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QUANTITATIVE MORPHOMETRIC ANALYSIS OF UPPER BEL RIVER BASIN, DECCAN BASALTIC TERRAIN, CENTRAL INDIA

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ABSTRACT

Morphometric analysis is one of the important aspects of geomorphology to determine slope, relief, area-altitude relationship and erosional pattern. The present study encompasses morphometric analysis of the upper Bel river basin, Warud tahsil, Amravati district, Maharashtra, India. The morphometric analysis was carried out by considering linear, areal and relief aspects of the basin. The catchment of the upper Bel river basin is covered by the Deccan basalt lava flows which exhibit dendritic drainage pattern. The morphometric parameters are influenced by the lithological variations, as the surface exposures and well sections reveals that lower parts of the basaltic lava flows are fine grained, greyish black in colour, compact and vertically jointed, while the upper part is vesicular and amygdaloidal in nature. It is also observed that the lava flows are separated by approximate 1 to 3 meter thick red bole horizons. The dendritic drainage pattern is observed in the hilly and plateau area, indicating homogeneity in texture and lack of structural control. The southern part of the basin exhibits parallel to sub-parallel drainage pattern due to the exposure of soft and weathered rocks. The drainage density is high in the northern part of the basin and low in the southern part, indicating exposure of hard and soft rocks respectively. The average drainage density of the basin 0.83 km/km^2 which is comparatively low, indicating moderate infiltration and moderate possibility of recharge. The calculated mean bifurcation ratio for the basin is 2.55, indicating structurally stable basin which suffered less structural disturbances. Thus, the basin has moderate infiltration capacity and moderate groundwater recharge probabilities.

Key Words: *Basin, Morphometry, Linear, Aerial and Relief Aspects.*

INTRODUCTION

The drainage basin is considered as an open system because it receives energy from the climate over the basin and is losing energy through the water and sediment lost by the basin, largely through the basin mouth (Gregory and Walling, 1968 & 1973).The drainage basin analysis is an important part of geomorphology, as it establishes relationship between runoff, recharge, erosion and terrain evolution characteristics. It also explains the geomorphic characteristics like size, shape, slope and length of the drainage basin (Rastogi and Sharma, 1976). The detailed morphometric analysis of any basin is useful to understand the influence of morphometric parameters on different landforms. Aim of the present study is to evaluate morphological and terrain evolution characteristics of the basin.

STUDY AREA

The study area is an integral part of Urad village, Warud tahsil, Amravati district, Maharashtra, part of Central India. This area is a part of WR-2 (over-exploited) watershed (GSDA and CGWB,2014) and included in the Survey of India toposheets 55 K/6 and 55k/7 with coordinates 78^{0}22'55" E: 21^{0}30' 04" N(Figure:1).

METHODOLOGY

Morphometric analysis of the upper Bel river basin was carried out by using Survey of India toposheets 55K/6 and 55K/7 of 1:50,000 scale. The morphometric characteristics of the basin are calculated on the basis of methodology proposed by Horton (1932 and 1945), Strahler (1957 and 1964), Miller (1953) and Schumn (1956). On the other hand, district resource map published by Geological Survey of India (GSI, DRM, 2001) is referred for geology of the area.

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LITHOLOGY AND DRAINAGE

The entire upper catchment of Bel river basin is a part of Wardha river basin and covered by the Deccan basalt lava flows of Upper Cretaceous to Eocene Age (GSI, DRM, 2001). The lava flows exposed are of 'simple' type and composed of upper vesicular unit and lower hard, massive unit. The alternate hard and soft (vesicular) layers of basalt lava flows are exposed in the area, which has impact over the morphological characteristics of the basin. The surface exposures and well section reveals that lower part of basaltic lava flow is fine grained, greyish black in colour, compact and vertically jointed, while the upper part is vesicular and amygdaloidal in nature. In between the successive lava flows, red bole horizons (1 to 3 meter) are exposed at some places.

The area is drained by Bel river basin, which is flowing over the flat terrain, with total basin relief of 59 meters and longest basin length of 9 km. The dendritic pattern is associated with the areas of homogeneous lithology, horizontal or very gentle dipping strata, flat and rolling extensive topographic surfaces having extremely low relief (Singh,2018). The Bel river basin exhibit dendritic drainage pattern especially over the Deccan basalt lava flows.

MORPHOMETRIC ANALYSIS

The morphometric analysis is an important aspect of geomorphology to identify terrain evolution characteristics

and physiographic characteristics like size, shape, slope, area, relief, drainage density etc. (Rastogi and Sharma,1976). The drainages exhibit different geomorphic signatures on different types of rocks, which is ultimately reflected in the morphometric measurements. It is adapted mainly to understand the structure, process and evolution of the landscape. During this study, Survey of India toposheets are utilized to prepare drainage layer, which is ultimately used for morphometric analysis.

