GEOMORPHIC ASSESSMENT OF SAVITRI BASIN

Priyadarshani B. More

S. N. D. T. Women's University, Dept of Geography, PGSR, Pune -38,

priyadarshani.more@gmail.com

| Abstract |

The basin characteristics such as basin relief, size, shape, drainage density etc. play an important role in the generation of floods. Drainage basins are the fundamental units of the fluvial landscape. The term morphometry is used in several disciplines to mean the measurement and analysis of form characteristics. In geomorphology it is applied to numerical examination of landform, which may be more properly termed geomorphometry. This morphometry is essential because every drainage basin unit differs in shape, size, area, relief and gradient from other basins. If these features can be measured using some form of mathematical analysis, then it is possible to describe accurately the morphology of a region.

Keywords: Morphometry, Linear, Areal and Relief Aspects

Introduction:

Systematic description of the geometry of a drainage basin and its stream channel system requires measurement of linear, areal and relief aspects of drainage network. The drainage network of the Savitri basin displays a dendritic drainage network arrangement in Mahad and trellis drainage network around Mahad (fig. no. 1.1). There are 6 major tributaries having a length of more than 30 km. Most of the higher order tributaries enter the Savitri River from north and south direction. Other tributaries are shorter in length and have smaller catchment areas.

Basin morphometry plays a vital role in the hydrological behavior of a basin. In the present work stream order analysis, Bifurcation Ratio (Rb), Drainage Density (Dd) has been computed to get the picture of a basin configuration for flood study. Systematic description of the geometry of a drainage basin and its stream-channel system requires measurement of linear aspects of the drainage network, areal aspects of the drainage basin, and relief (gradient) aspects of channel network and contributing ground slopes.

Study Area:

The study area selected for the morphometric studies lies in konkan coastal track of Maharashtra. River Savitri is one of the major west flowing river of coastal track of

Maharashtra. It has a source at the Aurthorsit Point of Mahabaleshwar Plateau at an altitude of 1212 m. The basin lies in between 18^0 9' N to 73^0 40' E. The total catchment area of Savitri River is 2899 sq.km with total length of 99 km from its source at Mahabaleshwar to the confluence at Bankot. The whole Savitri basin comprises six major tributaries namely Kadwal, Kamthi, Raigad-Kal, Gandhari, Ghod and Kal meet the main river from the right bank while Chol and Nageshwari both meet the main river from left bank.

The basin has rather round shape with its broad extent in north-south direction and it tapper to the west. Savitri meets to Arabian Sea at Bankot Creek near Devgad village in Shrivardhan tahasil.

Database and methodology:

The Savitri River basin was demarcated from the Survey of India (SOI) toposheets of 1:50000 scale. The parameters of morphometric characteristics were analyzed using the standard techniques followed by several pioneers in the field such Horton (1945), Strahler (1964), Schulz (1976), Miller (1953), Schumm (1956), Stoddart (1965), Melton (1957), Langbein (1947) and Morisawa (1985).

Linear Aspects of the Channel System :

Stream Orders:

The first step in drainage-basin analysis is designating of stream orders. There are different methods of designating the stream order, however, the modified method of Strahler (1952) is adopted for the present analysis, and the number of segments of each order is tabulated in table no. 1.1.

Bifurcation Ratio (Rb) :

After the drainage-network elements have been assigned their order numbers, the segments of each order are counted to yield the number $N\mu$ of segments of the given order μ (Table no.1.1). According to Strahler (1964) 'the ratio of number of segments of a given order ($N\mu$) to the number of segments of the higher order ($N\mu+1$) is termed as *bifurcation ratio Rb*. Mathematically the bifurcation ratio (Rb) is given by the following formula:

$Rb = N\mu / N\mu + 1$

Table No. 1.1: Bifurcation Ratio Analysis

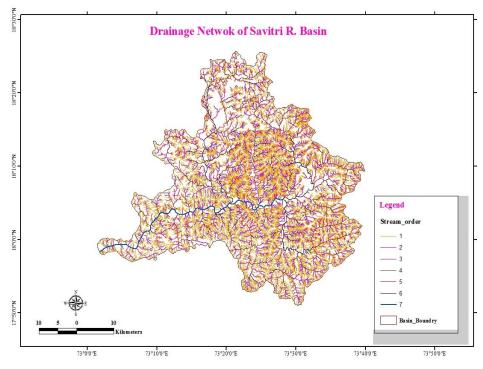| Sr.No	Stream Order	Total Stream Length(km)	Total Streams	Ratio
1	1st	4724.28	9716	4.26
2	2nd	1333.00	2283	4.58
3	3rd	621.36	498	4.53
4	4th	364.97	110	4.4
5	5th	190.31	25	6.25
6	6th	99.54	4	4
7	7th	0.81	1	0
		7394.29	**12637**	28.02
			Bifurcation Ratio	**4.67333333**

Fig. No. 1.1: Drainage Network Of Savitri Basin

Length of main channel:

This is the length along the longest water course from the outflow point of designated sub basin to the upper limit of the catchment boundary. Various methods are used for length measurement from topographic maps. For measuring the length of Savitri River, the thread length method is used. The total length of Savitri River is 99 km.

