



Morphometric slope analysis in some part of Por river Sub Basin Nagpur district Maharashtra using, SRTM DEM

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Abstract

Morphometric slope analysis in part of Por River sub basin Nagpur District Maharashtra The total area is about 647.516km² has been analysed and various slope categories are classified. A complete profile of slope elements comprising Crest, Scarp, Debris and pediments has been delineated in the given study area. The evolutionary process 'slope decline' and parallel retreat of slope evolution of wood (1942) and King (1962) are predominant in the study area. Lithology and structure mainly control in the study area. Along with the regional slope studies an attempt e has been made to analysed the slope profile of the landform and its evolution.

Keywords: Morphometric slope, SRTM DEM, Por river

Introduction

DEMs are used for visual analysis of topography, landscapes and landforms other than modeling of surface processes (Welch, 1990) ^[36, 37]. Currently Digital elevation models (DEMs) is considered as the main resource for the extraction of various geomorphologic and topographic features depending on their elevation, spatial distribution and deviations (Felicisimo, 1994) ^[7]. Digital Elevation Model (DEM), Digital Elevation Data (DED), Digital Terrain Data (DTD) (Campbell, 2002) ^[4] or Digital Terrain Model (DTM) all consists of different arrangements of individual points of x (east-west direction) and y (north-south direction) coordinates of horizontal geographic positions. Z is the vertical elevation value that is relative to a given datum for a set of x, y points (Bolstad, 1994, Welch, 1990) ^[3, 36, 37]. The satellite images are becoming useful and necessary in geomorphology, especially in obtaining quantitative measurements and performing geomorphic analyses. Image analysis provide geologists an opportunity to enhance, manipulate, and combine remotely-sensed digital data with several types of geographic information that in turn increases the amount of extracted information related to topographic and geologic features (Horsby & Harris 1992) ^[9]. The southern part of the Watersheds contains alluvium. The Shuttle Radar Topography Mission (SRTM) is an international research effort that obtained digital elevation models on a near-global scale from 56° S to 60° N, to generate the most complete high-resolution digital topographic database of Earth. This data is provided in an effort to promote the use of geospatial science and applications for sustainable development and resource conservation in the developing world. Digital elevation models (DEM) for the entire globe, covering all of the countries of the world, are available for download. The SRTM 90m DEM's have a resolution of 90m at the equator, and are provided in mosaic 5 deg x 5 deg tiles for easy download and use. All are produced from a seamless dataset to allow easy mosaicing. These are available in both ArcInfo ASCII and GeoTiff format to facilitate their ease of use in a variety of image processing and GIS applications. Data can be downloaded using a browser or accessed directly from the ftp site. In the Study Approach is made to analyse the slope with SRTM-DEM data. The slope information is useful in understanding the topography, geomorphology, soil types and their erodability, surface drainage etc (Tale and Manjare 2016, Masurkar *et al.*, 2019) ^[16, 21]. DEM-based terrain visualization and quantification of topographic attributes made GIS a powerful tool in evaluation and analysis of various morphometric indices (Reddy 2018, Manjare, Manjare *et al.*, 2021) ^[19]. Many authors used DEM in conjunction with remote sensing in delineation of structural, drainage features and quantification of morphotectonic parameters in GIS environment (Reddy *et al.* 2002; Bhatt 2007; Reddy *et al.* 2004; Sharma and Sarma 2017; Pande *et al.* 2018, Shrivatra *et al.* 2021a) ^[2, 26, 29, 23, 30]. DEM with the help of GIS are being used in delineation of many geological features such as linement, structures, geomorphological mapping etc (Manjare and Jagtap, 2013, Tale and Manjare, 2016, Manjare *et al.* 2017a, Shrivatra *et al.* 2021b) ^[16, 20, 15, 31]. SRTM is still the most popular global DEM because of its accessibility, feature resolution, vertical accuracy and a lower amount of artifacts and noise compared to alternative global DEMs (Rexer and Hirt, 2014; Umbarkar *et al.*, 2014, Jarihani *et al.*, 2015; Sampson *et al.*, 2016; Hu *et al.*, 2017, Manjare *et al.* 2018, Masurka *et al.*, 2019) ^[27, 33, 8, 20]. 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 (Uysal *et al.*, 2015; Coveney and Roberts, 2017, Manjare and Pophare. 2019) ^[34, 5, 14]. High resolution satellite data, DEMs and spatial data analysis capabilities of GIS found to be promising approach in characterisation and delineation of different terrain characteristics (Reddy *et*

