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Morphometric Investigation in a Semi-arid Watershed of Suryapet in Telangana

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ABSTRACT: The morphometric investigation is a numerical assessment of the shape and dimensions of the drainage catchment that shows the interrelationship between geomorphologic characteristics and hydraulic parameters. The current study demonstrates the viability of remote sensing (RS) and geographic information system (GIS) for the morphometric analysis of a watershed in Suryapet district of Telangana, India. The watershed and drainage network of the selected region was derived using ASTER DEM and toposheet. Morphometric parameters like linear, areal & shape, relief and other watershed aspects were determined. The drainage area of the watershed is 758.122 km^2 and has dendritic drainage pattern that designates homogeneous lithology, gentle slope with no structural control. The study region has streams up to fourth order with a drainage density (Dd) of 0.480 km km^{-2}. The outcomes will aid the planners in reducing the work involved in extensive field survey and is very important for engineers, managers, and planners for providing the best management activities for the conservation of soil and water in the study region.

Introduction

A catchment or a watershed is a characteristic hydrological unit that contributes surface overflow to a characterized drainage network and permits its exit at a specific point (Viji *et al.,* 2015). The catchment management includes a change in the regular arrangement of the watershed to accomplish explicit goals. The watershed development facilitates the protection of soil and water assets in the watershed area and thus, it is basic to focus on the watersheds in view of requirements for preservation and advancement (Nazari *et al.,* 2014). Watershed prioritization is a viable application for the conservation and management of soil and water assets. Stream morphometry is an advantageous strategy to clarify fluvially started landforms (Strahler 1964; Horton 1945; Schumm 1956; Gardiner and Park, 1978). Morphometry is the estimation and numerical investigation of the drainage catchment, its structure, and the aspect of its landforms (Reddy *et al.*, 2004). Since all hydrologic and geomorphic processes happen inside the watershed, morphometric properties uncover significant data regarding its beginning and development. The quantitative assessment of morphometric features is viewed as vital in understanding fluvial geomorphology. The effect of morphometric credits is viewed as a huge utility in watershed prioritization and natural resource management. Morphometry aids in hydrological scrutiny concerning environmental evaluation, pedology and groundwater management. A watershed morphometric investigation gives a mathematical depiction of the stream network.

Geomorphological parameters impact the whole watershed parameters consequently affecting watershed characteristics, for example, overflow and sediment loss. In case of the absence of hydrological estimations in the greater part of the watersheds, the morphometric parameters along with satellite information inferred data like land use land cover could be utilized to create prioritization of watersheds. Advanced Digital Elevation Model (DEM) inferred morphometric investigation is exceptionally helpful for ungauged or ineffectively check basins as this can give data to various parts of the drainage basin (Shaikh *et al.*, 2021).

The morphometric examination is commonly used in an ungauged basin which helps in better planning and management of watershed in context of the local hydrological modelling. The morphometric investigation of a catchment and its drainage network can be well known through factors viz. slope, drainage network, length of basin, stream order, stream length, mean stream length, stream length ratio, bifurcation ratio, form factor, elongation ratio, circulatory ratio, compactness coefficient, drainage density, stream frequency, texture ratio, constant of channel maintenance, length of overland flow, basin relief, relief ratio and ruggedness number for catchment prioritization and authorization of protection drives for natural assets. Morphometry characterizes the design of the earth's surface, shape, and aspect of its landforms (Campbell *et al.*, 1982; Melton 1957 & 1965; Chorley 1957; Nooka *et al.*, 2005; Strahler 1964; Horton 1945; Schumm 1956; Miller 1957; Umrikar 2017).

Remote sensing (RS) and geographic information systems (GIS) are advantageous tools for morphometric investigation. A satellite picture gives a brief perspective on a huge region and is extremely helpful in refreshing the drainage networks. Different morphometric parameters, for example, drainage pattern, stream order, bifurcation ratio, drainage density, and other linear aspects have been concentrated on utilizing RS techniques and topographical maps (Sharma *et al.*, 2021). A few analysts have done morphometric examination coupled with RS and GIS for concentrating on the land and water resources of an area. The Suryapet district has issue of water assets for agriculture, domestic, industrial utilization and construction of dams (Webb and Iskandarani 1998; Bhangaonkar 2020). Tropical wet and dry climate, expanded farming situation and broad water use in industry/domestic created the issue of as of now water-scant areas (Singh et al., 2009). Hence, an attempt was carried out to determine the morphometric parameters for characterizing the semi-arid watershed of Suryapet.

