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Study of Liner aspects of marphometric parameters of the Sahanura river basin using Remote Sensing and GIS approach

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Abstract:

In the present paper, an attempt has been made to study the quantitative geomorphology of the Shahanur river basin. It is a sub-basin of Purna river basin of Maharashtra state, India. Authors have evaluated the morphometric characteristics based on Survey of India toposheets at 1:50,000 scale, and LISS III image. GIS and image processing techniques were adopted to identify the morphological features such as linear aspects of the river basin and also analysis their properties. ArcGIS software was used for the extraction of drainage and the Morphometric parameters. The results indicated that the drainage area of basin is 868.86 Km2, perimeter 162.36 Km, basin length 92.03 Km, and stream order of the basin is up to Seven orders, total stream length is 1674.98 Km., the stream segments are 2027, Sinuosity Index is 1.28, Stream length ratio, mean Stream length, bifurcation Ratio, mean bifurcation ratio, is also computed. The outcomes thus generated equip us with significant knowledge and may provide input that is essential in decision-making for watershed planning and drainage development of the watershed.

Keywords: *Quantitative geomorphology, Image processing techniques, Morphometric parameters.*

Introduction

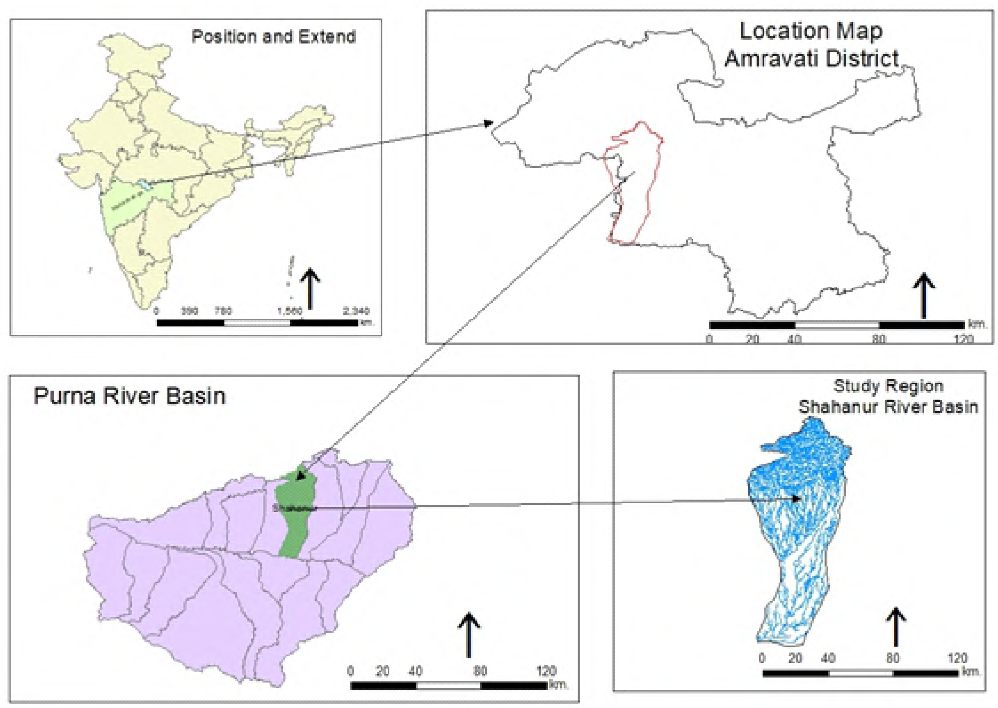
'Morphometry may be defined as the measurement and mathematical analysis of the configuration of its earth's surface and the shape and dimension of its landforms'(J.I.Clarke1970). A major emphasis in geomorphology over the past several decades has been on the development of quantitative physiographic methods to describe the evolution and behavior of surface drainage networks (Horton, 1945). Morphometric analysis of a watershed provides a quantitative description of the drainage system, which is an important aspect of the characterization of watersheds (Strahler, 1964). Remote sensing and GIS techniques are now a day used for assessing various terrain and morphometric parameters of the drainage basins and watersheds, as they provide a flexible environment and a powerful tool for the manipulation and analysis of spatial information. In present study an

