

## Morphometric Analysis and Drainage Anomaly Assessment of The Kanchi River Basin, Jharkhand, India: Insights from DEM and GIS Techniques

KABITA LEPCHA

Department of Geography, University of GourBanga, Malda, West Bengal, India.

### Abstract

This study examines the morphometric characteristics and drainage anomalies of the Kanchi River Basin, which is a tributary of the Subarnarekha River located in Jharkhand, India. SRTM DEM data alongside ArcGIS 10.3.1 were utilized to outline the drainage system and conduct morphometric evaluations. The recorded drainage density stands at 1.13 km/km<sup>2</sup>, the stream frequency at 0.97 streams/km<sup>2</sup>, and the relative relief at 276.66 m. The anomalies in DD range from -1.23 to -2.35 km/km<sup>2</sup>, while the anomalies in stream frequency range from -1.21 to -4.77 stream/km<sup>2</sup>. The basin is elongated, moderately dissection, and is influenced by the underlying structure. Tectonic activity and variations in lithology have a significant impact on how drainage anomalies are spatially distributed. The combination of DEM and GIS has proven effective for geomorphological studies, assisting in watershed management and planning for land use.



### Article History

Received: 03 November 2025

Accepted: 22 December 2025

### Keywords

Anomaly;  
DEM;  
Drainage;  
GIS;  
Morphometry.

### Abbreviations

DD	drainage density,
RS	Remote Sensing,
GIS	Geographic Information Systems,
SL	stream length,
SF	stream frequency,
MSL	mean stream length,
SO	stream order,
SLR	Stream Length Ratio,

**CONTACT** Kabita Lepcha ✉ [kabitaugb@gmail.com](mailto:kabitaugb@gmail.com) 📍 Department of Geography, University of GourBanga, Malda, West Bengal, India.



© 2025 The Author(s). Published by Enviro Research Publishers.

This is an  Open Access article licensed under a Creative Commons license: Attribution 4.0 International (CC-BY).

Doi: <http://dx.doi.org/10.12944/CWE.20.3.10>

BR	Bifurcation Ratio,
SN	Stream number,
CCM	Constant of Channel Maintenance,
DT	drainage texture,
DI	Drainage Intensity,
IN	Infiltration Number,
LOF	Length of Overland Flow,
ER	Elongation Ratio,
FF	Form Factor,
RR	Relief Ratio,
DI	Dissection Index (Di),
RN	Ruggedness Number,
MRN	Melton Ruggedness Number,
BR	Basin relief

### Introduction

The systematic and descriptive study of landforms is known as geomorphology. A geomorphic system, generally described in terms of the dominant agent of geomorphic activity, refers to a set of interconnected landforms and processes.<sup>1</sup> Within this discipline, fluvial geomorphology focuses on understanding how river processes and landform dynamics interact across different spatial and temporal scales. In recent years, geomorphology has significantly advanced with the integration of RS and GIS. The application of statistical techniques to landform analysis and drainage morphology has enabled geomorphologists to approach problem-solving in diverse planning and developmental contexts. Progress in simulation modeling, morphological mapping techniques, and quantitative evaluation of landforms and surficial deposits using instrumental methods has further strengthened this field. Consequently, geomorphologists increasingly rely on statistical datasets and morphometric properties to interpret landform evolution.

Morphometric analysis systematically evaluates landforms, concentrating on the dimensions, contours, and configurations of topographical features.<sup>2</sup> It aids in comprehending the characteristics of basins, the evolution of drainage systems, and the historical context of geomorphology. A Numerous studies have utilized morphometric methods in various river basins.<sup>3-5</sup> Irregular stream patterns or densities, known as drainage anomalies, often indicate tectonic or geological disruptions. These anomalies can signal crustal deformation, faulting, or extensions of folds.<sup>6</sup> In summary, morphometric

analysis, particularly regarding hierarchical drainage systems, highlights the influence of tectonics on the development of basins.<sup>7</sup>

In the present study, the Kanchi River Basin was examined for drainage anomalies using morphometric parameters such as SL, DD and SF. Research shows that both qualitative and quantitative assessments of drainage networks, especially in folded mountains and tectonically active regions, are crucial for identifying the influence of tectonic processes on geomorphic development.<sup>8</sup> Recent studies have consistently underscored the strong association between drainage system characteristics and tectonic activity, thereby reinforcing the importance of morphometric analysis in geomorphological research.<sup>9-11</sup>

### Study Area

The Kanchi River Basin encompasses an area of 1,023.76 km<sup>2</sup>, located across the Ranchi and Khunti districts in Jharkhand. It is geographically positioned between latitudes 23°13'N and 23°17'N as well as longitudes 85°12'E and 85°50'E. The elevation within the basin ranges from 762 m in the upper sections to 207 m at its downstream outlet. The Kanchi River begins its journey near Hakajanj village at an elevation of 739 m on the Ranchi Plateau, situated at 23°17'N and 85°12'E. It predominantly flows eastward for approximately 80 km before it joins the Subarnarekha River close to Bhakuyadi village in West Bengal. A notable geomorphic feature along its pathway is Dassam Falls, a natural waterfall created by the river. The drainage system shows a dendritic configuration, indicating homogeneity

in the lithology and uniform soil characteristics. This pattern illustrates how the river modifies itself in response to the geological formations and the incline of the surface. The predominant soils in the basin are loamy and sandy, allowing for diverse

agricultural practices. The region experiences a humid subtropical climate, and approximately 80% of its annual rainfall takes place during the southwest monsoon period (*June–September*).

