International Journal of Research Studies on Environment, Earth, and Allied Sciences (IJRSEAS)
| *Volume-3 Issue-1* | *February-2026* | *ISSN: 3066-0637* | *Website:* https://eesrd.us

Manuscript ID:
IJRSEAS-2026-030124

OPEN ACCESS

Quick Response Code:

Website: https://eesrd.us

DOI: 10.5281/zenodo.21554812

DOI Link:
https://doi.org/10.5281/zenodo.21554812

Volume: 3

Issue: 1

Pp. 116-120

Month: February

Year: 2026

E-ISSN: 3066-0637

Submitted: 16 Jan. 2026

Revised: 27 Jan. 2026

Accepted: 10 Feb. 2026

Published: 28 Feb. 2026

Address for correspondence:
Kattimani Pooja Tukaram
Research Student, D. B. F. Dayanand College of Arts and Science
Email:
poojakattimani349@gmail.com

How to cite this article:
Shinde, N. G. & Kattimani, P. T. (2026). Geomorphological Analysis of the Nira River Basin Terrain Using Contour Length Characteristics: A Case Study. International Journal of Research Studies on Environment, Earth, and Allied Sciences, 3(1), 116–120. https://doi.org/10.5281/zenodo.21554812

Geomorphological Analysis of the Nira River Basin Terrain Using Contour Length Characteristics: A Case Study

Dr. Shinde Namdeo Gorakh[1], Kattimani Pooja Tukaram[2]
[1]Professor and Head, Department of Geography, D. B. F. Dayanand College of Arts and Science
[2]Research Student, D. B. F. Dayanand College of Arts and Science

Abstract

The Nira River Basin is an important tributary of the Bhima River and is located in the western part of Maharashtra. The basin shows clear variations in landform, slope, and relief because of differences in height, rock structure, and natural processes. These geomorphological conditions directly affect land use patterns, agricultural activities, drainage development, and human settlements in the region. The main purpose of the present study is to analyze the geomorphological characteristics of the Nira River Basin terrain using contour length characteristics with the support of GIS and remote sensing techniques. The basin covers an area of about 8,580.4 square kilometers and extends from the steep, rugged Sahyadri hill ranges in the western part to the gently sloping plains of the Deccan Plateau in the eastern part. On the basis of contour length analysis, the terrain of the basin has been classified into four categories, namely short, moderate, long, and very long contour lengths. These categories clearly explain the variation in slope and relief conditions across the basin. Short contour lengths represent steep slopes and highly dissected hilly terrain, while moderate contour lengths indicate undulating plateau regions. Long and very long contour lengths show gentle slopes, plains, and broad valley floors, which are more suitable for agriculture and settlements. Geologically, the basin is mainly composed of basaltic lava flows of the Deccan Traps. This geological structure plays an important role in controlling drainage patterns, soil formation, erosion processes, and groundwater availability in the basin. The application of contour length data along with geospatial techniques provides a simple and effective way to understand the spatial variation of geomorphological features in the Nira River Basin. This study clearly shows that contour length analysis is very useful for understanding slope and relief conditions of the basin. The results of this study are helpful for watershed planning, agricultural development, water resource management, and sustainable regional development in the Nira River Basin.

Keywords: *Geomorphology, Nira River Basin, Contour Length, Terrain Analysis, GIS, Remote Sensing*

