International Journal of Advanced Biochemistry Research 2025; 9(2): 480-484

International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2025; 9(2): 480-484
www.biochemjournal.com
Received: 15-11-2024
Accepted: 20-12-2024

PS Butte
Department of Soil Science and Agricultural Chemistry, IGKV, Raipur, Chhattisgarh, India

NG Patil
ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, Maharashtra, India

K Tedia
Department of Soil Science and Agricultural Chemistry, IGKV, Raipur, Chhattisgarh, India

RK Naitam
ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, Maharashtra, India

MS Raghuwanshi
ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, Maharashtra, India

AO Shirale
ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, Maharashtra, India

VN Mishra
Department of Soil Science and Agricultural Chemistry, IGKV, Raipur, Chhattisgarh, India

PS Pakhare
ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, Maharashtra, India

BS Deshkar
ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, Maharashtra, India

Corresponding Author:
PS Butte
Department of Soil Science and Agricultural Chemistry, IGKV, Raipur, Chhattisgarh, India

Landform and land use mapping in the Boldagaon watershed, Hingoli district, Maharashtra, India using high-resolution remote sensing data

PS Butte, NG Patil, K Tedia, RK Naitam, MS Raghuwanshi, AO Shirale, VN Mishra, PS Pakhare and BS Deshkar

DOI: https://doi.org/10.33545/26174693.2025.v9.i2g.3845

Abstract
This study focuses on application of high-resolution remote sensing data for detailed landform and land use mapping in the Boldagaon watershed, located in Hingoli district, Maharashtra, India, covering an area of 11,092.85 hectares. Advanced geospatial techniques were utilized to analyze landforms and land use patterns for effective watershed management, sustainable land use planning, and resource conservation. Landform mapping was conducted using the ALOS PALSAR Digital Elevation Model (DEM) with a resolution of 12.5 meters, along with Resourcesat LISS-IV data and Survey of India (SOI) toposheets. Elevation, contour, hill-shade, slope, and drainage network maps derived from the DEM served as critical inputs for landform identification. Six landforms were delineated: plateau, escarpment, pediments, isolated mounds, narrow valley, and pediplains. Resourcesat LISS-IV data having 5.8 m resolution was also employed to map land use, identifying five categories: arable land, forest, wasteland, habitation, and waterbodies. The findings underscore the efficacy of high-resolution remote sensing in enhancing spatial analysis for resource planning in the Boldagaon watershed.

Keywords: Digital elevation model, landform, land use land cover, Resourcesat LISS-IV, watershed

Introduction

Managing land is an arduous challenge to ensure production, productivity, profitability, and food security. About 121 million hectares area of India (37% of the total geographical area) are affected by various kinds of degradation (ICAR NAAS, 2010) [3]. The situation is expected to worsen in the wake of weather aberrations/climate change. Such a situation in the face of foodgrain production target of about 455 million tons in 2050 from the present level of about 257 million tons (Kathpalia and Kapoor, 2010) [4], is an arduous task for the country to nourish the rising population estimated to be 1.6 billion in 2050 from the current level of 1.2 billion. Again, by 2050, per capita land holding will go down to an abysmally low 0.087 ha, posing a serious concern. In 2050, crop land available for production may be reduced by 20 percent due to land degradation, urban expansion and conversion of crop land to non-food production (Sharma, 2006) [9]. The situation will be more precarious due to the scarcity of water. The present water availability for the country is around 2000 BCM which will go down to 1500 BCM by 2050 thus downscaling India from a status of water sufficiency to water scarcity (Amarsinghe *et al.*, 2007) [1].

Landform and LULC mapping forms the base for natural resource management. The accuracy of a soil map largely depends on how precisely and accurately the landform units are delineated. It is based on understanding the landform-regolith soil pattern and it typically presents empirical rules relating land forms to soil classes (Mcleod *et al.*, 1995) [5]. Further, LULC analysis helps policymakers to understand environmental change to ensure sustainable development.