Materials and Methods

Study area

The present study was done in a watershed in the Suryapet district of Telangana state. Geographically, it lies between 16^0 50' 0'' to 17^0 10' 30'' N latitudes and 79^0 36' 30'' E to 79^0 58' 30'' E longitudes with an elevation of 165 to 178 m above mean sea level (Figure 1). The total geographical area of the study area is 758.12 km^2.

Under the Koppen climate classification, study area experiences tropical wet and dry climate (Lohmann *et al.*, 1993). The average annual rainfall of the study area is 820 mm and it receives 90% of the rainfall during the south-west monsoon and more than 70% of rainfall occurs during July, August and September. The warmest month (with the highest temperatures) is May (39ºC) and the month with the lowest temperature in January and December (16ºC). The soils of the study area are moderately shallow to moderately deep gravelly red loam underlined by 15 to 25 cm thick dark greyish loamy soils. Farming is the pillar of the watershed and the main crops grown are paddy, red gram and cotton.

Data sources and analysis

Thematic layers like ASTER DEM, toposheets, geology data and field information were used in this study to derive morphometric parameters of the area. The Advanced Spaceborne Thermal Emission and Reflection Radiometer Digital Elevation Model (ASTER DEM) information were downloaded from ASTER GDEM Website (https://ssl.jspace-systems.or.jp/ersdac/GDEM/E/) (Figure 2a). Survey of India (SOI) toposheet gives the study area at the size of 1:50,000 utilized for ground reference. Remote sensing (RS) and GIS-based morphometric investigation gives higher precision. The watershed, stream network (Prakash *et al.,* 2015), slope, flow accumulation and other morphometric-related information have been extracted from ASTER DEM in the GIS environment (Figure 2b & 3a-b).

Morphometric Analysis

The geomorphological investigation is the precise determination of watershed's geometry, stream channel network, linear parameters like basin length (L), stream order (U), stream length (Lu), mean stream length (Lsm), stream length ratio (Rl) and bifurcation ratio (Rb). In addition to this, relief parameters like basin relief (Bh), relief ratio (Rh), ruggedness number (Rn) were also estimated. Furthermore, areal & shape parameters like drainage density (Dd), stream frequency (Fs), texture ratio (T), form factor (Rf), circulatory ratio (Rc), elongation ratio (Re),

