Morphotectonic Analysis of the Muchkundi River Basin, Ratnagiri District, Maharashtra, India: A Remote Sensing and GIS Approach.

Pratiksha P. Bagul*, Omkar Parab and Milind A. Herlekar

Department of Geology, Savitribai Phule Pune University, Pune, 411007 India.

(*Corresponding author, E-mail: pratikshapbagul@gmail.com)

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Abstract

The Muchkundi River basin is located on the Central West Coast of India, in Ratnagiri district, Maharashtra. Remote sensing techniques using IRS-P6 satellite images are useful tools for morphotectonic analysis of a drainage basin. To assess the tectonic activity in the Muchkundi River basin area, various morphometric indices, including the Sinuosity index, Stream length gradient index (Sl), Hypsometric analysis and integral (HI), and Drainage basin asymmetry, are applied. Morphotectonic study of a drainage basin involves significant measurement and numerical analysis of linear, areal, and relief parameters related to the basin using satellite images. The morphotectonic parameters carried out, bifurcation ratio, drainage density, channel maintenance constant, stream frequency, stream length, form factor, circulatory ratio, elongation ratio, and hypsometric analysis.
The bifurcation ratio of the basin indicates that it is a structurally controlled drainage basin. Poor stream frequency values suggest permeable subsurface material and low relief. Also, the basin is elongated having a fine drainage texture which indicates a higher susceptibility to moderate to severe flooding and increased sediment transport in the river system. The Muchkundi river basin features a very steep slope and is highly dissected. Basin relief is a key factor in understanding erosional characteristics and influences the development of landforms. High hypsometric integral values indicate deep incision and rugged topography. Intermediate and low values of the integral are associated with more evenly dissected drainage basins. An asymmetry factor significantly less than 50 suggests tectonic tilt in SSW direction.

1. Introduction

Morphometric and hypsometric analyses play a crucial role in understanding landscape evolution and in the sustainable management of river basins. These analyses are essential tools for implementing soil and water conservation measures, erosion control strategies, and overall watershed development (Bagyaraj and Gurugnanam, 2011). Morphometric parameters—including linear, areal, geometric, and relief aspects—help decode the structure and evolution of drainage basins. A fundamental concept in morphometry is that the shape and characteristics of a drainage basin reflect the geological and geomorphological processes acting over time (Horton, 1945; Strahler, 1952, 1964; Chorley et al., 1984; Ohmori, 1993). Morphotectonic indices such as the asymmetry factor, stream length-gradient index, transverse topographic symmetry, mountain front sinuosity, and the valley floor width-to-height ratio are increasingly employed as reconnaissance tools to assess the influence of tectonics on drainage morphology (Keller and Pinter, 1996, 2002). These tools have been effectively applied in regions like the Rietspruit Sub-basin, South Africa (Rimuka Dzwairo, 2024), and the Western Ghat rivers of Maharashtra, which show signs of active tectonics and deformation from the Tertiary to recent times (Kale and Shejwalkar, 2008).
The geomorphic and tectonic evolution of the western coast of India is intrinsically linked to a series of rifting events, beginning with the Late Jurassic–Early Cretaceous breakup of Gondwanaland and followed by the Late Cretaceous separation of Madagascar around 88 Ma (Storey, 1995). The present Indian continental margin was formed due to a ridge jump during Deccan volcanism that led to the detachment of India from the Seychelles (Norton and Sclater, 1979; Chandrasekharam, 1985). The Western Ghats, a prominent escarpment and major drainage divide of Peninsular India, play a vital role in determining the drainage direction. Rivers such as the Godavari, Krishna, and Bhima flow eastward into the Bay of Bengal, while the Konkan rivers—including the Vaitarna, Kundalika, Savitri, Vashishti, and Karli—flow westward into the Arabian Sea. These westerly flowing rivers begin with graded profiles and evolve into estuarine systems near their mouths. The observed asymmetry in continental-scale drainage is not unique to the Western Ghats and is also reported from regions like the Paraná Basin in Brazil and the Karoo Basin in southeastern Africa (Cox, 1989), believed to be caused by dynamic plume uplift prior to rifting (Widdowson, 1997).
The region's tectonic framework is complex and characterized by a variety of fault systems and structural discontinuities. One of the most prominent features is the Panvel Flexure, a westward-dipping monocline (2°–15°) formed around 63–62 Ma as a result of the rifting of India from the Seychelles (Sheth and Pande, 2014). This structure represents a post-rift extensional fault composed of tilted fault blocks (Desai and Bertrand, 1995). The West Coast Fault, originally part of a passive continental margin active during the Triassic–Jurassic period, was reactivated in the Cretaceous–Paleocene (Biswas, 1987). Near the Koyna region, a NNE-trending strike-slip fault zone aligns with the Dharwar foliation trend (Gupta, 1999; Gombos, 1995). Numerous faults have been identified within the Deccan Traps through geophysical and remote sensing studies, particularly in rift zones such as the Narmada Rift,