Maharashtra state is 3rd largest state of India and it is located in North central part of the peninsular plateau of India. Maharashtra state is bounded by Arabian Sea on western side. Administratively it is bounded by Gujrat and Madhya Pradesh which lies on northern side, Chhattisgarh on eastern side. Southern side is bounded by Karnataka and Andhra Pradesh. The Western Ghats (Sahyadri) runs North-South direction separates Coastal area from main land. Due to topography of Maharashtra Western side of Sahyadri receives maximum amount of rainfall which is orographic in nature. While on the other hand eastern side of Sahyadri where suddenly drops in the amount of rainfall known as Rain Shadow Zone. Meteorologically Maharashtra state subdivided into four divisions namely Konkan, Madhya Maharashtra, Marathwada and Vidarbha (Report on Climate of Maharashtra).

Principally Maharashtra State classified into three climatic classes namely Tropical Savana (Hot) Climate (Aw), Tropical Rainy Monsson Climate (Am) and Dry Climate (Bsh). The Maharashtra state receives rainfall mostly during South-West Monsoon period from June to September. The amount of rainfall is unevenly distributed over Maharashtra. The amount of rainfall received over Maharashtra state ranging from 600 cm at Ghats to less than 60 cm at Madhya Maharashtra. The Maximum temperature of Maharashtra varies between 270C and 400 C while minimum temperature of Maharashtra varies between 140C and 270C. The maximum temperature during summer season is between 360C and 410C and minimum temperature is during winter season which ranges between 100 C and 160 C (Report on Climate of Maharashtra).

Study Area

The study area belongs to Godavari Upper basin. The latitudinal extension is 190 33' 58.505" to 200 26' 43.551" North and longitudinal extension is 730 28' 34.467" to 750 01' attempt was made to analysis liner aspects of Shahanur river basin with the help of Remote Sensing and GIS



Shahanur watershed is the right hand side sub-watershed of the Purna river basin The Shahanur watershed in the adjacent to upland of the Purna river Valley, is an oval-shaped drainage basin of Amravati district, Maharashtra (Fig. 1). Shahanur is the westernmost tributary of the Purna river of Amravati district. The Shahanur river rises in the Gawilgarh hills and after a fairly long and winding course first eastwards and then south-westwards at the foot hills of Gawilgarh hills enters the plains near Malkapur and flows southwards passing by Anjangaon Surgi and turns south-westwards at Umri and continues in this direction to join the Purna river at Wadad in Akola Taluka of Akola district. The overall length of the river is 130 km.

It is situated between 200 51!44" to 21051'44" N latitude and 7706' 3"to 770 21'16 "E longitudes with a total area are 868.86 Km2, Average annual rainfall is 975 mm. The soil of the basin is medium to deep black soils is dark brown or grayish black. They possess a clayey texture and blocky structure. Deep black soil is found in the lower part of the basin.

1.2 Objective:

1. This paper's main objective is to analysis liner aspects of the Sahanur river basin.
2. Find out the morphometric impact of the drainage basin.

1.3 MATERIALS AND METHODS

1.3.1 Data and Methodology

In the Present paper for the preparation of the base map and drainage map, topographical maps of 1:50,000 scale (SOI) No 55 G/3, 4,7 and 8,55 H/1, and 5 toposheets and LISS III images are used. Linear, aspects of morphometric parameters are computed by using Arc GIS software. Morphometric analysis has been carried out by measuring linear aspects of the basin, and using the mathematical formulae given in table No. 1.

