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Morphometric Analysis Of Kanger River Basin, Bastar, Chhattishgarh, India

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Abstract
A river basin's hydrological behavior, geomorphology, and drainage features can all be quantitatively assessed by morphometric analysis. Using remote sensing and geographic information system (GIS) methods, this research work focuses on the morphometric analysis of the Kanger River Basin, which is situated in Chhattisgarh, India's Bastar district. The lithology, topography, and climate all have an impact on the Kanger River's notable geomorphic diversity as it flows through the forest of the Kanger Valley National Park. To understand the drainage features and hydrological behavior of the basin, a number of morphometric metrics were examined, including stream order, drainage density, bifurcation ratio, and basin relief. The findings show a dendritic drainage pattern, which suggests uniform geological conditions. Nonetheless, the existence of parallel drainage in some areas indicates the impact of slope and extended topography, where streams typically run in a consistent direction because of gradient control. Furthermore, the impact of structural elements like joints, fractures, or faults that direct stream courses at extreme angles is reflected in the presence of angular drainage patterns. These variations are related to the karst terrain of Kanger Valley National Park, where underground channels and fissures created by limestone dissolution affect both surface and subsurface drainage. The study emphasizes the significance of lithology and geomorphic processes in watershed management and conservation planning by highlighting how they shape both karst and fluvial systems.
Keyword: *Morphometric Analysis, Drainage Pattern, GIS, QGIS, Bifurcation Ratio, Watershed Management*

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I. Introduction

A quantitative and analytical examination of the Earth's surface structure, including the size and form of its landforms, is referred to as morphometric characteristics. The local geology, structural components, geomorphology, vegetation, and soils all have an impact on the river's drainage networks and flow pattern. These characteristics are intricate and change throughout time and space. (Suresh & Krishnan, 2022).

Morphometric parameters are useful for analyzing watersheds because they demonstrate the relationships between various catchment factors, such as stream order and length. (Tiwari, 2023). The most popular morphometric parameters are stream order, stream number, stream length, mean stream length, stream length ratio, bifurcation ratio, mean bifurcation ratio, drainage density, drainage texture, stream frequency, relief ratio, form factor, elongation ratio, circularity ratio, and length of overland flow.

Drainage basin/watershed analysis based on morphometric parameters is crucial for watershed planning because it gives information about the basin's topography, slope, soil quality, runoff characteristics, surface water potential, etc. (Sukristiyanti et al., 2018). The following headings have been used to derive the morphometric properties for the entire basin: Areal aspects are two-dimensional, relief aspects are three-dimensional, and linear aspects are one-dimensional. Drainage morphometry is necessary to analyze different hydrological processes in the watershed. Morphometric analysis is used to determine flood susceptibility.

Soil erosion is associated with the linear and relief properties of bifurcation ratio, drainage density, stream frequency, drainage texture, relief, and roughness number. Geographic indices and geomorphic elements, such as longitudinal profile, slope, asymmetry factor, and basin elongation ratio, can be analyzed to gain an understanding of drainage dynamics and landscape changes. Hydro morphometric feature computation, remote sensing, geographic information system (GIS) technology, and catchment terrain analysis are major rivers and asymmetric factors associated with basin side slopes.

Stream networks and the river boundary can be delineated using either contemporary techniques utilizing remote sensing data and GIS technologies or traditional approaches utilizing toposheets and on-site observations. (Gupta, 2024).

