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MORPHOMETRIC PERSPECTIVE OF THE DELIMI CATCHMENT ON THE JOS PLATEAU, NIGERIA

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ABSTRACT

The Delimi River catchment, a headwater tributary of the Lake Chad Basin draining the crystalline basement of the Jos Plateau, is increasingly exposed to urbanisation and flood risk, yet remains ungauged. This study conducted a comprehensive morphometric assessment using 30 m SRTM DEM data and GIS remote sensing based Horton–Strahler analysis to compute 29 linear, areal, and relief parameters, supported by field validation. Results show that the 237.32 km² fourth-order basin exhibits a dendritic drainage pattern typical of basement terrains, with low drainage density (0.98 km/km²) and very coarse drainage texture (1.02), indicating permeable subsoils and infiltration dominance. Its highly elongated shape (elongation ratio = 0.37; form factor = 0.11) favours attenuated flood peaks, while moderate relief (0.52 km), ruggedness (0.51), and a hypsometric integral of 0.56 suggest a mature, moderately dissected landscape under structural control (mean bifurcation ratio = 6.06). Overall, the catchment's morphometric configuration indicates natural buffering capacity against extreme floods; however, rapid urban expansion in Jos metropolis threatens to reduce infiltration and increase runoff. These baseline findings provide essential inputs for flood forecasting, stormwater planning, and sustainable watershed management in this data-sparse region.

Keywords:
Morphometric analysis, Drainage basin, Delimi River, Jos Plateau, GIS, Watershed Management, Flood hydrology

1. INTRODUCTION

River catchment morphometry provides a quantitative basis for understanding watershed structure, geological controls, and hydrological responses to rainfall. By analysing drainage networks, basin geometry, and relief characteristics, it offers critical insights into flood susceptibility, sediment transport, erosion potential, infiltration capacity, groundwater recharge, and runoff behaviour, thereby supporting watershed prioritisation and sustainable water resource management (Alfa, Ajibike, Adie, & Mudiare, 2019; Obeidat, Awawdeh, & Al-Hantouli, 2021; Gautam, 2023). Morphometric parameters strongly influence hydrological response: high drainage density and stream frequency are associated with rapid runoff and greater flood risk, whereas elongated basins tend to produce lower, longer-duration peak flows; similarly, relief indices such as ruggedness number and basin slope indicate erosion intensity and flash flood potential (Oruonye, Ezekiel, Atiku, Baba, & Musa, 2016; Udoka et al., 2016). Beyond hydrology, morphometric analysis remains essential for river basin evaluation, natural resource management, and understanding landform and soil process interactions.

The concept of a river catchment, or drainage basin, has evolved significantly since Horton first outlined it in 1932 as the land area that channels surface runoff to a specific point, bounded by topographic divides. This marked the Geomorphic-Hydrological Foundations era (1950s - 1970s). Chow (1964), Dooge (1973) and Nash & Sutcliffe (1970) expanded this view of catchment definitions to include a collection of precipitation and surface water toward a shared outlet like a river or lake. This perspective marked the Hydrological-System Perspective Era (1950s–1970s). The ecohydrology era (1980s - 1990s) incorporated biophysical and ecological elements into the definition of a catchment and portrayed it as a unified landscape of soils, vegetation, atmosphere, and water cycles acting as an ecological system (Peterjohn & Correll, 1984; Likens, 1985). The definition shifted toward a socio-hydrological framework (1990s - 2000s), under integrated water resources management, where catchments are viewed as an interconnected socio-environmental system where water flow, land use, governance, and human choices interact dynamically (Global Water Partnership (GWP), 2000; Falkenmark & Rockström, 2004). In recent times, contemporary definitions blend Earth-system and socio-ecohydrological views, seeing catchments as dynamic units that integrate surface and groundwater, climate influences, land use, and human factors to manage water quantity and quality (Wagener et al., 2010; Sebestyen et al, 2025). This progression reflects growing recognition of catchments as complex, adaptive systems beyond mere topography.

Morphometric analysis refers to the quantitative evaluation of drainage basin form and structure and has developed progressively through foundational and contemporary scholarship. Robert E. Horton established the empirical basis of basin analysis by introducing a hydro-physical framework for measuring stream number, stream length, basin area, bifurcation ratio, and drainage density, thereby shifting geomorphology toward quantitative reasoning and formulating what became known as Horton's Laws (Horton, 1945). Building on this foundation, Arthur N. Strahler refined and formalised morphometric analysis through systematic classification of linear, areal, and relief parameters, and by introducing the Strahler stream ordering system, which strengthened the statistical and mathematical characterisation of drainage networks (Strahler, 1957, 1964). Subsequently, John I. Clarke expanded the conceptual scope of morphometry by defining it as the quantitative measurement of landform attributes that reflect geological structure, evolutionary history, and hydrological behaviour. Clarke emphasised transforming qualitative terrain descriptions into measurable variables to support applications in geomorphology, hydrology, and environmental planning (Clarke, 1966). Recent advancements demonstrate a shift toward geospatial integration and applied watershed analysis. Singh, Malik, and Kumar (2020) incorporated Geographic Information Systems (GIS) and Digital Elevation Models (DEMs) to enhance precision in evaluating basin geometry, drainage configuration, and relief characteristics, with direct implications for flood susceptibility, erosion risk, and watershed prioritisation (Singh et al., 2020). More recently, Shekar et al. (2024) underscored the role of advanced computational techniques and remote sensing in linking morphometric indices to soil properties, sediment dynamics, and hydrological response processes within drainage systems (Shekar et al., 2024). Collectively, this intellectual trajectory illustrates the transformation of basin morphometry from descriptive geomorphology to a robust, multidisciplinary, and data-driven framework that underpins contemporary hydrological modelling and watershed management