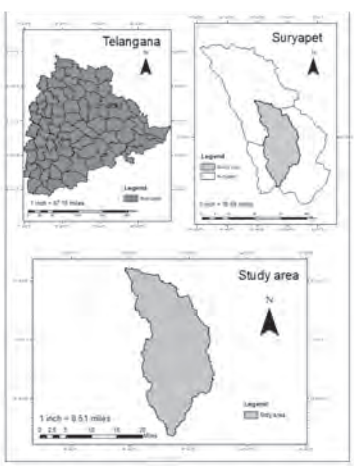

Fig. 1: Location map of the study area

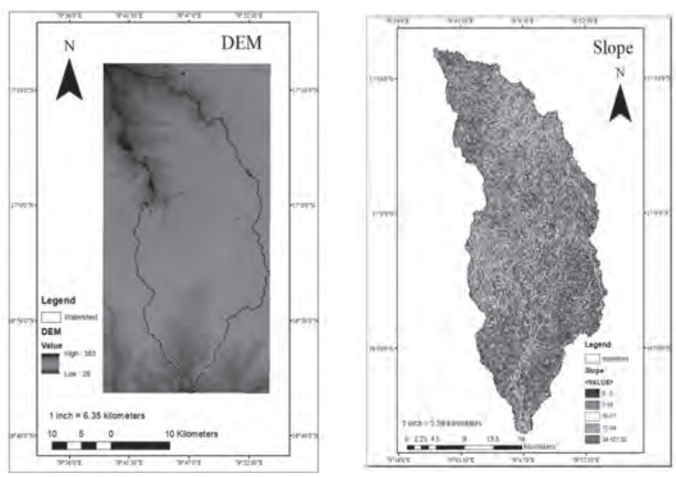

Fig. 2a-b: ASTER DEM and slope of watershed

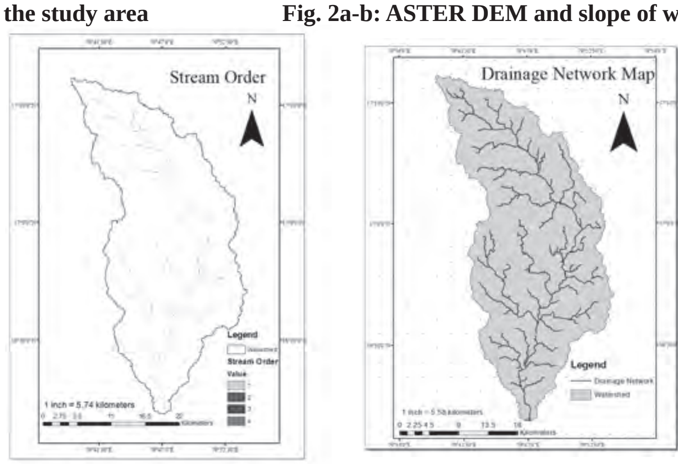

Fig. 3a-b: Stream order and drainage network

length of overland flow (Lof), constant channel maintenance (C), infiltration number (If) and compactness coefficient (Cc) were derived. Other Watershed Parameters like relative perimeter (P_{rel}), mean basin width (W_{mb}), fitness ratio (R_f), lemniscate ratio (K), and melton ruggedness number (M_{Rn}) were assessed which can be used for the evaluation of the runoff and sediment loss in the watersheds (Campbell *et al.*, 1982; Melton 1957 & 1965; Chorley 1957; Nooka *et al.*, 2005; Strahler 1964; Horton 1945; Schumm 1956; Miller 1957; Umrikar 2017). The geomorphological boundaries were assessed using formulas depicted in Table 1 and Table 2.

Table 1: Standard formula for morphometric analysis

Aspects	Morphometric Parameters	Methods/Formulae	Reference
Other Watershed parameters	Relative perimeter (P_{rel}) (km)	$P_{rel} = \frac{A}{P}$ Where, A= Area of the basin (km^2), P=Perimeter of the basin (km).	Campbell et al., 1982
	Mean basin width (W_{mb}) (km)	$Wmb = \frac{A}{L}$ Where, A= Area of the basin (km^2) L=Length of the basin (km).	Horton, 1932
	Fitness ratio (R_f)	$Rf = \frac{L}{P}$ Where, L=Length of the basin (km), P=Perimeter of the basin (km).	Melton 1957
	Lemniscate ratio (K)	$K = \frac{L^2}{A}$ Where, A= Area of the basin (km^2), L=Length of the basin(km).	Chorley *et al.*, 1957
	Melton ruggedness number (M_{Rn})	$Mrn = \frac{Bh}{A^{0.5}}$ Where, A= Area of the basin (km^2), B_h = Basin Relief (km).	Melton 1965

