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Characterization of landform in Bastar plateau using high resolution ALOS-DEM data

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Abstract
In the study, an attempt has been made to delineate the landforms of Goriyabahar Nala watershed in hot sub-humid ecological sub-regions (ESR) of Bastar Plateau, Chhattisgarh. To achieve the objectives of the study, freely available open source high resolution satellite data *viz.* 12.5 m ALOS-DEM (Digital Elevation Model) were utilized. ALOS-DEM was analyzed to extract terrain parameters like elevation, contour, slope, hillshade, drainage, *etc*. and was visually interpreted. Based on the contour lines at 5 m intervals, seven major landforms were identified, namely subdued hills, undulating uplands, undulating midlands, undulating lowlands, upper valley, narrow valley and alluvial plains. The study manifest that the high resolution satellite data *viz.* ALOS-DEM will be of immense help in delineation of distinct landforms.

Keywords: ALOS-DEM, Landform

Introduction
Geospatial techniques have immense potential and being widely used in digital terrain analysis, land resource inventory, land use/land cover mapping, wastelands mapping, water resources and environmental management (Ramteke *et al.*, 2018) [1]. Quantitative mapping of geomorphological parameters includes the recognition and characterization of the basic units of the topography. The scope has further expanded with the landform maps widely used in various fields of land resource surveys, environmental analysis, hydrological studies and many more applications. Free availability of digital data sources in the public domain, such as digital elevation models (DEMs) data can speed up the digital databases generation and improve the overall quality, consistency and reliability of the database. With the increasing availability of digital elevation models (DEMs), a surface is characterized by attributes such as elevation, slope, aspect, plan and profile curvature, and flow accumulation to obtain relief or surface topography units, and these provide greater functionalities than the qualitative and nominal characterization of topography (Reddy *et al.* 2002) [2]. A DEM is an electronic model of the Earth's surface that can be stored and manipulated to provide many kinds of data that can assist the surveyor in mapping and giving a quantitative description of landforms (Ardak *et al.* 2010; Sankar *et al.* 2010) [3].
The use of high resolution satellite data to complement topographic information has been suggested by several researchers to correct satellite data distortions arising from topographic variations of the landscape and to provide additional data for the precise delineation of landform units, which improves the mapping of natural resources. The elevation information available in the Survey of India toposheet (Srivastava and Saxena 2004) [5] or coarse-resolution Shuttle Radar Topographic Mission (SRTM) digital elevation model is inadequate for precise delineation of landforms, which is very important for cadastral-level soil mapping (Nagaraju *et al.*, 2014) [4]. The recent availability of digital elevation models in different forms and from different sources facilitates the 3D viewing of the landscape to enhance feature representation and the human perception of spatial entities (Nagaraju *et al.*, 2014) [4].
The aim of this study is to delineate the landforms of a watershed in the eastern plateau of Bastar with the help of high resolution DEM.

Materials and Methods

Study area

The present study area of Goriyabahar Nala Watershed in Jagdalpur block, Bastar district of Chhattisgarh state lies between 18° 55′ 17.54″ to 19° 06′ 2.82″ N latitude and 81° 57′ 41.32″ to 82° 07′ 18.67″ E longitude, surrounded by Jamawada and Babusemra villages & Kanger reserve forest to the east, Sargipal forest & Pandaripani, Biranpal, Kaknar and Chhindbahar villages to the west, Indravati River, Jagdalpur city, Hatguda and Dhurguda villages to the north and Kanger reserve forest to the South. The altitude of the watershed is ranges from 459-563 m above mean sea level (MSL). The study area falls under Garjat Hills, Dandakaranya and Eastern Ghats, hot moist sub-humid ecological sub region (ESR), with deep loamy red and lateritic soils, low to medium AWC and LGP 180-210 days with average mean annual rainfall of 1451 mm out of which, 70% received during southwest monsoon period (June-September). Geologically the area is very complex with varied formation. Oldest rocks Bengpal Group of Archaean age are exposed in the study area. They also occur as remnant inliers in the Dongargarh granite. Indravati Group of Meso to Neo Proterozoic age is divided into Tirathgarh and Jagdalpur formations comprises shale, sandstone, quartzite, sub-arkose and thin beds of conglomerate. Jagdalpur Formation is exposed in the study area and comprises granite/niess shale and limestone. Rice is the major crop of the region. Other important crops are minor millets, maize, black gram, horse gram, niger, toria, vegetables and fruits. The study area is dominated with tribal population, in general their economic condition is very poor and most of them are small farmers with fragmented land holdings.

Data used

In the study, open source 3-diamentional view ALOS-DEM is downloaded from USGS earth explorer was used to generate contour lines and elevation map of watershed using Arc GIS 10.1 software in 15 m interval. It imports altitude values from contours and produces a raster representation of elevation of the study area. Different land resource maps of the watershed *viz.* landforms and slope were prepared using the satellite data.