Current debates in catchment morphometry increasingly centre on issues of standardisation, data uncertainty, and predictive capability. Shekar and Mathew (2024) highlight the persistent lack of a clearly defined standard classification system for morphometric parameters, particularly regarding the interpretation of their values and associated hydrological implications. They note that many studies simply describe parameter values as "high" or "low" without establishing explicit value ranges, threshold categories, or process-based interpretations. This ambiguity limits comparability across basins and constrains the practical application of morphometric indices in watershed management. Closely related to this concern is the question of input data reliability, especially the influence of Digital Elevation Model (DEM) selection and spatial resolution on derived morphometric results. Tesema (2021) demonstrated that variations in DEM source and resolution can produce significantly different drainage networks and parameter values, raising concerns about the comparability and reproducibility of morphometric analyses across studies. Beyond methodological standardisation and data quality, another active area of discussion concerns the predictive strength of morphometric indices in hydrological modelling. Arash, Fryirs, and Ralph (2025) question the extent to which traditional morphometric metrics reliably predict hydrological behaviour, particularly in rainfall–runoff modelling for extreme events and ungauged basins. They argue that widely used indices such as elongation ratio and form factor may oversimplify basin complexity and fail to capture nonlinear flow processes unless integrated with physically based hydrological frameworks. Together, these discussions reflect a broader shift in catchment morphometry from routine parameter computation toward critical evaluation of interpretation standards, data sensitivity, and process-based relevance.

Geospatial techniques (GIS and RS) have significantly contributed to the field of morphometric analysis through improved data collection, spatial analysis and enhanced visualisation. The free availability of Digital Elevation Models (DEMs) from the World Wide Web like open topography and others, enables the creation of detailed topographic representations, allowing researchers to extract precise information on land surface characteristics, such as landscape, slope and drainage networks, which are essential for morphometric analysis and available for areas which hitherto are not accessible for direct field surveys (Obeidat, et al, 2021). According to Balasubramanian (2017), a DEM is the digital representation of land surface elevation concerning any reference datum. At the forefront of DEM data and sources, according to GIS Geography (2018), are the Space Shuttle Radar Topography Mission (SRTM), which is at 90 or 30 metre resolution, and sourced from the USGS Earth Explorer; the ASTER Global Digital Elevation Model is also available at 90 or 30 metres resolution on NASA Earthdata; the JAXA's Global ALOS 3D World 30m resolution and adjudged the most accurate in today's world among the first two, sourced from the JAXA Global ALOS portal, and, lastly, the Light Detection and Ranging (LiDAR) for the USGS Earth Explorer. Studies that have notably utilised GIS and RS technologies in morphometric analysis with huge successes are numerous to include Gautam (2023), Chowdhury (2024), and Oruonye et al. (2016). Others are Alfa (2018), Jeb (2014) and Laka (2023), amongst others.

The Delimi River drains part of the tropical highland known as the Jos Plateau in North-Central Nigeria, Africa (Figure 1). It is one of the headwaters of the Delimi-Bunga river system, a sub-system of the Chad drainage basin. It originates from the rocky terrains of the Jos Plateau and traverses through four Nigerian states (Plateau, Bauchi, Yobe, and Borno), where it has acquired different names such as Delimi, Bunga, Jama'are, and Kamadougou Yobe (Laka, 2023), before finally emptying into Lake Chad (Figure 2). The Jos Plateau landscape comprises gently undulating terrain dissected by valleys and streams that radiate outward. The Delimi River rises in this highland terrain and flows northeastward through the Jos urban area, forming a key drainage corridor within the metropolitan basin (Yohanna, Lawuyi, & Yakubu, 2022).

