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MORPHOMETRIC ANALYSIS OF JANUNA MINI WATERSHED NANDGOAN (KH.), DIST. AMRAVATI, MAHARASHTRA USING GIS.

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Abstract: The morphometric parameters of the mini watersheds are discussed with respect to linear and areal aspects. In the present study, the watershed has been prioritized using GIS based on morphometric analysis to assess the geo-hydrological characteristics of Januna mini-watersheds of Nandgaon Khandeswar region Amravati district, Maharashtra. The dendritic drainage pattern shows IIIrd stream order in the study area. The bifurcation ratio reflecting geotectonic characteristics of the Januna mini watershed was estimated 5.6 indicate that this watershed has suffered through less structural disturbance and drainage density of study area is 2.07 km/km^2. The analysis reveals that the influence of drainage morphometry is very significant in understanding the landform processes, soil physical properties and erosional characteristics. In the study area, horizontal nature of lava flow with fair degree of uniformity in the rock type (Khadri and Thakur, 2013).
Keyword: Watershed, Morphometric analysis, GIS.

Introduction

Morphometry is defined as the measurement of the shape. The morphometric analysis of the drainage basin and channel network play a vital role for understanding the geo-hydrological behavior of drainage basin and expresses the prevailing climate, geology, geomorphology, structural, etc. antecedents of the catchment. Morphometry represents the measurement and Analysis of landform characteristics. Watershed/ Drainage basin is considered as the most satisfactory basic unit for morphometric analysis because it is an aerial unit defined by characteristics that can be measured quantitatively, thus providing an objective basis for analyzing and classification (McCullagh, 1978). The village Januna is situated at SSW side from the district place Amravati and NNW from the taluka place Nandgaon Khandeswar. The present study area lies between latitude $20^0$45'00" to $20^0$50'00 North and longitude $77^0$42'00" to $77^0$45'00" East comes under the Survey of India Toposheet No. 55H/9(fig no.1).

The study of basin morphometry relates basin and stream network geometries to the transmission of water and sediment through the basin. The size of a drainage basin acts upon

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the amount of water yield; the length, shape and relief, affect the rate at which water is discharged from the basin and total yield of sediments. In the present study, the morphometric analysis is carried out with respect to parameters like stream order, stream length, bifurcation ratio, drainage density, drainage texture, stream frequency, circularity ratio, etc. using mathematical formulas. The properties of the stream networks are very important to study the landform making process. Morphometric parameters such as relief, shape and length also influence discharge pattern strongly through their varying effects on longtime.

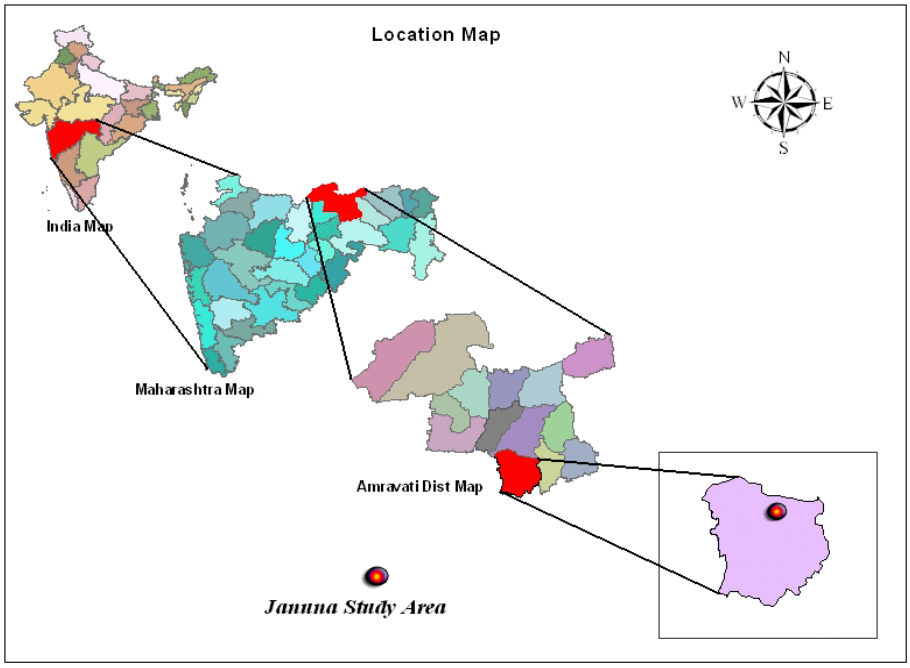

Fig.1. Location Map of Study Area

1. Linear Aspects of the Drainage Basin

The linear aspects of morphometric analysis of watershed include stream order, stream number, stream length, bifurcation ratio, etc.

