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Morphometric analysis and LULC change dynamics of Nayar watershed for the sustainable watershed management

Ashish Mani[1] · Srijani Guha[1] · Shatakshi Sharma[1] · Sk Zeeshan Ali[1] · Ruchi Badola[1] · Syed Ainul Hussain[1]

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Abstract
The morphometric analysis of the watersheds is essential for the conservation of natural resources, including soil, water, and vegetation. The Morphometric analysis defines the linear, areal and relief aspects of the watershed. It involves the comprehensive analysis of various factors such as drainage network, surface water flow, and other topographical features. The aim of this study is to develop a sustainable watershed management strategy for the Nayar watershed based on morphometry and Land Use Land Cover (LULC) change dynamics. The Nayar watershed has a total area of 1956.33 km^2. The multispectral satellite imagery, Digital Elevation Model (DEM) data, and Survey of India (SOI) Toposheets were used for understanding the topographical and morphological characteristics along with the LULC change dynamics. The findings of this research conclude that the Nayar watershed has parallel and dendritic drainage patterns with high relief. According to the LULC change dynamics, the Nayar watershed's area change comprising 57.60 km^2 and 57.15 km^2, are from Agricultural Land to Wasteland and from Forest Cover to Wasteland, respectively. This shift in the hilly region will increase the risks of landslides and erosion. Furthermore, the change of 110.03 km^2 area of Forest Cover to Agricultural Land raises further challenges due to loss of natural vegetation in long run. In summary the change in LULC of Nayar watershed is vulnerable to risk of natural calamities like landslide, erosion. This work would be helpful to many experts and decision-makers for sustainable watershed management and natural resource management.

Keywords Drainage · Land use land cover · Morphometric analysis · Watershed · Landslide

1 Introduction

In this common era, the rivers are experiencing a multitude of challenges across the globe [1]. Critical issues like water stress or insufficiency of fresh water and ceaseless pollution are majorly increasing due to the acceleration of rapid urbanization [2]. The swift development of socio-economic and demographic structure of any country have led to different serious impact on the riverine ecosystem such as alteration of land covers, reduction of river beds, and transformation of river morphology and topography [3]. India is a land of rivers, there are four major water resource regions in this river-irrigated country [4]. The rivers of India have made a valuable contribution towards civilization and its enlargement. Human population which is more closely dependent on rivers in many ways like water supply, ecological services, and agricultural usage indicate the dominant role of rivers in urbanization and industrialization. In India, river preservation efforts and sustainable water resource management are crucial to preserving the health of rivers and a steady flow of

✉ Syed Ainul Hussain, ainul.hussain@gmail.com; Ashish Mani, maniashish6@gmail.com; Srijani Guha, srijani.titas1@gmail.com; Shatakshi Sharma, sharmashatakshi161@gmail.com; Sk Zeeshan Ali, zeeshanearth@gmail.com; Ruchi Badola, ruchi@wii.gov.in | [1]Ganga Aqualife Conservation Monitoring Centre, Wildlife Institute of India, Chandrabani, Dehradun 248001, Uttarakhand, India.

fresh water [5]. In this instance morphometric analysis plays vital role in recognizing the characteristics of the watershed, the potential of groundwater, and river flow [6, 7].

It can also be very useful for studying the soil erosion management of upstream and channel siltation problems downstream [8, 9]. The morphometric analysis is one of the best ways to investigate the fluvial structure and its different aspects [10]. Morphology is the part of geography that covers the physical structure of a portion of land and the processes that create it [11]. The main themes of geomorphology are fluvial, aeolian, tectonics, and glacial processes [12].

In this study, channel morphology is considered, which is a comprehensive study of the geography aspect and channel flow dynamics aspect of a river [13]. A drainage basin is a fundamental aerial unit of hydrology that accumulates precipitation and directs it towards a shared outlet like a lake, river, or ocean. It includes all surface water flow within its boundaries, playing an essential role in water cycle regulation and resource management. In a simple way, it can be defined as a portion of land where water from precipitation and flow will end up in a common water outlet [14, 15]. The channel or river morphometric study typically helps to understand channel patterns, geometry, water discharge, surface runoff, channel gradient, stream orders, stream frequency, stream length, bifurcation ratio, compactness ratio, channel stability, and movement [16, 17].

Remote Sensing and GIS are the most appropriate techniques for morphometric analysis, watershed delineation, and monitoring to protect river functionality and ecology [18]. Multispectral satellite imagery from various GIS-based platforms combined with remote sensing data, has a significant effect on natural resource management [19]. Numerous researchers have investigated watersheds in diverse terrains using GIS and remote sensing technologies [20–23].