In recent years, high-resolution DEMs and satellite remote sensing data have given a credible source of information to delineate and generate a comprehensive inventory of landform units and soils (Reddy *et al.*, 2013; Nagaraju *et al.*, 2014) [8, 6]. Satellite remote sensing and GIS techniques are being effectively used in determining the quantitative description of the terrain features and landform mapping (Chattaraj *et al.*, 2017) [2]. Digital image processing enables speedy and accurate interpretation of multispectral multisensory /multidate digital data received from remote sensing satellites (Radhakrishnan *et al.*, 1992) [7]. The study aims to delineate the landforms and land use land cover of Boldagaon watershed, Hingoli district, Maharashtra with the help DEM and satellite data.

Materials and Methods

Study area

The Boldagaon watershed lies in the southern part of the Hingoli district, Maharashtra, India. It extends from 19.4711 to 19.5762°N latitude and 77.1687 and 77.3223°E longitude covering an area of 11092.85 ha. Geologically, the study area belongs to the Deccan trap formation, represented by almost horizontal lava flows of basaltic composition, which were emplaced from fissures towards the close of the Mesozoic era (i.e., late Cretaceous) onto the lower Tertiary era (early Eocene). The minimum temperature of the district is 14.4 °C and the maximum temperature is 40.3 °C. The average annual rainfall is 737 mm.

Data used

Open-source Digital Elevation Model (DEM) ALOS PALSAR 12.5 m was used for landform mapping, which was downloaded from the website https://earthdata.nasa.gov/eosdis/daacs/asf. The landforms were delineated using the DEM, contour map, drainage, and hill shade map. At the initial stage, the broad landscapes were identified for systematic mapping of landforms. Geological Survey of India (GSI) was used as the base to delineate the broad geological formations. The area is mainly formed by Deccan trap formation represented by basaltic composition. For LULC mapping, IRS Resoursat-2A LISS IV data with 5.8 meter spatial resolution was downloaded from Bhoonidhi and used to delineate the land uses in the watershed.

Remote sensing data interpretation

Landform delineation was carried out by analyzing various elevation levels, contour lines at 10-meter intervals, and other terrain features such as slope, drainage, and hillshade, generated using ALOS-DEM in ArcGIS 10.5 software. Different landform units were delineated through on-screen digitization in ArcGIS. The Resourcesat 2A LISS-IV data (5.8 m resolution) was used for delineating the land use classes. The object-based classification with maximum likelihood was carried out to identify and delineate the major land uses. The map was further refined by visual digitization. The Google Earth image was also used for reference.

Results and Discussion

Landform mapping

The landform map is prepared with the help of ALOS PALSAR 12.5 m resolution DEM along with Resourcesat LISS-IV data and SOI toposheet. The database *viz.* elevations (Fig. 1), contours (Fig. 2), hill-shades (Fig. 3), drainage network (Fig. 4), and slopes (Fig. 5) derived from the DEM were used to identify and delineate the landforms.