1.1. Stream Order (u)

In the present study, the channel segment of the drainage basin has been ranked according to Strahler's (1964) stream ordering system. According to him, the smallest fingertip tributaries are designated as order 1. Where two first order channels join, a channel segment of order 2 is formed and where two of 2nd order 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 highest order. The study area is a 3rd order drainage basin. Drainage patterns of stream network from the basin have been observed as mainly dendritic type which indicates

the homogeneity in texture and lack of structural control. The properties of the stream networks are very important to study the landform making process (Strahler and Strahler, 2002).

1.2 Stream number (Nu)

The number of stream segments decreases as the order increases. The higher amount stream order indicates lesser permeability and infiltration. In the present study the order wise stream numbers estimated are given in the Table 1.

Stream Order	Number of Stream
I^{st}	31
II^{nd}	5
III^{rd}	1
Total	37

Table 1. Total stream number

1.3 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 indicates flatter gradients. Generally, the total length of stream segments is maximum in first order streams and decreases as the stream order increases. The numbers of streams of various orders in the basin are counted and their lengths from mouth to drainage divide are measured with the help of GIS software.

Stream Order	No. of Stream	Stream Length in meter	Stream Length in km
I^{st}	31	23662.33	23.66
II^{nd}	5	9791.80	9.79
III^{rd}	1	4053.65	4.05
Total Stream	37	37507.78	37.50

Table 2. Stream order wise stream length

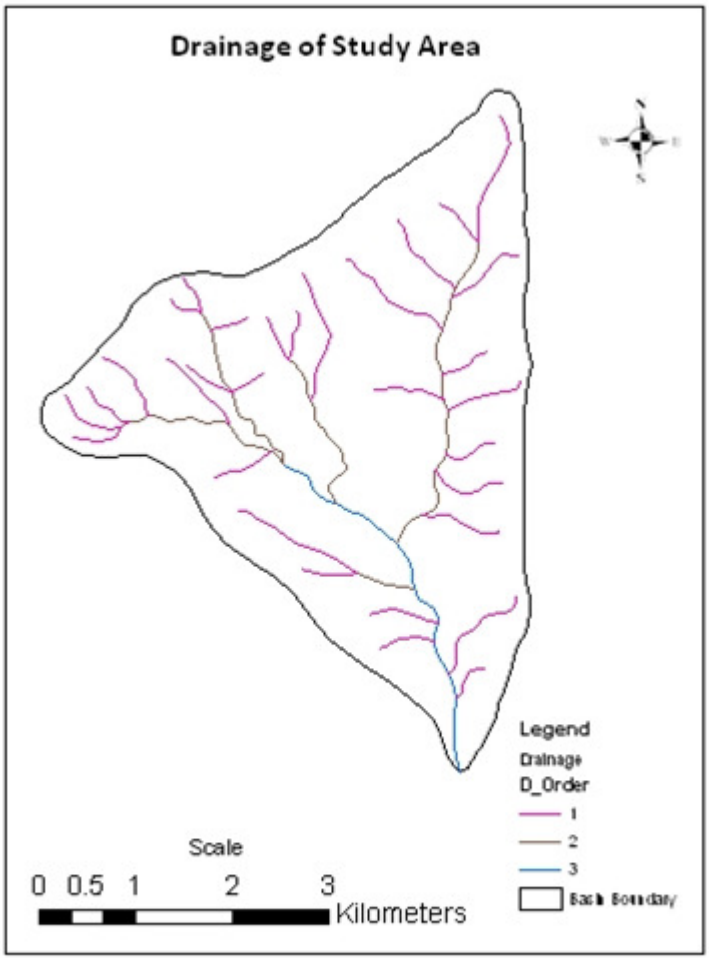

Fig. 2 Drainage Map of Study Area

1.4 Bifurcation Ratio (Rb)

Bifurcation ratio (Rb) which is related to the branching pattern of the drainage network, is define as a ratio of the number of streams of any given order to the number of streams in next higher order. The bifurcation ratio of study area is 5 and the mean bifurcation ratio value is 5.6.