According to Singh et al., the accuracy of remote sensing DEM data utilized for watershed's hydrological analysis is significantly higher than that of older conventional approaches [24]. Bajirao et al. in their study looked at how various issues at the watershed scale, such as deforestation, urbanisation, drought, flood proneness etc. can be identified and resolved by utilizing GIS and remote sensing technologies to analyze the hydrology and morphometry of the watershed [25]. Another study by Mani et al., shows that the areal, linear, and relief features of a watershed are explained by GIS and remote sensing-based morphometric analysis, which is useful in understanding the hydrology of the area [26]. Prabhakar et. al., reported that morphometric analysis and satellite imagery show Land Use Land Cover (LULC) changes in the Champua watershed, affecting its hydrologic performance [27]. The LULC coverage over the river catchment is studied in various landscape. Das et. al. (2018) reported LULC changes in eastern India's river basins which resulted to decrease evapotranspiration and increase of runoff and base flow, affecting water resources management [28]. Tena et al. reported that LULC changes in the Chongwe River catchment negatively impacted its hydrological components [29]. As per Khiavi and Mostafazadeh, their study reveals significant land use changes in Meshginshahr, Iran, with notable increases in residential areas and declines in forest and rangeland, highlighting the need for urgent attention to sustainable land management [30]. Another study by Mostafazadeh and Talebi, predicts significant land-use changes in Meshgin-Shahr, Iran, using the CA–Markov model, highlighting the need for effective policies to conserve landscape integrity and connectivity by 2032 [31].

The morphological characteristics of the Nayar watershed have not previously been studied. Using geospatial techniques, this study will investigate the morphological features and LULC change dynamics of the Nayar watershed. The affecting factors of LULC change in the study area are anthropological dependencies on river. Through this assessment, we aim to improve the Nayar watershed for sustainable watershed management. These scientific databases can also be useful sources for upcoming hydrological research. The findings of this study will also help decision makers and the policy makers to improve their understanding of the earth's resources.

2 Methodology

2.1 Study area

The Nayar River, which flows fully within the Pauri Garhwal region, is the second-largest perennial spring-fed river in the state of Uttarakhand after the Ramganga River [32, 33]. Its two main branches, Purvi Nayar River and Pashchimi Nayar River originates in the dense Dudhatoli Reserved Forest. Purvi Nayar River is approximately 94 km long, while Pashchimi Nayar River is around 91 km long [34]. Near Satpuli, they eventually combine to form the 20 km-long Nayar River. After joining of these two rivers with each other, the river travels to Vyas Ghat where it finally confluences with Ganga River. According to Rashid et al., the Nayar River's watershed is bounded by districts of Uttarakhand, Tehri Garhwal to the north, Chamoli to the east, Almora to the south-east, Nainital to the south, and Dehradun to the west [35]. Horn peaks, serrated canyons, hanging valleys, and waterfalls make it unique. Paithani, Thalisain, Pathisain, Pabo, and Satpuli are significant cities in the Nayar watershed. Its latitude and longitude boundaries are, respectively, 29°45′N to 30°15′N and 78°32′E to 79°12′E. The Nayar watershed covers an area of 1956.33 km^2, which has elevations ranging from 428 to 3102 m and receives about 1700 mm of rainfall on average annually. Also, the area's yearly average temperature ranges from 25 °C to 30 °C. The location has a pleasant summertime climate. Figure 1 below shows a study area map.

2.2 Data and methods

In the present study, the integrated use of multispectral satellite imagery, Digital Elevation Model (DEM) data, and Survey of India (SOI) Toposheets are carried out for the generation of a geodatabase and assessment of various hydrological analysis. The Advanced Land Observing Satellite (ALOS) DEM data [36] along with SOI Toposheets was used for the delineation of topographical and morphological features of the Nayar watershed. The Pre-processed NRSC multi-temporal Advanced Wide Field Sensor (AWiFS) LULC data was utilized for LULC change dynamic [37, 38]. The Morphometric analysis method was used to analyze the Linear, Areal, and Relief aspects of the watershed. Further, the Spatial Analysis Tools (SATs) in ArcGIS desktop software were used for the delineation of watershed boundary and drainage network. Additionally, the watershed, slope, aspect, LULC change, elevation, and drainage density maps, all were created using ArcGIS desktop software. The formulas for performing morphometric analysis, data source information and flowchart of the methodology were define below in Tables 1, 2 and Fig. 2 respectively. Also, the formulas of user's accuracy, producer's accuracy, overall accuracy (OA), and kappa coefficient (k) are mentioned in Eq. 1, Eq. 2, Eq. 3 & Eq. 4.

$$\text{User's accuracy} = \frac{\text{Number of Correctly Classified Pixels in each Category}}{\text{Total Number of Reference Pixels in that Category (The Row Total)}} \tag{1}$$

$$\text{Producer's accuracy} = \frac{\text{Number of Correctly Classified Pixels in each Category}}{\text{Total Number of Reference Pixels in that Category (The Column Total)}} \tag{2}$$