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Cambay Rift, and along the passive western margin (Harinarayan, 2007; Chandrasekhar, 2011; Kumar, 2011). The Kurduwadi Lineament, a deep crustal shear zone in the sub-trappean Precambrian rocks, consists of NW–SE-oriented dextral faults (Peshwa and Kale, 1997). Stress analyses have indicated NW–SE/NE–SW and N–S compressive regimes within the Kalsubai, Lonavala, Wai, and Salsette Subgroups (Mishra, 2014), defining the Western Deccan Strike-slip Zone.

Further evidence of tectonic activity comes from the Konkan region, where Srinivasan (2002) identified a series of N–S trending faults downthrown toward the west, interpreted as post-Deccan features unrelated to the volcanic activity. Recent structural studies have revealed regional fracture zones that have significantly influenced drainage development along the coast (Kundu and Matam, 2000). In the seismically active Koyna Warna region, the Chiplun–Warna Lineament traced from the Precambrian basement acts as a significant structural control (Kale, 2014; Rajaram, 2017; Arora, 2018). Additionally, the Malvan coastal strip exhibits a NW–SE trending fault extending for nearly 30 km (Hanamgond and Mitra, 2008). These buried Precambrian structures, reactivated during the Quaternary period, have played a critical role in shaping the modern landscape and drainage evolution of the Konkan coastal belt.

The rivers of the Konkan region, originating in the Western Ghats escarpment, are seasonal and fast-flowing in their upper reaches due to the steep gradient. These rivers flow east to west and ultimately debouch into the Arabian Sea, with estuarine conditions near their mouths. Their courses and the surrounding landscape have been significantly shaped by tectonic activity and monsoonal discharge, particularly during the southwest monsoon (Gunnel and Fleitout, 2000). The heavy rainfall sustains numerous rivers and contributes to the formation of erosional or depositional landforms depending on the stage of the river and resistance of the underlying lithology (Liu et al., 2019; Thakuriah, 2021).

Several regional studies emphasize the influence of tectonics and morphometric parameters on landscape evolution. In the Jog River Basin along the Maharashtra coast, morphometric studies reveal neo-tectonic influences (Herlekar and Waware, 2014). Similar results were observed in the Wan River sub-basin of Amravati district, where active tectonics were found to control drainage development (Masurkar et al., 2019). Watersheds between Harnai and Kolthare in Ratnagiri district show structurally guided drainage networks (Kamble et al., 2019). The WGKD sub-watershed within the Wainganga catchment of the Godavari basin exhibits low infiltration and high runoff conditions, indicating high erosion potential (Kale and Deshmukh, 2020). Morphometric investigations of micro-, sub-, and mega-watersheds across India have also aided in groundwater resource mapping and evaluation (Choudhari et al., 2018; Lamsoge et al., 2019). Additionally, morphometric and hypsometric analyses of the Markandeya River basin demonstrate clear evidence of structural control and varying stages of erosion (Herlekar et al., 2020). Coastal morphodynamics in this region are shaped by a range of interacting factors including tides, waves, sea-level fluctuations, sediment supply, climate, oceanographic conditions, and the underlying geology (Wang, 2012). Most coastal landforms along the west coast of India were formed during the Late Quaternary period. Tectonic activity during the Mio-Pliocene epoch further contributed to the evolution of this rugged coastal terrain (Tandale, 1993). The cumulative evidence from morphometric, geomorphic, and structural studies underscores the active role of tectonics in shaping the Western Ghats, the Konkan coastal belt, and associated drainage networks.

2. Study area

The Muchkundi River Basin is situated along the Central West Coast of India, within the Ratnagiri district of Maharashtra. It lies between latitude 16°40′ to 16°57′ N and longitude 73°18′ to 73°52′ E. The basin area is represented on the Survey of India (SOI) topographic maps numbered 47H/5, 47H/6, 47H/9, and 47H/13, at a 1:50,000 scale. The river originates in the Western Ghats near Vishalgad (located at 16°53′28″ N, 73°43′35″ E) and flows westward, eventually discharging into the Arabian Sea at Purangad (16°48′26″ N, 73°18′59″ E). The basin has a total area of 777.534 km^2 and the basin has a maximum elevation of 834 meters. The watershed experiences a humid tropical climate with evenly distributed rainfall throughout the monsoon season.