al., 2018a), geomorphology, structures/ lineaments (Manjare *et al.*, 2017a) ^[15]. Systematic analysis of remotely sensed data helps in identification and delineation of landforms, structural features and evaluation of drainage characteristics more precisely (Manjare, 2017b) ^[13].

Study Area

The study area falls in Nagpur district of Maharashtra between 2102'15'' N to 2107'30''N latitude and 7907'20'' E to 79011'40'' E longitude. The area is located in the southern side of Nagpur with total area 647.516km². It is covered in the Survey of India (OSM) toposheet numbers 55O/6 on 1:50,000 scale (Fig.1). Pora river is the right bank tributary of Nag river. the origin of the river is untraceable, but it is believed to originate somewhere in the catchment area of Sonogao lake. The river and its tributaries flow through different terrain having varied land use activities, soil condition, vegetation and agricultural practices.

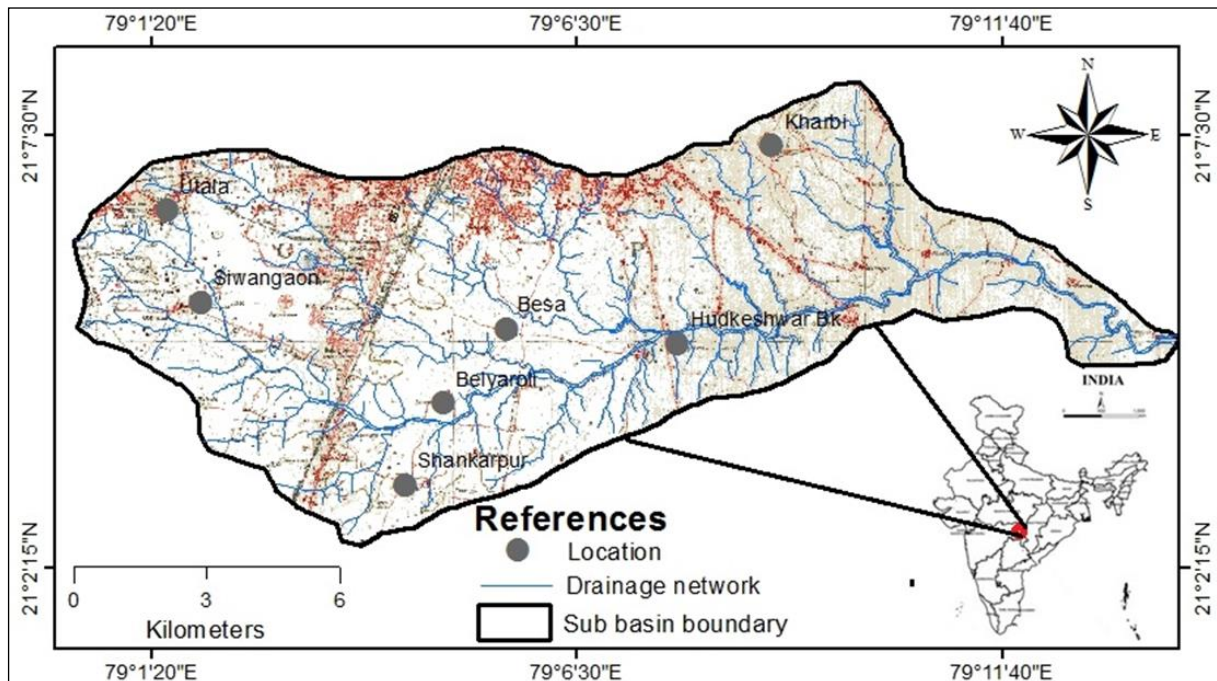


Fig.1: Location and topomosaic map of study area

Methodology

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), and Global Digital Elevation Map (GDEM) 30m resolution as input data used to study the present area. Digital elevation model (DEM) map is representing the altitude of the study area ranging from 282 to 1138 m mean sea level. Aspect map which is generated in ARC GIS 9.3 software from the input data to know the topographical slope direction and geological features of the area. Slope map is also generated to know the intensity of slope. A number of shaded reliefs have also generated from digital elevation model in different azimuth, sun angle and vertical exaggeration. It is observed that the different azimuth and sun angle enhances to interpretations of the present existing area. The slope map has been prepared for the Salbardi and adjoining region using 1: 50,000 scale SOI topographical maps with 20m contour interval and support from the ASTER (DEM). The raster layer was georeferenced using Erdas Imagine software. The isotangent lines were digitized and final isopleth map (a map displaying the distribution of an attribute in terms of lines connecting points of equal