The portion of the catchment area of study is nested within the rugged terrain of the Jos Plateau, a region of highlands and hills in central Nigeria. As a highland catchment, the Delimi exhibits a low base flow during the dry season and relatively high flows during the wet season, with seasonal discharge variations driven largely by convective thunderstorms and orographic enhancement associated with the plateau's elevated topography (Sabo, Gani & Ibrahim, 2013). The river network is dendritic in nature, characterised by a tree-like branching drainage system, common in regions with relatively uniform lithology and limited structural control. This pattern naturally promotes efficient drainage but also leads to concentrated surface runoff flowing into main channels (Ocheri et al. 2025). The Delimi basin boasts a unique blend of natural and urban landscapes. It is marked by rapid urbanisation, particularly within Jos town (Denis & Moriconi-Ebrard, 2008; UN-Habitat, 2014). According to UN-WPP (2025), Jos City has an estimated population of about 1,035,000 persons with a growth rate of 3.4% in 2025. This rapid urbanisation has significant implications for the Delimi catchment's hydrology, water resources, and ecosystem well-being. The river functions both as a hydrological conduit and an urban ecosystem influenced by rapid city growth. Laka, Ibimode, Anyamele & Maigida (2023) revealed significant land use and land cover change in Jos over recent decades, affecting runoff processes, soil infiltration capacity, and watershed hydrodynamics that directly impact the river. To this end, there is a need for Sustainable urban planning and improved drainage systems; therefore, the overall objective is to catalogue morphometric characteristics of the Delimi Catchment on the Jos Plateau, Nigeria, and their implications for hydrological processes. Specific objectives are to delineate and characterise the catchment's morphometry using Geographic Information Systems (GIS) and Remote Sensing techniques to compute morphometric parameters at the basin micro-level. Quantitative morphometric analysis is particularly important, since the study area is primarily ungauged, and information about its past hydrological behaviours is sparingly available. The results of this study can be considered to be helpful for decision-making in areas of flood risk assessment and mitigation, water harvesting and conservation, land use optimisation, soil erosion control, environmental impact assessment and hydrological modelling.

2. STUDY AREA

The study catchment lies between latitudes 9° 52′N and 10° 50′N of the equator and longitudes 8°45′E and 9°37′E of the prime meridian (Figure 3). Its spatial coverage is about 237.32 km^2. Its boundaries are set in the north-east by the Tiden Fulani River Basin, to the far east is the Shere-Jarawa Hills; to the south-east, the boundary is set by the Shen River basin, in the south and south-west, is the N'gell River catchment, and to the west and the south-west are the Rukuba Hills and Gambo and Karami River basins (Figure 4). Finally, further north, the