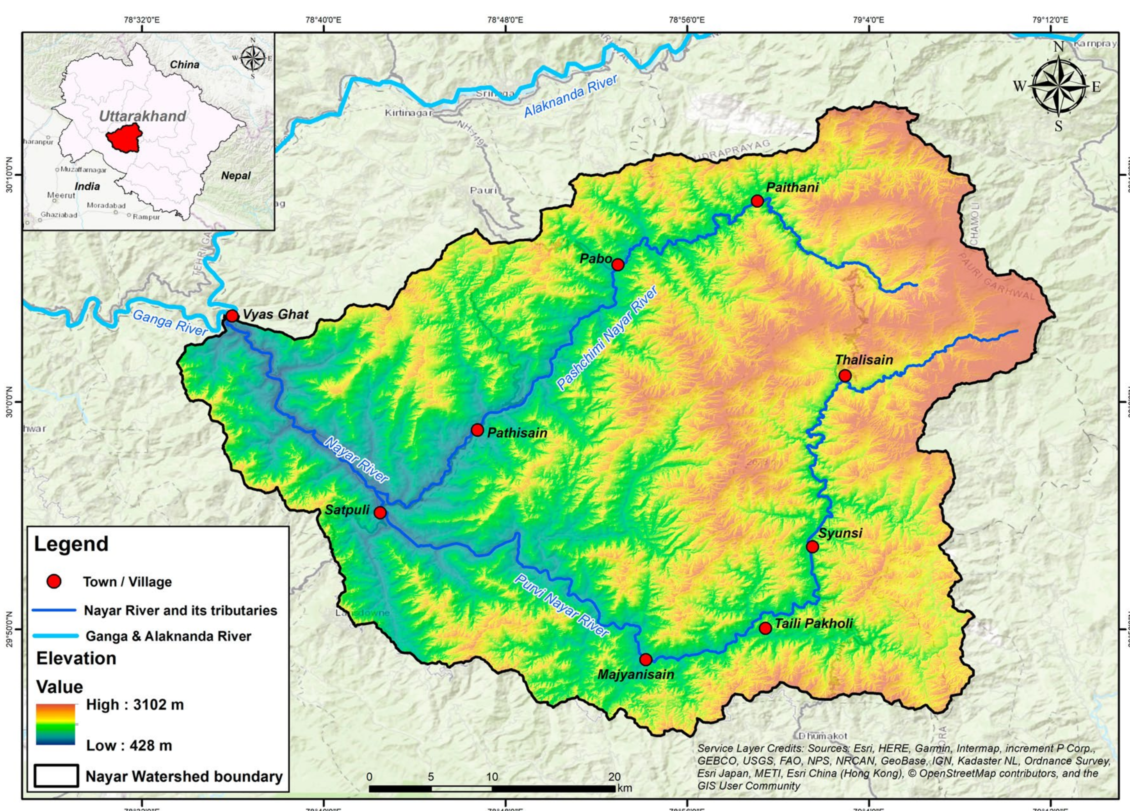

Fig. 1 The study area map of Nayar watershed

Table 1 Morphometric analysis formulas

S. No	Parameter	Formula	References
1	Stream order (w)	*Hierarchical rank*	[39]
2	Stream length (L_u)	*Length of the stream*	[40]
3	Mean stream length (L_{sm})	$L_{sm} = L_u/N_u$	[39]
4	Stream length ratio (R_L)	$R_L = L_u/(L_u-1)$	[40]
5	Bifurcation ration (R_b)	$(R_b) = Nu/Nu + 1$	[41]
6	Mean bifurcation ratio (R_{bm})	R_{bm} = *average of bifurcation ratios of all order*	[42]
7	Drainage density (D_d)	$D_d = L_u/A$	[40]
8	Drainage texture (T_d)	$T_d = N_u/P$	[40]
9	Stream frequency (F_s)	$F_s = N_u/A$	[40]
10	Elongation ratio (R_e)	$Re = 2\sqrt{(A/\pi)}/L_b$	[41]
11	Circularity ratio (R_c)	$R_c = 4\,\pi\, A/P^2$	[43]
12	Form factor (F_f)	$F_f = A/L^2$	[40]
13	Basin relief (R)	$R = H-h$	[44]
14	Relief ratio (Rr)	$R_r = R/L$	[41]
15	Compactness coefficient (Cc)	$Cc = 0.2821*P/(A)0.5$	[40]

$$\text{Overall Accuracy (OA)} = \text{Total Number of Correctly Classified Pixels (Diagonal)}/\text{Total Number of Reference Pixels} \quad (3)$$

$$\text{Kappa Coefficient (k)} = (\text{TS} \times \text{TCS}) - \sum(\text{Column Total} \times \text{Row Total})/(\text{TS})^2 - \sum(\text{Column Total} - \text{Row Total}) \times 100 \quad (4)$$

3 Results

3.1 Morphometric analysis

The morphometric analysis explains the linear aspects, areal aspects, and relief aspects of the drainage basin, which is useful to understand its hydrological and morphological characteristics [45]. Morphometric analysis is used in this watershed study to evaluate landforms' form and shape, which influences hydrological behavior. It facilitates comprehension of runoff potential, sediment output, and drainage patterns. This analysis is crucial for managing sustainable watersheds, preventing erosion, and forecasting floods. It also helps with land use planning and the preservation of natural resources.

3.1.1 Linear aspect

The linear aspect of Nayar watershed is one-dimensional in nature. It contains stream length, stream number, stream order, bifurcation ratio, and length ratio. The Nayar watersheds have 1426 streams in total (Table 3). According to Horton's first law, which is illustrated by the graph in Fig. 3, the number of streams in the watershed reduces as stream order advances. Figure 4 depicts the total stream order for the Nayar watershed, which ranges from 1 to 6 [40]. The mean value of the bifurcation ratio is 4.05. The various drainage pattern types in the watershed are explained by the bifurcation ratio. The patterns used in this research are parallel and dendritic. Sediment movement, erosion rates, and water flow patterns are all impacted by linear features in watershed study. They calculate flood hazards, groundwater recharge, and the effectiveness of drainage networks. Comprehending these linear characteristics helps efficient land use planning, management of natural resources, and reduction of hazards, hence advancing sustainable watershed management and environmental resilience.