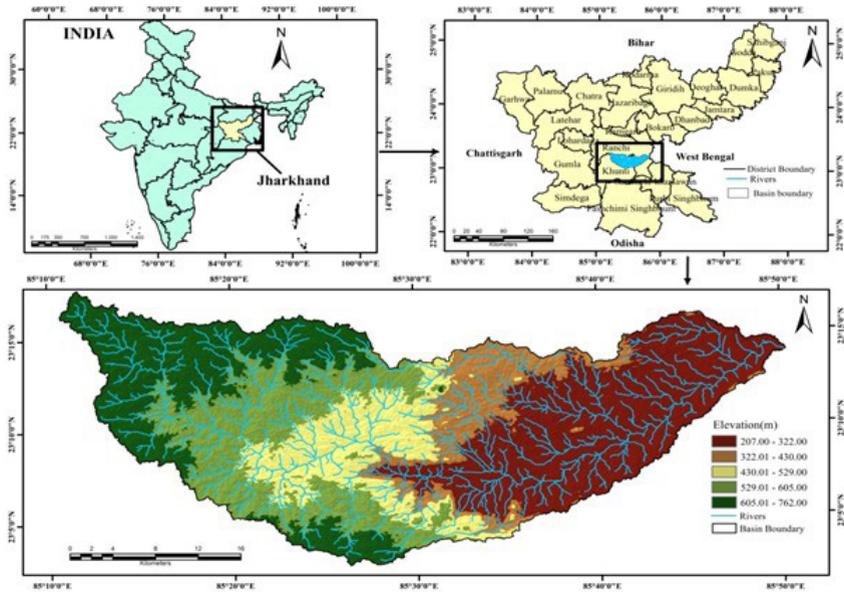


Fig. 1: Study Area

### Materials and Methods

The present study analyses the morphometric characteristics and drainage anomalies of the Kanchi River Basin using the ArcGIS environment and SRTM DEM. The SRTM data were obtained from the USGS portal.<sup>26</sup> The methodological flow chart outlining the procedure for deriving morphometric characteristics and drainage anomalies is presented in Figure 2. The Kanchi River's drainage network and basin boundary were delineated using ArcGIS. The basin was methodically segmented into 1,136 grids, each measuring 1 km<sup>2</sup>, with the help of the grid index tool in ArcGIS 10.3.1. For each grid and parameters such as SL, SF, and contour elevation were assessed to produce maps illustrating areal

and relief properties. Morphometric parameters were computed following standard methods.<sup>12-14</sup> grouped into 3 aspects

- Linear Aspects: SO, SN, SL, MSL, SLR and
- Areal Aspects: DD, SF, CCM, DT, DI, IN, LOF, FF, ER.
- Relief Aspects: BR, RR, RN, MRN.

These parameters were examined to understand the geomorphic behavior of the basin and identify any drainage anomalies. To assess drainage anomalies, three specific parameters were taken into account: stream length anomaly, drainage density anomaly, and stream frequency anomaly (Table 1).

Table 1: Drainage Anomaly parameters and formula

Drainage Anomaly parameters	Formula
Length Anomaly(La)	$La = (X - \bar{X})$ , Where, X=length, $\bar{X}$ =Mean of Length
Range of Variability Approach (RVA)	$RVA = La \pm SD$ , Where, La =length Anomaly, $\pm SD$ =Standard Deviation of Length

	Drainage Density Anomaly(Dda)	$Dda=(X-\bar{X})$ , Where, X=Drainage Density, $\bar{X}$ =Mean of Drainage Density
Drainage Anomaly	Range of Variability Approach (RVA)	$RVA=Dda\pm SD$ , Where, DDa =length Anomaly, $\pm SD$ =Standard Deviation of Length
	Stream Frequency Anomaly(Fsa)	$Fsa=(X-\bar{X})$ , Where, X=Stream Frequency Density, $\bar{X}$ =Mean of Stream Frequency.
	Range of Variability Approach (RVA)	$RVA=Fsa\pm SD$ ,Where, Fsa = Stream Frequency Anomaly, $\pm SD$ =Standard Deviation of Stream Frequency Anomaly

## Results

### Linear Properties

The Kanchi River Basin covers an area of 1,023.76 square kilometers, with its highest stream order classified as fifth order. The basin predominantly exhibits a dendritic drainage pattern, which is generally associated with regions of homogeneous lithology. Drainage analysis, when combined with hydrogeological interpretations, provides critical insights into the complex interactions between geological structures and basin morphology.<sup>15</sup> The basin is classified as a fifth-order stream, with higher-

order streams mostly found in the lower part of the basin. Conversely, first-order and second-order streams are more evenly spread throughout the basin, indicating the hydrological immaturity in the upper catchment areas and increased integration in the downstream areas. A total of 772 stream segments have been identified. The first-order streams are the most abundant and also exhibit the maximum total stream length, whereas the number and length of streams progressively decrease with increasing stream order. (Fig no: 3.A)