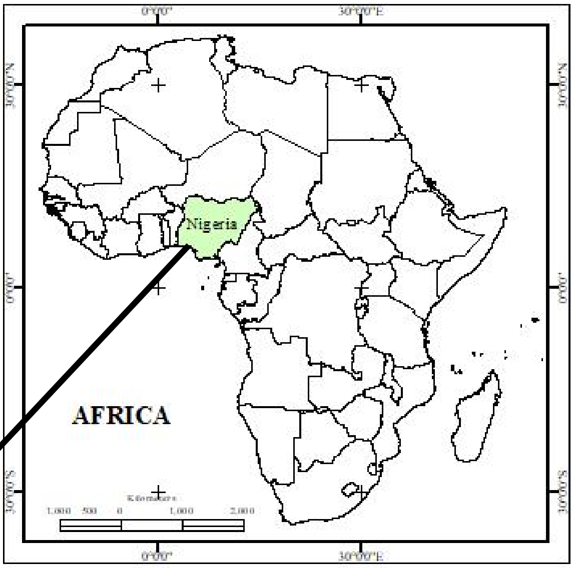

Figure 1: The Jos Plateau and Delimi-Komadugu River System, Nigeria

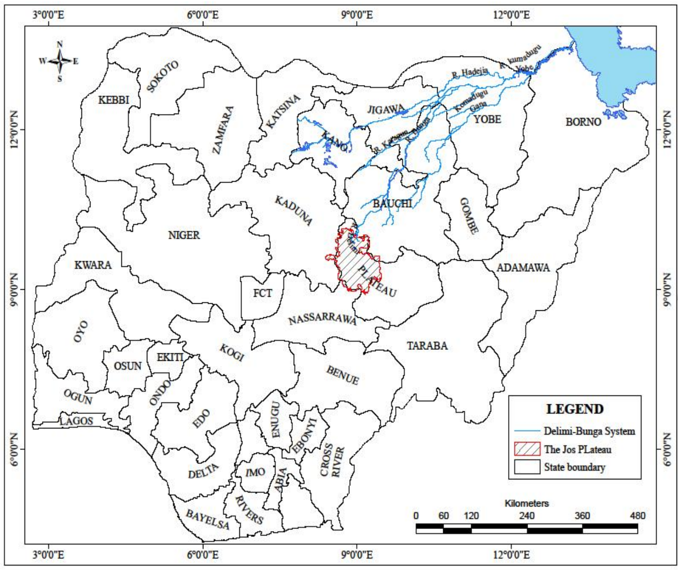

Figure 2: The Jos Plateau and Delimi-Komadugu River System, Nigeria

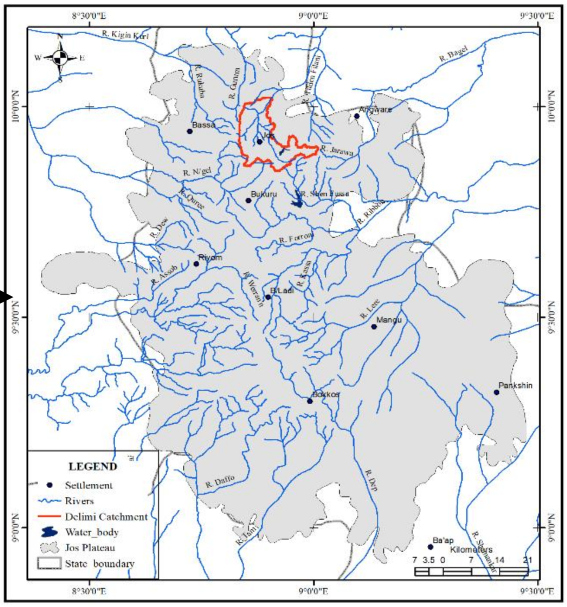

Figure 3: The Jos Plateau and Delimi River Catchment

boundary is marked by the Southern margin of the Zala and Bauchi Plain. The source of the river is at a height of about 1351m amsl, and the basin length is about 46.97km. The highest point in the catchment is at about 1386m amsl (Figure 5). The catchment climate data (Table 1) reveals a tropical wet–dry (Aw) climate with moderate temperatures (a mean annual temperature of 23.7 °C and a low annual thermal range of about 4.9 °C). Annual rainfall totals approximately 1253.9 mm and follows a strongly seasonal unimodal pattern, with the rainy season extending from April to October and peaking in August. Nearly 58% of the annual rainfall occurs between July and September, resulting in pronounced seasonal runoff, elevated flood potential during peak months, and reduced baseflow conditions in the dry season.

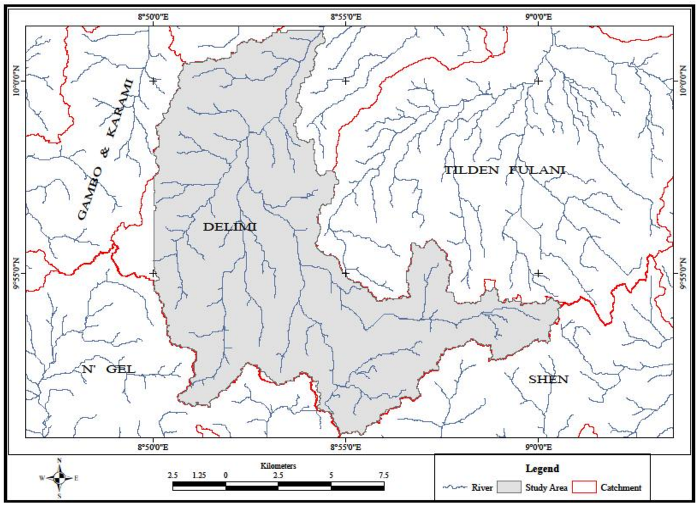

Figure 4: The Delimi River Basin and Neighbouring Catchments

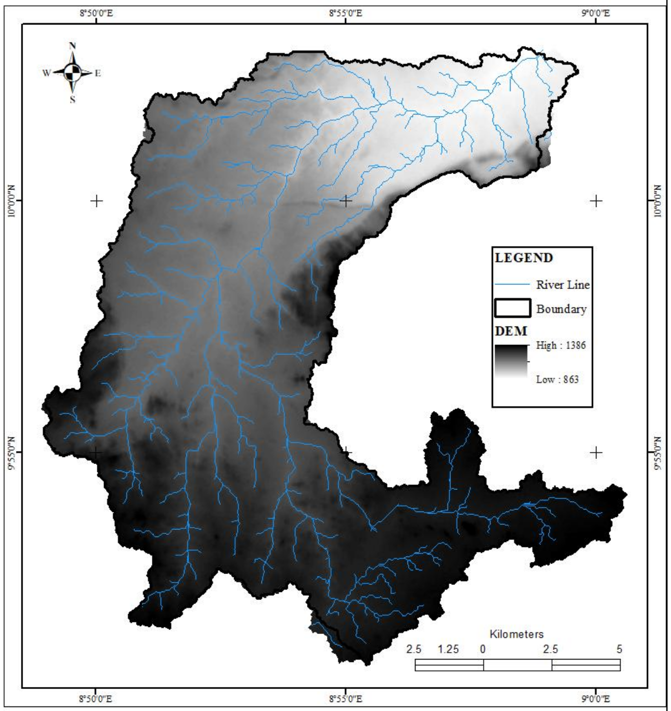

Figure 5: Drainage System of the Delimi Catchment on DEM.

3. METHODOLOGY

A Quantitative Research design approach is used to analyse the basin morphometry using Geographic Information Systems (GIS) and Remote Sensing (RS) techniques. The data collection is both Primary Data – based on field observations, surveys, and measurements. Secondary Data - Utilising existing data sources such as topographic maps, satellite imagery and the internet. Research tools are GIS Software to include ArcGIS and Archydro, to calculate morphometric parameters and analyse spatial relationships. The methodological flow is in Figure 6.