Table 2: Standard formulae for morphometric analysis

Aspects	Morphometric Parameters	Methods/Formulae	Reference
LINEAR	*Length(L) (km)*	$L = 1.312xA^{0.568}$ Where, L= Basin Length (km), A= Area of the Basin (km^2)	Nooka *et al.*, 2005
	Stream Order (U)	Drainage Hierarchical Order (Strahler's Law)	Strahler, 1964
	Stream Length (Lu)	Length of the Stream (km)	Horton, 1945
	Mean Stream Length (Lsm) (km)	$Lsm = \frac{Lu}{Nu}$ where, Lu=Stream Length of Order u (km), Nu= Total Number of Stream Segments of Order, u (km)	Horton, 1945
	Stream Length Ratio (RI)	$RI = \frac{Lu}{Lu-1}$ RI=Lu/Lu-1; where Lu=Total Stream Length of Order ,u (km), Lu-1=Stream Length of Next Lower Order (km).	Horton, 1945
	Bifurcation Ratio (Rb)	$Rb = \frac{Nu}{Nu+1}$ where, Nu=Total Number of Stream Segment of order u, Nu+ 1=Number of Segment of Next Higher Order	Schumm, 1956
RELIEF	*Basin Relief (Bh) (km)*	Vertical Distance between the Lowest and Highest Points ofWatershed	Schumm, 1956
	Relief Ratio (Rh)	$Rh = \frac{Bh}{lB}$ where, Bh=Basin Relief (km), Lb=Basin Length (km)	Schumm, 1956
	Ruggedness Number (Rn)	$Rn = Bh \times Dd$ where, Bh =Basin Relief (km); Dd=Drainage Density (km km^{-2})	Schumm, 1956
AREAL& SHAPE	*Drainage Density (Dd)* (km km^{-2})	$Dd = \frac{L}{A}$ where, L=Total Length of Streams (km); A=Area of Watershed (km^2)	Horton, 1945
	Stream Frequency (Fs)(km^{-1})	$Fs = \frac{N}{A}$ where, N=Total Number of Streams; A= Area of Watershed (km^2)	Horton, 1945
	Texture Ratio (T) (km^{-1})	$T = \frac{Nu}{P}$ where, NU =Total Number of First Order Streams;P=Perimeter of Watershed(km)	Schumm, 1973
	Form Factor (Rf)	$Rf = \frac{A}{Lb^2}$ where, A=Area of Watershed (km^2), Lb=Basin Length (km)	Horton, 1932
	Circulatory Ratio (Rc)	$Rc = {4\pi A}/{P^2}$ where, A=Area of Watershed (km^2), π=3.14, P=Perimeter of Watershed (km)	Miller, 1953
	Elongation Ratio (Re)	$Re = {2\sqrt{A/\pi}}/{Lb}$ where, A=Area of Watershed (km^2), π=3.14, Lb=Basin Length (km)	Schumm, 1956
	Length of Overland Flow (L_{of}) (km)	$Lof = \frac{1}{2Dd}$ where, Dd=Drainage Density (km km^{-2})	Horton, 1945
	Constant Channel Maintenance (C) (km)	$C = \frac{1}{Dd}$ where, Dd=Drainage Density (km km^{-2})	Horton, 1945
	Infiltration Number (If) (km^{-2})	$If = Dd \times Fs$ Where, Dd= Drainage density (km km^{-2}) Fs=Stream frequency *(km^{-1})*	Umrikar, 2016
	Compactness coefficient (Cc)	$Cc = 0.2821 \times \frac{P}{A^{0.5}}$ Where, P=Perimeter of the basin (km), A= Area of thebasin (km^2).	Horton, 1945