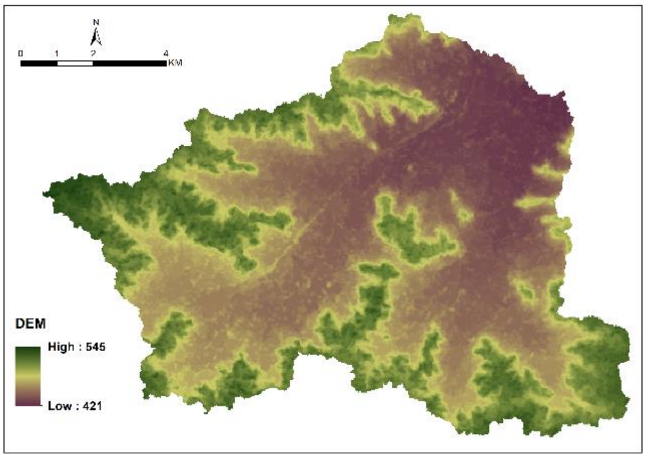

Fig 1: DEM of Boldagaon watershed, Hingoli district, Maharashtra

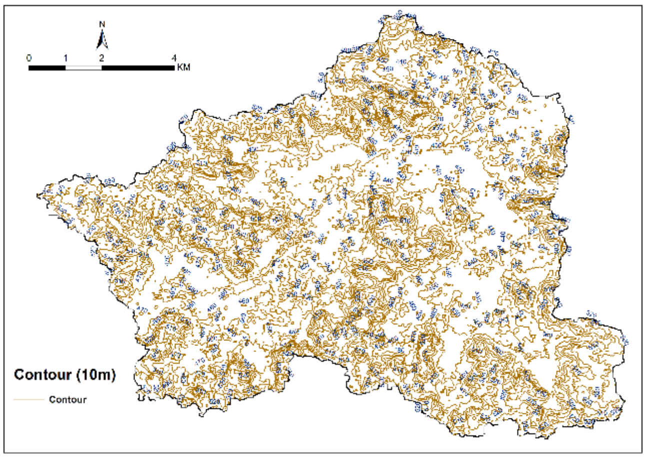

Fig 2: Contour map (10 m) of Boldagaon watershed, Hingoli district, Maharashtra

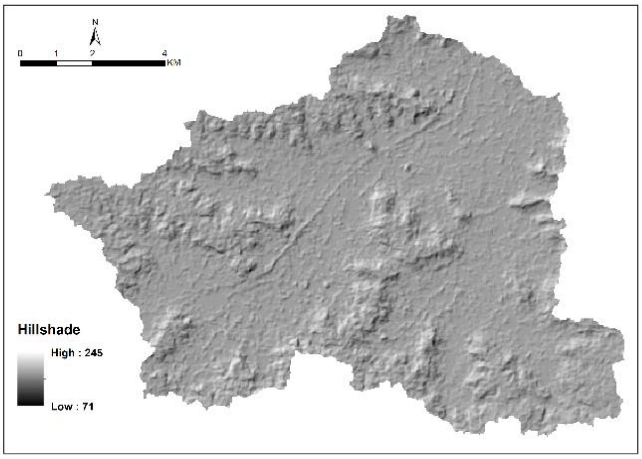

Fig 3: Hillshade map of Boldagaon watershed, Hingoli district, Maharashtra

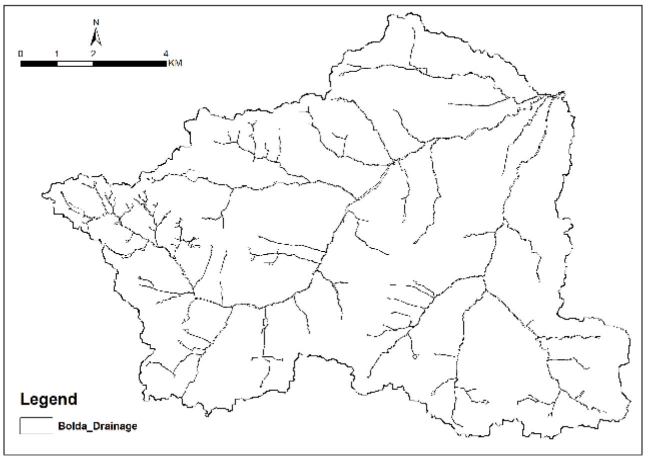

Fig 4: Drainage map of Boldagaon watershed, Hingoli district, Maharashtra

A total of eight slope classes were identified and mapped in the watershed viz. level to nearly level (0-1%), very gently sloping (1-3%), gently sloping (3-5%), moderately sloping (5-10%), moderately steeply (10-15%), steeply sloping (15-25%), very steeply sloping (25-33%), strongly sloping (33-50%) representing 7.53, 56.36, 5.64, 3.51, 0.86, 3.71, 2.63,18.19 percent of total geographical area of the watershed, respectively (Table 1 and Fig. 5).

