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Areal Morphometric Analysis of *Adhula* Drainage Basin : Using the Geospatial Techniques

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Abstract:

Basin morphometry is a means of numerically analyzing or mathematically quantifying different aspects of basin. The morphometric analysis is widely used to assess the drainage characteristics of watershed, development and management plans of the river basin. The morphometric parameters of basin can address linear, areal and relief aspects. For this study selected the Adhula basin area due to the large relief ratio as well as covering 221.94 sq. km. area. The present study deals mainly with areal morphometric parameters such as basin area, drainage density, stream frequency, texture ratio, elongation ratio, circularity ratio, form factor ratio etc. The stream frequency in the study area has shows positive correlation with the drainage density which indicates that the stream population increases with the increase of drainage density**.** Form factor ratio for the study area (0.1371), indicating elongated basin with flatter peak flows of longer duration. In this study using the GIS tools for the morphometric analysis. This study is very useful for planning and drainage basin management. The areal morphometric parameters are important for the integrated decision making process in flood management, soil erosion assessment and water resource management at micro level.

Keys words: morphometric, areal, drainage, GIS.

Introduction:

Morphometry is an essential means in geomorphic analysis of an area. Morphometry is defined as the measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimension of its landforms (Clarke, 1966).The term 'Morphometry' literally means measurement of forms; *Horton* introduced the quantitative description for landforms. GIS technique is very useful in analyzing the drainage morphometry. Evaluation of morphometric parameters necessitates the analysis of various drainage parameters such as ordering of the various streams, measurement of the basin area and perimeter, length of drainage channels, drainage density, stream frequency, bifurcation ratio, basin relief and ruggedness number. The main objective of this study is using the GIS technology to compute various parameters of Adhula basin area for areal morphometric characteristics. The study of drainage basin is significant to get idea of the size and strength of specific waterways within stream networks and important component to water management. The prime objective of morphometric analysis is to find out the areal drainage characteristic to explain the overall evaluation of the basin. In the present study stream number, stream order, stream frequency, drainage density, circularity ratio, elongation ratio and form factor are derived and tabulated on the basis of areal properties of drainage channels using GIS based on drainage lines as represented over the topographical maps. These studies are very useful for planning and drainage basin management. The areal morphometric parameters are important for the integrated decision making process in flood management, soil erosion assessment and water resource management at micro level.

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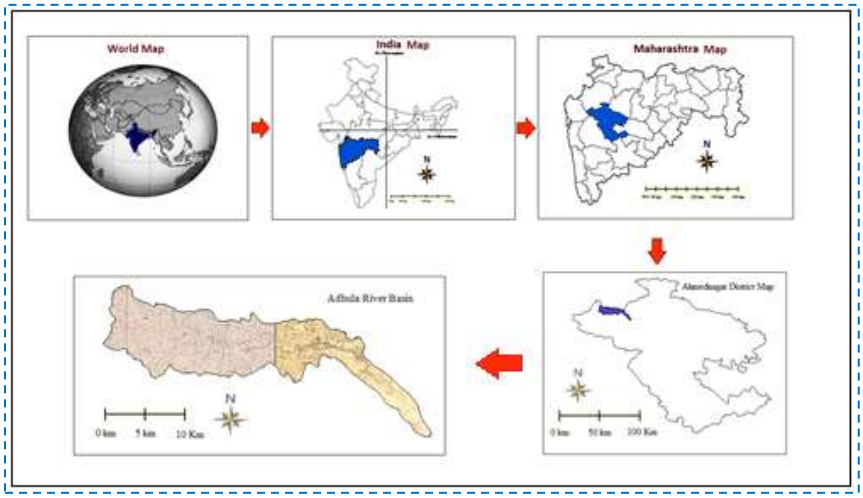
Study Area:

The Adhula rises in north of Akole on the Slopes of Patta and Mahakali at1391 Met MSL .It flows for fifteen miles in an easterly direction between two ranges of hills which encloses the Samsherpur valley ;then falling into the rocky chasm some 150 feet deep it winds between rugged and precipitous hill-sides for couple of miles, when debouching in to the plain of Sangamner, it turns south and falls in to the plain into the Pravara three miles west of the town of Sangamner .The investigated area is enclosed between latitudes 19° 32' 26.84"N to 19° 42' 35.32"N and longitudes 73° 48' 23.13"E to 74° 10' 29.36"E and covering area of 221.94 sq.km. The maximum height of the basin area is the 1391 m at the Patta fort and lowest height near to Magalapur 560 m.



Map No 1 : Study Area

Objectives:

1. To demarcation of the watershed area of the Adhula river basin using GIS techniques.
2. To analyze the areal morphometry parameters of the Adhula river basin .

Methodology:

In present study morphometric analysis of basin is based on the integrated use of GIS technique. The remotely sensed data is geometrically rectified with respect to Survey of India (SOI) topographical maps at 1:50000 and demarcation watershed area of the basin area. The order was given to each stream by following Strahler's stream ordering technique. The fundamental parameter namely stream length, area, perimeter, number of streams and basin length are derived from drainage layer. The values of morphometric parameters namely stream length, drainage density, stream frequency, form factor, texture ratio, elongation ratio and circularity ratio are calculated based on the formulae suggested by Horton (1945), Miller (1953), Schumn (1956), Strahler(1964), Nookaratm (2005) .