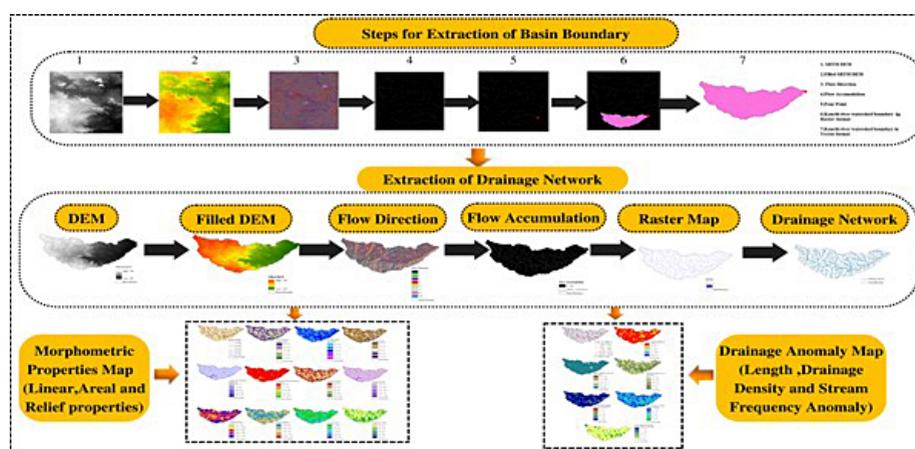


Fig. 2: Methodological flow chart

The total length of streams in the Kanchi River Basin is 1166.38 km. The order-wise stream lengths are presented in Table No 2 and Figure 3.B. According to Das and Pardeshi,<sup>16</sup> MSL represents “the characteristic size of drainage network components and provides an index of surface runoff and slope conditions within the basin”. In the Kanchi River Basin, the MSL varies from 1.03 km in the 1st order to 72.32 km in the 5th order, indicating a progressive increase with stream order. This trend suggests that as stream order increases, stream segments

become longer and drain larger areas, which is typical of mature basins under normal geomorphic conditions. The positive correlation between SO and MSL highlights that the basin follows law of stream length.<sup>12</sup> (Fig no: 3.C).

The SLR is defined as “the ratio of the MSL of a given order to that of the next lower order”.<sup>17</sup> The SLR of the river basin varies from 1.12 to 12.43, with the highest ratio recorded in the fifth-order stream at 12.43. This exceptionally high ratio at the higher order signifies

a major increase in the contributing area and indicates that the main river channel has attained a more mature geomorphic stage. The overall trend reveals a positive correlation between SO and SLR, suggesting that the basin's hydrological and erosional processes are progressively well-adjusted downstream. The BR is an important morphometric parameter that indicates "the ratio of the no of streams of a given order to those of the next higher order". It provides valuable information about the degree of branching within the drainage network and the structural influence on basin morphology.<sup>18,19</sup> Typically, Rb values range between 3 and 5 for basins that are structurally undisturbed and have homogeneous lithology. Values exceeding 5 generally indicate structural disturbances, faulting, or lithological variations.<sup>19</sup> In the Kanchi River Basin, the BR ranges from 4.12 to 6.00, with an average value of 5.00. Lower-order streams (1st and 2nd order) exhibit Rb values within the normal range (4.12–4.38), indicating minimal structural influence and well-developed drainage texture. In contrast, higher-order streams (3rd and 4th order) record values exceeding 5, implying that the upper reaches of the basin are structurally and lithologically controlled. A positive correlation exists between stream order and bifurcation ratio (Fig. 3.D), suggesting that the

increase in Rb with stream order is associated with tectonic and lithological heterogeneity within the basin. These variations signify that the Kanchi River Basin, though predominantly dendritic, is influenced locally by geological structures, which control the alignment and organization of the drainage network. The calculated mean BR of the river basin is 5.001, which is slightly above the typical range of 3–5 indicated by Horton.<sup>19</sup> This figure suggests a moderate level of structural influence, although it is not high enough to imply significant tectonic control. Consequently, it can be deduced that while variations in lithology may be present, the drainage pattern is primarily governed by topography and surface runoff processes rather than major structural disturbances. The Rho coefficient ( $\rho$ ), proposed by Horton,<sup>17</sup> is a significant morphometric parameter linking the physiographic development of a basin with its DD. The Rho coefficient value of the river basin is 0.905, which is considerably higher than 0.50. A higher  $\rho$  value indicates greater hydrological storage capacity, implying that the basin has a well-developed drainage network capable of retaining and regulating surface runoff. This high Rho coefficient thus suggests that the Kanchi River Basin possesses substantial flood-related storage potential and exhibits advanced geomorphic maturity.