Table 1: Area under different slope classes in Boldagaon watershed

Slope Class (%)	Area (ha)	% TGA
Level to nearly level (0-1)	834.81	7.53
Very gently sloping (1-3)	6251.71	56.36
Gently sloping (3-5)	626.18	5.64
Moderately sloping (5-10)	389.27	3.51
Moderately steeply (10-15)	95.76	0.86
Steeply sloping (15-25)	411.24	3.71
Very steeply sloping (25-33)	292.21	2.63
Strongly sloping (33-50)	2017.43	18.19
Habitation	91.78	0.83
Waterbody	82.46	0.74
Total Geographical Area	11092.85	100.00

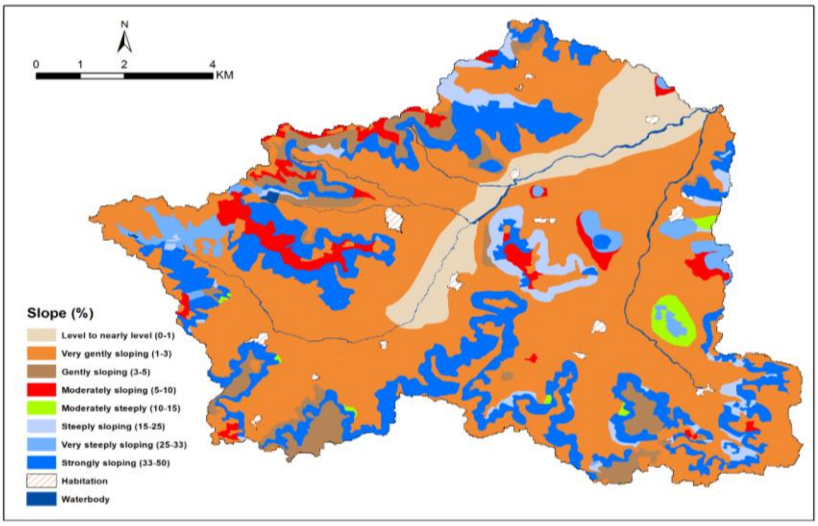

Fig 5: Slope map of Boldagaon watershed, Hingoli district, Maharashtra

Six landforms were identified *viz.* plateau, escarpment, pediments, isolated mounds, narrow valley, and pediplains. The landform map is presented in Figure 6 and their spatial extent is detailed in Table 2. The landforms were validated through ground truthing. A brief description of each landform is provided below

- **Plateau:** The plateaus are highly elevated areas of the watershed with elevations ranging from 480 to 545 m above MSL. The slope of the plateau ranges from very gently (1-3%) to moderately sloping (5-10%). The area occupied by plateau is 1776.67 ha representing 16.02 percent of the total geographical area (TGA) of the watershed. Very gently sloping plateaus are under cultivation. Gently to moderately sloping plateaus are mostly under forest cover and wasteland.
- **Escarpment:** The steep to very strongly sloping escarpments occupy 2523.82 ha representing 22.75 percent of TGA. The escarpments are mostly under forest with patches of cultivated and wastelands. The elevation ranges from 425 to 541 m above MSL.
- **Isolated Mounds:** Isolated mounds are moderately steep to very strongly sloping and are mostly under forest and wasteland with patches of agriculture on a comparatively low slope gradient. The elevation ranges from 431 to 508 m above MSL. Mounds occupy 292.81 ha area (2.65% of TGA).
- **Pediments:** The pediments are very gently to moderately sloping and mostly under agriculture comprising 3414.81 ha area representing 30.78% of the TGA. The elevation ranges from 422 to 521 m above MSL. The gently to moderately sloping pediments (Upper Pediments) adjacent to hills are under rainfed agriculture. The very gently sloping pediments (Lower Pediments) have irrigation facilities at some places through groundwater irrigation and can sustain two crops per year.
- **Narrow Valley:** Narrow valleys occur at an elevation ranging from 435 to 494 m above MSL with an area of 902.23 ha representing 8.13 percent of the TGA. Valleys are very gently sloping and are mostly under double crop.
- **Pediplain:** Pediplains are at the lowermost elevation ranging from 421 to 481 m above MSL. They occupy an area of 2008.27 ha (18.10% of TGA). Pediplains are nearly level (0-1%) to very gently sloping (1-3%) and are mostly under double crop.