Table 1: Average Rainfall and Temperature Distribution for the Catchment

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Sum	AVE
Temp °C	21.70	23.40	25.70	26.60	25.10	23.80	22.50	22.20	22.80	23.30	22.90	21.70	284.20	23.70
Rainfall (mm)	0.17	0.98	25.54	86.02	158.98	205.79	270.53	286.56	175.20	42.18	1.11	0.84	1253.90	104.49

Source: Laka (2023)

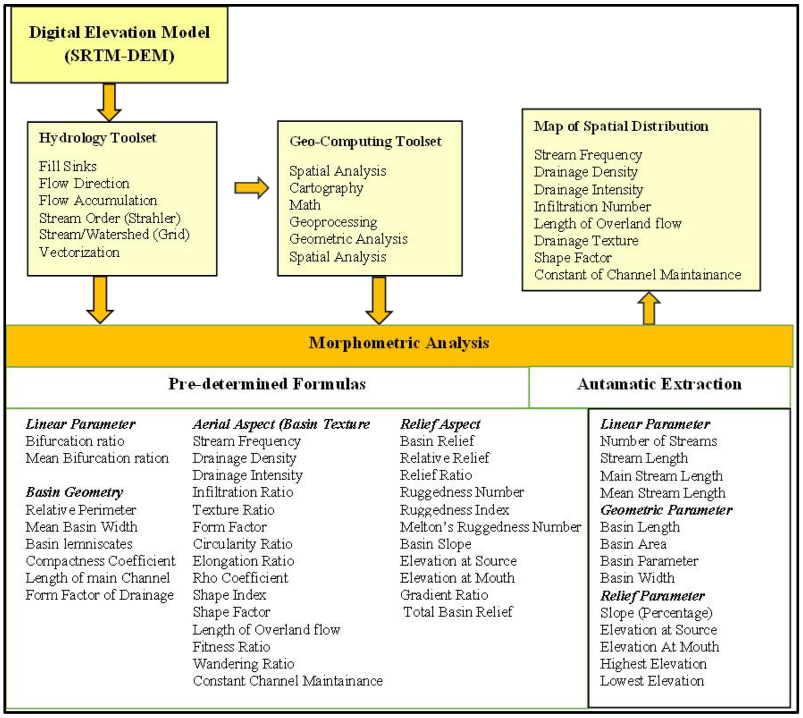

Figure 6: Methodological flow of the research
Adopted from Chowdhury (2024).

3.1 Data Acquisition and Morphometric Analysis

The 30 m SRTM DEM was downloaded from Open Topography, projected to WGS 1984 UTM Zone 32N, and used to delineate the study catchment. This dataset was selected for its reliability in tropical watershed analysis (Singh et al., 2024), as terrain accuracy is fundamental to precise watershed delineation (Azmeri et al., 2016). Terrain analysis was performed in ArcMap (10.3) using the Arc Hydro extension, involving sink filling and the derivation of flow direction, flow accumulation, stream networks, sub-catchments, and slope to generate the necessary shapefiles for morphometric analysis. Catchment parameters, as presented in Table 2, were generated.

4. RESULTS AND DISCUSSION

The GIS-based morphometric analysis classifies the Delimi River as a fourth-order basin (Strahler, 1957) with a total stream length of 233.63 km, predominantly composed of first-order streams (Table 3, Figure 7). The stream network exhibits a systematic decrease in stream number and an increase in mean stream length with increasing order, conforming to Horton's laws (Figures 8-11). The dominance of low-order streams and the near-linear logarithmic plots of stream number and length versus order confirm a hierarchically well-organised and mature drainage network (Strahler, 1957; Singh et al., 2024). According to the Tamil Nadu University of Agriculture catchment area classification, the Delimi is a Sub-watershed with its spatial coverage of 237.32 km² falling between 100-500 km2 (Rai, Mishra, & Mohan, 2021; Barh, 2023). The mean bifurcation ratio (Rb) is 6.06, with individual ratios ranging from 3.11 to 9.00 (Table 3). This high average bifurcation ratio points to significant structural and lithological control by the underlying crystalline basement rocks, which imposes strong constraints on drainage development (Coulibaly et al., 2025). Other linear parameters are presented in Table 4 to include length of over land flow (Lg) 0.49, Basin Length (Lb) 46.97km and Lemniscate Ratio (K) 2.32.