Sr. No.	Parameter	Formula	Reference
Linear Aspects			
1	Stream Order (u)	Hierarchical Rank	Strahler (1994)
2	Stream Number (Nu)	Stream number with Stream order	Horton (1945)
3	Stream Length (Lu)	Length of the Stream	Horton (1945)
4	Mean Stream Length (Lsm)	Lsm $\frac{Lu}{}$ Where, Lsm = Mean Stream Length, Lu = Total Stream Length Of order 'u' .Nu = Total no. of Stream segments of order 'u'	Horton (1945)
5	Stream Length Ratio (RL)	RL $\frac{Lu}{}$ Where, RL = Stream Length Ratio Lu = The Total Stream Length of order 'u' Lu-1 = The Total Stream Length of its next lower order.	Horton (1945)
6	Bifurcation Ratio (Rb)	Rb $\frac{Na}{}$ Where, Rb = Bifurcation Ratio Nu = Total Number of Stream segments of order 'u' Nu+1 = Number of Stream segments of the next higher order	Schumm (1956)
7	Mean Bifurcation Ratio (Rbm)	Rbm = Average of bifurcation ratio of al order.	Strahler (1957)
8	Sinuosity index	Cs = OL / EL , Where Ol = Observed path of the stream El = Expected strait path of the stream	

1.4 Results and Discussion

Liner aspects of the Sahanur river basin were determined and are summarized in Tables No.1 and 2

Table No. 1 Liner aspect of Shahanur

River Basin	Stream Order	Stream number (Nu)	Stream length In km. (Lu)	Stream length ratio (RL)		Mean Stream length (Lsm)	Sinuosity Index
Shahanur River Basin	1	1435	910.42			0.63	1.28
	2	420	383.94	I/II	0.42	0.91	
	3	137	183.40	II/III	0.48	1.34	
	4	41	91.04	III/IV	0.50	2.22	
	5	12	57.18	IV/V	0.63	4.76	
	6	7	105.22	V/VI	1.84	15.03	
	7	1	14.66	VI/VII	0.14	14.66	

Bifurcation Ratio (R_b)						Mean bifurcation ratio (R_{bm})
1st order/ 2ed order	2ed order/ 3ed order	3ed order/ 4th order	4th order/ 5th oSrder	5th order/ 6th order	6th order/ 7th order	
2.371	2.093	2.014	1.592	0.543	7.179	2.63

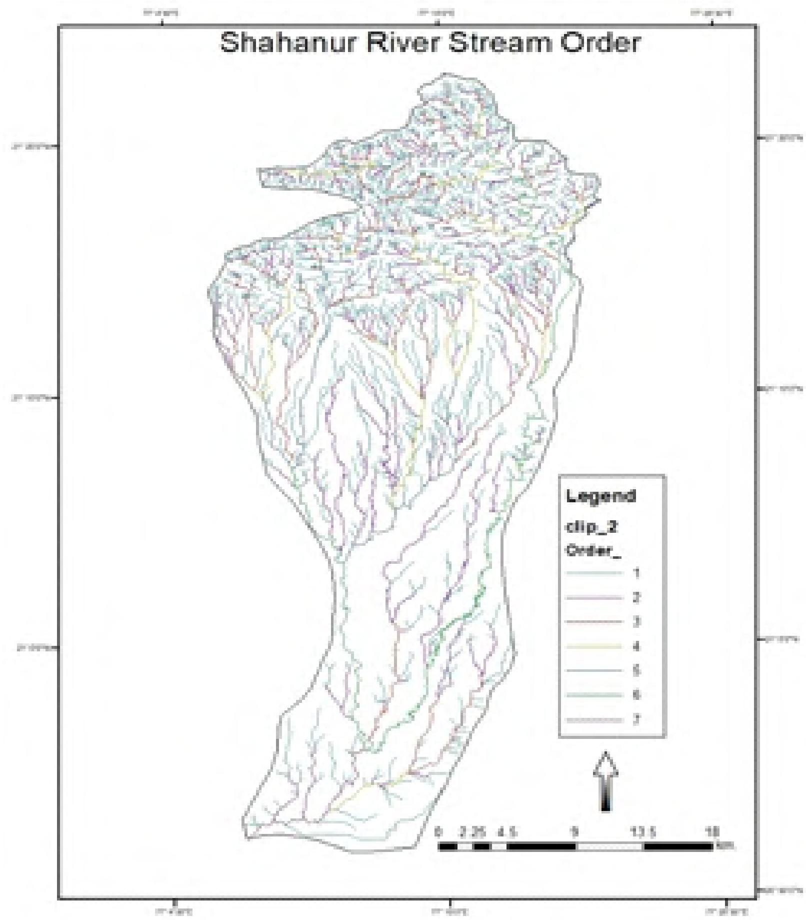
Table No. 2 Bifurcation Ratio and Mean Bifurcation Ratio