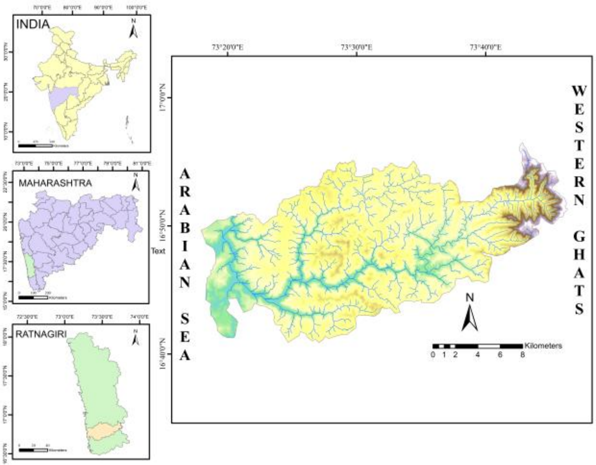

Figure 1: Location map of study area

The present study utilizes Remote sensing and GIS technologies to analyze various morphometric parameters of the Muchkundi River basin, aligning with recent advancements and research in the field, (Fig. 1)

Numerous regional investigations highlight the significant role of tectonic activity and morphometric parameters in shaping landscape evolution (Fig. 2). Different type of lithologies have been exposed in the area. The Kaladgi sandstone is exposed in the study area overlain by Deccan trap basalt followed by laterite. The Alluvium is also exposed at some area (Fig. 3).

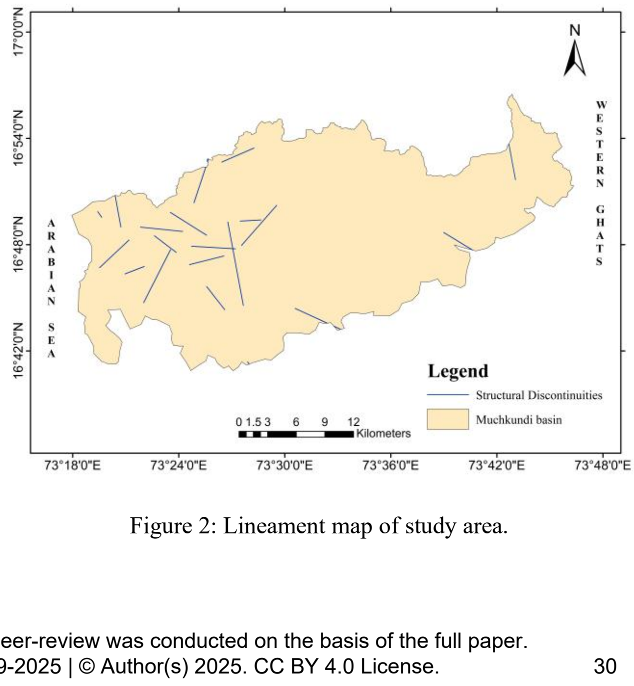

Figure 2: Lineament map of study area.

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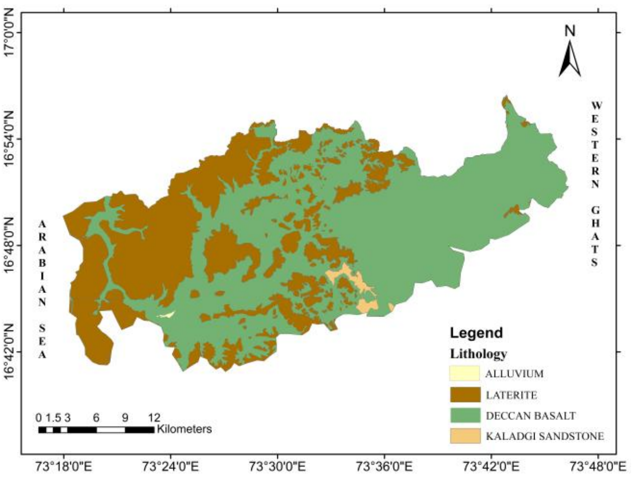

Figure 3: Lithology map of study area.