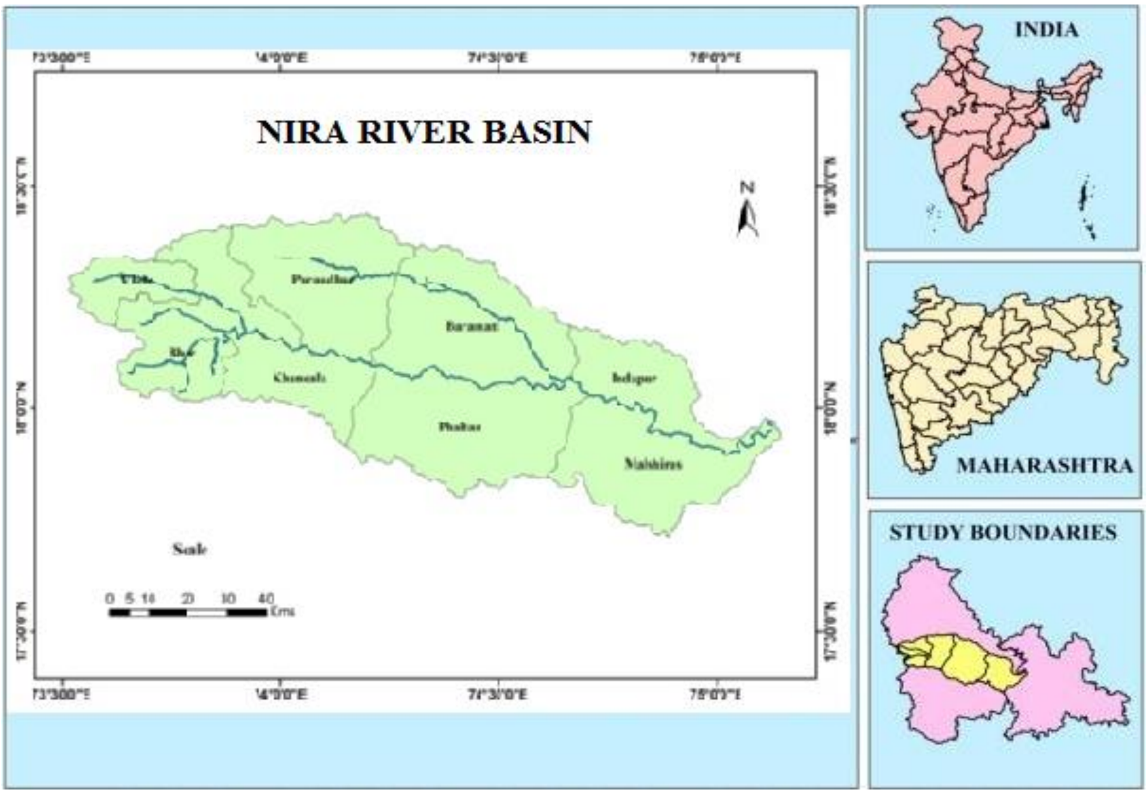
Introduction

Geomorphology is a branch of physical geography that studies landforms, their origin, evolution, and the processes that shape the Earth's surface. Rivers play a crucial role in modifying landforms through erosion, transportation, and deposition of materials. Therefore, river basins serve as ideal units for geomorphological studies, as they clearly demonstrate the combined influence of geological structure, climate, slope, and drainage characteristics. Understanding the geomorphological characteristics of a river basin is essential for proper planning and management of land, water, and other natural resources. In recent times, geomorphological studies have increasingly utilized quantitative and geospatial techniques to analyze terrain characteristics. Among these techniques, contour line analysis is a simple and reliable method for understanding slope, relief, and surface morphology. Contour lines represent lines of equal elevation on topographic maps, and their spacing and length provide valuable information about the terrain. Short and closely spaced contour lines indicate steep slopes and rugged topography, while long and widely spaced contour lines indicate gentle slopes and flat areas. Thus, contour line length characteristics serve as an effective indicator for identifying variations in terrain and geomorphological conditions within a river basin. The Nira River basin, a significant sub-basin of the Bhima River system in Western Maharashtra, exhibits a diverse range of geomorphological features. This basin extends from the steeply sloping and heavily eroded Sahyadri mountain ranges in the west to the gently sloping plains of the Deccan Plateau in the east. The undulating topography, slopes, and variations in elevation make the Nira River basin suitable for in-depth geomorphological analysis. This basin supports agriculture, irrigation, settlements, and various economic activities, all of which are significantly influenced by the characteristics of the terrain and landforms.

The development of Geographic Information Systems (GIS) and remote sensing technologies has greatly improved the accuracy and efficiency of geomorphological studies. GIS allows for the systematic analysis of terrain characteristics by integrating contour line data, digital elevation models, and other spatial datasets. In this study, contour length characteristics derived from topographic maps of the Survey of India and supported by DEM data have been used to understand the spatial variations in slope and undulation within the Nira River basin.