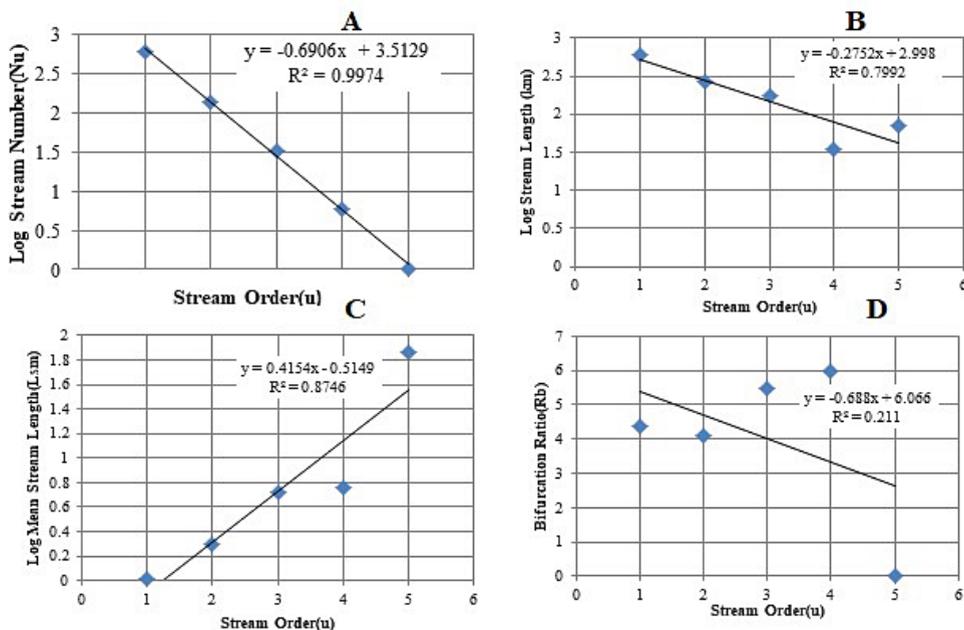


Fig. 3: A-SO vs SN , B.SO vs SL , C- SO vs MSL and D-SO vs BR

**Table 2: Table for SO, SN, SL and BR**

SO (u)	SN (N $\mu$ )	LogNu	SL (Lu)	Log Lu	MSL	Log MSL	BR
1	596	2.775	613.933	2.788	1.030	0.013	4.38
2	136	2.134	273.559	2.437	2.011	0.304	4.12
3	33	1.519	171.677	2.235	5.202	0.716	5.5
4	6	0.778	34.886	1.543	5.814	0.764	6
5	1	0	72.32	1.859	72.32	1.859	

### Areal Properties

SF refers to “the total number of streams of all orders per unit area”.<sup>20</sup> The SF of the river basin is measured as 0.97 streams/km<sup>2</sup> which signify a moderate degree of dissection. In this basin, the lithological features and drainage texture significantly influence the SF. DD measures “the total length of all stream segments in a drainage basin per unit area”.<sup>17</sup> DD of the river basin is 1.139 km/km<sup>2</sup>, which indicates a coarse drainage texture and implies that the surface of the basin is supported by relatively impermeable or weak rock formations. The CCM, first proposed by Schumm 1956,<sup>14</sup> is defined as “the inverse of DD and reflects the average area needed to support a unit length of stream channel”. It offers valuable information regarding the erosional characteristics of a watershed and has important implications for geomorphology and hydrology, as noted by Strahler 1952.<sup>21</sup> Elevated CCM values signify greater infiltration and reduced surface runoff, while lower values correspond to less permeable surfaces and an increased potential for runoff. In the Kanchi River Basin, the CCM value is recorded at 0.878 km<sup>2</sup>/km, indicating a moderate level of infiltration and a balanced situation regarding runoff. DT refers to “the relative spacing of drainage lines within a basin”,<sup>12</sup> The DT value of the river basin is 4.725, representing a moderate DT, which suggests both moderate relief and permeable geological formations. DI is “the ratio of SF to DD”. It represents the relative influence of drainage characteristics on the landscape. The Kanchi River Basin records a DI value of 0.853, which is relatively low. This low value implies that denudational processes are more dominant than fluvial erosion, and that the surface is not strongly dissected by streams. The IN is calculated by “multiplying DD by SF”.<sup>12</sup> In the River Basin, the Infiltration Number is 1.108, suggesting a moderate level of permeability and infiltration rates. The characteristics of the basin are

influenced by its lithology, relief, and soil texture. The LOF represents the average distance traveled by surface runoff before joining a stream channel. In the Kanchi River Basin, the LOF value is 0.439 km, suggesting active surface runoff processes and the presence of both channel and sheet erosion. The ER, introduced by Schumm,<sup>14</sup> and The ER of the River Basin is 0.54, signifying a moderately elongated shape typical of mature basins with gentle slopes and lower flood peaks. The FF, introduced by renowned Horton,<sup>12,17</sup> and FF value of the river basin is 0.230, confirming its elongated nature and suggesting that it has a longer concentration time and lower peak discharge potential.

### Relief Properties

The topography of the Kanchi River Basin is characterized by moderately steep slopes, variable lithology, and elevated areas that influence fluvial behavior and surface runoff. The highest altitude in the basin is 760 m, and the lowest altitude is 210 m, resulting in a total basin relief of 550 m. The RR expresses “the ratio between the basin’s total relief and its longest dimension parallel to the main drainage line”.<sup>14</sup> For the Kanchi River Basin, the RR is 0.008, which signifies moderate relief and gentle slopes, typical of a semi-mature geomorphic stage. The DI quantifies the degree of dissection and erosional maturity of the terrain. It represents “the ratio of relative relief to the maximum possible relief within a basin”.<sup>22</sup> The DI of the River Basin is 0.724 (72.4%), signifying a very high degree of dissection. This suggests that the basin has undergone intense erosional activity, resulting in a highly dissected and rugged landscape. The RN, introduced by Strahler,<sup>23</sup> serves as “a quantitative measure of terrain roughness calculated by multiplying basin relief with drainage density”. It reflects the complexity of the structure and the variability of slopes within a basin. Higher

RN values indicate steep inclines, pronounced dissection, and disturbed terrain, whereas lower values signify gentle slopes and less rugged regions. The RN for the Kanchi River Basin is 836.25, indicating notable topographic irregularity and considerable relief energy. The MRN, proposed by Melton,<sup>24</sup> represents "the relief roughness or ruggedness of a basin in terms of the ratio of basin relief to the square root of basin area." The MRN value of the river basin is 22.94, which indicates an extremely rugged topography and significant relief contrast between high and low areas.