Table 2: Linear, Areal and Relief Parameters

S/N	Category	Parameter	Symbol	Formula	Description / Significance
1	**Linear Parameters**	Stream Order	U	—	Hierarchical ranking of streams (e.g., Strahler method).
2		Stream Number	Nu	—	Total number of streams of a given order.
3		Stream Length	Lu	—	Length of streams of a particular order.
4		Mean Stream Length	Lsm	$Lsm = Lu / Nu$	Average length of streams of a given order.
5		Stream Length Ratio	RL	$RL = Lu / Lu-1$	Ratio of the mean length of streams of one order to the next lower order.
6		Bifurcation Ratio	Rb	$Rb = Nu / Nu+1$	Ratio of the number of streams of one order to the next higher order; indicates structural control.
7		Mean Bifurcation Ratio	Rbm	Rbm = Average of Rb values	Indicates the degree of basin branching.
8		Length of Overland Flow	Lg	$Lg = 1 / (2Dd)$	The average distance water travels over the ground before reaching a channel. **Dd** = Drainage density
9		Basin Perimeter	P	—	Total boundary length of the basin.
10		Basin Length	Lb	—	Longest dimension of the basin parallel to the main drainage line.
11		Lemniscate Ratio	K	$K=L_b^2 /4A$	Describe the **basin shape** in relation to runoff characteristics and hydrological response.
12	Areal Parameters	Basin Area	A	—	Total surface area draining into the basin outlet.
13		Drainage Density	Dd	$Dd = \Sigma Lu / A$	Total stream length per unit area. Indicates runoff potential and permeability.
14		Stream Frequency	Fs	$Fs = \Sigma Nu / A$	Number of streams per unit area.
15		Drainage Texture	Dt	$Dt = \Sigma Nu / P$	Relative spacing of drainage lines is influenced by geology and relief.
16		Form Factor	Rf	$Rf = A / Lb^2$	Indicates basin shape and flood potential.
17		Circularity Ratio	Rc	$Rc = 4\pi A / P^2$	Measures the similarity of basin shape to a circle.
18		Elongation Ratio	Re	$Re = (2\sqrt{(A/\pi)}) / Lb$	Indicates basin elongation and relief characteristics.
19		Compactness Coefficient	Cc	$Cc = P / (2\sqrt{(\pi A)})$	Indicates deviation from circular shape.
20		Infiltration Number	If	$If = Dd \times Fs$	Indicates infiltration characteristics of the basin.
21		Constant of Channel Maintenance	C	$C = 1 / Dd$	Area required to sustain a unit length of channel.

S/N	Category	Parameter	Symbol	Formula	Description / Significance
22	Relief Parameters	Basin Relief	Bh or H	Bh = Hmax − Hmin	Elevation difference between the highest and lowest points in the basin.
23		Relief Ratio	Rh	Rh = Bh / Lb	Indicates steepness and erosion intensity.
24		Ruggedness Number	Rn	Rn = Bh × Dd	Combines relief and drainage density to express terrain ruggedness.
25		Relative Relief	Rr	Rr = Bh / P	Ratio of basin relief to perimeter.
26		Dissection Index	Di	Di = Bh / Maximum Relief	Indicates the degree of landscape dissection.
27		Hypsometric Integral	HI	HI = (Mean Elevation − Min Elevation) / (Max Elevation − Min Elevation)	Indicates the stage of geomorphic development.
28		Channel Gradient	S	S = ΔH / L	Slope of the main stream channel.
29		Melton Ruggedness Number	MRn	MRn = Bh / √A	Used to assess flash flood and debris flow potential.

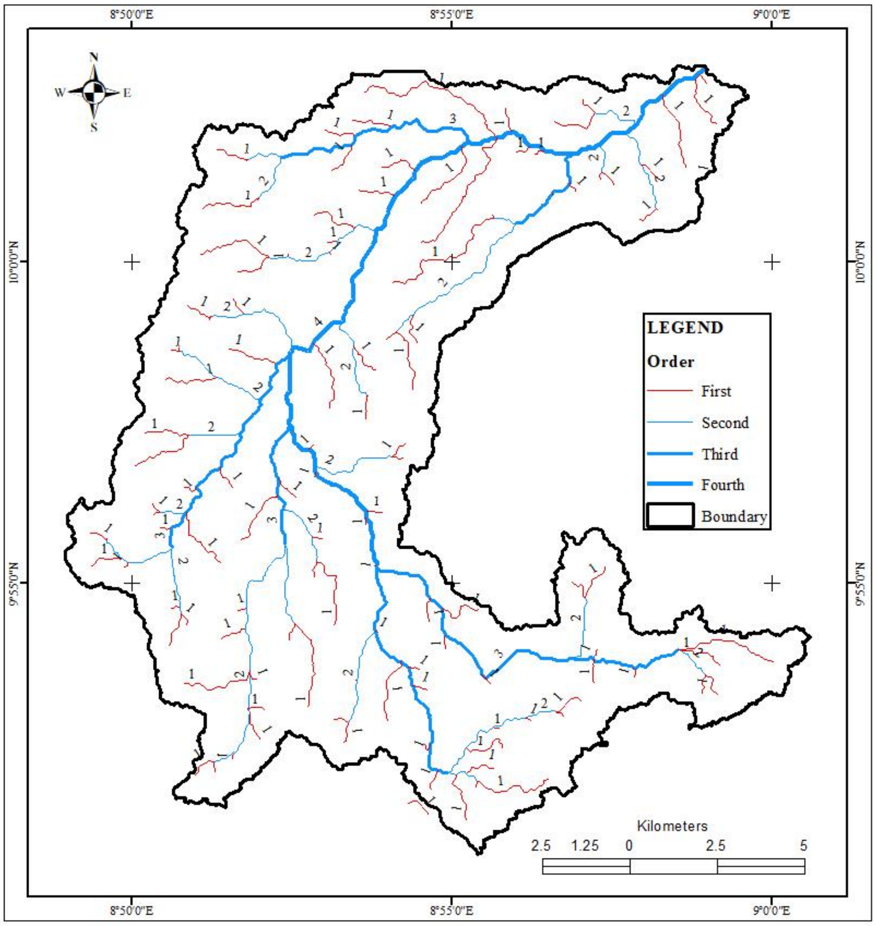

Figure 7: Stream Ordering of the Delimi River after Strahler (1968)