Table 2 Data type and data source

S. No	Data type	Data source
1	Digital elevation model (DEM)	Advanced Land Observing Satellite (ALOS) DEM data at 30 m spatial resolution of year 2016 https://www.eorc.jaxa.jp/ALOS/en/index_e.htm
2	Multispectral satellite imagery	NRSC multi-temporal Advanced Wide Field Sensor (AWiFS) LULC data at 56 m spatial resolution of year 2008–09 and 2018–19 https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php
3	Survey of India Toposheets	Toposheets number: 53J12, 53J16, 53K9, 53K13, 53N4 and 53O1 at 1: 50,000 scale. Survey of India, Govt. of India

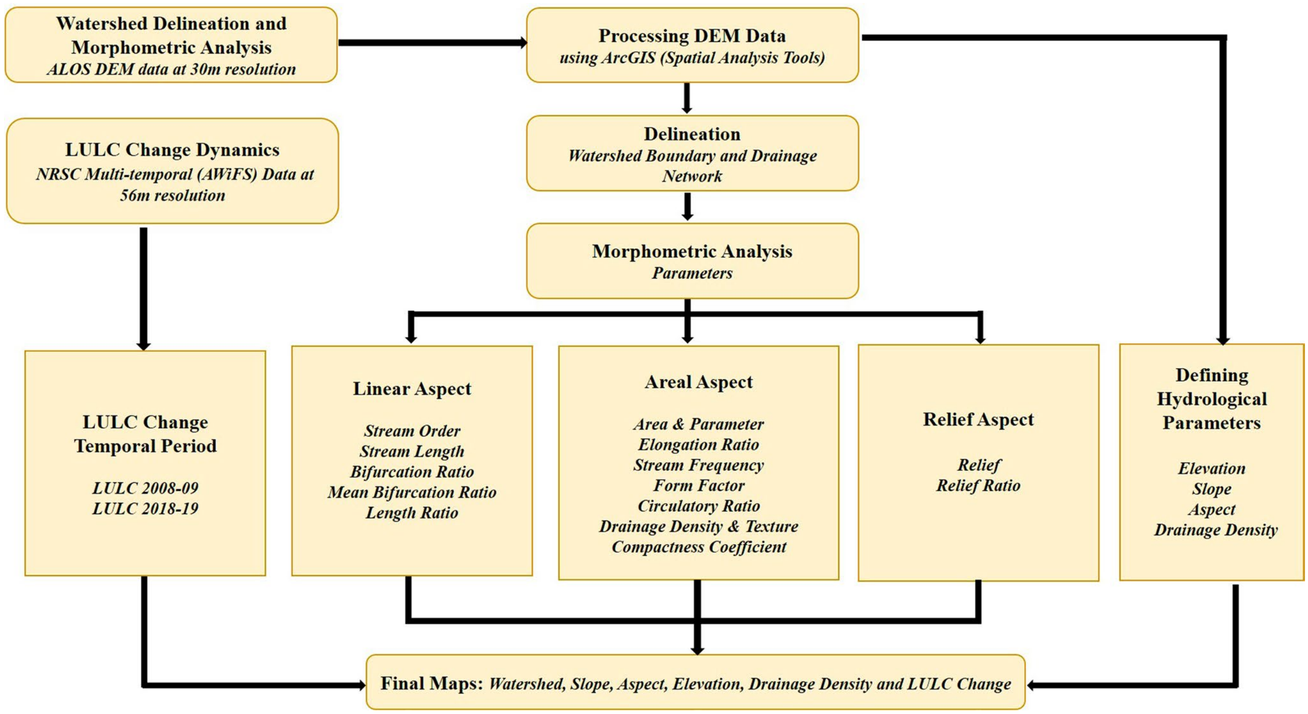

Fig. 2 Flowchart of the methodology

Table 3 Linear aspects table

Stream Order (w)	No. of streams (Nu)	Length of streams (km) (Lu)	Mean length of streams (km) (Lsm)	Cumulative mean stream length (km)	Length ratio (R_L)	Bifurcation ratio (Rb)	Mean bifurcation ratio (Rbm)
1	1102	913.09	0.83	0.83			
2	246	450.93	1.83	2.66	0.49	4.23	
3	61	281.07	4.61	6.44	0.62	4.42	
4	14	111.13	7.94	12.55	0.40	5.30	4.05
5	2	127.80	63.90	71.84	1.15	3.33	
6	1	23.08	23.08	86.98	0.18	3.00	
Total	**1426**	**1907.10**					

Bold represents the total values

3.1.2 Areal aspect

A two-dimensional areal aspect is utilized for the evaluation of the areal characteristics of the Nayar watershed. These include the watersheds' perimeter, area, drainage texture, drainage density, circularity ratio, compactness coefficient, frequency of streams, form factor, and elongation ratio. The 1956 km^2 and 236.16 km comprise the Nayar watershed area and perimeter, respectively (Table 4). According to Schumm, the elongation ratio can be divided into four categories: circular (> 0.9), oval (0.9–0.8), less elongated (0.8–0.7), and elongated (0.7) [41]. With a value of 0.77, the watershed's shape is less elongated. The circularity ratio of 0.44 also indicates that the watershed is less elongated. The form factor influences the watershed's flow intensity. 0.46 is the form factor value. According to Horton, drainage density and stream frequency are associated with each other [40]. For the Nayar watershed, the stream frequency value is 0.73. The watershed's mean drainage density is 0.97 km/km^2. The Nayar watershed has a drainage texture value of 4.67, indicating a coarse drainage texture [46]. The compactness coefficient determines the watersheds' overall compactness. The compactness coefficient has a value of 1.51. According to Farhan et al. [47], a compactness coefficient value of more than 1 corresponds to a higher risk of landslides and erosion; as a