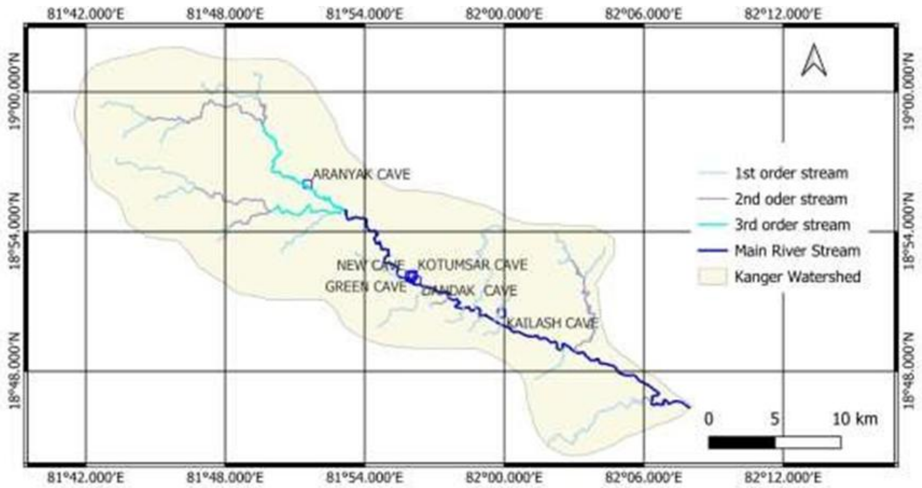
II. Study Area

The study area is confined between latitude 18°48'00"N to 19°00'00"N and longitude 81°42'00"E to 82°12'00"E. Kanger watershed is situated in and around the Kanger valley national park in the Bastar district, Chhattisgarh and covers an area of 613.288 km2. Based on Google Earth images, the research area's maximum and lowest elevations are 868 and 365 meters above mean sea level, respectively. The Kanger River Watershed is part of the Indravati basin. Sandstone, limestone, shale, and dolomites are the lithologies that support the entire drainage system; the limestone area is karstic. The Kanger River is a well-known river in the Kanger Valley National Park and its environs. It is a Kolab River tributary. This is evident in several naalas, including the Munga Bahar Nala, Jhodi nala, Ekta Nala, Uidir nala, Kola Jhodi, Karanji Jhodi etc. which meet the Kanger River after mostly flowing from NW to SE direction.

Plate No.1 Tributary of Kanger River

III. Methodology

Using Google Earth (Pro) and QGIS, a morphometric analysis of the Kanger River watershed was done. The morphometric and morphotectonic characteristics of the Kanger River Basin were examined using topographic maps and digital elevation model (DEM) data from the Survey of India. All morphometric parameters (linear, areal, and relief) have been derived using DEM and consulting SOI topographical maps, Google Earth, and QGIS (Gautam, 2023). The Survey of India's 1:50000 scale topographic maps of India, 65F/1 and 65J/1, were the main tools used to analyze the drainage pattern. The Kanger River and other streams are mostly controlled by structural and lithological factors, according to a study of the topographical and regional geological maps of the region. (Deshmukh et al. 2021, Gupta, 2024).



Map No. 1 - Showing Kanger River Watershed and Location of Caves in the Study Area (after Gupta,2024)

Map No. 2 - Google Earth Image and Elevation Profile of Basin of Kanger Watershed (after Gupta,2024)

Table No. 1 - Parameters for Morphometric Analysis and Results (after Gupta,2024)

S.N.	Morphometric Parameters	Methods	References	Results
		LINEAR ASPECTS (La)		
1.	Stream order (U)	Hierarchical order	Strahler, 1964	1st order – 25 2nd order - 07 3rd order – 02 4th order – 01
2.	Stream Number (Nu)	Nu= N1+N2…+Nn	Horton (1945)	(Nu)-35
3.	Stream length in km (Lu)	Length of the stream Lu=L1+L2…. +Ln	Horton 1945	1st order – 100.19 km 2nd order – 43.799 km 3rd order – 22.428 km 4th order – 43.597
4.	Mean stream length (Lsm)	Lsm=Lu/Nu; where, Lu=Stream length of order 'u', Nu=Total number of stream segments of order 'u'.	Strahler, 1964	1st order – 4.0076 2nd order – 6.257 3rd order – 11.214 4th order – 43.597
5.	Stream length ratio (Rl)	Rl=Lu/Lu-1; Where, Lu=Total stream length of order 'U', Lu-1=Stream length of next lower order.	Horton, 1945	2nd order – 0.43 3rd order – 0.51 4th order – 1.94
6.	Bifurcation ratio (Rb)	Rb=Nu/Nu+1; where, Nu=Total number of stream segment of order 'u', Nu+1=Number of segments of next higher order.	Schumn, 1956	1st order – 3.57 2nd order – 3.5 3rd order – 2 4th order - _
7.	Mean Bifurcation Ratio (Rbm)	Average of Rb ratio of all orders	Strahler, 1964	3.02
8.	Basin Length (Lb)	Google Earth software analysis	Schumn, 1956	52. 58 km
S.N.	**Morphometric Parameters**	**Methods**	**References**	**Results**
		AREAL ASPECTS (Aa)		
9.	Basin Area (A)	GIS software analysis	Schumn, 1956	613.288 sq.km
10.	Basin Perimeter (P)	GIS software analysis	Schumn, 1956	129.599 km
11.	Drainage density (Dd)	Dd=Lu/A; where, L=Total length of streams, A=Area of watershed	Horton, 1932	0.34 km
12.	Stream Frequency (Fs)	Fs=Nu/A; where, Nu=Total number of streams of all orders, A=Area of the Basin.	Horton, 1932	0.05 km^{-2}.
13.	Form factor (Rf)	$Rf=A/(Lb)^2$; where,	Horton, 1932	0.22