Result and Discuss: Areal Aspects of Drainage Basin:

Morphometric parameters	Symbol/ formula	Result	Morphometric parameters	Symbol/ formula	Result
Area (Sq.Km)	A	221.94	Texture ratio	T= N1/p	7.01
Perimeter(Km)	P	111.99	Elongation ratio	$Re=\frac{2\sqrt{A/\pi}}{Lb}$	0.2358

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Basin length (Km)	Lb	40.23	Circularity ratio	Rc= $4\pi Au/P^2$	0.2223
Drainage density (Dd)	Dd= ∑Lu/A	2.60	Form factor ratio	Rf= A/Lb^2	0.1371
Stream Frequency	Fs= ∑Nμ/A	3.54	-	-	-

Table No 1: Areal Aspects of Drainage Basin

Basin Area and Basin Length:: The total catchment area of the Adula basin area has 221.94 sq.km. as well as the 5th order basin. It is the covered of Akole, Sangamner, tahsil area in Ahmednagar district. The basin length of the Adula basin is 40.23 km.

Basin Perimeter (P): Basin perimeter is the outer boundary of the watershed that enclosed its area. The perimeter (P) of the basin is 111.99 km. Basin shape is the elongation shape.

Drainage Density (Dd): Drainage Density is defined as the ratio of total length of all streams to the total area of the basin (Horton, 1932).The drainage density of the catchments 2.60/sq.km. is an influence of structurally controlled low permeable rock strata with less vegetation cover. It increases high surface runoff, which cause erodability of rock, and loss of thin cover of topsoil. It was inferred that the area is very coarser watershed. The drainage density obtained for the study area is low indicating that the area has highly resistant or highly permeable sub-soil material.

Stream frequency (Fs): The stream frequency of basin is the ratio of total number of stream segment of all order to the basin area. Higher drainage density and high stream frequency in river basin indicate larger runoff from the basin vice-versa**.** The stream frequency (Fs) or channel frequency or drainage frequency of the whole basin is 3.54 sq. km. It is an index of the various stages of landscape evolution. The stream frequency depends on the rock structure, infiltration capacity, vegetation cover, relief, nature and amount of rainfall and subsurface material permeability. The stream frequency of Adhula shows that the basin has good vegetation upper catchment area of the basin, medium relief, high infiltration capacity and later peak discharges owing to low runoff rate. The stream frequency in the study area has shows positive correlation with the drainage density which indicates that the stream population increases with the increase of drainage density**.**

Form Factor: Form factor is defined as the ratio of basin area to the square of the basin length(Horton, 1932). Form factor value should be always less than 0.7854 (the value corresponding to a perfectly circular basin). A form factor near to zero indicates a highly elongated shape and value that is closer to 1 indicates circular shape. Form factor ratio for the study area (o.1371), indicating elongated basin with flatter peak flows of longer duration. Flood flows of such elongated basins are easier to manage than of the circular basin. (Christopher et al., 2010).

Circularity ratio (RC): Circularity ratio is influenced by length and frequency of streams; geological structure, land use and land cover climate and slope of the basin. The Circularity ratio value of the study area show the 0.2223, it indicating they are more elongated. Adhula basin is in the youth stage of its development with a Circularity ratio of 0.2223.The result showed that the study area has Circularity ratio value <0.5 indication elongated shape in addition, miller (1953). Circularity ratio is the significant ratio that indicates the dendritic stage of a watershed. This is mainly due to the diversity of slope and relief pattern of the basin.

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Elongation Ratio (Re): Schumns1956 used an elongation ratio (Re) defined as the ratio of diameter of a circle of the same area as the basin to the maximum basin length .The value of Re various form 0(in highly elongated shape) to unity i.e. 1.0 (in the circular shape) values close to 1.0 are tropical of regions of very low relief, whereas that of 0.6 to 0.8 are usually associated with high relief and steep slope (Strahler, 1964).The value elongation ratio 0.2328 indicates high relief, steep ground slope, high runoff and elongated shape of catchment.

Texture ratio (T)/Drainage Texture ratio: Drainage texture ratio (T) is total number of stream segments of all orders per perimeter of that area (Horton, 1945).It depends upon a number of natural factor such as climate, rainfall and stage of development. An important geomorphic concept is texture which means the relative spacing of drainage lines (Smith, 1950). Similarly Horton (1945) defined drainage texture on the basin of stream frequency. In the present study the drainage texture value of Adhula basin at 7.01it indicates that the texture pattern of Adhula river basin is fine drainage texture.

Conclusion:

The Drainage basin is being frequently selected as a unit of morphometric analysis because of its topographic and hydrological unity. The present study using GIS techniques for the morphometric analysis made the task easier of the computation of morphometric parameters and analysis. The morphometric study of Adhula river indicates that the basin is seventh order basin .The basin shows dendritic type drainage pattern. The Dd and Fs are the most useful criterion for the morphometric classification of drainage basins that certainly control the runoff pattern, sediment yield and other hydrological parameters of the drainage basin. The development of stream segments in the basin area is affected by rainfall, groundwater discharge. Drainage density, texture ratio, circulatory ratio and elongation ratio shows that texture of basin is moderate and shape of basin almost elongated .The value of stream frequency indicate that the watershed show positive correlation with increasing stream population with respect to increasing drainage density. Higher drainage density and high stream frequency in river basin indicate larger runoff from the basin vice-versa. Stream frequency is an index of the various stages of landscape evolution. Form factor ratio for the study area (o.1371), indicating elongated basin with lower peak flows of longer duration than the average. Shape factor of the study area 7.29, which indicates the elongated shapes of basin. Adhula basin is in the youth stage of its development with a Circularity ratio of 0.2223. The value elongation ratio 0.2358 indicates high relief, steep ground slope, high runoff and elongated shape of catchment. The value of catchments 0.2358 indicates that there is low permeability, moderate to steep slope and high surface runoff. These studies are very useful for planning and drainage basin management. The areal morphometric parameters are important for the integrated decision making process in flood management, soil erosion assessment and water resource management at micro level.

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