value) was prepared (Fig. 2). Slope can be regarded as the outcome of active processes sloping passive materials with depending on the time during which the processes have operated. Slope can be identified in term of structure, processes and stage as outlined by Davis (1899) ^[6]. A more realistic approach is to view slope as numerous and complex linkage between factor, processes and forms.

Shuttle Radar Topography Mission (SRTM)

SRTM was a single pass, synthetic aperture radar interferometry (InSAR) campaign conducted in February 2000. For the first time a global high-quality DEM was achieved with a resolution of 1 arc sec (~ 30 m) and 3 arc sec (~90 m, free availability) covering the Earth's area between 60° N and 54° S (Van Zyl, 2001). Vertical errors of the DEM are ± 16 m and ± 6 m for absolute and relative accuracy, respectively; the horizontal positional accuracy is ± 20 m at a 90% confidence level (Rabus *et al.*, 2003). Absolute accuracy thereby relates to the error throughout the entire mission while relative accuracy describes the error at a local 200 km-scale. First assessments in highmountain terrain compared the 90 m SRTM DEM with aerophotogrammetric DEMs and found root mean square errors (RMSE) of the height of 12–36 m and maximum vertical errors of more than 100 m in extremely rough topography (Kääb, 2005) ^[12]. Other studies in relatively flat terrain reported an RMSE of

SRTM DEM data of about 10 m in comparison with shuttle laser altimeter data. In mountainous terrain, the SRTM DEM shows sections with data gaps, generally due to radar shadow, layover and insufficient interferometric coherence (Kääb, 2005) [12]. For given study, a 30 km×40 km SRTM DEM was used and resampled at a grid resolution of 90 m. Only a few data gaps were present in this DEM subset and were of marginal relevance for the purpose of this study. The positional accuracy is within the subpixel range when compared with 1:50,000 topographic maps (Fig.2).SRTM data for this study was downloaded from the website of the Consultative Group on International Agricultural Research Consortium for Spatial Information (CGIAR-CSI -http://srtm.csi.cgiar.org) (Fig.2.2).