		A=Area of watershed, Lb=Basin length.		
14.	Circularity Ratio (Rc)	Rc=4πA/P2; where, A=Area of watershed, π = 3.14, P=Perimeter of watershed.	Miller, 1953	0.45
15.	Elongation Ratio (Re)	Re=2√(A/π)/Lb; where, A=Area of watershed, π = 3.14, Lb=Basin length.	Schumn, 1956	0.21
16.	Drainage Texture (T)	Rt=Nu/p; where, Nu=Total number of streams of all orders, P=Perimeter of watershed.	Horton, 1945	0.2
S.N.	**Morphometric Parameters**	**Methods**	**References**	**Results**
		RELIEF ASPECTS (Ra)		
17.	Basin relief (H)	H= Z-z where Vertical distance between the lowest (z) and highest (Z) points of watershed.	Strahler, 1952	503 m. 0.503 km
18.	Relief Ratio (Rh)	Rh=H/Lb; where, H=Basin relief, Lb=Basin length.	Schumn, 1956	9.56 0.009.
19.	Ruggedness Number (Rn)	Rn= Dd*(H/1000); where, H=Basin relief, Dd=Drainage density.	Patton & Baker, 1976	0.171.

Table No. 2 – Parameters Standard Values and Interpretation for Morphometric Analysis of the Study Area (after Gupta,2024)

S. no.	Parameters	Standard values	Standard value result	Study areas Values	Interpretation
1.	**Area (A)**	**Small basins:** Less than 10 square kilometers. **Medium basins:** 10 to 100 square kilometers. **Large basins:** Greater than 100 square kilometers.	**Small basins:** These may indicate localized drainage systems, such as small streams or creeks, with limited water and sediment discharge. **Medium basin:** These may indicate moderate drainage network such as medium streams or medium water and sediment discharge. **Large basins:** Larger areas suggest extensive drainage networks with potentially higher runoff and sediment yield, impacting larger river systems.	613.288 sq.km	**Large basins:** Greater than 100 square kilometers. Larger areas suggest extensive drainage networks with potentially higher runoff and sediment yield, impacting larger river systems.
2.	**Perimeter (P)**	**Small basins**: Less than 30 kilometers. **Medium basins:** 30 to 100 kilometers**.**	**Small perimeters:** Typically associated with compact or circular basin shapes, which may lead to shorter flow paths and reduced stream branching.	129.599 km	**Large basins:** Greater than 100 kilometers**.** Large perimeter indicates Irregularly shaped basins with
		Large basins: Greater than 100 kilometers**.**	**Medium perimeter:** Moderate shape basin, which may have, medium drainage pattern and moderate flow path. **Large perimeters:** Irregularly shaped basins with longer boundaries may have more complex drainage patterns and longer flow		longer boundaries may have more complex drainage patterns and longer flow
3.	**Length of Main stream (L)**	**Small basins:** Less than 20 kilometers. **Medium basins:** 20 to 100 kilometers. **Large basins:** Greater than 100 kilometers.	**Short main streams:** Reflects basins with less-developed drainage networks or linear flow paths, common in mountainous or steep terrain. **Medium main streams:** Indicates medium drainage patterns with moderate flow path and medium	43.597 km	**Medium basins:** 20 to 100 kilometers. Medium main streams Indicates medium drainage patterns with moderate flow path and medium stream order.