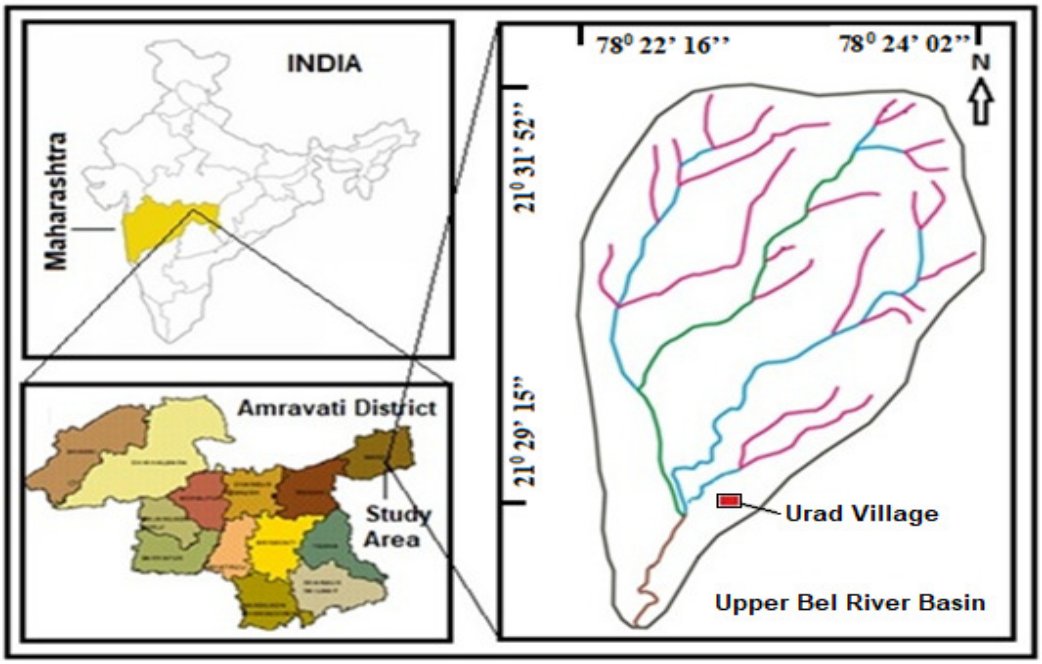

Fig. 1: Location map of the study area.

Table 4: Morphometric analysis of upper Bel river basin.

Sr. No.	Morphometric Parameters	Result	Methodology/ Reference
Linear Aspects			
1	Stream Order (Nu)	4th	Strahler (1964)
2	Total Number of Streams (N)	31	---
3	Total Stream length (Lu)	41 km	Horton (1945)
4	Bifurcation Ratio (R_b)	2.55	Schumn (1956)
Aerial Aspects			
6	Area of Basin (A)	49.37 km^2	---
7	Length of the basin along river course	21 km	
8	Maximum Length of Basin (L_b)	9 km	---
9	Maximum Width of Basin	5 km	---
10	Basin Parameter (P)	22 km	Schumn (1956)
11	Basin Circularity Ratio	0.63	Miller (1953)
12	Basin Elongation Ratio	0.84	Schumn (1956)
13	Drainage Density	0.83 km/km^2	Horton (1945)
14	Stream Frequency	0.62 km^2	Horton (1932)
Relief Aspects			
15	Height of the Basin Mouth	406 m	---
16	Highest elevation in the basin	465 m	---
17	Lowest elevation in the basin	406 m	---
18	Total Basin relief	59 m	Schumn (1961)
19	Relief Ratio	2.80	Schumn (1956)
20	Relative Relief	2.68	Milton (1958)

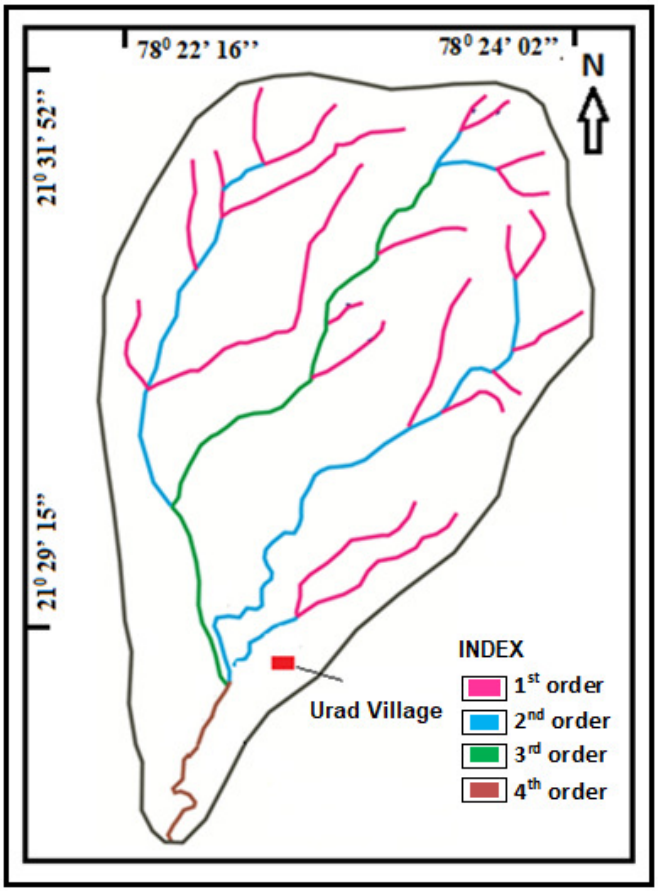

Fig. 2: Drainage map of the study area.