Remote sensing data interpretation

Based on the toposheet, ALOS-DEM was used to generate contour lines and elevation map of watershed using Arc GIS 10.1 software in 5 m interval. It imports altitude values from contours and produces a raster representation of elevation of the study area.

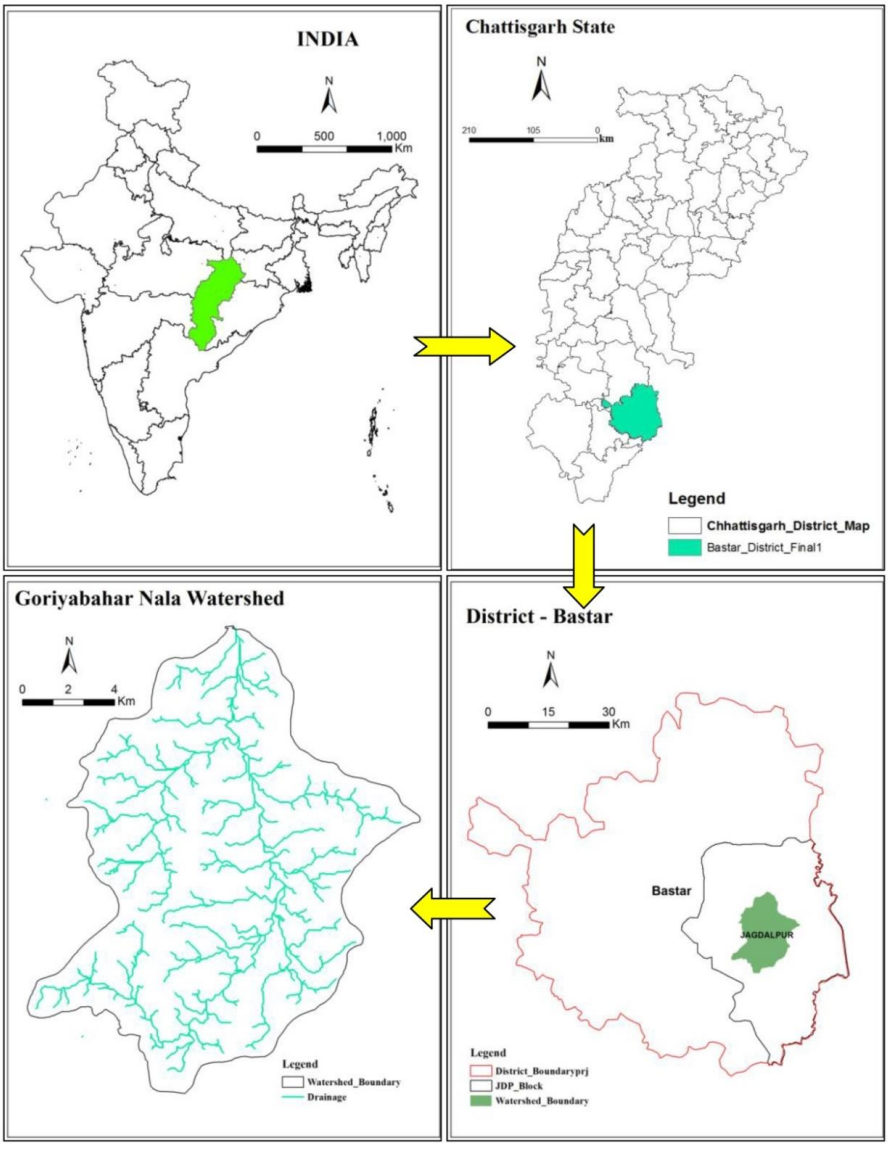

Fig 1: Chhattisgarh maps of the watershed

Landform delineation

Based on the various levels of elevations, contour lines in 5 m interval and other terrain features like slope, drainage hillshade etc. generate using ALOS-DEM of study area in Arc GIS 10.1 software. Altitude values imported from contour lines produces a raster representation of elevation. These elevation levels were visually interpreted systematically and delineated various landform units by on screen digitization in Arc GIS.

Results and Discussion

Slope

The slope information was derived from the ALOS-DEM (figure 2). After eliminating the speckle effects due to the high-resolution DEM, the raster slope map was reclassified into four slope classes, *viz*. very gently sloping (1– 3%), gently sloping (3–8%), moderately sloping (8-15%) and moderately steep sloping (15– 30%) (Table 1). Moderately slope class (8-15%) has largest coverage of about 5589.9 ha representing 30.7 per cent of watershed area followed by nearly level to very gentle slope slass (1-3%) and gentle sloping class (3-8%) account for 3811.0 ha and 3471.7 ha coverage area and representing 20.9 and 19.0 per cent respectively of the watershed. The moderately steep sloping (15-30%) class had lowest aerial coverage of about 2051.2 ha representing 11.2 per cent of the watershed. Overall it is observed that the moderately deep to seep soils occur on lands with lower slopes. The results are in close agreement with the findings reported by Ardak *et al.*, (2010) [3].