			stream order. **Long main streams:** Indicates more dendritic drainage patterns with longer flow paths and potentially higher stream order.		
4.	**Drainage Density (Dd)**	**Low density:** Less than 2 kilometers per square kilometer. **Moderate density:** 2 to 5 kilometers per square kilometer. **High density:** Greater than 5 kilometers per square kilometer.	**Low density:** Basins with lower drainage density may have fewer and longer streams, resulting in slower runoff and sediment transport. **Moderate density:** Basin with medium drainage density which may leads to medium stream, resulting in medium runoff and sediment transport. **High density:** Higher drainage density suggests a denser network of streams, which can lead to faster runoff response and increased erosion potential.	0.34 km.	**Low density:** Less than 2 kilometers per square kilometer. Low density: Basins with lower drainage density may have fewer and longer streams, resulting in slower runoff and sediment transport.
5.	**Stream Order (Nu)**	**First-order streams:** Most common in headwater regions. **Second-order streams:** Formed by the confluence of two first-order streams. **Higher-**order streams:	**First-order streams:** Predominant in headwater regions, where streams have not yet formed significant tributaries. **Second-order streams:** Reflects moderate drainage networks middle stream, with middle streams formed by the confluence of medium ones. **Higher-order streams:** Reflects more developed drainage networks	1^{st} - 100.19 km. 2^{nd} - 43.799 km. 3^{rd} - 22.428 km. 4^{th} - 43.597 km	
		Generally, increase in number downstream.	downstream, with larger streams formed by the confluence of smaller ones.		
6.	**Bifurcation Ratio (Rb)**	**Low branching:** Less than 3. **Balanced branching:** Ranges from 3 to 5. **High branching:** Greater than 5.	**Low branching:** Indicates fewer tributaries and a simpler drainage pattern, often associated with more homogeneous landscapes. **Balanced branching:** Indicates a relatively even distribution of streams across different orders, leading to a more uniform drainage network. **High branching:** Indicates a more complex and branched network, potentially resulting from varying geological and topographical conditions.	3	**Balanced branching:** Ranges from 3 to 5. Balanced branching Indicates a relatively even distribution o f streams across different orders, leading to a more uniform drainage network.
7.	**Texture Ratio (T)**	**Low irregularity:** Less than 1. **Moderate** irregularity: 1 to 2. **High irregularity:** Greater than 2	**Low irregularity:** Basins with lower texture ratios have smoother, more regular drainage networks, which may result from uniform geological conditions. **Moderate irregularity:** Indicate basin with medium irregular drainage network, which may lead to moderate geology and topography. **High irregularity:** Indicates basins with more irregular and rough drainage networks, potentially resulting from heterogeneous geology and topography.	0.2 km	**Low irregularity:** Less than 1. Low irregularity**:** Basins with lower texture ratios have smoother, more regular drainage networks, which may result from uniform geological conditions.

8.	**Relief Ratio (Rh)**	**Low relief:** Less than 0.05. **Moderate relief:** 0.05 to 0.2. **High relief:** Greater than 0.2.	**Low relief:** Indicates relatively flat basins with gentle slopes, which may lead to slower erosion rates and more uniform sediment transport. **Moderate relief:** Indicate moderate basin with middle slopes, which may lead to moderate erosion rates and medium sediment transport. **High relief:** Indicates steep basins with significant elevation differences, resulting in faster erosion rates, increased sediment transport, and potentially higher flood risks.	0.009	**Low relief:** Less than 0.05. Low relief: Indicates relatively flat basins with gentle slopes, which may lead to slower erosion rates and more uniform sediment transport.

