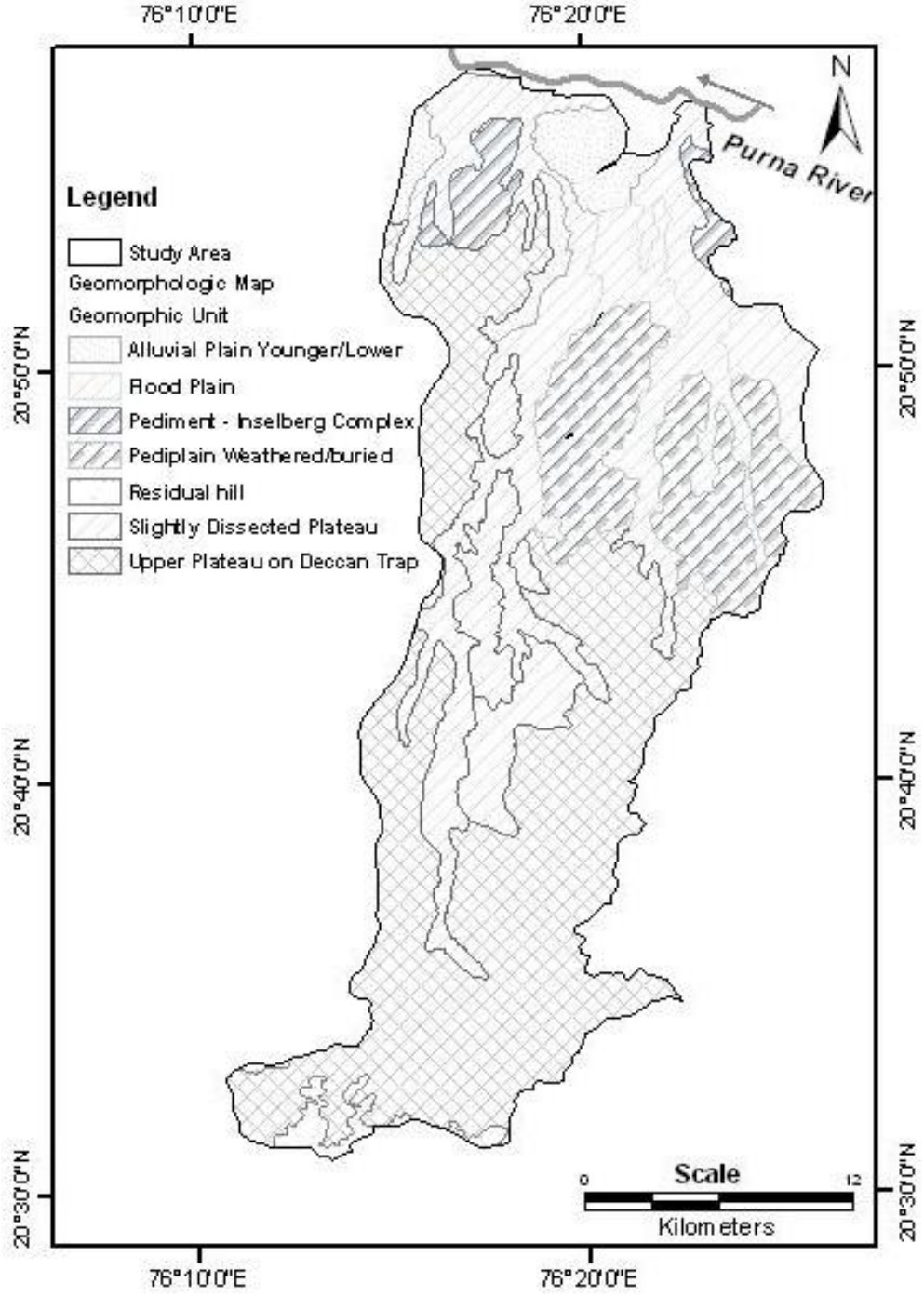

Fig.6: Geomorphological map of the study area

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SOIL DRAINAGE CHARACTERISTICS OF DIFFERENT LANDFORMS

Soil pattern reflects a local condition such as surface drainage conditions, sub surface geology, type of landform, slope, erosion, landuse and soil development. The analysis reveals that soil drainage is excessive in the higher elevations and poor in the low land areas of the basin (NBSS&LUP, 1990). Selected soil profiles were studied on different geomorphic units as per the procedure laid down by All India Soil and Land Use Survey organization (AISLUS, 1970) considering the heterogeneity of topography, geology and vegetation conditions. The soils were classified following the USDA Handbook (USDA, 1990). In the study area eight types of soil series have found (Fig.7).

1. Deep, imperfectly dry, fine, cal soils on very gently sloping plains and valleys with moderate erosion moderate salinity and slight sodality associated with deep, Mod. well dry soils with moderate erosion.
2. Shallow to deep, well dry, clayey cal soils on very gently sloping isolated hillocks and pediments with moderate erosion.
3. Very deep, moderately well dry fine, cal soils on very gently sloping plains and valleys with moderate erosion
4. Very deep, moderately well dry, fine, cal soils on very. gently sloping plains and valley with moderate erosion
5. Very shallow extremely soils on moderately steeply sloping undulating to rolling lands with mesas and buttes with severe erosion.
6. Very shallow extremely dry soils on gently sloping rolling lands with mesas and buttes with severe erosion
7. Very shallow extremely dry loamy soils on gently sloping dissected table lands with severe erosion.
8. Very shallow well dry, loamy soils on gently sloping summits / spurs of lower plateau with severe erosion.