Table 3 Stream Orders, Stream Number, Stream Length for the Delimi River Basin

Stream Order (U)	Segment Count (Nu)	Lu (Km)	Mean Stream Length (Lsm) Km	Stream Length Ratio	Bifocation Rb
1	123	110.29	0.90		4.39
2	28	58.24	2.08	2.32	3.11
3	9	39.93	4.44	2.13	9.00
4	1	25.18	25.18	5.68	
Total	161	233.63	1.45		12.11
Average				3.38	6.06

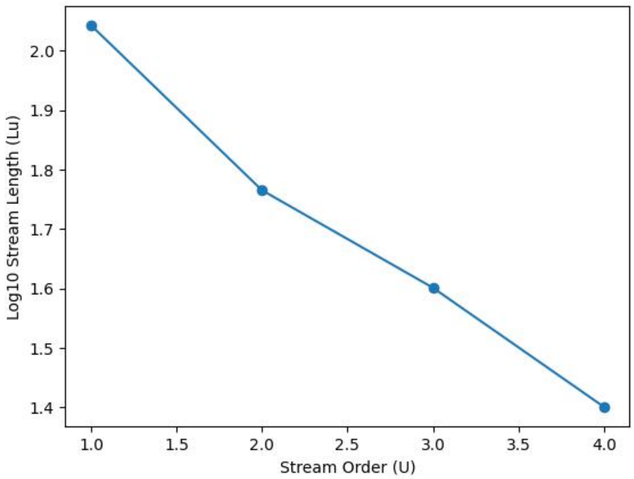

Figure 8: Log₁₀ of Stream Length (Lu) versus Stream Order (U)

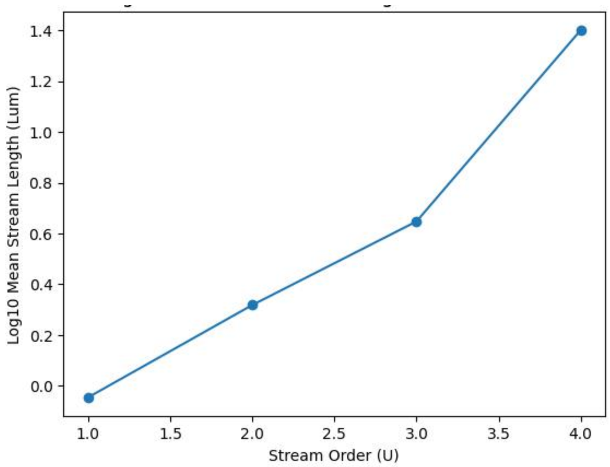

Figure 9: Log₁₀ of Mean Stream Length (Lum) versus Stream Order (U).

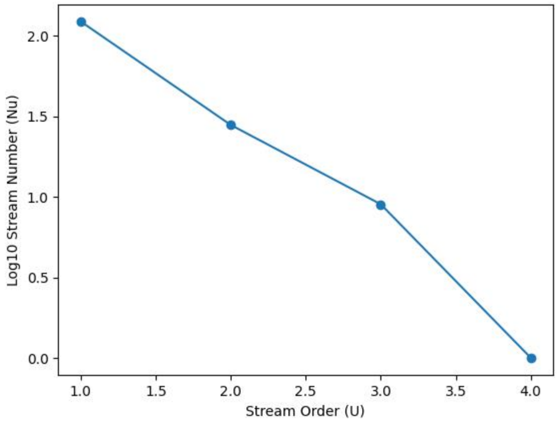

Figure 10: Log₁₀ of Stream Number (Nu) versus Stream Order (U)

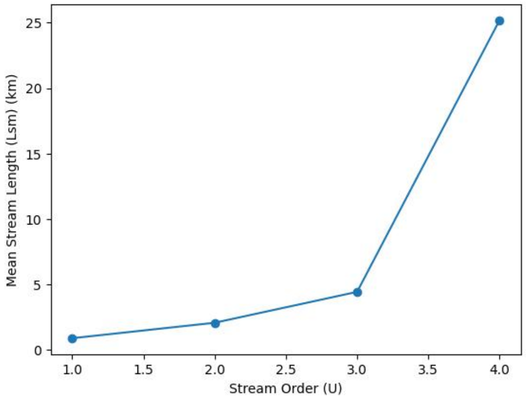

Figure 11: Mean Stream Length (Lsm) against Stream Order (U)

Areal parameters (Table 5) indicate a basin area of 237.32 km², a low drainage density (Dd) of 0.98 km/km², a very coarse drainage texture (Dt) of 1.02, and an elongated shape indicated by a form factor (Rf) of 0.11, Circularity Ratio (Rc) of 0.12 an elongation ratio (Re) of 0.37, Compactness Coefficient (Cc) of 5.80, and Infiltration Number (If) of 0.67. The low drainage density and very coarse drainage texture reflect highly resistant, permeable subsurface materials that inhibit channel incision and promote infiltration over surface runoff (Kumar & Singh, 2021; Ocheli et al., 2023). This interpretation is strongly supported by the high bifurcation ratio, which together indicate a basin where surface runoff is generated less efficiently. Hydrologically, this basin arrangement, combined with the elongated shape (Rf = 0.11, Re = 0.37, Cc = 5.80), results in a prolonged concentration time and attenuated flood peaks (Waikar and Nilawar, 2021; Revuelta-Acosta et al., 2025).