The LULC map depicts the spatial distribution of various land use and land cover categories in a region located between latitude 16°42′N to 17°00′N and longitude 73°18′E to 73°48′E, bounded by the Arabian Sea to the west and the Western Ghats to the east. (Fig. 4) Forest is the dominant land cover, occupying 48.34% of the area, mainly in the central, eastern, and southern parts near the Western Ghats. Rangelands cover 45.08%, often interspersed with forests, representing grasslands, shrublands, or grazing lands (Fig. 5).

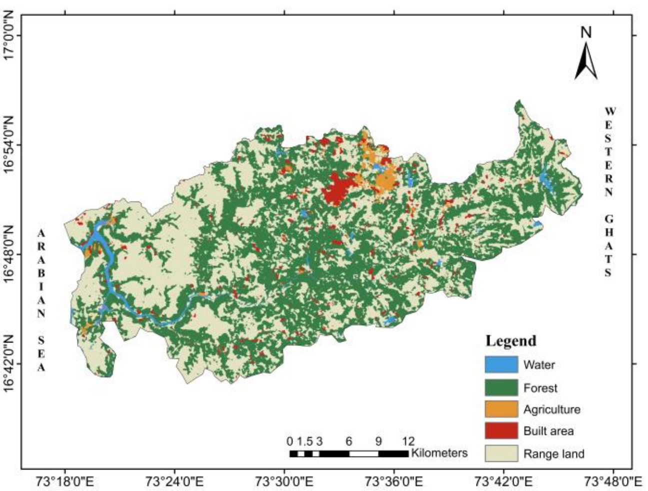

Figure 4: LULC map of study area.

3. Methodology

The topographical information of the Muchkundi River basin (MRB) was georeferenced and digitized from Survey of India (SOI) toposheets number 47H/5, 47H/6, 47H/9, and 47H/13, at a 1:50,000 scale; using ArcGIS 10.8. Strahler's method has been used to calculate stream order (Strahler, 1957). Quantitative morphometric analysis of basin characteristics such as stream number, stream length, bifurcation ratio, drainage density, stream frequency, texture ratio, elongation ratio, circularity ratio, form factor, length of overland flow and basin

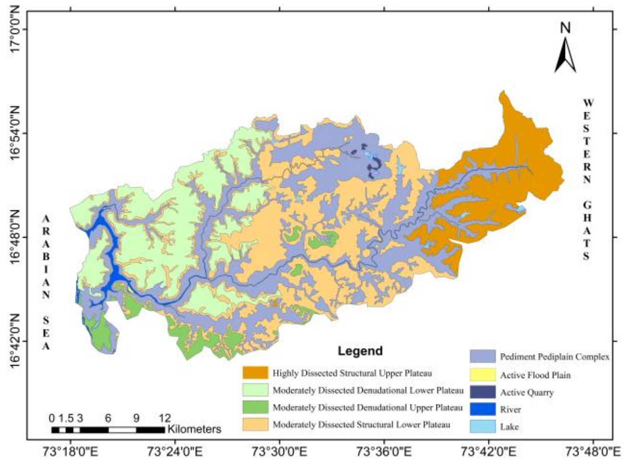

Figure 5: Geomorphology map of study area.

relief, etc. have been computed using linear, areal and relief parameters using mathematical equations (Table. 1). The SOI toposheets at a 1:50,000 scale and ASTER GDEM data with a 30-meter spatial resolution were utilized to identify the drainage pattern and conduct the morphometric analysis of the Muchkundi River Basin (MRB). The drainage network was extracted from the DEM using River Tools 3.0 software (Fig. 6).

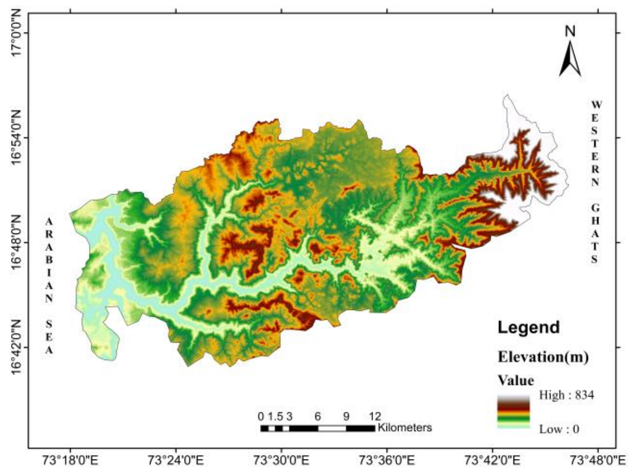

Figure 6: Digital Elevation Model of study area.