Linear Aspects

Stream Order: Stream ordering refers to the hierarchical position of a stream within a basin. A river basin consists of its several tributaries having different positions in the basin and have their own morphometric characteristics. The stream order is measure of position of a stream in the hierarchy of tributaries. The present basin comprises maximum 4th order stream.

Total Number of streams: The total number of streams are defined as sum of all number of order of streams. The total number of streams in a basin are 31.

Stream length: Stream length is measured as sum of length of all the streams in a basin (Horton,1945). The total stream length for the present basin is 41 km.

Bifurcation ratio: Bifurcation ratio is the ratio of number of the streams of the specific order to the number of streams of the next higher order (Schumn,1956). The value of bifurcation ratio which ranges between 3 to 5 indicates natural drainage system(Strahler,1957). The calculated mean bifurcation ratio for the basin is 2.55 which indicates structurally stable basin which has suffered less structural disturbances.

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

Where, Nμ = number of streams of given order

Nμ+1 = number of streams of the next higher

Order

Area of basin**:** A drainage basin is any hydrological unit where precipitation is received and drain out through the common drain point. It is also called as catchment area, basin catchment or drainage area of a basin.In present case the total area of the basin is 49.37 km^2.

Length of Basin along river course**: It** is a distance along the river course from the starting point of the river to the exit point and the value for the present basin is 21 km.

Maximum length of the Basin: It is length in a straight line from the mouth of a stream to the farthest point in the drainage basin. The value obtained for the present basin is 9 km.

Maximum Width of Basin: It is width of the basin and the measured value for upper Bel river basin is 5 km.

Basin Parameter**:**It is the length of a line that encloses the catchment area of a basin. The calculated value for the basin is 22 km.

Aerial Aspects

Drainage density**:** Drainage density is the total length of all the streams of all the orders to the total basin area (Horton, 1945). The lower value of drainage density indicates poorly drained basin, with slow hydrologic response in which surface runoff is not rapidly removed from the basin, making it highly susceptible to flooding and erosion. On the other hand, higher value of drainage density indicates quick hydrological response to water received from precipitation. The value obtained for the basin is 0.83 km/Km^2.

Stream frequency: Stream frequency (Fs) is the total number of channel segments of all stream orders per unit area of the basin (Horton,1932). The calculated value for the study area is 0.62 km^2 indicating low surface runoff.

Circularity ratio: It is the ratio of the areas of basin to the area of circle having the same circumference as the perimeter of the basin (Miller,1953). The value of circularity ratio for the present basin is 0.63 which indicates lack of circular shape of basin and short flush out time for excess water to flow.

Relief Aspects

Basin Relief: Basin relief is the difference between highest and lowest elevation within a basin (Schumn,1961). This is an important factor which mainly control weathering and erosion. The total basin relief calculated for the present basin is only 59 meter which indicates that the area is less susceptible to erosion.

Relative Relief**:** It is the ratio of maximum basin relief to the basin parameter (Melton,1957).The calculated value for the Bel river basin is 2.68.

Relief ratio: It is the ratio of horizontal distance along the longest dimension of the basin parallel to the principal

drainage line (Schumn,1956). It is a measure of overall steepness of a drainage basin and also indicates the intensity of erosion process as operating on the slopes of the basin. The calculated value for the study area is 2.80 which indicates steep slope and high relief.

RESULT AND CONCLUSION

The catchment area of upper Bel river basin is covered by the Deccan basalt lava flows. The lithological variations are also reflected in the drainage pattern of the area. The surface exposures and well sections reveals that lower part of the basaltic lava flow is fine grained, greyish black in colour, compact and vertically jointed, while the upper part is composed of vesicular and amygdaloidal in nature. The individual lava flows are separated by approximately 1 to 3 meter thick red bole horizons, which are not important as far as groundwater prospectus is concerned. The morphometric analysis was carried out by considering linear, areal and relief aspects of the upper Bel river basin, where the calculated mean bifurcation ratio for the basin is 2.55 which indicates structurally stable basin which suffered less structural disturbances. The dendritic drainage pattern is observed in the hilly and plateau area, indicating homogeneity in texture and lack of structural control. The southern part of the basin exhibits parallel to sub-parallel drainage pattern due to the exposure of soft and weathered rocks. The drainage density is high in the northern part of the basin and low in the southern part, indicating presence of hard and soft rock respectively. The average drainage density of the basin 0.83 km/km^2, which is comparatively low, indicating moderate infiltration and moderate possibility of recharge. Thus, the basin has moderate infiltration capacity and moderate groundwater recharge probability.

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