Stream lengths (Lu) :

The stream length has an important relationship with the surface flow discharge, longer the length slower the appearance of flood and larger the surface flow.

Horton observed that mean length of channel segments of a given order is smaller than that of higher order in a particular ratio called "length ratio", which is defined as the ratio of mean channel length of an order (Lu) to that of lower order (Lu+1). Mathematically the length ratio (RL) is given by the following formula:

$$RL = Lu / Lu + 1$$

The length ratio of the Savitri basin is 2.31 and the values are presented in table no. 1.2. In the case of Savitri basin, when the order of streams plotted against the cumulative mean length of streams, it forms a direct geometric sequence by increasing systematically with order and thus confirms Horton's (1945) law of stream length (fig.1.3).

Table No.1.2: Morphometry (Linear Aspects) Of Savitri Basin

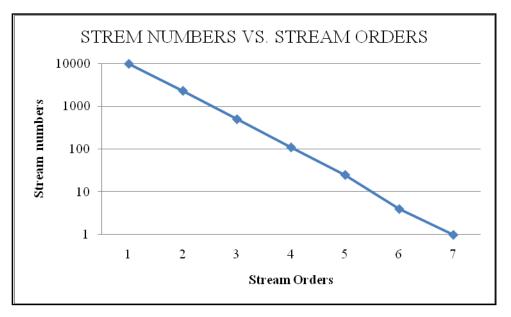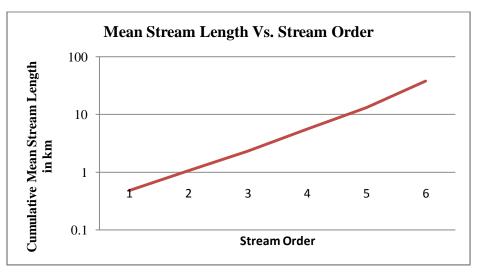| Stream Order 'u'	Stream Number 'Nu'	Bifurcation Ratio 'Rb'	Mean Length of segment 'Lu' in km	Length Ratio 'RL'
1	9716		0.48	1.20
2	2283	4.25	0.58	2.13
3	498	4.58	1.24	2.66
4	110	4.52	3.31	2.29
5	25	4.4	7.61	3.26
6	4	6.25	24.88	
7	1	4.0		

Fig.No. 1.2: Stream Number Vs. Stream Orders

Fig.No. 1.3: Mean Stream Length Vs. Stream Order

Basin Perimeter :

Basin perimeter is an important linear aspect of the morphometry. It can be defined as the length of the water divide of the catchment area of the basin. It is also the determinant factor of the size of the drainage basin. The basin perimeter of Savitri basin is 200 km.

Table No.1.4: Some Quantitative Information Of Savitri Basin

Basin	Basin Length	Basin Perimeter	Basin Sq.Km	Area	Relative Perimeter
Savitri	80	200	2899		18.99

Relative Perimeter :

The value of the relative perimeter has been calculated with the help of following expression.

Relative Perimeter = P2 / A

The relative perimeter of Savitri is 18.99 km.

Areal aspects :-

Drainage Area (A) :

Drainage area represents the area enclosed within the boundary of the watershed divide. The drainage area (A) is probably the single most important watershed characteristic for hydrologic design. It reflects the volume of water that can be generated from rainfall. The area of the whole basin is 2899 sq.km.

3.3.1 Drainage Density (D) :

According to Horton, drainage density is the length of streams per unit of the drainage area. Here it is derived by using the formula i.e.

$$D = \sum Lu / Au$$

$$D = \mathbf{7394.2929/2105.9552}$$

= **3.51**

Drainage Density = 3.51 km /sq. km

So, the drainage density of Savitri basin is 3.51. This density is very high because this basin is situated in high rainfall zone with steep slopes in the upstream reach of the basin. It clearly indicates that the basin is dominated by erosion, comparable relief, low infiltration and higher surface runoff due to steep hillside slopes.