IV. Basic Morphometric Parameters Of River Basin

Linear Aspects:

Stream order (U)

There are numerous stream ordering schemes (Horton, 1945; Strahler, 1952; Scheidegger, 1965). Strahler's approach, a slightly modified version of Horton's system, has been employed here because of its simplicity. First order refers to the smallest, unbranched fingertip streams; two first order channels come together to form a second order segment, two second order streams come together to form a third order segment, and so on. When two channels of the same smaller order merge, the subsequent higher order is preserved. The trunk stream is the highest order stream section (Lama, 2021). The Strahler (1952) approach classifies the Kanger River as a fourth order stream. Of the 35 streams found, 25 are first order, 7 are second order, 2 are third order, and 1 is fourth order.

Due to the network of many tributaries and the main stream that runs along the general slope direction, which is in turn well adhered to the associated geological features, the Kanger basin area's total drainage system has a dendritic, parallel, and angular structure. In certain areas of the study area, the Kanger River in the Kanger Valley National Park exhibits structural control. The Kanger River runs from west to east. The Karger River makes a few sharp twists from Majpal to Kotumsar village in the northwest of the study area. The river from Kotumsar village to Kailash Cave exhibits a mature stage of valley formation, as seen by a few prominent meanders. Typically, the gullies meet the Kanger River at acute angles. The Kanger Valley's gullies exhibit a dendritic pattern. Except when they merge with the Kanger River, gullies typically do not exhibit structural control. The gullies exhibit parallel orientation with one another whenever they merge with the Kanger River. Observations show that first order streams have the highest frequency. Additionally, an increase in stream order was shown to be accompanied by a decrease in stream frequency. (Gupta, 2024).

Stream number (Nu):

According to Horton, the order number and the stream segment numbers finally come together to create an inverted geometric sequence. Here, the stream branching complexity of a watershed is quantitatively assessed (Horton, 1945). Since the majority of first-order streams originate from hills and ridges with steeper slopes, slope is crucial to the development of streams within the watershed; second-order streams form downstream, and so on. (Lama, 2021).

First and second order ephemeral streams occupy the majority of the Kanger Valley Region. The fourth-order stream of the perineal Kanger River flows about from northwest to southeast before joining the Kolab River. The topographical altitudes are often followed by the first and second order streams. Elevations range from steep to moderate. The carbonate terrain frequently experiences intense erosional activity, which results in the development of sink holes, dolines, uvalas, and hums. Many first-order streams are created as a result of the linear ridges formed by the Tirathgarh Sandstone. Because the Tirathgarh Sandstone is porous and permeable, runoff water percolation cannot be completely ruled out. Because the Kanger limestone has joints, runoff water percolation is typical in this area. (Gupta, 2024).

Stream Length (Lu)

The total length of the various stream segments in each order is determined by adding the stream lengths in that order. Stream length can be calculated as the average (or mean) length of a stream in each order by dividing the total length of all streams in that order by the number of streams in that order. The length of the stream indicates the hydrological characteristics of the bedrock and the degree of drainage. Whereas a large number of shorter streams arise where the bedrock and formations are less permeable, a small number of longer streams occur wherever the bedrock and formation are porous in a well-drained watershed (Sethupathi et al., 2011). The length of the stream often grows exponentially as stream order increases (Lama, 2021). However, the distribution of stream length in the Kanger basin changes significantly as order increases. The first order stream has a length of 100. Second order streams (43.79 km), fourth order streams (43.59 km), and third order streams (22.42 km) come after 19 km. (Gupta, 2024).

Mean stream length (Lsm)

The entire stream length of an order divided by the total number of order segments yields the mean stream length. The topography and permeability have an impact on the mean stream length. As stream order increases, the mean stream length typically rises as well (Lama, 2021). The first through fourth order streams in the Kanger River basin have mean stream lengths of 4.007, 6.25, 11.21, and 43.59, respectively. As stream order grows, permeability rises.

Stream Length Ratio (Rl)

The stream length ratio is calculated by dividing the entire stream length of one order by the subsequent lower order stream segment. A pattern of increasing stream length ratio from lower order to higher order indicates their mature geomorphic stage (Tiwari, 2023). The Kanger Valley Region's II (0.43) and III (0.51) order streams' length ratios show that runoff water percolates through them somewhat. The IV order stream's 1.94 stream length ratio suggests that there is more percolation across the Kanger River in this area due to structural control of the river. describes this value in further detail. (Gupta, 2024).