Stream Order	Number of Stream	Bifurcation Ratio (Rb)
I^{st}	31	--
II^{nd}	5	6.2
III^{rd}	1	5
Average (Rb)		5.6

Table 3. Bifurcation ratio of the area

2. Areal Aspects of the Drainage Basin

The area of Januna watershed is 18.04 km^2 and the perimeter is 19.47 km. The aerial aspects of the drainage basin such as drainage density (D), stream frequency (Fs), drainage texture (Rt), and circularity ratio (Rc) were calculated.

2.1 Drainage Density (D)

Drainage density is a measure of the length of stream channel per unit area of drainage basin. Mathematically drainage density is expressed as:

$$D = \frac{L}{A}$$

$$D = \frac{37.50}{18.04}$$

$$D = 2.07$$

Where, L- Total length of all stream

A- Area of basin

The drainage density (D) of the study area is 2.07 km/km^2 indicating low drainage density. It is suggested that the low drainage density indicates the basin is highly permeable subsoil and thick vegetative. The type of rock also affects the drainage density. The chief rock type in the study area is basalt and weathered basalt. This indicates the low drainage density observed in the drainage basin.

2.2 Stream Frequency (Fs)

Stream frequency or channel frequency (Fs) is the total number of stream segments of all orders per unit area (Horton, 1932). It is expressed by the following equation:

$$Fs = \frac{\sum Nu}{A}$$

$$Fs = \frac{37}{18.04}$$

$$Fs = 2.05$$

Where, Nu- Stream Number

The stream frequency value of the basin is 2.05. The value of stream frequency (Fs) for the basin exhibit positive correlation with the drainage density value of the area indicating the increase in stream population with respect to increase in drainage density.

2.3 Drainage Texture (Rt)

The drainage texture is considered as one of the important concept of geomorphology which shows the relative spacing of the drainage lines. In the present study, drainage density is 2.07.

It was found that the drainage density are variable and suggests that the study area falls into coarse texture category and indicates good permeability of sub-surface material in the study area. Mathematically drainage texture is express as:

$$Rt = \frac{\sum Nu}{P}$$

$$Rt = \frac{37}{19.47}$$

$$Rt = 1.90$$

Where, P - Perimeter (km)

2.4 Circularity Ratio (Rc)

Miller (1953) defined a dimensionless circularity ratio (Rc) as the ratio of basin area to the area of circle having the same perimeter as the basin. He described the basin of the circularity ratios range 0.4 to 0.5 which indicates strongly elongated and highly permeable homogenous geologic materials. The circularity ratio of Januna watershed is 0.59. Mathematically Circularity Ratio is expressed as:

$$Rc = \frac{4\pi A}{P^2}$$

$$Rc = 0.59$$

Conclusion

The quantitative analysis of morphometric parameters is found to be of immense utility in river basin evaluation, watershed prioritization for soil and water conservation, and natural resources management at micro level. The morphometric analysis carried out in the Januna drainage system exhibits as mainly dendritic type which indicates the homogeneity in texture. In this study, the drainage density and stream frequency values is an indication that the intensity of dissection in the area is very low. Low drainage densities are often associated with widely spaced streams due to the presence of less resistant materials. The low drainage density is also indicative of relatively long overland flow of surface water. The drainage density in the study area is low and it is 2.07 km^2, thus indicates clearly that the region has highly permeable subsoil, dense vegetation cover and low relief. The law of lower the order higher the number of streams is implied throughout the catchment. The total length of stream segments is maximum in first order streams and decreases as the stream order increases. The study has shown that the catchment is in conformity with the Horton's law of stream numbers and law of stream lengths.

S. No.	Morphometric Parameters	Symbols/Formula	Values
1	Stream order	u	3rd order
2	Stream Number	Nu	37
3	Bifurcation Ratio (Rb)	Rb = Nu / Nu+1	5
4	Mean Bifurcation Ratio	Rbm	5.6
5	Stream Length (Lu)	Length of the Stream (km)	37.50 km
6	Mean Stream Length	Lsm = Lu / Nu	1.01 km
7	Area	A	18.04 km^2
8	Perimeter	P	19.47 km
9	Drainage Density (D)	D= ΣLu /A) km/km^2	2.07
10	Drainage Texture(Rt)	Rt = Σ Nu/P	1.90
11	Stream Frequency (Fs)	Fs = Σ Nu /A	2.05
12	Circularity Ratio (Rc)	Rc = $4\pi A/ P^2$	0.59

Table 4. Morphometric parameter and their values

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