### Drainage Anomaly Analysis

#### SI Anomaly

The length of the stream is a crucial hydrological characteristic of a watershed, as it offers insight into surface runoff. In regions with steeper slopes and finer textures, streams tend to be shorter. Conversely, streams that are longer in length usually have gentler gradients. The total length of a stream

of any order is the aggregate of all its individual stream segments. The term "stream length signifies the average (or mean) length of a stream within each order, calculated by dividing the total length of all streams in a specific order by the number of streams within that order." Positive anomalies are shown by individual stream lengths that are greater than the mean stream length, and Negative anomalies are indicated by individual lengths that are lower than the mean stream length. Overall, the spatial pattern of positive and negative anomalies offers valuable insight into the internal geomorphic organization of the Kanchi River Basin. Clusters of positive anomalies reveal relatively stable and mature sub-basins with favourable conditions for channel elongation, while negative anomalies point to environmentally sensitive or tectonically influenced areas. Understanding this distribution enhances interpretation of basin evolution, drainage adjustments, and potential zones of differential uplift or slope instability.

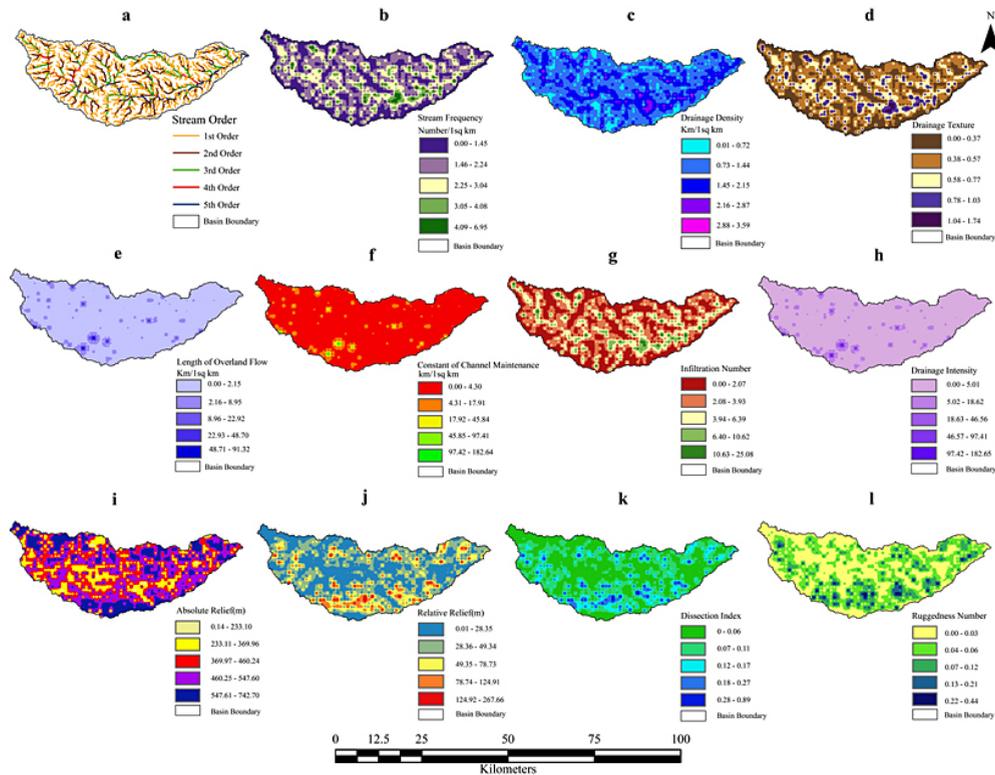
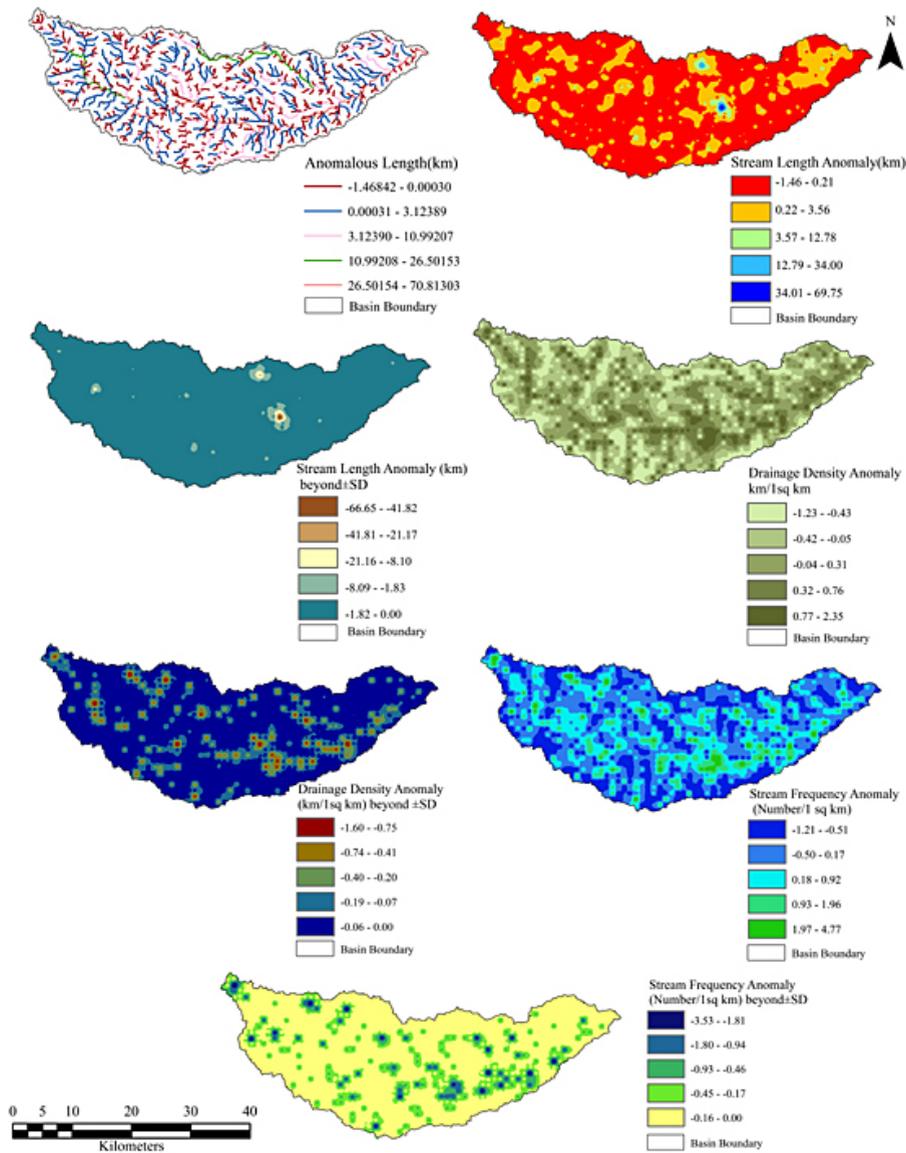