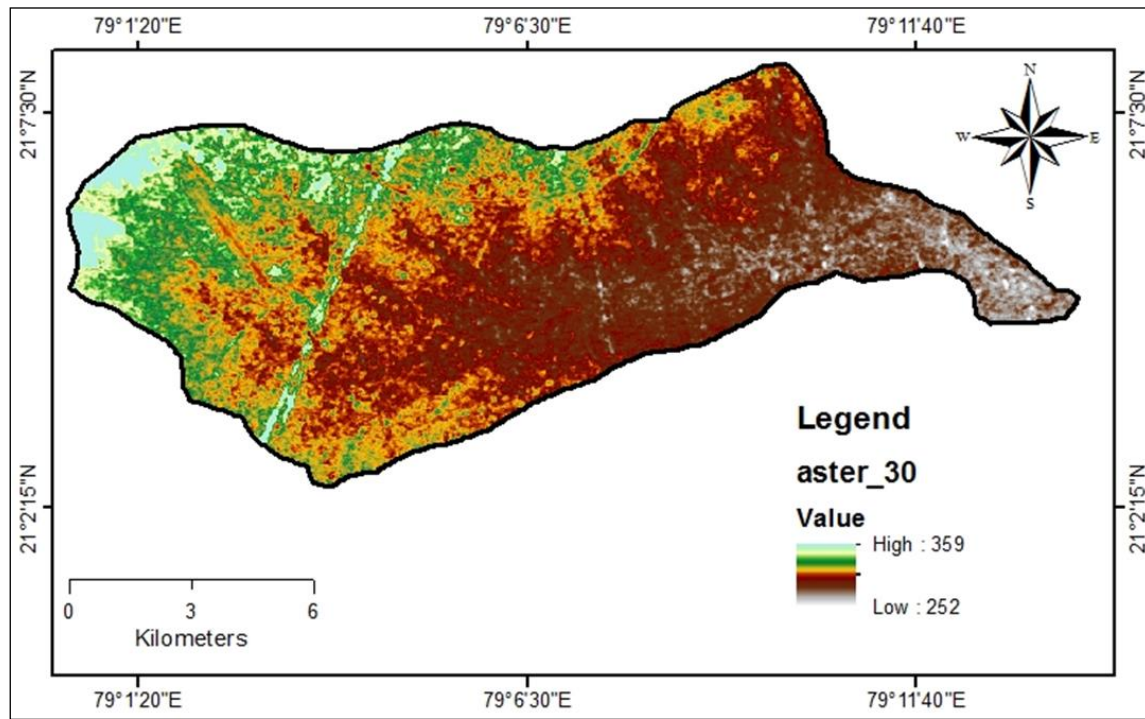


Fig 2: SRTM DEM map of the study area.

Slope Mapping

The slope of a surface refers to the maximum rate of change in height across a region of the surface. Slope is an important terrain parameter and it affects the land stability. The slope map has been prepared from SRTM DEM. The slopes in the study area have been categorized into seven classes as per the IMSD Guidelines (NRSC, 1995). The following slope classes were mapped for the study area; nearly level, very gently sloping, gently sloping, moderately sloping, strongly sloping, moderately steep to steep sloping, and very steep sloping (Fig. 6). Slope of an area is one of the controlling factors of groundwater recharge. It influences surface and subsurface flow of rain water and its recharge to the groundwater reservoir. Gentle slope of an area provides more time to infiltrate the rainwater to aquifer zone where as high slope allows lesser time resulting low infiltration to underlying groundwater reservoirs. The slope map of the study area has been prepared from SRTM DEM 90m.(Fig.5). The slope of study area has been classified into seven classes as per the IMSD guidelines (NRSC, 1995). The elevation ranges from 256 to 605 mt (Fig.5).The study area shows the slope category 00 to 30 0 and majority of the falls into 0-1% i.e. nearly level and 1-3%. High slope is observed in the north east part, eastern part and southwestern part of the study area (Fig. 4.2).

Slope Classification

It is evident from the slope map that seven slope category (Table 1) are present in the given study area and are described below;

Table: 1: Classification and Terminology of The Slope System

Class 1 - 00 to 0.5 0

It has been designated as level slope. This is the lowest category of slope in this region and is associated with extremely flat part of the area. This class covers more in the almost all part of the study area except in the central part which is drained by the river. It represents an erosional surface of the current cycle (Figure 2).

Class 2 - 0.50 to 10

It has been designated as almost level slope. This category of slope in this region and is associated with extremely flat part of the area.

This class also covers almost all part of the study area except in the central.

Class 3 - 10 to 20

It has been named as very gentle slope. It covers the flat land around Morshi and Gahtakli village. Some flat tops of the hills also show the same slope (Figure 2).

Class 4 - 20 to 50

It has been named as gentle slope. It is represented by the area south east to the Salbardi and Hiwarkhed village. It also notices the Morshi plain (Figure 2).

Class 5 - 50 to 100

It has been named as moderate slope. It covers the area in patches in different parts. It mainly covers around Koala, Mathadhana, Gehunbarsa village and along the Todlia nala. In this slope the steepest acceptable slope angle is 100. This slope zone is prominent along the contacts of hill ridges and flat grounds. Pediments are included in this category (Figure 2).

Class 6 - 100 to 180

It has been named as moderately steep slope class. It covers the central part of the study area. The area of this slope angle ranges occur in narrow parallel continuous stretch along with the next higher slope zone (180- 300). It has been observed near north east and south east to the village Salbardi village (Figure 2).