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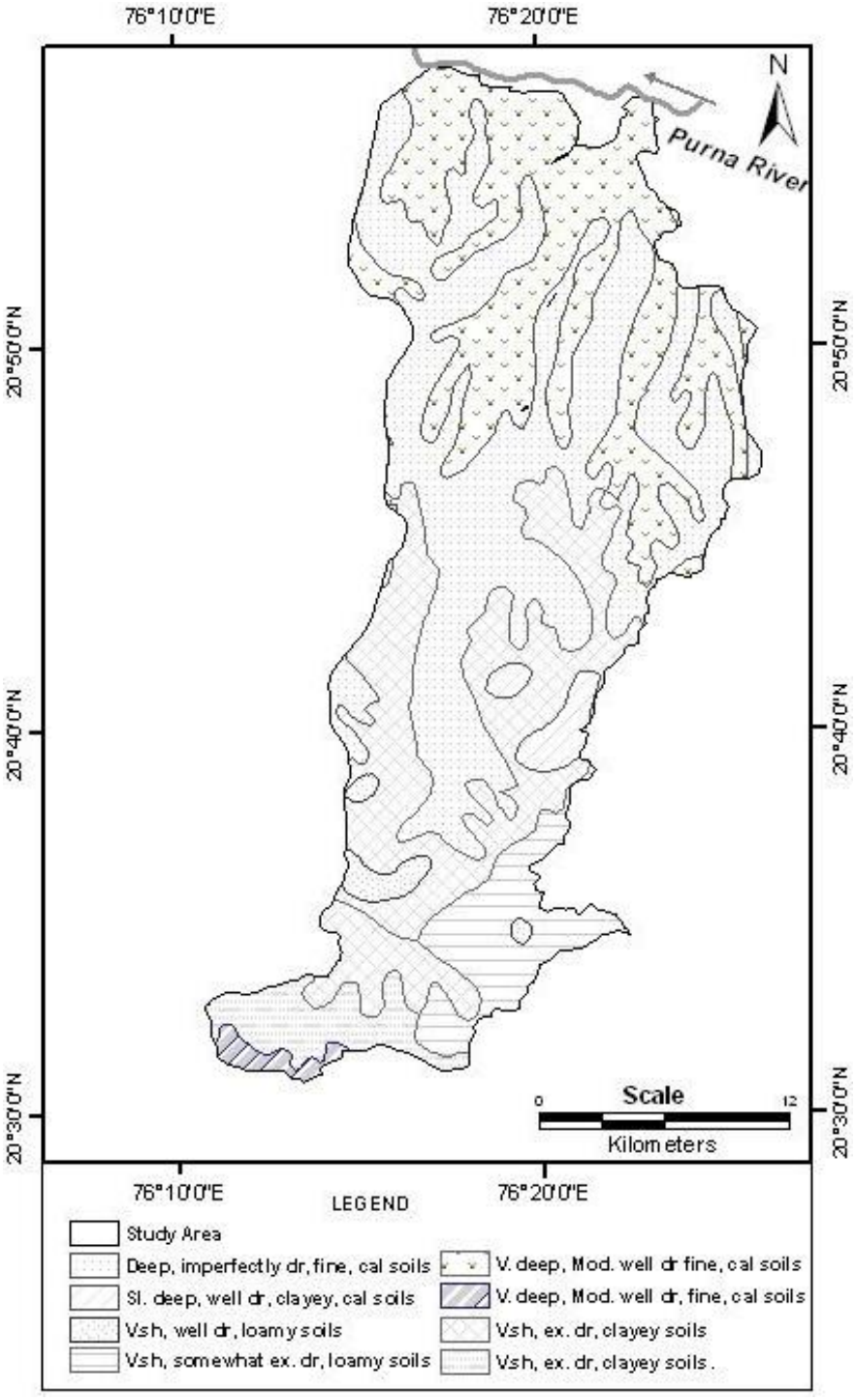

Fig.7: Soil map of the study area

VI.CONCLUSION

The remotely sensing and GIS based approach in evaluation of drainage morphometric parameters and their influence on landforms, soils, geomorphology and eroded land characteristics at river basin level is

more appropriate than the conventional methods. SRTM DEM data provides the opportunity for extracting elevation information from nadir and aft images. The simultaneous along-track stereo data eliminates radiometric variations caused by multi-date stereo data acquisition while improving image-matching performance and it is useful for geomorphological mapping especially at medium scales. Interpretation of multi-spectral satellite sensor data is of great help in analysis of drainage parameters and delineation of distinct geological, geomorphological and landform units and eroded lands. GIS techniques facilitate analyze of different morphometric parameters and to explore the relationship between the drainage morphometry and properties of landforms, soils and eroded lands. Different landforms were identified in the basin based on visual interpretation of satellite sensor data. These are slightly dissected plateau, residual hill, pediments, pediplains and flood plains. The sub basin is associated with high Drainage density, impermeable geology and high runoff conditions. High drainage density, high bifurcation ratio and steep slopes are the main causative factors for the development of well drained soils. The soil drainage of the basin is associated with drainage morphometry and the majority of the area is under well drained condition. Low and moderate eroded lands are noticed in the sub basins which are in association with high drainage density, stream frequency and texture ratio. The detailed quantitative morphometric analysis at the sub basin level enables to understand the relationships among the different aspects of the drainage patterns and their influence on landform processes, drainage, and land erosion properties.

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