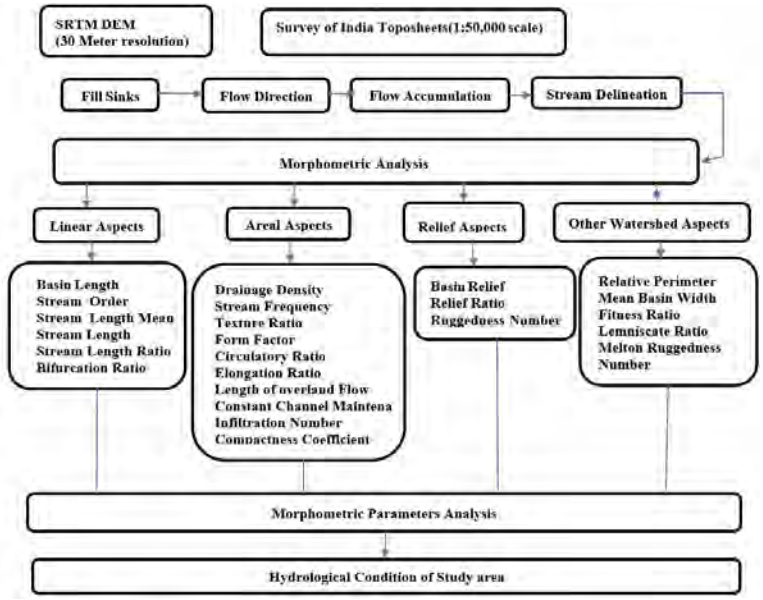

Fig. 4: Flow chart for morphometric analysis of study region

Results and Discussion

Morphometric analysis

The morphometric analysis of the watershed in light of the linear, areal, shape, relief and other watershed parameters have been carried for the watershed. Morphometric boundaries for the chosen watershed were processed and analysed effectively. They extensively influence the runoff and soil erodibility and hence needs an intricate investigation and discussion (Wischmeier and Mannering 1969).

Linear parameters

Stream Order (U): Horton (1945) first set forward the idea of stream ordering, yet Strahler (1964) rolled out a couple of improvements and recommended them later. The first phase of the quantitative examination of the basin is streams ordering. The study region has streams up to fourth order determined using Strahler method (Figure 3).

Stream Number (Nu): The complete number of streams in a specific order is known as stream number. Horton's (1945) law of stream numbers expresses that the number of stream segments of each order forms a reverse geometric series with the order number. It is noticed that the absolute number of streams diminishes with an increment in stream order and consequently shows consistence with Horton's law of stream order. This result shows that the catchment has no structural control or regional upliftment. The study region included a total number of 406 stream segments and out of which 45.81% are 1st order, 25.86% are 2nd order, 6.16% are 3rd and 22.17% are 4th order respectively. Stream Number in the current study region is mainly occupied by lower order stream segments.

Stream Length (Lu): The stream length (Lu) of each order segment is determined by Horton's law for the watershed. Lu addresses the development stage of drainage segments and reciprocates to the surface runoff of the catchment. In the study region, the 1st order Lu is 180.48 km, the 2nd order is 100.94 km, the 3rd order is 35.89 km and the 4th order is 46.34 km. Figure 5 matches with the Horton's law (1945) that as the stream order increases, the length of the stream diminishes, addressing the

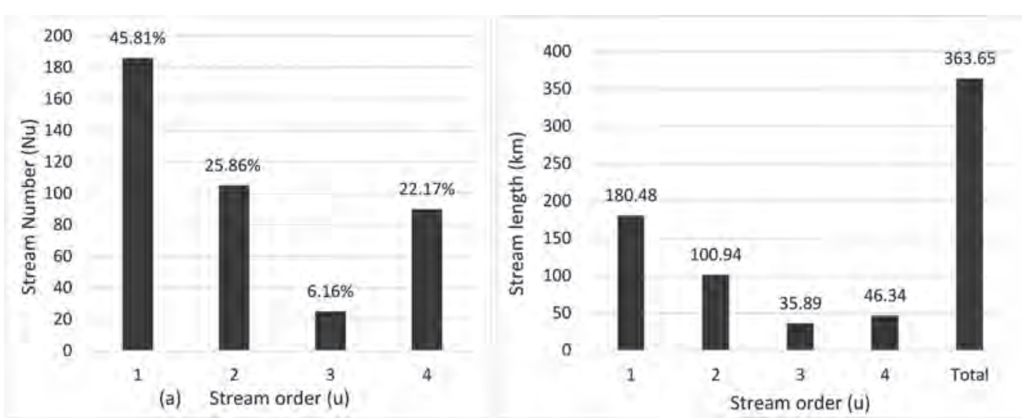

Fig. 5: Relationship between stream order with (a) stream number (b) stream length

control over morphological and geographical parameters of the catchment and lithological inconsistency.

Mean Stream Length (L_{sm}): The mean stream length (Lsm) of a channel is a dimensional property that reveals the characteristic size of components of the drainage network and its contributing catchment surfaces (Strahler 1964). Table 3 shows that the calculated Lsm of the watershed ranged from 0.970 to 0.515 km. The variation in slope because of local structure control in the watershed. The Lsm value of any order is higher than the lower order in the watershed except for order IV.