Stream Frequency :

Stream frequency is defined as the number of streams per unit area in a drainage basin. It is also computed by the formula i.e.

$F = \sum Nu / Au$

The stream frequency of Savitri basin is 6.0, so the texture of the drainage net is of good quality.

Circularity Ratio :

The circularity ratio and form factor are the measurements to analyze the outline form of the basin. The circularity ratio is the ratio of the basin area of a circle having the same perimeter as the basin. The value of these ratio approaches 1 as the shape of the basin approaches a circle. It is calculated from the following relationship:

$RC = $ Area of basin $/$ Area of Circle $= 4\pi A / P^2$

The circularity ratio of Savitri basin is 0.66. Therefore it is semi circular shaped basin because value is close to 1.

Form Factor :

Horton (1932) suggested the 'form factor' which can be expressed as:

$F = A / L^2$

If these 'F' values are higher then the basin shape is more circular. The 'F' value of Savitri basin is 0.32 which is not much less so it is semi circular shaped basin.

Relief Aspects :

The parameters converging the relief aspect of the basin and channel network are as follows:

Basin Relief (H) :

Relief of a basin is the maximum vertical distance from the stream mouth to the highest point on the divide. The total relief (H) of Savitri basin is 1300 meter.

Relief Ratio (Rh) :

The relief ratio of Savitri basin is 16.25.

Ruggedness Number (Rn) :

Ruggedness number is dimensionless measure combines slope and length characteristics into one expression:

Rn = HD.

So, the ruggedness number of Savitri basin is 4524.

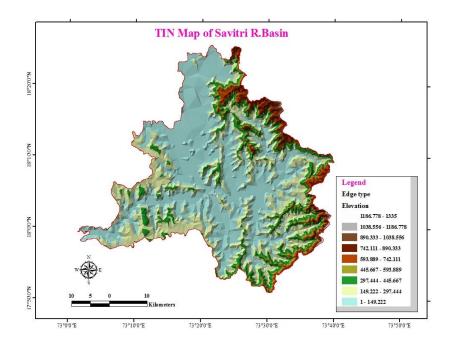**Relief :**

Relief can be defined as the difference in elevation of any part of the surface. It can be expressed in two ways:

i)   Absolute Relief ii) Relative Relief

Relative Relief:

Relative relief is the difference between highest and lowest height in 1 inch sq.grid. The relative relief of Savitri basin is divided into 5 categories.

According to TIN map (fig.no.1.5) the hilly relief (700 – 1300 m height) is seen in upper reach part and small hills having topography between 450 to 600 m height is seen in middle reach part whereas the flat topography is seen in lower reach part.

Fig. No. 1.5: Tin Map of Savitri Basin

 In above map white color indicates the high elevation and cyan color represents the lower elevation area.

Conclusion

In this paper various parameters representing the geomorphologic characteristics of a basin covering the linear, areal and relief aspects have been discussed together with the mechanics of their determination. The bifurcation ratio 4.67 and hypsometric analysis indicate that the basin has reached a mature stage of fluvial cycle of erosion. After studying the morphometric characteristics of Savitri River it can be concluded that the basin obeys the laws of stream numbers, stream length and the stream areas of Horton. It is a seventh order basin with a drainage density of 3.48 km/sq.km. The Savitri is semi circular shaped basin. Lineament, faults and fractures are seen in the basin. Most of the tributaries join the Savitri River nearly at 90° in the Mahad region. The drainage pattern around Mahad is trellis also indicative of structurally control and neotectonic activity.

References:

Abrahm's, A.D. (1984): "Channel networks: A geomorphological Perspective", Water resource research, 20, 161-168.

Bloom, A.L. (1979): "Geomorphology: A systematic analysis of late Cenozoic landforms", Prentice Hall, New Delhi.

Embleton, C. and Thornes, (1980): "Process in Geomorphology", Arnold Heinemann pub, New Delhi.

Gregory, K.J. and Walling, D.E. (1973): "Drainage basin form and process, London; Arnold.

Horton, R.E. (1932): "Drainage basin characteristics", Trans. Am. Geophys. Union, Vol. 13, pp.350-360.

Leopold, L.B., Wolman, M.G. and Miller, J.P.(1964): "Fluvial processes in geomorphology", Freeman and Co., San Francisco, 522pp.

Strahler, A.N. (1964): "Quantitative geomorphology of drainage basins and channel networks", In V.T. Chow (ed.), Handbook of Applied Hydrology, 4-39.