Study Area

The Nira River Basin is an important sub-basin of the Bhima River system located in western Maharashtra. The river originates near Veruli village in Bhor taluka of Pune district on the eastern slopes of the Sahyadri hills at an elevation of about 1,210 meters and flows eastward to join the Bhima River near Nira Narsingpur in Malshiras taluka. The basin covers an area of about 8,580.4 square kilometers and lies between 17°47′ N to 18°18′ N latitudes and 73°40′ E to 75°11′ E longitudes. The basin falls under a semi-arid tropical climate with rainfall decreasing from west to east. The western part receives high rainfall (1,000–1,200 mm), while the eastern region receives low rainfall (400–600 mm). Physiographically, the basin consists of rugged Sahyadri hills in the west, a moderately sloping plateau in the central part, and gently sloping plains in the east. Geologically, the basin is underlain by Deccan Trap basalt. Major tributaries of the Nira River include the Karha, Shivganga, Mandki, and Gunjawani rivers. The basin extends over several talukas of Pune and Solapur districts and includes more than 80 villages. The Nira River Basin is important for agriculture, irrigation, drinking water supply, and rural livelihoods and is suitable for geomorphological and geospatial analysis due to its varied terrain and climatic conditions.



Objectives Of the Study

1. To analyze the geomorphological characteristics of the Nira River Basin using contour length data.
2. To classify contour lengths into different categories in order to understand variations in terrain and relief.
3. To examine slope and relief conditions of the basin based on contour length characteristics.

Database And Methodology

In the present research study, both primary geospatial data and secondary sources were used to study the geomorphological characteristics of the Nira River Basin, with special focus on contour length characteristics. Geographic Information System (GIS) techniques were used for data processing, analysis, and preparation of maps. The main primary data used in this study were contour lines obtained from Survey of India (SOI) topographic maps at a scale of 1:50,000. These topographic maps were first scanned and then georeferenced in ArcGIS software. After georeferencing, the contour lines were digitized to create a contour database. From this contour data, the length of each contour line (Shape_Length) was calculated, which forms the basic database for the geomorphological analysis of the basin. Along with contour data, a 30-meter resolution Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) was also used to support terrain analysis. The DEM helped in understanding elevation variation and was used for preparing slope and relief information. The basin boundary of the Nira River was delineated using hydrological tools in ArcGIS, such as flow direction and flow accumulation, which were generated from the DEM. The contour length data were divided into four categories, namely short, moderate, long, and very long contour lengths, to clearly understand variations in slope, relief, and terrain conditions. Short contour lengths generally represent steep slopes and rugged terrain, while long and very long contour lengths indicate gentle slopes, plains, and valley floor areas. Statistical calculations were carried out to find the frequency, total contour length, and percentage contribution of each contour length class. Slope and relief maps were prepared using surface analysis tools available in ArcGIS software. The spatial distribution of different contour length classes was then studied to identify various geomorphological zones within the Nira River Basin. These zones helped in understanding the nature of terrain and relief variation across the basin. Finally, thematic maps, tables, and graphs were prepared to present the spatial and numerical distribution of contour length characteristics.