Table 3: Details of morphometric analysis of the study area

Linear Parameters				
Stream order (U)	I	II	III	IV
Stream Number (Nu)	186	105	25	90
Stream length (Lu)(km)	180.477	100.939	35.892	46.342
Bifurcation Ratio (Rb)	I/II	II/III	III/IV	
	1.771	4.200	0.278	
Mean Bifurcation Ratio (Rbm)	1.562			
Mean Stream Length (Lsm) (km)	0.970	0.961	1.436	0.515
Stream length ratio (RI)		II/I	III/II	IV/IIII
		0.559	0.356	1.291
Area (km^2)	758.12			
Perimeter (km)	209.068			
Length (km)	56.706			
Elevation (m)	Maximum	383		
	Minimum	28		
Relief parameters				
Basin Relief (Bh) (km)	0.355			
Relief Ratio (Rh)	0.0062			
Ruggedness Number (Rn)	0.1702			
Aerial and Shape Parameters				
Drainage density (Dd) (km km^{-2})	0.480			
Stream frequency (Fs) (km^{-1})	0.536			
Texture ratio (T) (km^{-1})	0.890			
Form factor (Rf)	0.236			
Circularity ratio (Rc)	0.218			
Elongation ratio (Re)	0.548			
Length of overland flow (Lof) (km)	1.042			
Constant of channel maintenance (C) (km)	2.085			
Infiltration number (If) (km^{-2})	0.257			
Compactness co-efficient (Cc)	2.142			
Other Watershed parameters				
Relative perimeter (Prel) (km)	3.626			
Mean Basin Width (Wmb) (km)	13.369			
Fitness ratio (Rf)	0.271			
Lemniscate Ratio (K)	4.241			
Melton ruggedness number (MRn)	0.0128			

Stream Length Ratio (RI): Stream length ratio (Rl) addresses the higher order of stream length divided by segments of the following lower order streams. The RI value ranges from 0.559 to 1.291 in the study area (Table 3) which gives signifying late youth stage of geomorphic development (Rai *et al.*, 2014). Stream length ratio values demonstrate significant control of surface stream/discharge and erosional elements of the catchment.

Bifurcation Ratio (Rb): Bifurcation Ratio (Rb) is an important linear parameter in morphometry, demonstrating the carrying capacity of water and the capability of the event of a flood in the catchment. Sriyana (2011) states that the bifurcation ratio (a) Br <3: River channels that have a fast ascent in rising floodwater level, while the decline is slow (b) Br 3-5: River channels have an increment and abatement in rising floodwater level, neither too quick nor too slow (c) Br >3: River divert has fast ascent in rising water level, in like manner it declines. In view of results (Table 3), the study region has mean Rb <3, which shows the watershed has river channels that have a quick ascent in rising floodwater level, while the decline is slow.

Relief parameters

Basin Relief (Bh): Basin relief (Bh) is connected with geomorphic processes and characteristics of the landform of the catchment. The absolute and relative relief is derived from the greatest difference in elevation. Basin relief is predominantly affected by geomorphology, drainage characteristics and basic topography of the area. The elevation values range from 0.028 to 0.383 km. The basin relief is obtained as 0.355 km, which shows medium erosional and denudational rates in the catchment (Table 3).

Relief Ratio (Rh): Relief Ratio (Rh) is the function of complete catchment relief and the length of the basin. It relies upon various aerial and relief parameters, for example, shape, high catchment relief and area of the catchment. The relief ratio for the watershed is obtained as 0.0062 (Table 3). It is obvious that the less resistant rocks of the area in the watershed (Sreedevi *et al.*, 2005).

Ruggedness Number (Rn): Ruggedness number (Rn) is determined from the watershed relief and drainage density of the catchment and essentially relies upon the climate of the area, underlying geography, vegetation cover, slope steepness and geomorphology. The ruggedness number for the region is estimated as 0.17028 (Table 3). The study area has a higher ruggedness number which gives that the peak discharge is probably going to be moderately high in the watershed (Bisantino *et al.*, 2015).

Areal/Shape parameters

Drainage Density (Dd): A low drainage density is described by a stream region with negligible branching, an elongated watershed shape and sloping geology. This makes the response passage of precipitation is extremely slow and concentration time is long. The time expected for water from the remotest point to arrive at the control point is generally short in watersheds with high drainage density contrasted with watersheds with low density.

