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MORPHOMETRIC CORRELATION OF SPATIAL AND LINEAR ASPECTS OF PANCHAGANGA RIVER

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ABSTRACT:

The term Morphometry senses the measurement and analysis of form and its properties. In context of geomorphology which is science of land forms it is concerned with the various geometrical aspects of the landforms. It is inevitable in the study of fluvial geomorphology. Morphometric analysis particularly deals with quantitative measurements of different aspects like linear and spatial of river channel for instance stream order, stream length, drainage density, drainage frequency, bifurcation ratio constant channel maintenance etc. Panchaganga River one of the major tributaries of Krishna River flows on southern part of Deccan Trap of Maharashtra that occupies an area of 2099.63km². The river amasses the water all over from 9111 streams which together forms the Panchaganga river basin. Total length of all tributaries is 6418.49km. The average drainage density of the river is 3.52; however it varies within the basin which detects the minor changes in the terrain configuration and gradient intensity and its aspects. Drainage frequency is also dynamic however, the average drainage frequency is 4.33 which is an out come of the undulating and rugged terrain supported by the constant of channel maintenance of basin that is 0.36 km²/km.

Keywords: *Stream order, Drainage Density, Drainage Frequency, Bifurcation ratio, Channel Maintenance.*

INTRODUCTION

Since the geomorphology is the science of landforms, the study of the same is necessarily concerned with the linear and spatial aspects of the landforms. The linear aspects of the drainage network morphometry incorporate stream order, stream length, bifurcation ratio, and spatial aspects like drainage density, drainage frequency; constant of channel maintenance etc. carries inevitable significance in the analysis of river basin.

THE STUDY REGION

Panchaganga river is one of the principal tributary the Krishna river system lays within the 16^0 44" 4' to 16^0 31"22' North Latitude and 74^0 14" 33' to 74^0 36"03' East Longitude. The river incorporated with sub river basins of Kasari, Kumbhi, Bhogavati Dhamani and Tulasi claims an area of 2099.63km² that falls under Kolhapur district of western Maharashtra.

OBJECTIVE

To examine morphometric correlation between spatial and linear aspects of the Panchaganga River basin.

DATA BASE AND METHODOLOGY

The principal source of the data is an SOI topographical map of 47L/1, 2, 3, 5, 6, 9, 10 and 47H/13, 14, 15 at the scale of 1:50,000. Stream ordering method as suggested by the Strahler (1964) has been employed. Mean stream length, bifurcation ratio, stream length ratio, drainage density, drainage frequency and allied morphometric parameters have been calculated with respective formulae.

STREAM ORDER

Stream order of the drainage basin is the successive assimilation of the streams within a drainage basin. There are varieties of methods to determine the stream order. Horton (1945), Strahler (1952), Scheidegger (1965), Shreve (1967) have well defined stream order measurement methods. According to the Strahler's (1952) method stream ordering of Panchaganga basin has been accomplished. The entire basin has seventh order stream that reveals fine well developed dendritic type drainage network.

Table: 1 Stream orders {u}

Name of stream	Stream Order							
	I	II r	III r	IV	V r	VI	VII	Total
Kumbhi	940	265	52	7	2	1	0	1267
Kasari	2382	536	120	29	05	01	00	3073
Bhogavti	1277	305	69	11	02	01	01	1665
Dhamani	1053	156	35	04	01	00	00	1249
Tulasi	496	91	20	03	02	01	00	613
Panchaganga	948	221	56	12	5	00	01	1244
Panchaganga basin	7096	1574	352	66	17	4	2	9111

Source: Based on Morphometric Analysis.

STREAM NUMBERS

Individual counting of the streams in the river basin reveals the total number of the streams. According to the stream order one can segregate order wise stream numbers. Whole Panchaganga river basin has 9111 streams. In the basin Kasari river has 3073 streams, whereas the lowest streams bearing by Tulasi River that is 613.

