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Morphometric Analysis of Kunda River Basin, Khargone District, Madhya Pradesh -Based on Watershed Approach

***Lal Singh Solanki[1], Vinita Kulshreshtha[2] and Mohammad Rizwan[3]**

Author's Affiliations:
[1]Research Scholar Vikram University Ujjain and Asst. Prof. Govt. J.S.T. P.G. College Balaghat, Madhya Pradesh 481101, India.
[2]Department of Geology, Govt. P.G. College Mandsour, Madhya Pradesh 458001, India.
[3]School of Studies in Earth Science, Vikram University, Ujjain, Madhya Pradesh 456010, India.

***Corresponding Author: Lal Singh Solanki,** Research Scholar Vikram University Ujjain and Asst. Prof. Govt. J.S.T. P.G. College Balaghat, Madhya Pradesh 481101, India.
E-mail: solankilalu@gmail.com

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ABSTRACT

The Quantitative morphometric analysis is found to be dynamic study in considerate hydrological characteristics and its collaboration with the environment of any Watershed scheme. The main objective of the learning is to analyze the morphometric parameters of the Kunda River Watershed, Methods. The proposed study area is confined to latitude 21^{0}50' 0'' to 21^0 55' 0'' Nandlongitude75^0 35' 0''to75^0 45' 0''E (Survey of IndiaToposheet No.46O/9. The study area has been covered 159.97 sq. km. kunda river Watershed belonging to the northern part of Khargone district, is a solid rocks topography consisting typically Basalt. The study area is composed of flat terrain with gentle slope, which consists of basaltic lava flows. Geologically, these flows constitute a part of the Deccan Volcanic Province, the Watershed is of fourth order drainage having drainage density, and stream frequency 0f 0.977 and 0.922 separately. The Watershed shows extended in nature. The method practical to the river basin give a current calculation of the morphometric parameters of the region. The drainage morphometric analysis is important in range of water renew site, Watershed showing and groundwater visualization mapping. The study would deliver an important data collection about future Watershed view of the area.

KEYWORDS: *Kunda River, Groundwater, Environment, Morphometric analysis, Watershed, Khargone.*

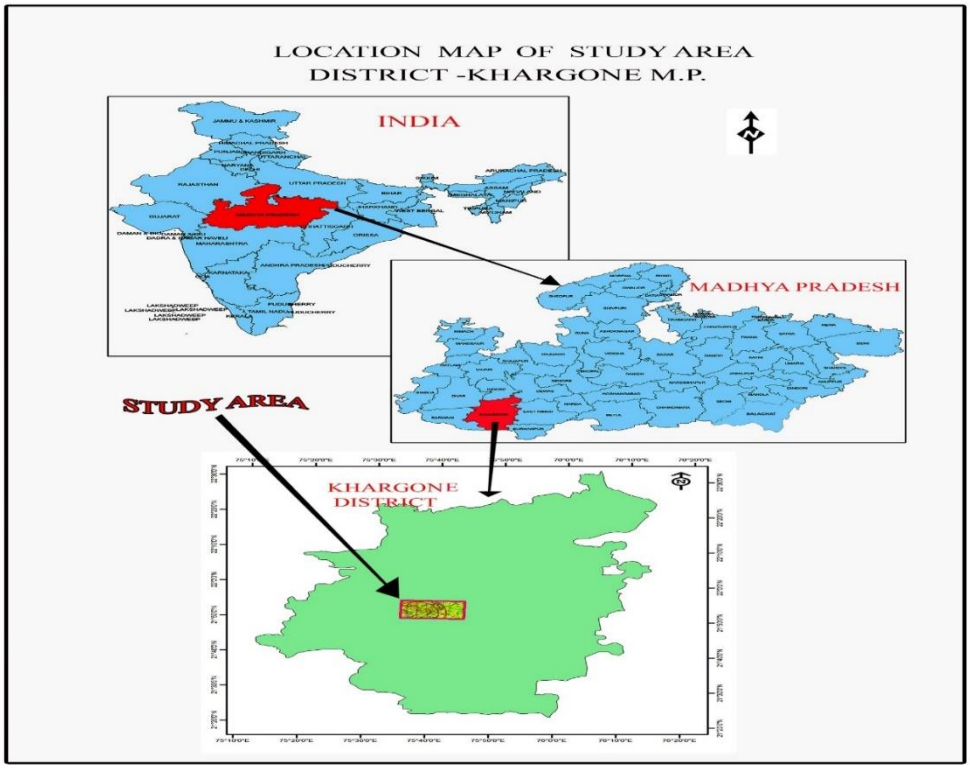
INTRODUCTION

Morphometric analysis or Morphometry is the term commonly used to refer to quantitative geomorphological analysis. According to Clark, 1966, Agrawal, 1998, Obi Reddy et al., 2002, that Morphometry, the shape, and dimensions of the earth's landforms are measured and mathematically analyzed. The morphometric analysis includes the quantitative study of an area, volume, slope, profiles of the land, and drainage basin characteristics of the area in question, according to Singh (1998). Horton (1945), Leopold and Maddock (1953), Abrahams (1984), and others have been proposing

quantitative methods for the description of the evolution and behavior of surface drainage networks.