Fig. 4: Maps of morphometric parameters

**DD Anomaly**

DD is a crucial morphometric parameter for stream networks that depicts the processes governing landscape segmentation (Dd). A good criterion for assessing the rates of uplift and horizontal dispersion of anticlines is DD.<sup>7</sup> In the Kanchi River Basin, both positive and negative DD anomalies are observed, indicating a heterogeneous geomorphic setting. Positive anomalies—areas where drainage

density exceeds the mean—typically reflect zones of highly dissected terrain, steep slopes, or regions undergoing active uplift. In such zones, rapid runoff and accelerated incision promote the development of closely spaced channels, resulting in high drainage density values. These anomalies may therefore signify structurally active segments of the basin or areas where lithology is more susceptible to erosion.



**Fig. 5: Maps of drainage anomaly**

### SF Anomaly

The main factors that determine stream frequency anomaly are the lithology and the consistency of the drainage system. According to Obi Reddy *et al.*,<sup>25</sup> low values of SF suggest the presence of a permeable underlying surface and low relief. In the Kanchi River Basin, the spatial distribution of SF anomalies reveals a predominance of negative to very low negative anomalies across most of the basin. A small portion of the area exhibits highly positive SF anomalies, suggesting localised conditions favouring channel proliferation—such as impermeable lithology, steep slopes, or geomorphic instability that promotes rapid drainage dissection. These zones may also correspond to structurally influenced areas where jointing, fracturing, or uplift enhances stream initiation. However, the anomalies values extending beyond  $\pm 1$  standard deviation (SD1) demonstrate that negative anomalies dominate substantially, affecting nearly the entire basin. High negative SF anomalies occur only over very limited pockets, while much of the basin is characterized by low negative to mildly positive anomalies. This pattern suggests that the majority of the area is underlain by permeable geological formations, gentle slopes, or stable terrain where channel initiation is naturally limited.

### Discussion

The morphometric configuration of the Kanchi River Basin reflects a drainage system that has evolved primarily under the control of regional topography and lithological uniformity, with only limited imprint of structural disturbances. The dominance of a dendritic drainage pattern is particularly significant, as it indicates that surface runoff has adjusted freely to slope and substrate conditions rather than being constrained by faulting or strong lineament control. Similar drainage organization has been reported from other geomorphically stable fluvial basins developed on relatively homogeneous lithology in peninsular and shield regions, where long-term denudation operates under tectonically quiescent conditions. This suggests that the Kanchi Basin represents a landscape shaped more by sustained fluvial processes than by episodic tectonic forcing. The conformity of the drainage network to Hortonian laws reflects an internally consistent and self-organized system, implying that stream development has proceeded through gradual headward extension and channel integration rather than abrupt reorganization. The prevalence of lower-

order streams in the upper reaches is not merely a structural characteristic but highlights zones where erosion is still actively extending the drainage network upslope. Comparable patterns have been documented in semi-mature basins of eastern and southern India, where upper catchments remain geomorphically dynamic despite overall basin maturity. In contrast, the concentration of higher-order channels downstream indicates efficient integration of tributaries, resulting in a stabilized trunk system capable of regulating flow over larger contributing areas. This downstream maturity is critical from a hydrological perspective, as it enhances flow continuity and reduces abrupt discharge fluctuations. Variations in bifurcation behavior across stream orders carry important geomorphic implications. Bifurcation ratios that remain largely within the expected range for undisturbed basins suggest minimal tectonic interference at the basin scale. However, slight increases in higher orders imply that local lithological contrasts or minor structural elements still exert selective control on channel branching. Such subtle deviations are common in basins developed on mixed sedimentary or weathered crystalline terrains, where joints, bedding planes, or differential resistance influence channel alignment without fundamentally disrupting basin-wide drainage organization. The relatively high Rho coefficient further reinforces the interpretation of an advanced evolutionary stage, as it reflects enhanced storage capacity and delayed runoff response, characteristics typically associated with mature fluvial systems. Areal morphometric characteristics provide additional insight into the hydrological behavior of the basin. Moderate stream frequency combined with low drainage density points to a landscape where infiltration processes play a dominant role in regulating runoff. This hydrological balance is particularly important when compared with basins in more humid or structurally disturbed regions, where higher drainage densities often correspond to rapid runoff generation and increased flood susceptibility. In the Kanchi Basin, the coarse drainage texture and low drainage intensity indicate that erosional processes operate at a measured pace, allowing for progressive landscape adjustment rather than rapid channel incision. Such conditions favor groundwater recharge and contribute to the overall resilience of the basin to short-duration, high-intensity rainfall events. Basin shape further modulates hydrological response by influencing flow