Table: 2 Numbers of stream (nu)

Name of stream	Order wise Number of Streams							
	I	II	III	IV	V	VI	VII	Total
Kumbhi	940	265	52	7	2	1	0	1267
Kasari	2382	536	120	29	05	01	00	3073
Bhogavti	1277	305	69	11	02	01	01	1665
Dhamani	1053	156	35	04	01	00	00	1249
Tulasi	496	91	20	03	02	01	00	613
Panchaganga	948	221	56	12	5	00	01	1244
Panchaganga basin	7096	1574	352	66	17	4	2	9111

Source: Based on Morphometric Analysis.

STREAM LENGTH

Stream length of river can be measured with help of Rotometer, from the respected SOI toposheets of the river basin and calculated by,

$$Lu = \sum \frac{Lu}{Nu}$$

Where 'Lu' = Mean stream length of order 'u'

ΣLu = Total stream length of order 'u'

Nu= Number of stream segment of order 'u'

It is prevailed that the total length of the streams in entire basin is 6418.49km. Among the tributaries of the river Panchaganga Kasari has highest stream length i.e. 2253.35km, where as Tulasi has 433.69km.

Table: 3 Stream Length

Name of river	Order wise Stream Length in km							
	I	II	III	IV	V	VI	VII	Total
Kumbhi	415.23	222.08	80.46	24.94	31.91	20.11	00	794.73
Kasari	1543.63	401.53	139.20	74.83	31.38	62.76	00	2253.33
Bhogavti	700.08	234.15	94.95	28.16	60.35	4.02	12.07	1133.78
Dhamani	658.21	116.67	43.85	10.46	27.35	00	00	856.97
Tulasi	296.92	75.63	28.16	14.48	18.50	00	00	433.69
Panchaganga	277.97	308.48	157.82	99.21	22.29	00	80.33	946.10
Panchaganga basin	3892.04	1358.54	544.44	252.40	191.78	86.89	92.40	6418.49

Source: Based on Morphometric Analysis.

STREAM LENGTH RATIO

The ratio in-between the average lengths of streams of successive orders is stream length ratio. Stream length ratio obtained by Horton (1945) equation of $RL = \frac{Lu}{Lu-1}$ Where 'RL' = Stream length ratio

Lu = the mean stream length of all stream segments of the order 'u'

Lu-1 = the mean length of all stream segments of next lower order.

Table: 4 Stream Length Ratio

Name of River	Stream Length Ratio					
	I/II	II/III	III/IV	IV/V	V/VI	VI/VII
Kumbhi	1.86	2.76	3.22	0.78	1.58	0
Kasari	3.84	2.88	1.86	2.38	0.50	0
Bhogavti	2.98	2.46	3.37	0.46	0.33	0
Dhamani	5.64	2.66	4.19	0.38	0	0
Tulasi	3.92	2.68	1.94	0.78	0	0
Panchaganga	0.90	1.95	1.59	4.45	0	0
Panchaganga basin	3.19	2.56	2.69	1.53	0.40	0

Source: Based on Morphometric Analysis.

DRAINAGE DENSITY (DU)

Drainage density can be defined as a ratio of total length of all stream to the total area of the same basin. According to Strahler (1952) drainage density can be obtained by

$$Dd = \frac{L_k}{A_k}$$

Where, Dd = Drainage density

L_k = Total lengths of all streams in basin.

A_k = Total area of basin.

Table: 5 Drainage Density (Du).

Name of River	Total Length of Stream (km)	Area (km²)	Drainage Density (Du)
Kumbhi	795.01	227.09	3.50
Kasari	2253.35	354.86	6.34
Bhogavti	1133.78	401.44	2.82
Dhamani	856.97	188.42	4.54
Tulasi	433.71	160.57	2.70
Panchaganga	946.10	767.25	1.23
Panchaganga basin	6418.49	2099.63	3.52

Source: Based on Morphometric Analysis.

Drainage density is the length of stream per unit area say for example square kilometer. Drainage density is an indicator of the terrain configuration that is rocks property and sometime vegetative wrap over the land. In the instance of the Panchaganga river basin the average density is 3.52 km/ km² which is an indicator of impermeability of the rocks beneath. In the entire basin Kasari river has maximum density i.e. 6.34 km/ km² which is a symptom of well-developed drainage with undulating topography. On the other hand Panchaganga main course has lowest density of 1.23 km/ km² owing to passing through flat terrain of well-developed regolith.