Class 7 - 180 to 300

It has been named as steep slope. The upper limit of this slope angle is 300. It is found along central of northern and north eastern part of the study area or center of north west and north east part of the area (Figure 2).

Class 8 - 300 to 450

It has been named as very steep slope and has been observed surrounding the steep escarpment slope of the area. It mostly from the upper part of debris slope. It noticed north to the Salbardi village (Figure 2).

Class 9 - 450 to 700, Class 10 - 700 to 900 and Class 11- Over 900: All these classes are not observed in the study area.

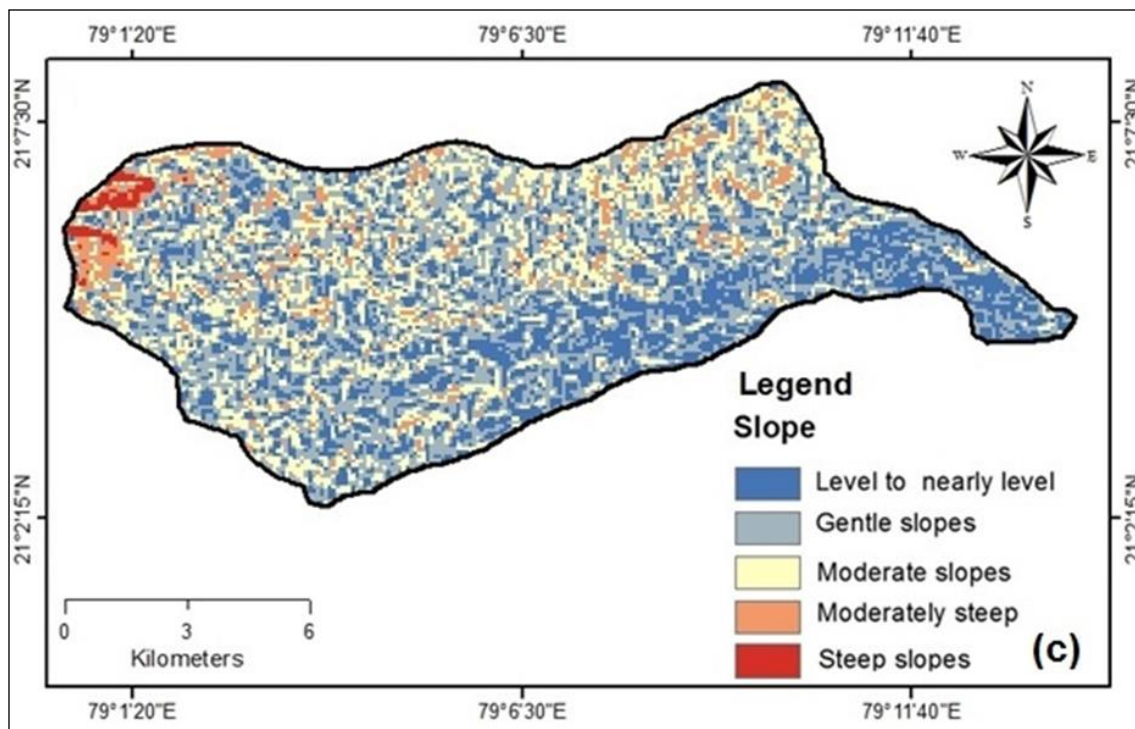


Fig 3: Slope map of the study area.

Conclusion

The crests are uneven surface on which plenty of rocks outcrop, weathered boulders and regolith are seen. The crests are border by steep escarpment of almost steep slope elements. These are indented by number of stream valley, with result of convexity of slope till merge in to the debris slope. These debris slopes have a slope angle of 200 to 450 and are usually terraced in nature. Abundant boulders are seen held upon these constant slopes. This debris slope connects the pediments below with slope level slope of the Morshi plane. The scrap face (600 to 650) is conspicuous as present in most part of the study area and found bordering to the plateaus. The slope element from the study area is dependent on variables such as stratigraphy, structure, inherited form, climate and

basal erosive activity of river. The slope information is useful in understanding the topography, geomorphology, soil types and their erodability, surface drainage etc.

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