Fig. 3 First law of horton for the Nayar watershed

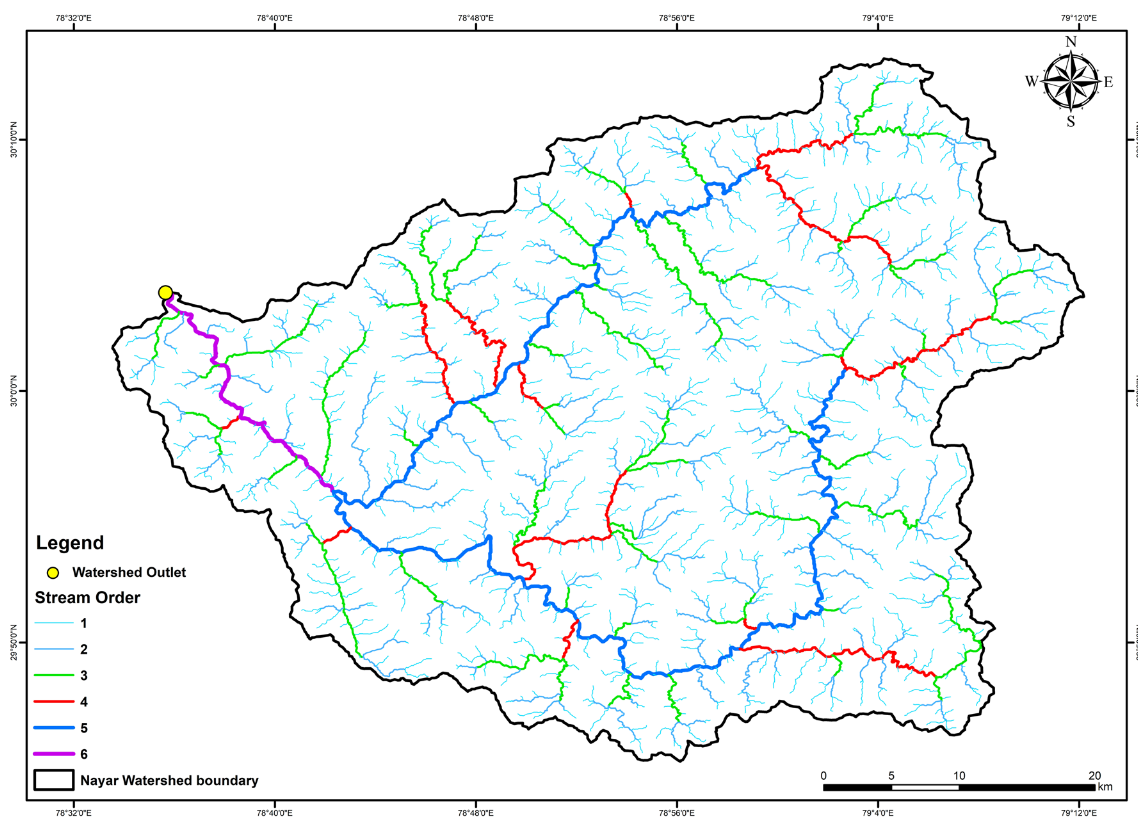

Fig. 4 Stream order and drainage network map of the Nayar watershed

result, the Nayar watershed is susceptible to landslides and erosion. reduced values of the elongation ratio, form factor, and circulation ratio imply less permeability, less infiltration, and higher runoff potential, whereas greater values suggest high permeability, more infiltration, and reduced runoff potential [48–50]. Morphometric characteristics help achieve successful management methods by efficiently identifying locations in watersheds that are prone to erosion.

Table 4 Areal aspects table

Area (km^2)	Perimeter (km)	Length (km)	Form factor (Ff)	Elongation ratio (Re)	Circularity ratio (Rc)	Drainage density (Dd)	Stream frequency (Fs)	Texture ratio (Rt)	Drainage texture (Td)	Compactness coefficient (Cc)
1956.33	236.16	65	0.46	0.77	0.44	0.97	0.73	4.67	6.04	1.51

Table 5 Relief aspects table

Height of basin mouth (z) m	Maximum height of the basin (Z) m	Total basin relief (R) m	Relief ratio (Rr)
428	3102	2674	41.14