DRAINAGE FREQUENCY

The drainage frequency senses the number of stream segments in per unit area. It is a good indicator of the drainage pattern. Drainage frequency has duly been obtained by the total number of streams divided by the total area in km². Kasari river has 8.67 drainage frequency, while an average frequency is 5.07 that denote the dendritic type of pattern.

Table 6: Drainage Frequency (Fu)

Name of River	Total no. of streams	Total area (km²)	Drainage Frequency
Kumbhi	1267	227.09	5.57
Kasari	3073	354.05	8.67
Bhogavti	1665	401.44	4.14
Dhamani	1249	188.42	6.62
Tulasi	613	160.57	3.81
Panchaganga	1244	767.25	1.62
Panchaganga basin	9111	2099.63	5.07

Source: Based on Morphometric Analysis.

CONSTANT OF CHANNEL MAINTENANCE

The channel maintenance is at par with drainage density (Du), however, it is an antithesis of drainage density i.e. total area of the basin divided by total length of all streams in the basin. Constant of channel maintenance designate the minimum required unit of area for sustaining or retaining the stream flow. It is therefore, higher the density lowers the constant of channel maintenance. Regarding the Panchaganga basin the constant of channel maintenance is higher

in Panchaganga river i.e. 0.81 km²/km. This strongly validates the typical configuration of terrain with profound regolith development and cultivated agriculture land. Constant of channel maintenance is lower in Kasari sub basin i.e. 0.15 which again strengthen the formation of topography with undulating resistant terrain. Average 'C' is 0.36 denote moderately developed topography.

Table 7: Constant of Channel Maintenance

River	Area of Basin	Length of Streams	C km²/km
Kumbi	227.09	795.01	0.28
Kasari	354.86	2253.35	0.15
Bhogavati	401.44	33.78	0.35
Dhamani	188.42	856.97	0.21
Tulasi	160.57	433.71	0.37
Panchaganga	767.25	946.53	0.81
Panchaganga basin	2099.63/ 6418.49	6418.49	0.36

Source: Based on Morphometric Analysis.

BIFURCATION RATIO

According to Schumm (1956) 'bifurcation ratio' is the ratio between the total numbers of steams of one order to that of the next higher order. It can be obtained by $Rb = \frac{Nu}{Nu+1}$

Where

'Rb' = Bifurcation ratio

Nu = Number of segments of a given order 'u'

Nu+1 = Number of segment of next higher order.

Bifurcation ratio is dominated by drainage density which again controlled by land configuration e.g. rock structure, basin shape etc. Average (Rb) in Panchaganga basin is 3.6 that diagnostic of homogeneity in rock structure.

Table 8: Bifurcation Ratio (Rb)

Name	Bifurcation Ratio (Rb)					
	Kumbhi	**Kasari**	**Bhogavti**	**Dhamani**	**Tulasi**	**Panchaganga**
I/II Stream	3.54	4.44	4.18	6.75	5.4 5	4.28
II/III Stream	5.09	4.46	4.42	4.45	4.55	3.94
III /IV Stream	7.42	4.13	6.27	8.75	6.66	4.66
IV/V Stream	3.5	5.8	5.5	04	1.5	2.4
V/VI Stream	02	05	02	00	02	0
VI/VII Stream	00	00	01	00	00	0
VII Stream	00	00	00	00	00	0
Average	3.59	3.97	3.89	3.99	4.03	2.18

Source: Based on Morphometric Analysis.

CONCLUSION:

From the foregoing analytical study it is inferred that Panchaganga river basin is an outcome of the distinguished topography which is configured by the homogeneous lithological element which has low intensity of permeability which resultantly facilitate the well development of drainage network. Parametric variation in drainage morphometry within the basin is result of relief gradient at upstream and anthropogenic activities (agriculture practice) at lower stream.

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