Table 2: Area under different landforms in Boldagaon watershed, Hingoli district, Maharashtra

Landform	Area (ha)	% of TGA
Plateau	1776.67	16.02
Escarpment	2523.82	22.75
Isolated Mounds	292.81	2.65
Pediments	3414.81	30.78
Narrow valley	902.23	8.13
Pediplains	2008.27	18.10
Habitation	91.78	0.83
Waterbody	82.46	0.74
Total Geographical Area	11092.85	100.00

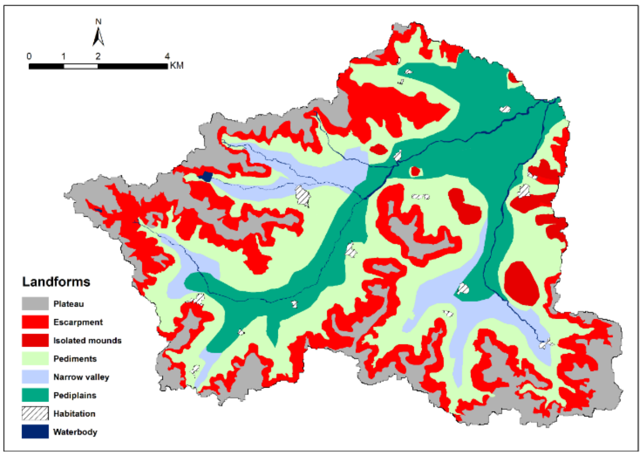

Fig 6: Landform map of Boldagaon Watershed, Hingoli district, Maharashtra

Land Use Land Cover Mapping

The LULC map was derived from Resourcesat-2A LISS-IV data (5.8 m resolution) using object-based classification with the maximum likelihood method and onscreen digitization. Five major land use categories were identified: arable land, forest, wasteland, habitation, and waterbodies. The spatial distribution of these land use classes is illustrated in Figure 7, with detailed area statistics provided in Table 3. A brief description of each land use category is presented below:

- **Arable land:** The arable lands are concentrated in nearly level to moderately sloping pediplains, valleys and pediments. Most of the areas in pediplains are under double crop. Very gently to moderately sloping plateaus are also under cultivation. Patches of cultivation were also mapped in moderately steeply sloping mounds and steeply sloping escarpments. Arable land occupies 7813.72 ha area representing 70.44 percent of TGA.
- **Forest:** Forest cover occurs mostly in gently to moderately sloping plateau, very steeply to very strongly sloping escarpments and isolated mounds covering an area of 2702.66 ha comprising 24.36 percent of TGA.
- **Wasteland:** The wastelands occur in moderately sloping plateau, very steeply sloping escarpment and mounds and moderately sloping pediments occupying an area of 402.23 ha representing 3.63 percent of TGA. The wastelands in the plateau and escarpment are mostly deforested and abandoned from agriculture due to low productivity and wildlife depredation.
- **Habitation and Waterbody:** The habitation and waterbody class occupies 91.78 and 82.46 ha area representing 0.83 and 0.74 percent area of the watershed.