4. Results and Discussion:

4.1 Linear aspects

Stream order represents the hierarchical position of streams within the network and serves as the initial step in drainage basin analysis. (Strahler, 1964). (Table. 2)

4.1.1. Stream order (U): In the present study, stream ranking has been conducted using the method proposed by Strahler (1964), which serves as the initial step in the quantitative analysis of the basin. The basin has been classified as a 6th order basin, (Fig. 7) and the drainage patterns observed in the area include dendritic, parallel, and rectangular types. Stream order is closely related to stream length, drainage area, slope, and channel size, offering a relative indication of the basin's physical characteristics and conditions (Buffington and Montgomery,2013).

Sr. No.	Morphometric Parameters	Formulae	References
1	Stream order (U)	Hierarchical rank	Strahler (1964)
2	Stream number (Nu)	Nu=N1+N2+…Nu	Strahler (1964)
3	Stream length (Lu) Kms	Lu=L1+L2+…Lu	Horton (1945)
4	Mean stream length ratio (Lsm)	Lsm= Lu/Nu Where, Lu= Stream length, Nu= Stream Number	Strahler (1964)
5	Bifurcation ratio (Rb)	Rb=Nu/Nu+1 Nu= Stream Number Nu+1= number of the segments of the higher order	Horton (1945)
6	Drainage density (Dd)	Dd=Lu/A Where, Lu= Stream length, A= Basin area	Horton (1932, 1945)
7	Stream Frequency (Fs)	Fs= Nu/A Where, Nu= Stream number, A= Basin area	Horton (1932, 1945)
8	Drainage Texture (T)	T= Dd*Fs Where, Dd= Drainage density and Fs= Stream frequency	Smith (1950)
9	Elongation ratio (Re)	Re= (2/Lb) $(A/\pi)^{0.5}$ Where, A= Basin area, Lb= Basin Length	Schumm (1956)
10	Circulatory ratio (Rc)	Rc= 4 $\pi A/P^2$ Where, A= Basin area, P= Basin Perimeter	Miller (1953)
11	Constant of channel maintenance (C)	C=1/Dd Where, Dd= Drainage density	Schumm (1956)
12	Form Factor (Ff)	Ff= A/Lb2 Where, A= Basin area, Lb= Basin length	Horton (1932)
13	Basin relief (R)	R=H-h	Hadley, Schumm (1961)
14	Relief ratio (Rr)	Rr=R/Lb Where, R= Basin relief Lb= Basin length	Schumm (1956) Piedade (1980)
15	Ruggedness number (Rn)	Rn= Dd*(R/1000) Where, Dd= Drainage density and R= Basin relief	Strahler (1956)
16	Relative relief ratio (Rhp)	Rhp=R*100/P Where, R= Basin relief	Melton (1957)
17	Melton ruggedness number (MRn)	MRn = H/A0.5	Melton (1965)
18	Sinuosity Index	Si=Cl/Vl, Where, Cl= Channel Length Vl= Valley length	Mueller (1968)
19	Hypsometric Integrals	Hi= Slsm-h/H-h ; Where, slsm=Mean slope of the basin	Strahler (1952)
20	Asymmetric factor	AF=100(Ar/At) ; Where, Ar=area of the basin to the right of the drainage basin	Hare and Gardner (1985)

Table 1: Morphometric parameters of drainage network and their mathematical expressions.

4.1.2. Stream Number (Nu): The total number of stream segments in each order is referred to as the stream number. In MRB, the 1st order stream is 2174, 2nd order stream 508, 3rd order stream 115, 4th order 29 streams, 5th order 7 streams and 6th order 1 stream. This reveals that the development of 1st order streams is most prominent in the Western Ghats and in the dissected hilly terrain. The 1st order streams account for approximately 77% of the total area, and such a high proportion suggests significant structural weaknesses within the Muchkundi River Basin (MRB), predominantly in the form of lineaments (Manjare 2014, Shrivatra 2021a).

Sr. No.	Stream order	Number of Stream	Bifurcation Ratio	Stream Length (Km)	Mean Stream Length	Stream Length Ratio
1	1	2174	4.3	590	0.27	0.59
2	2	508	4.4	346	0.68	0.12
3	3	115	4.0	42.5	0.37	0.85
4	4	29	4.1	36	1.24	1.68
5	5	7	7.0	60.5	8.64	0.60
6	6	1		36	36.00	

Table 2: Linear aspects of study area.

