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Geographical Information System Based Morphometric Analysis of Dibang River, Arunachal Pradesh, India

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Abstract

Geoprocessing techniques in GIS allow extraction of the river basin and its drainage networks, thus facilitating the computation of morphometric parameters of the basin. Multi Error Removed Improved Terrain (MERIT) DEM based delineation of the watershed of the Dibang River Basin and its sub-basins in the north-eastern Indian state of Arunachal Pradesh along with its drainage networks was attempted in this study using geospatial tools. Also, various morphometric parameters that describe the basin characteristics and morphotectonic parameters were derived. According to the Strahler's scheme, the Dibang River is a seventh order stream with a catchment area of 11823.9 km^2. Dri, Mathun, Emra, Ithun, Ahul, and Tangon are the major tributaries of the Dibang River. Various morphometric parameters show the dominant tectonic influence in the drainage development in the area. The morphometric parameters indicative of tectonic influences correlates well with the regional tectonics when compared with the lineament map and lithotectonic map.

Keywords: morphometric analysis, Geographic Information System, geomorphology, Dibang River, Dibang Multipurpose Project.

1. INTRODUCTION

The Dibang Multipurpose Project (3000 MW) is being planned on the Dibang River (Fig. 1), which flows from the snow-capped southern flank of the Himalayas near the Tibet border at an elevation of nearly 5000 meters. The dam is about 1.5 kilometers upstream from the junction of the Ashu Pani and Dibang rivers, and 43 kilometers from Roing. Morphometric analysis is the quantitative measurement configuration of the surface of the earth in terms of shape and dimension of the landforms (Babar 2005). The morphological analysis of a river basin and its fluvial processes play a vital role in deciphering the river's geohydrological characteristics and

express its climate, geological conditions, geomorphology, and structural (faults, joints, etc.) aspects of its catchment. The factors that play in the development of the watershed will be correlated with its shape, size, relief, the slope of the catchment, number and length of drainage channels, drainage density, etc. (Rastogi and Sharma 1976). It allows quantifying the geometry of the river basin which in turn provides insight into the underlying lithology, differences in rock hardness and its erodibility, structural controls, recent regional or local diastrophism (Strahler 1964). The morphometric analysis of the river provides an insight of the hydrological behavior of the river when the dam is constructed.

The basin morphometric parameters are broadly classified into linear, areal, relief, and aspects. Parameters under linear aspects describe the relationship between stream order, number, and length whereas the aerial aspects are computed to describe the shape and also understand the relationship of the stream length and number over the catchment development. Relief aspects give an idea about the erosive power of the streams and the amount of the mass to be eroded to reach the base level profile, the slope of the hills that determine the surface runoff. Quantitative morphometric analysis has been in wide use for prioritizing sub-watersheds for better management planning and practices in different parts of the world (Sangma and Guru 2020). The interplay of tectonics and drainage basin morphologies is widely used as an identification tool in tectonic geomorphology (Bull and McFadden 1977; Burbank and Anderson 2001).