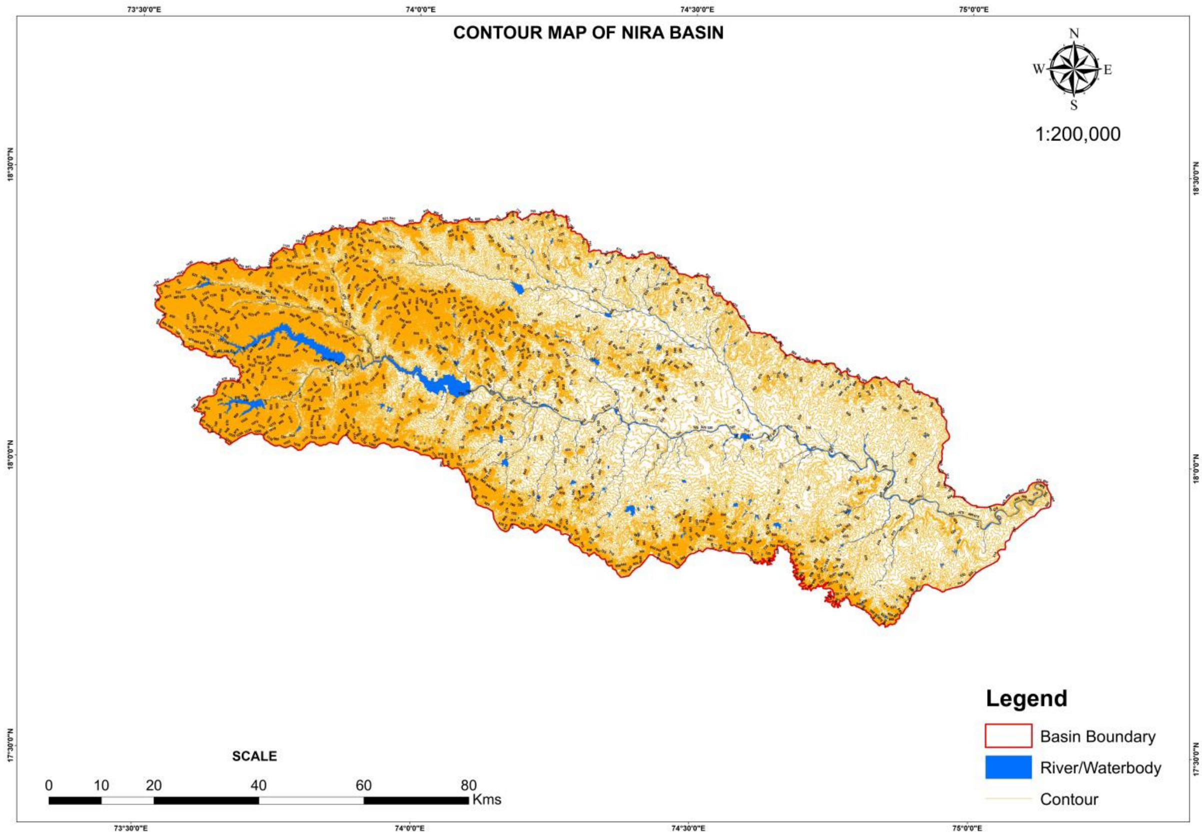
Data Discussion

The geomorphological characteristics of the Nira River Basin were studied using contour length data, as contour length is a very useful indicator for understanding terrain variation, slope conditions, and relief characteristics. The analysis of contour length helps in identifying whether the land surface is steep, moderate, or gentle. By classifying the contour lengths into four categories short, moderate, long, and very long,it becomes easier to understand the spatial variation of landforms and the geomorphological processes operating in different parts of the basin. This classification clearly shows how the terrain changes from the western hilly region to the eastern plain areas.

Table 1
Classification Of Contour Length Based on Nira River Basin Terrain

Sr. No.	Contour Length Class	Shape Length Range (meters)	Number of Contour Segments	Percentage (%)
1	Short Contours	< 500	650	31.74
2	Moderate Contours	500 – 2,000	684	33.40
3	Long Contours	2,000 – 5,000	329	16.06
4	Very Long Contours	> 5,000	385	18.80
Total			2,048	100

Source: Compiled by Researcher, 2025



The analysis reveals that short contour lengths (< 500) include 650 contour segments, which account for 31.74 percent of the total frequency. These short contours are mainly linked with steep slopes and highly dissected terrain. Such terrain conditions are mostly found in the western part of the Nira River Basin, especially in the Sahyadri hill ranges. In these areas, elevation changes rapidly over short distances, which results in closely spaced and short contour lines. This reflects rugged topography, high relief, and strong erosional activity. Surface runoff is very high in these regions due to steep slopes, leading to soil erosion and limited infiltration. As a result, these areas are less suitable for intensive agriculture and are more appropriate for forest cover, watershed conservation, and soil and water management practices.

The moderate contour length class (500–2,000) shows the highest frequency, with 684 contour segments, contributing 33.40 percent of the total. This class represents moderately steep slopes and undulating relief, which are commonly observed in the central plateau region of the basin. The terrain in this zone shows gradual elevation changes and is less rugged than the western hilly areas. Moderate contour lengths indicate balanced slope conditions where both surface runoff and infiltration occur. These conditions support mixed land use, including agriculture, settlements, and grazing. The dominance of this class clearly indicates that a large portion of the Nira River Basin lies in a transitional zone between the steep hill slopes of the west and the gentle plains of the east.

The long contour length class (2,000–5,000) consists of 329 contour segments, accounting for 16.06 percent of the total frequency. These contours indicate gentle slopes and low relief areas. Such terrain conditions are mainly observed in the eastern and south-eastern parts of the basin. The longer contour lines suggest that elevation changes occur slowly over larger distances, resulting in smoother land surfaces. These gentle slopes reduce surface runoff and promote better water retention and groundwater recharge. Due to these favorable conditions, these areas are highly suitable for agriculture, particularly irrigated farming, and also support well-developed rural settlements.