Landform delineation and characterization

Based on the contour lines at different elevations the study area is further classified into five groups of altitude *viz.* upto 480 m, 480-495 m, 495-510 m, 510-525 m and more than 525m above mean sea level (MSL) representing landform units of alluvial plains, undulating lowlands, undulating midlands, undulating uplands and subdued hills respectively, and two other landform units identified across the landscape namely upper valley and narrow valley (figure 2).

The subdued hills are the most elevated and very prone to soil erosion, rising above the common level of surrounding lands in the watershed and covering comparatively top portion of the hills and elevation ranges from 525-563 m above MSL. It comprises moderately sloping (8-15%) to moderately steep sloping (15-30%) forest, scrubland and cultivated lands and occupies 1408.11 ha (7.72 % of TGA) area of the watershed (Table 2).

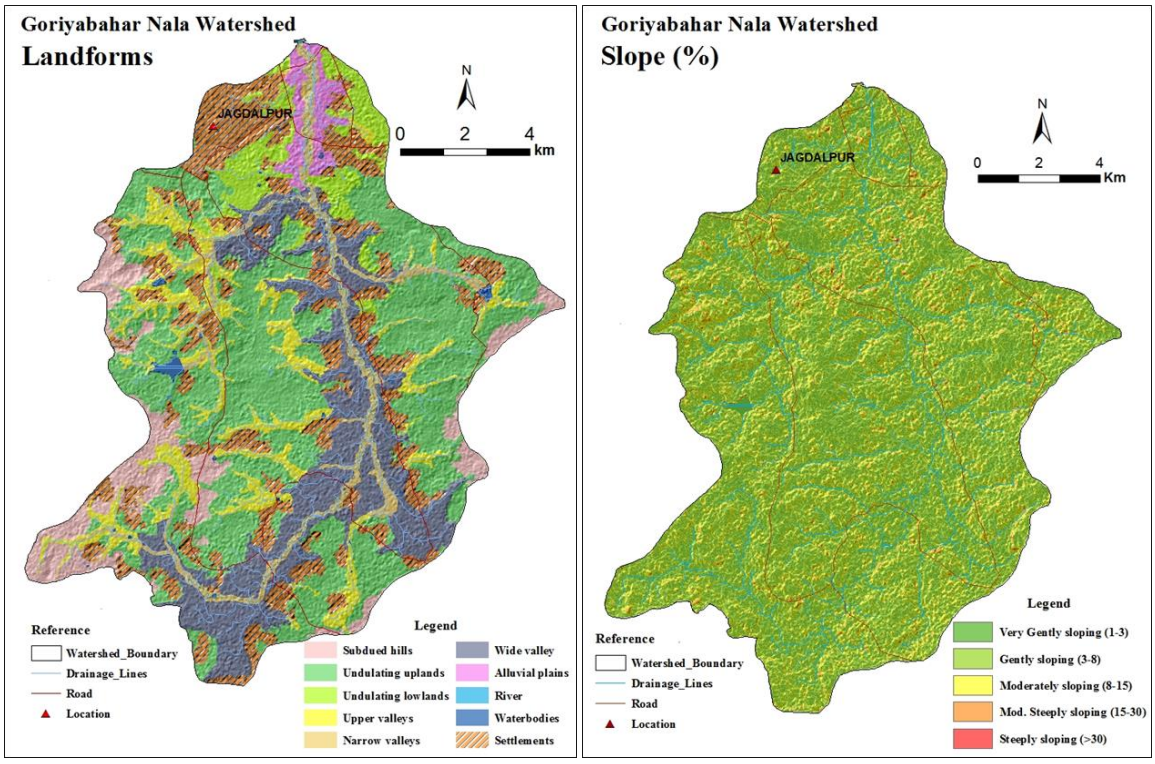

Fig 2: Landforms and slope maps of the watershed

Table 1: Extent and distribution of slope classes

S.N.	Slope class	Area (in ha)	% Area
1	Very gently sloping (1-3%)	4468.8	24.5
2	Gently sloping (3-8%)	7050.4	38.7
3	Moderately sloping (8-15%)	2975.4	16.3
4	Moderately steep slopping (15-30%)	429.1	2.4
5	River	57.7	0.3
6	Waterbodies	105.1	0.6
7	Settlements	3148.0	17.3
	Total	18234.5	100.0