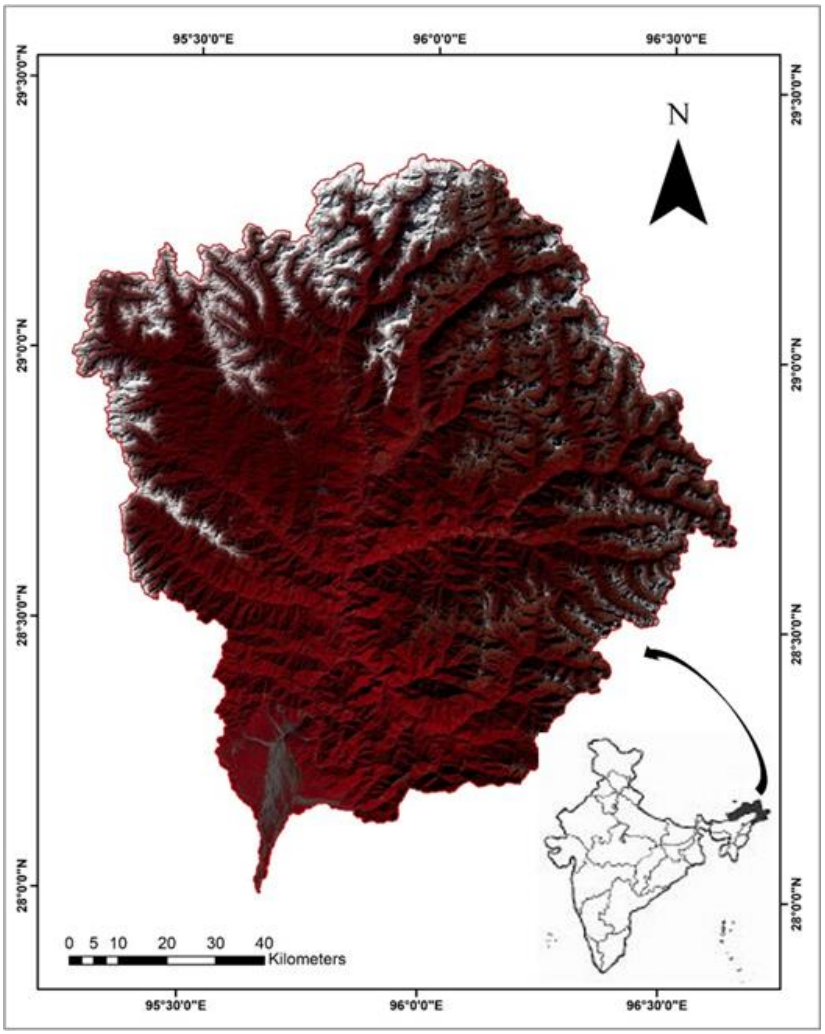

Fig. 1. Location of the Dibang River Basin.

2. DATA AND METHODOLOGY

The data used in the study include Landsat 8 Operational Land Imager (OLI) satellite imagery, Multi Error Removed Improved Terrain DEM (MERIT DEM), published lithotectonic maps, and the earthquake epicenter data adopted from United States Geological Survey, USGS (http:// earthquake.usgs.gov/ earthquakes /search/). Landsat8 OLI data is multispectral satellite imagery with 9 spectral bands: Band 1 to Band 9. OLI bands 1 to 7 represent coastal, blue, green, red, NIR, SWIR-1, and SWIR-2 bands with a spatial resolution of 30 m. Band 8 represents a Panchromatic band with a spatial resolution of 15 m. Band 9 represents a cirrus band with a spatial resolution of 30 m. Further details about the OLI imagery can be obtained from the website: https://landsat.gsfc.nasa.gov/landsat-8/landsat-8-overview. MERIT DEM (Yamazaki et al. 2017) represents the terrain elevations at a 3-arc second resolution. It was developed by removing multiple error components (absolute bias, strip noise, speckle noise, and tree height bias) from existing spaceborne DEM's (SRTM3 v2.1 and AW3D-30m v1). MERIT DEM was downloaded from http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_DEM/.

The study involves carrying out morphometric analysis of the Dibang River Basin to understand the hydrological and morphotectonic signature of the basin. The morphometric analysis of the Dibang River Basin was carried out using the MERIT DEM. Arcmap 10.2 software has been used to analyze the morphometric parameters. The software's hydrology toolset has been used to extract the basin and the corresponding drainage network and to derive the morphometric parameters. The various morphometric parameters derived to understand the linear (Stream Order, Stream Number, Stream Length, Stream Length Ratio, Mean Bifurcation Ratio), Aerial (Stream Length Index, Basin Length, Basin Area, Drainage Density, Stream Frequency, Elongation Ratio, Circulatory Ratio, Form Factor, Drainage Texture), Relief (Relief, Relief Ratio, Slope), and Morphotectonic (Hypsometric Integral, Sinuosity, Asymmetry Factor, Valley Width to Height Ratio) aspects of the basin. Further, the longitudinal profiles of the river channels were derived using Global Mapper 21.1 software. The results of morphotectonic parameters were correlated with the lineament map interpreted from the Landsat8 OLI False color image and the shaded relief map of the region using visual interpretation techniques and on-screen digitization. The published lihotectonic map of the area was also used for making the inferences. The study highlights the strong influence of tectonics in the development of drainage basin, which can be inferred from the moprhotectonic parameters and longitudinal profile.

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