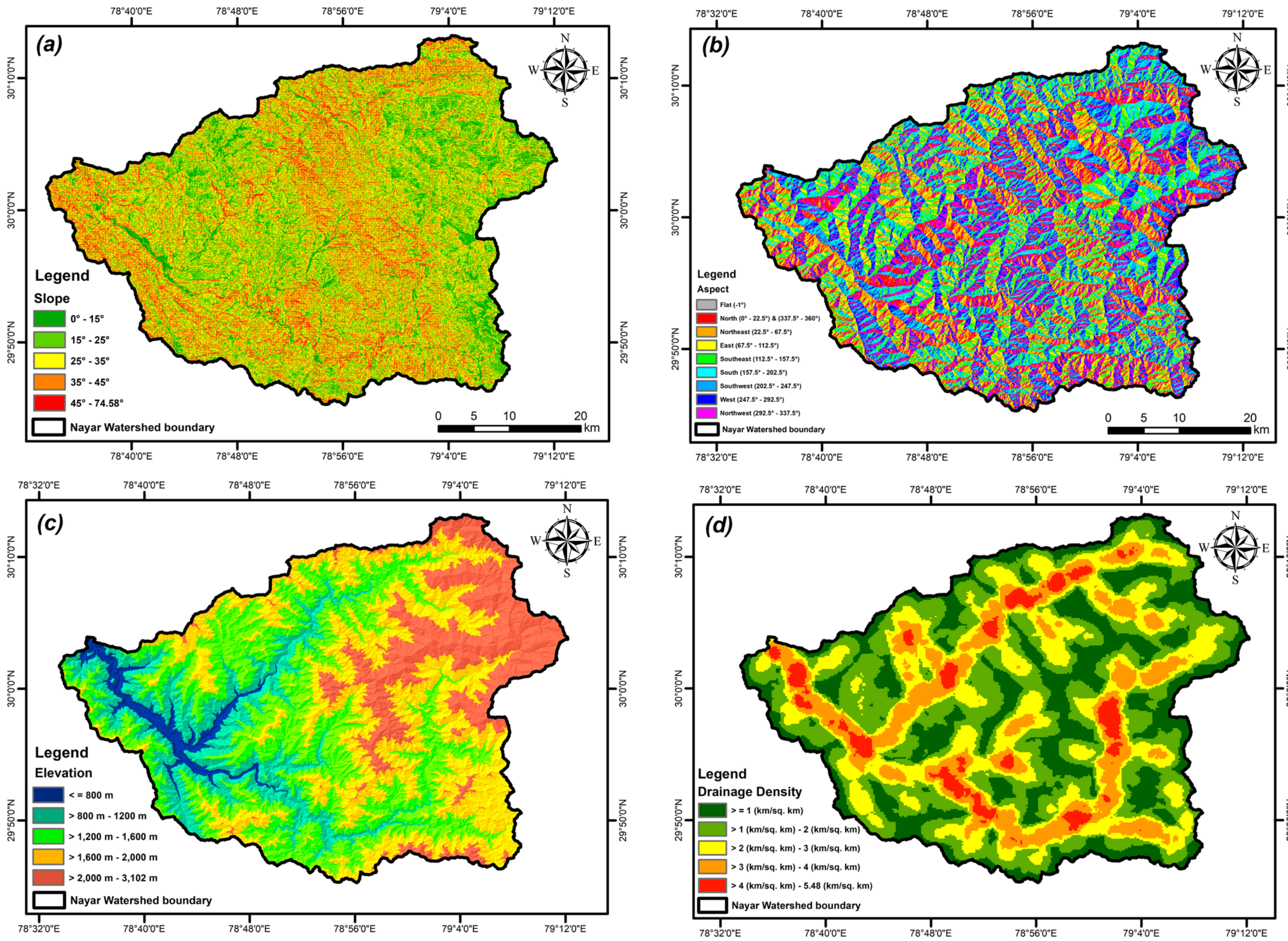

Fig. 5 **a** Slope Map, **b** Aspect map, **c** Elevation Map, and **d** Drainage density map of the Nayar watershed

3.1.3 Relief aspect

Relief is the third-dimensional aspect. The Nayar watershed has a basin relief value of 2674 m, which indicates significant elevation in the watershed (Table 5). 41.14 is the relief ratio value. According to Shit et al., a high relief ratio indicates that the watershed's maximum area has a steep slope and is therefore susceptible to landslides [51].

3.2 Slope

Understanding slope, a key concept in hydrology is necessary to comprehend how water moves across the Earth's surface. Typically, it implies the steepness or gradient of the landscape. According to Fig. 5a, there are five different classes of slope for the Nayar watershed: very gentle (<= 15°), gentle (> 15°–25°), moderate (> 25°–35°), steep (> 35°–45°), and extremely steep (> 45°–74.58°). The majority of the watershed has moderate, steep, and very steep slopes. A steep slope suggests that the watershed has more runoff and less infiltration, which increases the risk of soil erosion and landslides in the area [24].

3.3 Aspect

The aspect indicates the slope's direction. It identifies the predominant vegetation types in the area. Also, Aspect improves erosion modelling. The aspect value is north at 0° and 22.5°, northeast at 22.5 and 67.5°, and so on (Fig. 5b). The aspect for this study is south-facing on the right bank and north-facing on the left bank of the Nayar River. Both slope and aspect maps indicate that Nayar River is a hilly region that is susceptible to landslides and erosions.

3.4 Elevation

Another topographical feature important for the study of the watershed is elevation. It is a fundamental part of the research of hydrology and is important for managing water resources and understanding the environmental changes that will affect hydrological processes. The Elevation of Nayar Watershed is classified into five classes (Fig. 5c). Class 1: (<= 800 m), Class 2: (> 800 m–1200 m), Class 3: (> 1200 m–1600 m), Class 4: (> 1600 m–2000 m), and Class 5: (> 2000 m to 3102 m). Most of the watershed area has a higher elevation which means that Nayar River and its tributaries flow through the valley region. Elevation data analysis is crucial for characterizing a region's topography and comprehending how it affects the flow, storage, and availability of water [26].