4.1.3. Bifurcation Ratio (Rb): The 'Rb' ratio represents the ratio between the number of streams in a given order and the number of streams in the next higher order (Schumm, 1956). A bifurcation ratio above 2 indicates relatively flat terrain, values between 3 and 4 suggest a mountainous or highly dissected drainage basin, and ratios over 5 reflect strong structural control over the drainage pattern (Horton, 1945). The bifurcation ratio of Muchkundi River basin ranges between 4 to 7 which indicates structurally controlled drainage basin. The bifurcation ratio is a key parameter in drainage basin analysis, as it serves as a primary indicator connecting the hydrological regime of a watershed with its topological and climatic conditions.

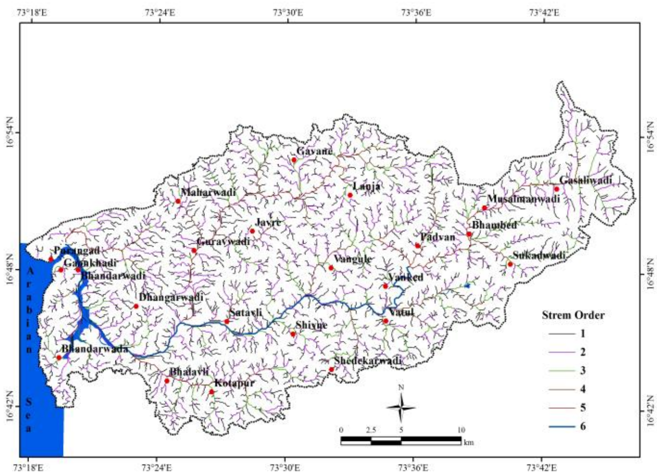

Figure 7: Drainage map of study area.

4.2. Areal aspects

In quantitative geomorphology, the area (A) and perimeter (P) of a basin are fundamental parameters. The basin area refers to the total surface area projected onto a horizontal plane, while the perimeter represents the total length of the basin's boundary. Areal aspects include various morphometric parameters such as; drainage density (Dd), drainage texture (Rt), stream frequency (Fs), form factor (Rf), circulatory ratio (Rc), elongation ratio (Re), Infiltration number (If), Compactness coefficient (Cc) and length of the overland flow (Lg). (Table. 3)

4.2.1. Drainage density (Dd): It can be calculated by measuring the total stream length to the total area of the basin (Strahler, 1964). Drainage density is influenced by factors that determine the characteristic length of a watershed. It is closely associated with various aspects of landscape dissection, including relief, climate, and vegetation cover (Moglen et al., 1998), as well as soil and rock properties (Kelson and Wells, 1989) and landscape evolution processes. The drainage density of Muchkundi River basin is 1.71 km/km^2, which indicates that the basin area is underlain by highly resistant and permeable subsurface material, characterized by intermediate drainage conditions and low to moderate relief.

4.2.2. Stream frequency (Fs): Stream frequency directly reflects the lithological characteristics of a region, as it is influenced by the nature and resistance of underlying rock formations to erosion and drainage development (Kumar et al., 2016, Shrivatra et al.,2021a). It is calculated as streams per unit area (Horton, 1945). The Stream frequency value of Muchkundi River basin is 3.64 km^2 which indicates poor stream frequency, which refers to the presence of a permeable subsurface material and low relief (Reddy et al., 2004).

4.2.3. Drainage texture (T): Drainage texture is the product of drainage density and stream frequency (Smith, 1950). The value of drainage texture for Muchkundi River basin is 6.22 indicating fine texture.

Drainage density (Dd)	1.70
Stream frequency (Fs)	3.64
Drainage texture (T)	6.22
Elongation Ratio (Re)	0.61
Circulatory Ratio (Rc)	0.27
Length of overland flow (Lg)	0.85
Form Factor (Ff)	0.29
Infiltration Number (If)	6.22
Rho Coefficient	1

Table 3: Areal aspects of study area.

4.2.4. Elongation ratio (Re): The elongation ratio is an important index used in basin shape analysis, providing insights into the basin's hydrological characteristics (Schumm, 1956). The elongation ratio value for Muchkundi River basin is 0.61, shows that basin is elongated. Lower elongation ratio values indicate moderate to severe flooding and increased sediment transport in the river system. The elongated shape of the MRB, combined with its high relief and steep slopes, results in a longer time lag for water to travel from the upper regions of the study area.

4.2.5 Circulatory Ratio : The circulatory ratio is primarily influenced by stream length and frequency, geological structures, land use and land cover, climate, relief, and the slope of the basin. (Kusre, 2016; Das et al., 2012; Sreedevi et al., 2013) The value of Circulatory ratio of MRB is 0.27.