1.4.1 The linear aspects of the drainage network

The linear aspects of the drainage network such as stream order (Nu), stream number (Nu), stream length (Lu), Mean stream length (km) (Lsm), Stream length ratio (RL), Bifurcation ratio (Rb), and Mean bifurcation ratio (Rbm) result have been presented in the Table No.1

Stream Order (Nu):

In the drainage basin analysis the first step is to determine the stream orders. In the present study, the channel segment of the drainage basin has been ranked according to Strahler's stream ordering system. According to Strahler (1964), the smallest fingertip tributaries are designated as order 1. Where two first order channels join, a channel segment of order 2 is formed; where two of order 2 join, a segment of order 3 is formed; and so forth. The trunk stream through which all discharge of water and sediment passes is therefore the stream segment of the highest order. The study area is a 7th stream order of the basin. Map No. 2



Stream Number (Nu):

The law of stream numbers relates to the definite relationship between the orders of the basins and stream numbers. Inverse correlation in stream order and stream number, as the order of stream is increase number of streams decreases. In study area highest numbers of streams are in the 1st order (1435), in 2ed it is 420, in 3rd it is 137, in 4th it is 41 and in 5th it is 12, 6th it is 7 and 7th is only 1 number of stream. Stream number is decrease as the order is increase.

Stream Length (Lu):

Stream length is one of the most significant hydrological features of the basin as it reveals surface runoff characteristics streams of relatively smaller lengths are characteristics of areas with larger slopes and finer textures. Longer lengths of streams are generally indicative of flatter gradients. Generally, the total length of stream segments is maximum in first-order streams and decreases as the stream order increases. The number of streams of various orders in the basin is counted and their lengths from mouth to drainage divide are measured with the help of GIS Software. Plot of the logarithm of stream length versus stream order showed the linear pattern which indicates the homogenous rock material subjected to weathering erosion Characteristics of the basin. Deviation from its general behavior indicates that the terrain is characterized by variation in lithology and topography. In the study area number of stream is decrease as the order of the stream is increases.

Bifurcation Ratio (Rb):

The term bifurcation ratio (Rb) is used to express the ratio of the number of streams of an given order to the number of streams in next higher order (Schumn, 1956). Bifurcation ratios characteristically range between 3.0 and 5.0 for basins in which the geologic structures do not distort the drainage pattern (Strahler, 1964). Strahler (1957) demonstrated that bifurcation ratio shows a small range of variation for different regions or for different environment dominates. Bifurcation ratio of the 1st to 5th order of stream is lower than three it means that the this area of the basin is mountainous or highly dissected drainage basins. The mean bifurcation ratio value is 2.63 for the study area (Table 2) which indicates that the geological structures are less disturbing the drainage pattern.

1.5 Conclusion:

Morphomatric analysis of Sahanur river basin shows 1st to 7th order of stream,and it is passing through an early mature stage to old stage of the fluvial geomorphic cycle. Study reveals that study area streams up to 1st to 3rd order maximum traverse in high altitudinal area of the basin which are categorized by steep slopes while the 6th and 7th order streams occur in comparatively flat lands The basin shows dendritic type drainage pattern. The larger number of first order streams points to uniform lithology and noble slope gradient. Lower value of bifurcation ratio indicates that the drainage of Sahanur river basin is underlined by uniform materials and the streams are usually branched systematically. Analysis of linear parameters of the Sahanura river basin indicates that the basin has a gentle slope, moderate to low relief with fine drainage texture. For the analysis of morphomatric parameters topographical maps and LISS III image are used and this type of analysis is very useful for watershed planning and management.

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