3.5 Drainage density

The shape and drainage flow of drainage networks in a particular region are described using the drainage density, an important parameter in hydrology study. It is calculated by dividing the entire length of the rivers or stream channels in a watershed by the watershed's entire area. As indicated in Fig. 5d, the drainage density of Nayar watershed is classified into 5 classes: (<= 1 km/km^2) is very Low, followed by low (> 1 km/km^2–2 km/km^2), medium (> 2 km/km^2–3 km/km^2), high (> 3 km/km^2–4 km/km^2), and very high (> 4 km/km^2–5.48 km/km^2). The majority of the watershed's areas have very low to low drainage density, which indicates a higher slope, less infiltration, and increased potential for runoff because of the valley region. Drainage density is a crucial parameter for hydrology researchers and water resource managers because it gives information about the spatial distribution of drainage networks, which has an impact on hydrological practices and is crucial for assessing and managing water resources, particularly in the context of sustainable watershed management [52].

3.6 LULC change dynamics

Land Use and Land Cover (LULC) change dynamics refer to the methods, trends, and components that influence changes in the land's utilization over time in a particular geographic location [53]. Effective land management, sustainable development, and informed decision-making all depend on an understanding of LULC change dynamics [54]. To address the complex issues caused by LULC change, a multidisciplinary strategy combining data analysis, GIS and Remote Sensing technologies, and policy development is required. The Pre-processed NRSC multi-temporal Advanced Wide Field Sensor (AWiFS) LULC data at 56 m spatial resolution for the years 2008–09 and 2018–19 were used to understand the LULC change dynamics of the Nayar Watershed. The LULC of the watershed was classified into five classes: Built-up, Agricultural Land, Forest Cover, Wasteland, and Waterbodies (Fig. 6). The most significant area changes in the Nayar watershed are from Forest Cover to Wasteland and from Agricultural Land to Wasteland, totaling 57.60 km^2 and 57.15 km^2, respectively (Table 6). The landslides and erosion risks will increase as the Wasteland area in the steep or hilly region expands. Also, landslide and erosion activities near water bodies like rivers, lakes, and waterfalls in the region will threat regions biodiversity [55]. The overall accuracy (OA) of the LULC of year 2018–19 is 0.86 with the kappa coefficient (κ) value is 78.43% (Table 7). According to rating criteria of kappa coefficient, the 78.43% κ value is substantial [56]. Long-term challenges are exacerbated by the shift of 110.03 km^2 of Forest Cover to Agricultural Land which is a threat to the biodiversity of the area. The area nearby Pabo and between Pathisain to Satpuli area under stress due to human and environmental processes. As per Joshi et al., the sub watersheds 6, 9, 10 and 11 of Pashchimi Nayar River are from moderate to high environmental risk and prioritized for conservation [34]. In addition, the significant shift of working class people from agriculture sector to non-agriculture sector in Purvi Nayar Watershed will eventually increases urbanization and infrastructure development in the region [57].