4.2.6 Constant of Channel Maintenance (C): The Constant of Channel Maintenance (C) is a morphometric parameter that reflects the relationship between a drainage basin's area and the total length of its stream channels. It indicates how much land area is needed to sustain one unit length of stream channel. The C value for Muchkundi River basin is 0.59. A higher value of the C indicates greater permeability of the basin's rocks, allowing more infiltration and less surface runoff. Conversely, lower values suggest lower permeability. The value of C is influenced by several factors, including climate, rock permeability, lithology, vegetation cover, and the degree of erosion within the drainage basin (Arulbalaji and Padmalal, 2020).

4.2.7 Length of overland flow (Lg) : The length of overland flow (Lg) is approximately equal to half the reciprocal of the drainage density. It represents the distance water travels over the land surface before concentrating into stream channels. This parameter reflects the surface runoff characteristics and is influenced by slope, infiltration capacity, and land cover. The length of the overland flow of the study area is 0.85 km km^{-2}, which suggests a moderately dissected basin with moderate runoff potential, likely underlain by moderately permeable rock or soil and influenced by moderate relief and vegetation cover.

4.2.8. Form factor (Ff) : The form factor (Ff) is a quantitative measure that expresses the shape or outline of a drainage basin. Lower form factor values indicate a more elongated basin, while higher values suggest a more circular basin shape. (Taib et al., 2023) The form factor influences the flow characteristics of the basin, with elongated basins typically having a longer runoff duration and lower peak flow, whereas circular basins tend to generate shorter, more intense flood peaks. The form factor value of MRB is 0.29 which indicates that the basin has an elongated shape. The form factor is used to predict the flow intensity in the basin (Horton,1945).

4.2.9. Infiltration number (If): The infiltration number is calculated as the product of drainage density and drainage texture, and it provides an indication of the permeability of the underlying bedrock. (Faniran, 1968) Higher values generally suggest low permeability and higher runoff, while lower values indicate higher permeability and greater infiltration capacity. The infiltration number of Muchkundi River basin is 6.22.

4.2.10. Rho coefficient : The Rho coefficient is an important parameter that relates drainage density (Dd) to the terrain development of a drainage basin, helping to assess the basin's water storage capacity (Horton, 1945). The Rho coefficient value of Muchkundi River basin is 1.

4.3. Relief aspects

4.3.1. Basin relief: Basin relief (R) refers to the elevation difference between the highest and lowest points within a basin. It plays a key role in determining stream gradient, influencing flood behavior, and affecting the volume of sediment transport (Hadley and Schumm,1961). The 'R' value in the study area is 834 m reflecting a high basin relief. Slope map of the area describes the different types of slopes in degrees over the area. (Fig. 8) (Table. 4)

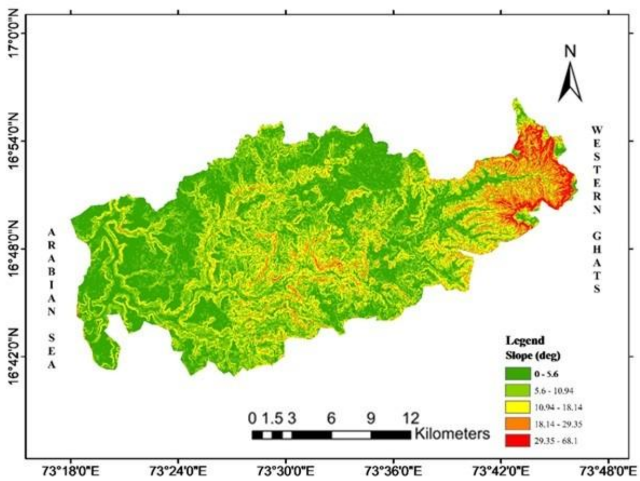

Figure 8: Slope map of study area.

4.3.2. Relief Ratio: According to Schumm (1956), the relief ratio is defined as the ratio of maximum basin relief to the horizontal distance along the longest dimension of the basin parallel to the main drainage line. The total relief of a river basin refers to the elevation difference between its highest point and the lowest point on the valley floor. Schumm (1963) also stated that the relief ratio is a dimensionless height-to-length ratio, equivalent to the tangent of the angle formed by two intersecting planes at the basin's mouth—one representing the horizontal plane and the other passing through the basin's highest point. The relief ratio for Muchkundi River basin is 0.016.