Bifurcation ratio (Rb)

According to Schumm (1956), the bifurcation ratio (Rb) is the ratio of the number of stream segments of one order to the number of segments of the subsequent higher orders. The Kanger basin's bifurcation ratio ranges from 2 to 3.57. whereas 3.02 is the mean bifurcation ratio. According to Strahler (1964), bifurcation ratio values between 3.0 and 5.0 are common in drainage basins with geological formations that do not change the drainage pattern. For a basin with little influence from geological structure, the mean bifurcation ratio of drainage network (Rbm) usually ranges from 3.0 to 5.0. However, certain areas of the Kanger River basin exhibit structural control, which may be the cause of the karst topography development in this area.

Basin Length (Lb)

The basin's longest dimension parallel to the main drainage line, according to Schumm (1956). Gregory and Walling (1968) defined the basin length as the longest portion of the basin, with the mouth at the end (Lama, 2021). The length of the Kanger basin is 52.58 kilometers. Lama (2021)

Areal Aspects:

Basin Area (A)

The watershed's area is another crucial factor, much as the stream drainage's length (Lama, 2021). The watershed area of the Kanger River basin can accurately depict the total volume of water. The Kanger River's basin comprises 613.288 km^2. The Kanger River's huge basin, which is classified as a large basin, indicates a vast drainage network with possibly higher runoff and sediment yield, affecting a wider river system. (Gupta, 2024).

Basin Perimeter (P)

The basin perimeter is the outside boundary of the watershed that surrounds the basin. It can serve as a reference for a watershed's dimensions and form. The Kanger River basin's perimeter is 129.599 kilometers. The Kanger River basin is classified as a major basin. A large basin suggests an irregularly shaped basin with longer boundaries, which may have a longer flow and a more complicated drainage pattern. (Gupta, 2024).

Drainage Density (Dd)

According to Horton, drainage density can be determined by dividing the stream's total length by the basin's area. However, because of significant infiltration, porosity, and permeability brought on by karstification, joint patterns, etc. of the underlying limestones, the Kanger basin has the lowest drainage density (0.34). Tiwari (2023).

Stream Frequency (Fs)

Horton (1945) defined stream frequency as the number of streams per unit area, which is determined by dividing the total number of streams by the drainage basin's area. Tiwari (2023). The Kanger River basin has an extremely low stream frequency (0.05 sq. km). Extremely low stream frequency the Kanger River basin shows that this area has little relief and highly permeable rock.

Form Factor (Rf)

The form factor is the ratio of the area of the basin to the square of its length. It usually represents a variety of basin shapes (Horton, 1945). The value of the form factor falls between 0.1 and 0.8. The form factor value of a completely spherical basin would always be higher than 0.78. The smaller the form factor, the longer the basin will be. The Kanger River basin has a form factor of 0.22. Because of the Kanger River basin's elongated shape and low form factor, there is less chance of flooding in this area during periods of high rainfall. (Gupta, 2024).

Circularity Ratio (Rc)

Miller (1953) determined the ratio between the area of the basin and the area of a circle whose diameter is equal to the basin's perimeter.The circulator ratio is primarily influenced by the length and frequency of streams, geological features, land use and cover, climate, relief, and basin slope. The dendritic stage of a watershed is indicated by an elevated circulatory ratio. Low, medium, and high levels correspond to the tributary watershed's juvenile, mature, and old life stages. The values of circularity ratios vary from 0 (in a line) to 1 (in a circle). Higher numbers suggest a more circular basin shape, and vice versa. All basins naturally have a tendency to extend in order to reach the mature stage (Lama, 2021). The circulatory ratio of Kanger River basin is 0.45. The circularity ratio's value is most likely caused by the Kanger River's structural control. (Gupta, 2024).