concentration times. The elongated geometry of the Kanchi River Basin implies a staggered contribution of runoff from different parts of the catchment, reducing the likelihood of sharp flood peaks. Similar elongated basins in comparable climatic and lithological settings have been shown to exhibit sustained discharge and reduced flood hazards, reinforcing the interpretation that basin form plays a critical role in moderating hydrological extremes. This has practical implications for flood management and water resource planning within the basin. Relief-related parameters highlight an important distinction between elevation and erosional intensity. Although the basin does not exhibit extreme relief, high dissection and ruggedness values indicate that prolonged fluvial erosion has deeply incised the landscape over time. This pattern is typical of semi-mature to mature basins where long-term denudation, rather than rapid uplift, drives terrain complexity. Comparable observations have been reported from dissected plateau margins and river basins in stable cratonic regions, where sustained erosion produces rugged topography despite moderate absolute relief. The implication is that slope instability and sediment delivery are more strongly linked to channel incision and hillslope processes than to elevation alone, particularly in the upper and middle reaches. Drainage anomaly analysis provides a nuanced understanding of spatial variability within the basin that is not captured by basin-wide averages. Zones exhibiting positive stream length anomalies reflect areas where lithological resistance and gentler slopes have allowed channels to extend and stabilize, signaling relative geomorphic equilibrium. Conversely, negative anomalies correspond to steeper or more unstable terrain segments, where erosion outpaces channel extension. The predominance of negative anomalies in drainage density and stream frequency across the basin further supports the interpretation of a permeable, stable substratum, while isolated positive anomalies point to localized zones of enhanced erosion or subtle structural influence. Similar anomaly patterns have been reported from mature basins undergoing differential erosion, where localized controls coexist with overall geomorphic stability. The Kanchi River Basin represents a predominantly mature fluvial system that has evolved through sustained interaction between topography, lithology, and surface runoff processes under limited structural control. The morphometric

patterns are significant not because they merely describe basin geometry, but because they explain how the basin regulates water and sediment fluxes, mitigates flood hazards, and accommodates ongoing erosion. When viewed in comparison with similar geomorphic settings, the basin emerges as geomorphically evolved yet dynamically active, characterized by balanced hydrological behavior and long-term landscape stability punctuated by localized zones of adjustment.

### Conclusion

This study employs RS and GIS techniques to analyse the morphometric characteristics and drainage anomaly zones of the River Basin. The GIS framework facilitated systematic mapping and quantitative evaluation of the basin's drainage network.

The River Basin, covering an area of 1023.76 km<sup>2</sup>, is part of the Ranchi Plateau and exhibits a classic combination of morphological features resulting from altitude variations. The Kanchi River, a right-bank tributary of the Subarnarekha River, has a total length of 80 km and originates from the Ranchi Plateau. Relief plays a crucial role in understanding the geomorphic characteristics of the basin. DEM was used to assess elevation patterns; with the basin exhibiting an absolute relief of 760 m. Relative relief varies between 10 m and 270 m, reflecting local variations in topography and slope.

The drainage network determines the linear characteristics of the basin. The basin's drainage density, calculated as the total stream length per unit area, along with DT, provides insights into the spatial organization and efficiency of the drainage system. Morphometric analysis of drainage anomalies further highlights the influence of tectonic activity, geological structure, lithological resistance, and slope on basin development.

Statistical analysis of drainage anomalies indicates that areas of very high positive stream length anomaly are limited, while the majority of the basin shows a range from negative to positive drainage density anomalies. Positive stream frequency anomalies are scattered throughout the basin, reflecting local variations in lithology and hydrological conditions. Overall, this integrated morphometric and drainage anomaly analysis provides a comprehensive understanding of the

Kanchi River Basin's geomorphic and hydrological behaviour, offering valuable insights for watershed management and planning.

#### Acknowledgement

I am highly grateful to the Department of Geography, University of GourBanga, for allowing me to carry out my work using the GIS Laboratory of the department. I am also thankful to my scholars Mr. Paban Ghosh and Ms. Tandra Roy, for their support. I am profoundly grateful to the National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO), Government of India, for providing easy access to satellite data.

#### Funding Sources

The author(s) received no financial support for the research, authorship, and/or publication of this article

#### Conflict of Interest

The author do not have any conflict of interest.

#### Data Availability Statement

This statement does not apply to this article

#### Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval.

#### Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

#### Permission to Reproduce Material from other Sources

Not Applicable

#### Author Contributions

The sole author was responsible for the conceptualization, methodology, data collection, analysis, writing, and final approval of the manuscript.