Area	777.534
Perimeter	189.73
Basin Length	51.532
Mean Basin Width	15.088
Relative Perimeter	4.098
Maximum Elevation	834
Minimum Elevation	0
Basin Relief	834
Relief Ratio	0.16
Ruggedness Number	1.42
Melton Ruggedness Number	29.91
Relative Relief Ratio	439.57

Table 4: Relief aspects of study area.

4.3.3. Ruggedness Number: The ruggedness number (Rn) is calculated as the product of maximum basin relief (H) and drainage density (Dd). It reflects the structural complexity of the terrain, with higher values indicating steeper slopes and more intricate landscapes. An elevated Rn suggests a greater vulnerability to soil erosion, while lower values imply a relatively stable terrain with less erosion potential. The ruggedness number is likewise high if the drainage density and relief are both high and the slope is steep (Strahler, 1956). The value of Rn for MRB is 1.42. The results highlight the terrain's structural intricacy and its potential vulnerability to erosion within the study area

4.4 Morphotectonic Aspects:

4.4.1 Sinuosity Index: This is a dimensionless parameter that can also be described as the ratio of the total stream length to the basin length. The sinuosity index reflects both the topographic influence on the river's meandering pattern and the hydraulic impact on unstable, easily reworked sediment deposits within the channel (Mueller, 1968). The sinuosity index of Muchkundi River basin is 1.53, which indicates meandering river channel. (Table. 5)

4.4.2. Hypsometric curve and hypsometric Integral (HI): It can be interpreted in relation to the stage of landscape dissection and the relative age of the landform. The Hypsometric Integral (HI) is also significantly influenced by the basin's geometry and the structure of the drainage network. (Strahler, 1952)

This study indicates that hypsometry is highly responsive to a range of natural factors, including tectonic processes, lithological characteristics, and climatic conditions. The hypsometric integral of the present study area is 0.48 (Fig. 9), indicating that the region is in a mature (equilibrium) stage of landscape development. The terrain transitions from moderately to highly dissected landforms at the starting point in the Western Ghats to the endpoint of the study area.

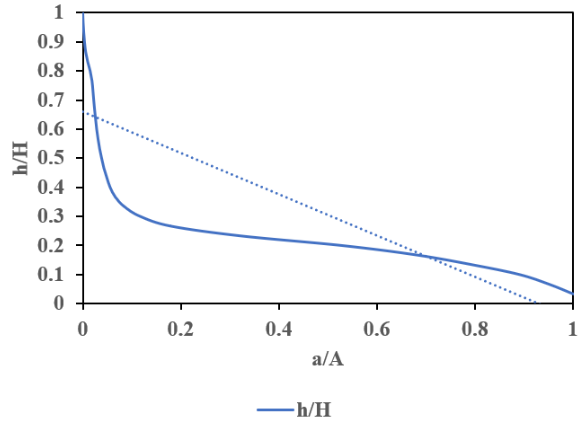

Figure 9 : Hypsometric curve of Muchkundi River basin.

4.4.3. Asymmetry Factor: The asymmetry factor (AF) is a tectonic geomorphological indices used to evaluate tilting or tectonic distortion within a drainage basin. It aids in detecting whether the basin has undergone lateral tilting, often as a result of tectonic forces. It is used to evaluate ground tilting in response to tectonic activity or lithological control over the basin (Hare and Gardner, 1985; Keller and Pinter, 2002). The asymmetric factor of Muchkundi River basin is 48.35, which shows tilting toward the left side (facing downstream) of the sub-basin.

Sinuosity Index	1.53
Hypsometric Integral	0.43
Asymmetric Factor	48.33

Table 5: Morphotectonic parameters of study area.

5. Conclusion

The morphometric analysis of the Muchkundi River basin reveals an inverse relationship between stream order and stream number. Higher-order streams suggest significant water accumulation in the peneplains, indicating a greater potential for flooding due to limited water dispersion. The low drainage density reflects a combination of low to moderate relief, moderate vegetation cover, and moderate infiltration capacity, which together contribute to moderate surface runoff. However, tectonic and structural factors appear to have significantly influenced the development of the drainage patterns—resulting in a trellis pattern near the Western Ghats where the river originates, and a rectangular pattern toward the end of the upper sub-basin. A high bifurcation ratio indicates strong structural control within the basin. Similarly, a high sinuosity index suggests that the Muchkundi River exhibits a meandering nature. The short length of overland flow points to rapid surface runoff, typically associated with steeper slopes. A low form factor indicates prolonged water flow with minimal discharge.

This study holds significance for understanding neotectonic activity in the drainage basins of the Konkan region in India.

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