Elongation Ratio (Re)

Schumm (1956) defined an elongation ratio (Re) as the ratio of the maximal length in the same area to the diameter of a circle in the basin. It is a measurement of the shape of the river basin, which is influenced by the climate and geology. The value of Re in a highly elongated shape falls between 0 and unity, or 1.0, in a circular shape. As a result, a basin with a higher elongation ratio will resemble a circle, and vice versa. The elongation ratio can be used to identify four different shapes: oval (0.9-0.8), round (>0.9), less elongated (0.8-07), and elongated (<0.7). While lower Re values show a high susceptibility to erosion and sediment load, higher elongation ratio values show less runoff and a good infiltration capacity (Lama, 2021). The Kanger River Basin is a very long drainage basin with an elongation ratio of 0.21. (Gupta, 2024).

Drainage Texture (T)

According to Horton (1945), the drainage texture is the total number of stream segments in a basin of all orders per basin perimeter. It is important to geomorphology because it indicates the relative distance between drainage lines. Drainage texture is influenced by the terrain's relief, infiltration capacity, and underlying lithology. Drainage can be classified into five different textures: extremely coarse (<2), coarse (2–4), intermediate (4–6), fine (6–8), and very fine (>8) (Tiwari, 2023). The Kanger River basin's drainage texture is 0.2 km/km2, indicating a very coarse drainage texture and a high rate of infiltration. (Gupta, 2024).

Relief Aspects:

Basin Relief (H)

The height differential between a basin's highest and lowest points is known as basin relief (Lama, 2021). The highest basin relief in the Kanger River basin is 503 meters. The Kanger River basin's highest point is 868 meters, while its lowest point is 365 meters. It establishes the slope, which affects runoff and silt movement.

Relief Ratio (Rh)

Schumm (1956) defined it as the ratio of the horizontal distance along the longest dimension of the basin that runs parallel to the main drainage line to the greatest basin relief. The Kanger River Basin's low relief ratio (9.56) suggests a mild slope and less severe erosion. (Gupta, 2024).

Ruggedness Number (Rn)

According to Strahler (1964), the ruggedness number (Rn) is the product of maximum basin relief and drainage density; it usually combines slope steepness with length. The roughness number may reach very high levels when the basin's slopes are both longer and steeper (Tiwari, 2023). The Kanger River Basin's ruggedness number is 0.171, indicating that the region has comparatively smooth geomorphic formations. While the majority of the area does not exhibit considerable structural complexity, some portions do exhibit structural control. (Gupta, 2024).

V. Conclusion

The Kanger River Basin's morphometric analysis has been studied in this paper. The Kanger River watershed was evaluated morphometrically using Google Earth (Pro) and QGIS. Geologically, the Kanger River Watershed is part of the Indravati basin. Sandstone, limestone, shale, and dolomite lithologies underpin the complete drainage network. The limestone region is karstic in nature.

The Kanger River can be categorized as a fourth order stream using the Strahler (1952) technique. Twenty-five of the thirty-five streams that were discovered are first order, seven are second order, two are third order, and one is fourth order. The total drainage system of the Kanger basin area has dendritic, parallel, and angular patterns because of the network of numerous tributaries and its main stream that runs along the general slope direction, which is in turn well adhered to the pertinent geological features.

The Kanger River in the Kanger Valley National Park demonstrates structural control in specific areas of the study area. Stream length influences erosion, groundwater flow, and the potential for cave channel growth, size, and complexity—all of which may have an effect on the formation and evolution of caves. The Kanger basin's bifurcation ratio ranges from 2 to 3.57, with an average of 3.02. According to Strahler (1964), bifurcation ratio values between 3.0 and 5.0 are commonly observed in drainage basins with geological formations that do not alter the drainage pattern. The development of karst topography in the area may be due to structural control in some parts of the Kanger River basin. The basin area of the Kanger River is 613.288 km2. A larger river system may be impacted by the Kanger River's large basin classification, which denotes a vast drainage network with potentially higher runoff and sediment delivery. With a perimeter of 129.599 kilometers, the Kanger River basin falls into the large category. Because of its irregular shape and extended limits, a large basin may have a longer flow and a more complicated drainage pattern (Lama, 2021). The lowest drainage density (0.34) is found in the Kanger basin. Significant infiltration, porosity, and permeability are caused by the karstification, joint patterns, and other characteristics of the underlying limestones. The Kanger River basin's extremely low stream frequency indicates the region's low relief and great permeability.

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