The very long contour length class (> 5,000) includes 385 contour segments, representing 18.80 percent of the total frequency. Although the number of contours in this class is lower than in the moderate class, it contributes the maximum total contour length (5,520,587). This clearly indicates the presence of extensive flat and very gently sloping surfaces, such as plains and valley floors. These areas are mainly located in the downstream and eastern parts of the basin. The flat terrain allows slow movement of water, increased sediment deposition, and better soil moisture conditions. As a result, these regions are highly favorable for intensive agriculture, irrigation networks, and major human settlements, playing a key role in the socio-economic development of the basin.

Generally, the contour length analysis clearly shows that the Nira River Basin has diverse geomorphological conditions, ranging from steep and rugged terrain in the western part to gentle and low-relief plains in the eastern part. The systematic variation in contour length reflects changes in slope and relief across the basin. This analysis successfully fulfills the objectives of studying geomorphological characteristics, classifying terrain types, and examining slope and relief conditions of the Nira River Basin using contour length data, and provides a strong base for land use planning and watershed management.

Conclusion

The present study clearly demonstrates that contour line length analysis is an effective method for understanding the geomorphic characteristics of the Nira River basin. Using GIS technology and contour line data, the basin was analyzed and classified into four contour line length categories short, medium, long, and very long which helped in identifying variations in topography, slope, and relief across the entire basin. The analysis reveals that short contour line lengths (< 500) are found in 650 contour segments (31.74%), primarily in the Western Sahyadri region, indicating steep slopes and highly dissected terrain. The medium contour line length category (500–2,000) is the most dominant, comprising 684 contour lines (33.40%), representing undulating and moderately sloping terrain in the central plateau region. Long contour line lengths (2,000–5,000) include 329 contour lines (16.06%) and represent areas of gentle slopes and low relief, which are primarily suitable for agriculture and settlements. Although very long contour line lengths (> 5,000) are fewer in number (385 contour lines or 18.80%), they contribute the most to the total contour line length (5,520,587), clearly indicating the extensive plains and valley bottom areas in the eastern and downstream parts of the basin. Overall, the contour line length analysis reveals a clear west-east transition from rugged, undulating terrain to gentle, low-relief plains. This study successfully fulfills its objectives and provides a strong scientific basis for land use planning, watershed management, and sustainable development in the Nira river basin.

Acknowledgment

The authors express their sincere gratitude to the Principal and Management of D.B.F. Dayanand College of Arts and **Science** for providing the necessary academic support and facilities to carry out this research work. Special thanks are extended to the Department of Geography for its encouragement and guidance throughout the study.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Chorley, R. J., Schumm, S. A., & Sugden, D. E. (1984). Geomorphology. Methuen, London.
2. Thornbury, W. D. (1969). Principles of Geomorphology. Wiley Eastern, New Delhi.
3. Strahler, A. N. (1964). Quantitative Geomorphology of Drainage Basins and Channel Networks. Handbook of Applied Hydrology, McGraw-Hill, New York.
4. Horton, R. E. (1945). Erosional development of streams and their drainage basins. Geological Society of America Bulletin, 56, 275–370.
5. Schumm, S. A. (1977). The Fluvial System. Wiley-Interscience, New York.

6. Singh, R. L. (2009). India: A Regional Geography. National Geographical Society of India, Varanasi.
7. Clarke, J. I. (1972). Population Geography. Pergamon Press, Oxford.
8. Jensen, J. R. (2005). Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson Education, New Delhi.
9. Burrough, P. A., & McDonnell, R. A. (1998). Principles of Geographical Information Systems. Oxford University Press, Oxford.
10. ESRI (2018). ArcGIS Desktop: Release 10.x. Environmental Systems Research Institute, Redlands, California.
11. Survey of India (SOI). (2010). Topographical Maps (1:50,000 Scale). Government of India, Dehradun.
12. Shuttle Radar Topography Mission (SRTM). (2015). Digital Elevation Model (30 m Resolution). USGS.
13. Leopold, L. B., Wolman, M. G., & Miller, J. P. (1964). Fluvial Processes in Geomorphology. W.H. Freeman, San Francisco.
14. NBSS & LUP (2014). Soil Resource Atlas of Maharashtra. ICAR, Nagpur.
15. Government of India (2011). Census of India 2011. Office of the Registrar General and Census Commissioner, New Delhi.