Table 3: Area under different land uses in Boldagaon watershed

Land use	Area (ha)	% TGA
Arable land	7813.72	70.44
Forest	2702.66	24.36
Wasteland	402.23	3.63
Habitation	91.78	0.83
Waterbody	82.46	0.74
Total Geographical Area	11092.85	100.00

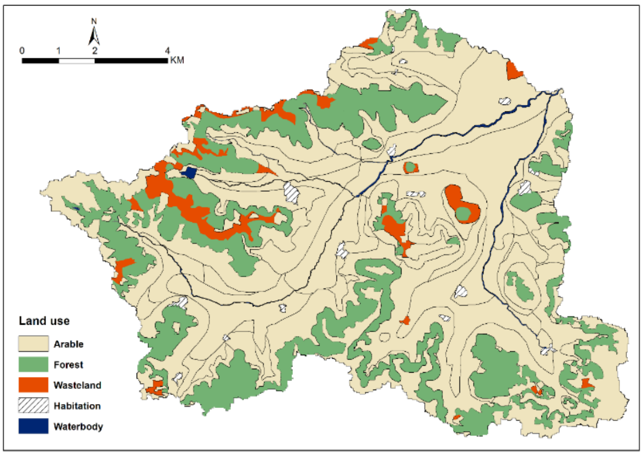

Fig 7: Land use map of Boldagaon watershed, Hingoli district, Maharashtra

Conclusion

The landform map of the Boldagaon watershed in Hingoli district, Maharashtra, was created using ALOS PALSAR data with a 12.5 m resolution. Six distinct landforms were identified and mapped within the watershed: plateau (16.02%), escarpment (22.75%), isolated mounds (2.65%), pediments (30.78%), narrow valley (8.13%), and pediplains (18.1%). Additionally, eight slope classes were mapped across the watershed. The land use land cover (LULC) map was developed using Resourcesat-2A LISS-IV data (5.8 m resolution), identifying five major land use categories: arable land (70.44%), forest and wasteland (24.36%), habitation (3.63%), and waterbodies (0.74%). Both the landform and LULC maps were validated through field-based ground truthing. This comprehensive mapping provides critical insights into the interrelationships between landforms, slope gradients, elevation, and land use, offering valuable guidance for sustainable watershed management and effective land use planning.

References

1. Amarsinghe UA, Shah T, Anand BK. India's water supply and demand from 2025-2050: Business-as-usual scenario and issues. IWMI, India. 2007;1-39.
2. Chattaraj S, Srivastava R, Barthwal AK, Giri JD, Mohekar DS, Reddy GPO, Daripa A, Chatterji S, Singh SK. Semi-automated object-based landform classification modelling in a part of Deccan Plateau of Central India. International Journal of Remote Sensing. 2017;38(17):4855-4867.
3. ICAR-NAAS. Degraded and wastelands of India. New Delhi: Indian Council of Agricultural Research; 2010. p.158.

4. Kathpalia GN, Kapoor R. Management of land and other resources for inclusive growth: India 2050. 2010.
5. McLeod M, Rijikse WC, Dymond JR. A soil-landscape model for close jointed mudstone, East Cape, North Island, New Zealand. Australian Journal of Soil Science. 1995;33:3.
6. Nagaraju MSS, Kumar N, Srivastava R, Das SN. Cadastral level soil mapping in basaltic terrain using Cartosat-1 derived products. International Journal of Remote Sensing. 2014;35(10):3764-3781.
7. Radhakrishnan K, Vardhan G, Diwakar PG. Digital image processing technique-An overview. In: Karale RL, editor. Natural Resource Management-A view perspective. NNRMS, Bangalore; 1992. p. 66-87.
8. Reddy GPO, Nagaraju MSS, Ramteke IK, Sarkar D. Terrain characterization for soil resource mapping in part of semi-arid tract of Central India using high-resolution satellite data and GIS. Journal of the Indian Society of Remote Sensing. 2013;41(2):331-343.
9. Sharma N. Population and economic growth as drivers of future land use in India. In: Browser F, McCarl BA, editors. Agriculture and Climate beyond 2015. Springer; 2006. p. 131-146.