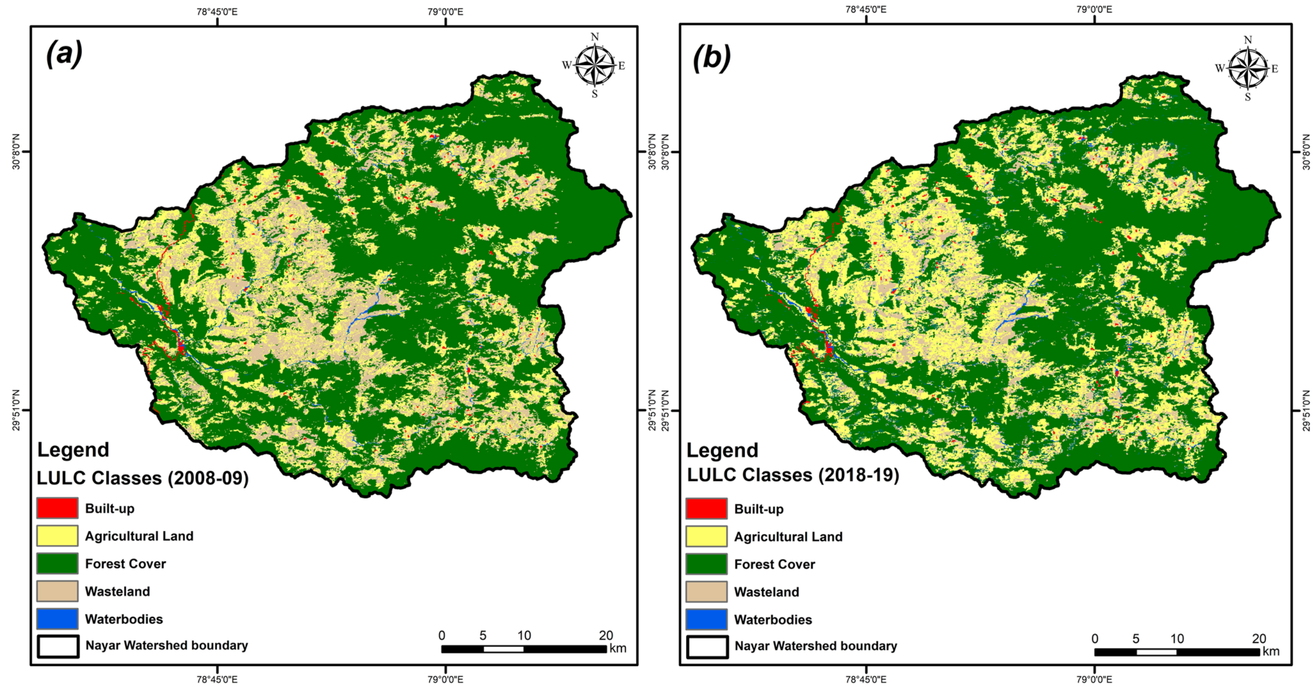

Fig. 6 LULC map of the Nayar watershed for the years **a** 2008–09 and **b** 2018–19

4 Discussion

This study highlights the importance of morphometric analysis in watershed management by revealing how variations in linear, areal, and relief aspects influence runoff, erosion potential, and watershed stability. The findings suggest that the nayar watershed requires an immediate conservation actions to address its erosion susceptibility. These insights are crucial for informing sustainable watershed management practices in the region, ultimately contributing to the conservation of soil, prevention of floods, and efficient planning for water resource utilization [58]. The LULC change dynamics highlight substantial transformations in the Nayar Watershed, raising environmental concerns such as increased erosion risk and biodiversity threats [59, 60]. For sustainable development, it is crucial to address these changing LULC dynamics through effective monitoring and management [61]. The findings from this study offer a crucial resource for watershed management, focusing on the morphometry and land use/land cover (LULC) of the Nayar River watershed to support sustainable planning. The water resource management in the study area can be executed by safeguarding biodiversity, land resources and other natural resources of the area. Experts and decision-makers involved in sustainable natural resource management will be benefitted with the findings of this study. It is recommended to implement immediate conservation actions, monitor LULC changes, and safeguard natural resources in the Nayar Watershed to support sustainable development and effective watershed management.

5 Conclusion

The assessment of watersheds' morphometry is crucial for conserving precious natural resources. The topographical and morphological characteristics along with LULC change dynamics of the Nayar watershed are thoroughly analysed using morphometric analysis in this study. The Nayar watershed displays a complex hydrological morphology with parallel and dendritic drainage patterns with higher relief. The identification of LULC changing dynamics is a significant outcome of this study. Notably, a substantial area transitioned from agricultural land to wasteland and forest cover to wasteland and agricultural land. This shift raises concerns about increased landslides and erosion risks in the region between Pathisain and Satpuli and the surrounding area of Pabo. The study highlights to the mitigation measures of landslides in the area by promoting plantation activities to protect soil erosion. Additionally, this change poses long-term challenges to the

Table 6 Table of LULC change dynamics. LULC Area Change in km^2 for the Year (2018-19)

		Agricultural land	Built-up	Forest cover	Wasteland	Waterbody	Grand total
LULC Area Change in km^2 for the Year (2008-09)	Agricultural Land	209.70	3.32	88.99	57.60	2.47	362.08
	Built-up	3.86	2.67	3.23	1.59	0.42	11.77
	Forest Cover	110.03	3.29	1024.19	57.15	3.57	1198.24
	Wasteland	166.33	2.44	82.03	119.28	2.82	372.91
	Waterbodies	4.48	0.19	2.99	2.14	1.53	11.33
	Grand Total	494.41	11.91	1201.44	237.77	10.81	**1956.33**

Bold represents the total values

Table 7 Table of accuracy assessment for the year 2018–19

	Reference data							
	LULC Class	Built Up	Agriculture	Forest	Wasteland	Waterbodies	Total (User)	User accuracy
Classified data	Built Up	**5**	3	0	1	0	9	0.56
	Agriculture	2	**16**	7	0	0	25	0.64
	Forest	0	0	**54**	0	0	54	1.00
	Wasteland	2	2	0	**22**	0	26	0.85
	Waterbodies	0	0	0	0	**4**	4	1.00
	Total (Producer)	9	21	61	23	4	**118**	
	Producer Accuracy	0.56	0.76	0.89	0.96	1.00		
				Overall Accuracy (OA) = 0.86				
				Kappa Coefficient (κ) = 78.43 %				

Bold represents the total values

region's ecological balance. The research finding is limited to the watershed and catchment scale as data used derived from DEM. The insights gained from this study provide a valuable resource for experts and decision-makers involved in sustainable natural resource management. They will be crucial for developing strategies for reducing environmental threats, protecting natural resources, and maintaining the long term sustainability of the Nayar watershed.

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Author contributions A.M. Conceptualization, A.M. Data curation, A.M., S.G. and S.Z.A. Formal Analysis, A.M., S.G., S.S. and S.Z.A. Methodology, A.M., S.G., S.S. and S.Z.A. Software, A.M., S.G., S.S. and S.Z.A. Validation, A.M. and S.G. Writing—Original Draft, S.Z.A., R.B. and S.A.H. Writing—Review and Editing, R.B. and S.A.H. Funding acquisition, R.B. and S.A.H. Investigation, R.B. and S.A.H. Supervision.

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Data availability Data is provided within the manuscript files.

Declarations

Competing interests The authors declare no competing interests.

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