#### References

- Dunne, T., & Leopold, L. B. Water in environmental planning. Freeman, *New York*, 1978.
- Rai, P. K., Mohan, K., Mishra, S., Ahmad, A., & Mishra, V. N. A GIS-based approach in drainage morphometric analysis of Kanhar River Basin, India. *Applied Water Science*. 2014;7(1):217–232. <https://doi.org/10.1007/s13201-014-0238-y>
- Abboud, I. A., & Nofal, R. A. Morphometric analysis of WadiKhumal basin, western coast of Saudi Arabia, using remote sensing and GIS techniques. *Journal of African Earth Sciences*. 2016. Elsevier Ltd. <https://doi.org/10.1016/j.jafrearsci.2016.11.024>
- Akoji, C., Olaide, O., Aderoju, M., Bisong, J., Idris, E., Adama, S., & Bukar, M. Morphometric analysis and prioritization of upper Benue River. *Applied Water Science*. 2021;11(2):1–28. <https://doi.org/10.1007/s13201-021-01364-x>
- Anish, A. U., Baiju, K. R., Thomas, P. K., Anns, M., Rajkumar, P. B., & Babu, S. Status of GIS-enabled morphometric analysis of river basins of Kerala, Southern India: A review and assessment. *Regional Studies in Marine Science*. 2021;44: 101792.
- Rozaanov, M. Investigation of active faults in Morocco using morphometric methods and *drainage pattern analysis*. 1992.
- Bahrami, S. PT Department of Physical Geography, Faculty of Geography and *Environmental Science. Tectonophysics*. 2013 <https://doi.org/10.1016/j.tecto.2013.07.026>
- Bahrami, S. Morphotectonic evolution of triangular facets and wine-glass valleys in the Noakoh anticline, Zagros, Iran: Implications for active tectonics. *Geomorphology*, 2012, 159–160, 37–49. <https://doi.org/10.1016/j.geomorph.2012.03.003>
- Rahaman, S. A., Abdul, S., Aruchamy, S., & Jegankumar, R. Prioritization of sub-watershed based on morphometric characteristics using fuzzy analytical hierarchy process and geographical information system: A study of Kallar Watershed, Tamil Nadu. *Aquatic Procedia*, 4(ICWRCOE), 2015, 1322–1330. <https://doi.org/10.1016/j.aapro.2015.02.172>
- Rai, P. K., Mishra, V. N., & Mohan, K. A study of morphometric evaluation of the Son basin, India using geospatial approach.

- Remote Sensing Applications: *Society and Environment*.2017;7:9–20.
11. Soni, S. Assessment of morphometric characteristics of Chakrar watershed in Madhya Pradesh, India using geospatial technique. *Applied Water Science*. 2017; 7(5):2089–2102. <https://doi.org/10.1007/s13201-016-0395-2>
  12. Horton, R. E. Erosional development of streams and their drainage basins: Hydrophysical approach to quantitative morphology. *Geological Society of America Bulletin*. 1945, [https://doi.org/10.1130/0016-7606\(1945\)56](https://doi.org/10.1130/0016-7606(1945)56)
  13. Strahler, A. N. Quantitative geomorphology of drainage basins and channel networks. In V. T. Chow (Ed.), *Handbook of applied hydrology*. McGraw-Hill Book Company, *New York*, 1964.
  14. Schumm, S. A. Evolution of drainage systems and slopes in badlands at Perth Amboy, *New Jersey*. *Geological Society of America Bulletin*.1956;67(5):597–646.
  15. Kumar, P., Narayan, V., & Mohan, K. A study of morphometric evaluation of the Son basin, India using geospatial approach. *Remote Sensing Applications: Society and Environment*.2017;7(May):9–20. <https://doi.org/10.1016/j.rsase.2017.05.001>
  16. Das, S., & Pardeshi, S. D. Morphometric analysis of Vaitarna and Ulhas river basins, Maharashtra, India: Using geospatial techniques. *Applied Water Science*. 2018;8 (6):1–11. <https://doi.org/10.1007/s13201-018-0801-z>
  17. Horton, R. E. Erosional development of streams and their drainage basins: Hydrophysical approach to quantitative morphology. *Geological Society of America Bulletin*. 1945[https://doi.org/10.1130/0016-7606\(1945\)56](https://doi.org/10.1130/0016-7606(1945)56)
  18. Strahler, A. N. Quantitative analysis of watershed geomorphology. *Eos, Transactions American Geophysical Union*. 1957;38 (6):913–919.
  19. Strahler, A. N. Quantitative geomorphology of drainage basins and channel networks. In V. T. Chow (Ed.), *Handbook of applied hydrology*. 1964. McGraw-Hill Book Company, *New York*.
  20. Horton, R. E. Drainage-basin characteristics. *Transactions, American Geophysical Union*.1932;13(1):350–361.
  21. Strahler, A. N. *Geological Society of America Bulletin*. 11. 1952.[https://doi.org/10.1130/0016-7606\(1952\)63](https://doi.org/10.1130/0016-7606(1952)63)
  22. Singh, S., Dubey, A. Geoenvironmental planning of watersheds in India. *Chugh*. 1994
  23. Strahler, A. N. Quantitative slope analysis. *Geological Society of America Bulletin*.1956;67(5):571–596.
  24. Melton, M. The geomorphic and paleoclimatic significance of alluvial deposits in southern Arizona. *The Journal of Geology*.1965
  25. Obi Reddy, G. P., Maji, A. K., & Gajbhiye, K. S. Drainage morphometry and its influence on landform characteristics in a basaltic terrain, Central India: A remote sensing and GIS approach. *International Journal of Applied Earth Observation and Geoinformation*.2004;6(1):1–16. <https://doi.org/10.1016/j.jag.2004.06.003>
  26. NASA Jet Propulsion Laboratory (JPL). *Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global, Tile SRTM1N23E085V3*. Pasadena, CA: NASA EOSDIS Land Processes DAAC; 2014. [www.usgs.gov](http://www.usgs.gov). Published September 23, 2014. Accessed. <https://doi.org/10.5067/MEaSURES/SRTM/SRTM1.003>.