Sriyana (2011) states that the drainage density can be arranged into (a) Dd: <0.25km km^{-2} as low (b) Dd: 0.25 – 10 km km^{-2} as moderate (c) Dd: 10 – 25 km km^{-2} as high (d) Dd: >25km km^{-2} as very high. In the present study, the calculated value of Dd is 0.48 km km^{-2} (Table 3). The watershed has a moderate Dd value shows that the watershed experiences moderate concentration time with a moderate surface stream rate so the reaction to the inundation of precipitation is likewise moderate.

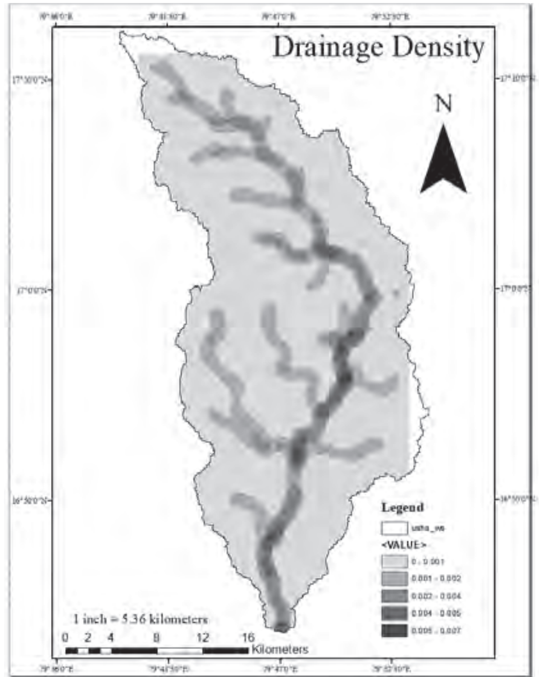

Fig. 6: Drainage density map of the study area

Stream Frequency (Fs): The stream frequency basically relies upon the watershed lithology and shows the drainage network. Fs was connected to relief, sloping, permeability (rock structure), precipitation and water shield limit of sub-surface material (Montgomery and Dietrich 1989). Fs diminishes in accordance with the increment in the stream number and is directly connected with the catchment density values (Figure 5). This study region shows a high Fs value of 0.536 km^{-1} which indicates that high runoff quality and catchment density in the stream populace.

Texture Ratio (T): It is the complete number of stream segments of first orders to perimeter of that area (Horton 1945). Horton perceived infiltration capacity as the single significant factor which impacted texture ratio (T) and thought about the drainage texture to incorporate drainage density and stream frequency. In this way, higher T values show lower infiltration capacity.

Table 4: Texture Ratio values and their description (Smith 1950)

Texture Ratio	Values Description
<4.0	Coarse
4.0 to 10.0	Intermediate
>10.0	Fine
>15	Ultra-fine (Bad land topography)

In the study region, the value of T is 0.89 km^{-1} which indicates that the texture ranges from very coarse to coarse (Table 4), shows that the region is more inclined to weathering (Table 3).

Form Factor (Rf): Form factors are generally <0.785 for a completely circular basin (Bhagwat *et al.*, 2011). Fewer form factors address elongated basins, though basins with high form factors address high peak flow of short duration. The elongated watershed with low form factors has a low peak of long duration. In the study region, the watershed has a low Rf value of 0.236 which demonstrates its elongated shape and less intensity of flood streams for a long duration (Table 3). Thus, flood streams of elongated basins are not difficult to manage as circular basins.

Circulatory Ratio (Rc): Circulatory Ratio (Rc) is a significant indicator and relies upon the geographical structure, environment, relief, drainage density, stream frequency and slope of the watersheds. Its value fluctuates between 0 to 1, which characterizes the minimum to maximum circulatory ratio (Javed *et al.,* 2009). The value of the circulatory ratio is calculated as 0.218 for watershed which characterizes the elongated shape and less peak flow on account of geomorphological change (Table 3).