Table 4: Other Linear Parameters for the Catchment

S/N	Parameter	Symbol	Values
1	Length of Overland Flow	Lg	0.49
2	Basin Perimeter (km)	P	158.39
3	Basin Length (km)	Lb	46.97
4	Longest flow path (km)	Lp	42.39
5	Lemniscate Ratio	K	2.32

Table 5: Delimi Area Parameters

S/N	Parameter	Symbol	Values
1	Basin Area (sqkm)	A	237.32
2	Drainage Density	Dd	0.98
3	Stream Frequency	Fs	0.68
4	Drainage Texture	Dt	1.02
5	Form Factor	Rf	0.11
6	Circularity Ratio	Rc	0.12
7	Elongation Ratio	Re	0.37
8	Compactness Coefficient	Cc	5.80
9	Infiltration Number	If	0.67
10	Constant of Channel Maintenance	C	1.02

Table 6: Delimi Relief Parameter

S/N	PARAMETER	SYMBOL	VALUES
1	Highest Relief (m)	Hmax	1386.00
2	Lowest Relief (m)	Hmin	864.00
3	Mean Elevation for Catchment (m)		1157.27
4	Up Stream Elevation (m)		1351.00
5	Down Str Elevation (m)		868.00
6	Basin Relief (km)	Bh or H	0.52
7	Relief Ratio	Rh	0.01
8	Ruggedness Number	Rn	0.51
9	Relative Relief	Rr	0.00007
10	Dissection Index	Di	0.38
11	Hypsometric Integral	HI	0.56
12	Channel Gradient	S	0.01
13	Melton Ruggedness Number	MRn	0.03

Relief analysis (Table 6) shows a highest relief (Hmax) of 1386.00m, a lowest relief (Hmin) of 864.00m, and a mean elevation for the catchment of 1157.27m. Others are the up-stream elevation of 1351.00m, basin relief of 0.52 km, a relief ratio (Rh) of 0.01, a ruggedness number (Rn) of 0.51, a dissection index (Di) of 0.38, a hypsometric integral (HI) of 0.56 and melton ruggedness number (MRn) of 0.03. The low relief ratio (Rh = 0.01) further supports the notion of a landscape with low gradient and a flashy but attenuated runoff regime. The landscape is in a mature geomorphic stage, characterised by balanced erosion and uplift processes, as evidenced by the moderate hypsometric integral (HI = 0.56) and dissection index (Di = 0.38), which together indicate a moderate erosion potential (Abdelkarim et al., 2020; Dar et al., 2023). While the ruggedness number (Rn = 0.51) indicates a moderately incised terrain, the very low Melton Ruggedness Number (MRn = 0.03) confirms that the basin is a standard fluvial system with negligible susceptibility to high-mountain hazards like debris flows (Tiranti & Deangeli, 2021). Collectively, the morphometric parameters depict a geomorphically stable catchment where hydrological response is primarily governed by a resistant geology and mature topography.

5. CONCLUSION

This study presents the first quantitative morphometric characterisation of the Delimi catchment, providing baseline insight into the drainage structure and hydrological behaviour of an urbanised ungauged basin on the Jos Plateau through the extraction of 29 linear, areal, and relief parameters using GIS and remote sensing techniques. The basin is distinctly elongated (form factor = 0.11; elongation ratio = 0.37; circularity ratio = 0.12), a geometry that favours weakened peak flows and longer lag times rather than flashy flood responses. Its coarse drainage texture (drainage density = 0.98 km/km²; stream frequency = 0.68 streams/km²) reflects permeable substrates and resistant crystalline lithology that promote infiltration, while moderate relief (basin relief = 0.52 km; ruggedness number = 0.51) and a hypsometric integral of 0.56 indicate a mature geomorphic stage approaching dynamic equilibrium.

A high mean bifurcation ratio (6.06) suggests strong structural control by the Plateau's basement complex, whereas the low Melton ruggedness number (0.03) confirms dominance of fluvial rather than debris-flow processes. Collectively, these attributes imply inherent natural buffering capacity against extreme flooding. However, rapid urban expansion in Jos metropolis is progressively increasing impervious surfaces, reducing infiltration, and potentially overwhelming the basin's natural regulation, particularly given its low drainage density and limited channel conveyance capacity.

The findings provide critical guidance for stormwater infrastructure design, floodplain regulation, hydrological modelling, and sub-catchment prioritisation, while establishing a benchmark for assessing future land-use impacts. Overall, the Delimi catchment represents a geomorphically mature but increasingly vulnerable highland basin whose hydrological stability will depend on balancing natural morphometric controls with accelerating urban transformation.

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