Table 2: Extent and distribution of various landform units

S. No.	Landform unit	Area (in ha)	% Area
1	Subdued hills	1408.1	7.7
2	Undulating uplands	6488.6	35.6
3	Undulating lowlands	943.4	5.2
4	Upper valleys	1801.6	9.9
5	Narrow valleys	864.0	4.7
6	Wide valley	3032.0	16.6
7	Alluvial plains	386.1	2.1
8	River	57.7	0.3
9	Waterbodies	105.1	0.6
10	Settlements	3148.0	17.3
	Total	18234.5	100.0

Undulating uplands are elevated unbunded or partially bunded with small size bunds in a very little extent covering areas of moderately prone to erosion losses and elevation ranges from 510 to 525 m above MSL. It comprises gently sloping (3-8%) to moderately steep sloping (15-30%) forest, scrubland and cultivated lands and occupies 3809.2 ha (20.9 % of TGA) ranked largest area of landform in the watershed.

Undulating midlands cover 2nd largest area of the watershed occupying an area of 3734.0 ha representing 20.5 per cent of total watershed area and occur within an altitude range of 500-510 m above MSL with a slope variation from very gently sloping (1-3%) to moderately steep sloping (15-30%) lands.

Undulating lowlands occurred at a lower elevation in relation to the surrounding landscape in the watershed area with gently sloping and small, smooth hills and includes some parts of valleys of similar slope levels. Undulating lowland covers an area of 2844.6 ha representing 15.6 per cent of total watershed area and occur within an altitude range of 480-500 m above MSL with a slope variation from very gently sloping (1-3%) to moderately sloping (8-15%) lands.

Upper valley occurs mostly on the sides of the main drainage approaching to the higher elevated hill tops covering an area of 1863.6 ha representing 10.2 per cent of the watershed area with slope ranging from gently sloping (3-8%) to moderately sloping (8-15%) single cropped area. Narrow valley occurs mostly on the sides of the main drainage lines across the loandforms covering an area of 903.0 ha representing 5.0 per cent of the watershed area.

Alluvial plains occur in the central lower portion of the watershed between altitude of 470-480 m above MSL comprising most of the fertile and deep soils of the area. It occurs on very gently sloping (1-3%) lands in a very little extent covering an area of only 361.1 ha representing 1.98 per cent of total watershed area.

Conclusion

Watershed characterization plays a vital role in planning, implementation and development of ecologically and socio-economically sounds natural resource management systems. The present study was carried out in Goriyabahar Nala watershed, Jagdalpur block, Bastar district of Chhattisgarh state representing 12.1 AESR in Dandakaranya plateau, Eastern Ghats of peninsular India to characterize the landforms using remote sensing and GIS techniques. Seven landform units *viz*, subdued hills, undulating uplands, undulating lowlands, upper valley, narrow valley, wide valley and alluvial plains representing 7.7, 35.6. 5.2. 9.9, 4.7, 16.6 and 2.1 per cent of (18234.5 ha) of the watershed, respectively were delineated using ALOS data of digital elevation model on 1:10000 scale. The DEM were further used to delineate four slope classes namely very gently sloping (1-3% slope), gently sloping (3-8% slope) moderately sloping (8-15%) and moderately steeply sloping (15-30%) occupying an area of 4468.8, 7050.4, 2975.4 and 429.1 ha, respectively.

References

1. Ramteke IK, Sen TK, Singh SK, Reddy GPO, Rajankar PB, Das SN. Geospatial technologies in land resource inventory and management: a review. Int. J. Remote Sens. Geosci. (IJRSG), 2018; 7(1):8-19.
2. Reddy GPO, Maji AK, Srinivas CV, Velayutham M. Geomorphological analysis for inventory of degraded lands in a river basin of basaltic terrain, using remote sensing data and Geographical Information Systems. J. Indian Soc. Remote Sens. 2002; 30(1&2):15 -31.
3. Ardak SA, Nagaraju MSS, Prasad J, Srivastava R, Barthwal AK. Characterization and evaluation of land resources in Khapri village of Nagpur district, Maharashtra using high resolution satellite data and GIS. Agropedology, 2010; 20(1):7-18.
4. Nagaraju MSS, Kumar N, Shrivastava R, Das SN. Cadastral-level soil mapping in basaltic terrain using Cartosat-1 derived products. Int. J. Rem. Sens., 2014; 35(10):3764-3781.
5. Srivastava R, Saxena RK. Techniques of large-scale soil mapping in basaltic terrain using satellite remote sensing data. Int. J. Rem. Sens. 2004; 25(4):679-688.
6. Krishnamoorthy P, Govindarajan SV. Genesis and classification of associated red and black soils under Rajolibunda Diversion Irrigation scheme (Andhra Pradesh). J. Indian Soc. Soil Sci. 1977; 25:239-246.