Elongation Ratio (Re): Elongation ratio (Re) is a significant index of the catchment shape. The Elongation ratio changes from 0.5 to 0.9 (Table 5). The Re was 0.548 for the watershed (Table 3). The estimated value shows the elongated characteristics of the watershed.

Table 5: Classification of elongation ratio (Sukristiyanti *et al.,* 2018)

N°	Re values	Class
1	>0.9	Circular
2	0.8-0.9	Oval
3	0.7-0.8	Less elongated
4	0.5-0.7	Elongated
5	<0.5	More elongated

Length of Overland Flow (L_{of}): As indicated by Horton, drainage density can be utilized as a reciprocal to calculate the length of overland flow. The length of overland flow shows the movement of water over the soil surface until it joins to the main drainage channel. The value of Lof is determined as 1.042 for the watershed (Table 3), which implies low relief and slope. The water movement is less, and it enters the stream for a long duration. Which proposes that water needs to go over 1.042 km before it gets accumulated in watershed streams.

Constant Channel Maintenance (C): Constant Channel Maintenance (C) is the outcome of density as depicted by Horton and it plays an important role in hydrological and physiographical advancement of catchment regions. Constant channel maintenance addresses the region that is important to keep one unit of length of stream (channel length) and characterize the erodibility of watershed. The calculated value of C is 2.085 for the study region (Table 3). The lower value (<3) of C addresses the capability of flood and the young phase of geomorphological development (Yadav *et al.,* 2018).

Infiltration Number (If): The infiltration number is determined by multiplying the stream frequency with drainage density. The infiltration number impacts the infiltration characteristics in the basin. The determined infiltration number is exceptionally low (0.257 km^{-2}) for the study region, indicates a high infiltration and lower drainage quality (Table 3).

Compactness coefficient (Cc): Compactness coefficient (Cc) is utilized to depict a relation between hydrological watersheds to the circular basin of a same region as the hydrological watershed. This is directly relative to the risk assessment of erosion. The Cc determined is 2.142 (Table 3), which implies a higher value proposes the lower elongation and high erosion (Umak *et al.,* 2017).

Other Watershed parameters

Relative perimeter is the area of the watershed to the perimeter of the watershed. The depicted Prel is 3.626 km (Table 3). Mean basin width is the area of the watershed to the length of the watershed and mean basin width is calculated as 13.369 km (Table 3). The fitness ratio (Rf) is the proportion of the length of the basin to its perimeter (Melton 1957), which is utilized to gauge the geological fitness of the basin (Rai et al., 2017 & 2018) and Fr determined is 0.271 (Table 3). Lemniscate ratio (K) is characterized as the proportion of square of basin length to the basin area (Chorley 1957). The higher the K worth, the higher the soil erosion will be, requiring high priority for basin prioritization. As per Chorley (1957), a basin is circular in shape for K is 0.9, calculated value of K is 4.249 which indicates the elongated shape of watershed and high erosion rate. Melton roughness number (MRn) is the proportion of Br to the square root of the basin area (Melton 1965). Melton roughness number (MRn) was estimated as 0.0128 (Table 3). It can give an explicit portrayal of relief ruggedness in a catchment, as it is a slope index (Melton 1965; Rai et al. 2018).

Conclusions

The present study shows the utility of remote sensing and geographic information system (GIS) for the morphometric examination of watersheds. The morphometric properties of different watersheds exhibit their respective effect on the hydrologic characteristics of the watershed. Execution of morphometric examination in a study region might give supportive knowledge to any hydrological examination like a prioritisation of watershed, assessment of groundwater potential, catchment management and environmental assessment. The selected watershed is medium drained in nature, with stream order ranging from 1 to 4. The drainage density has been determined as 0.48 km km^{-2}. The calculated results show that mean Rb is 1.562, texture ratio is 0.89 km^{-1}, circulatory ratio is 0.218, elongation ratio is 0.598 and constant of channel maintenance is 2.085 (km) revealing that the subsurface region is penetrable, a trademark component of very coarse to coarse drainage and quick ascent in rising floodwater level and elongated shape/ characteristics of watershed. Morphometric examination of the current study will be fundamental for field-based perception and planning strategies for the purpose of managing the watershed.

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