LOCATION AND STUDY AREA

The proposed study area is confined to latitude $21^0$50' 0'' to 21^0 55' 0'' Nandlongitude75^0 35' 0''to75^0 45' 0''E (Survey of India Toposheet No.46O/9. The study area has been covered 159.97 sq. km. The climate is tropical to sub- tropical. The average annual temperature is recorded as 25^0C. Temperature becomes maximum during April and May as 47^0C. The climate of the district on the whole is tropical and dry except during south west monsoon season (middle of June to September) winter season is between Nov. to Feb. Summer season starts from March and ends by June. It is hard rocks terrain consisting of Basalt as lithology of the region. The river in its path crosses agriculture lands and sparsely populated villages having some barren land due to uneven supply of rock contact. Various parameters of morphometry were calculated under major heads of linear, and relief aspects.



Figures 1: Location map of study area district Khargone Madhya Pradesh

METHODOLOGY

The stream network was previously digitized using toposheet and satellite imagery of the respect area using Arc GIS 10.3 software. The major and minor stream networks of the Watershed were analyzed using parameter of previous workers. The calculation was operated using mathematical equation and different required parameters were calculated, Table 1, which later on was verified in the field.

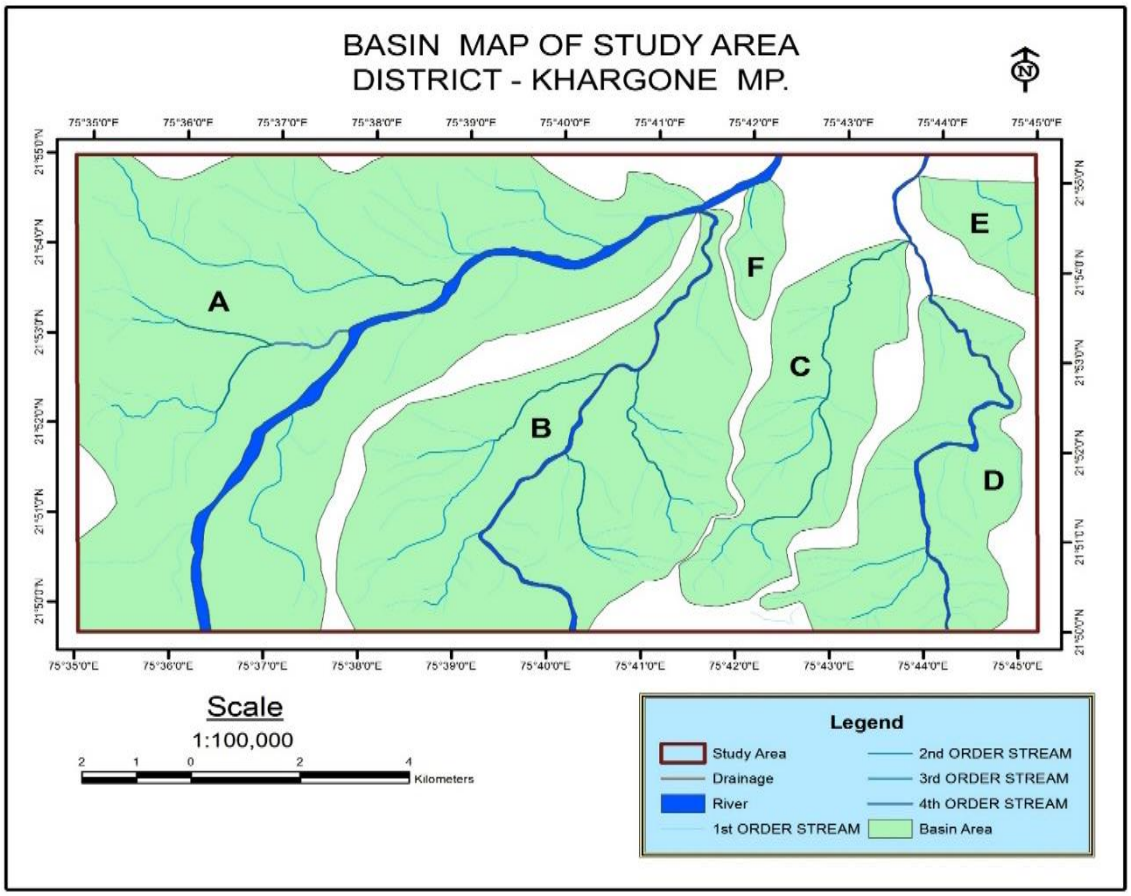


Figure 2: Basin map of Khargone study area, Khargone district (M.P.)

RESULT AND DISCUSSION

Morphometric analysis of a basin describes characteristics of basin based quantitative evaluation of different parameters. The study area is covered by basaltic rocks known as 'Deccan Trap` which are experimental as hard and solid though other are saft, vesicular or amygdaloidal taking hollows. The digitization of the Watershed has been done and various parameters of morphometric were calculated under major heads of linear, area and relief aspects.

Table 1: The Morphometric Parameters and their units are shown.

S. No.	Morphometric Parameters	Symbol Used	Unit	Dimension
1	Number of streams of order	Nu	Enumerative	0
2	Total number of streams within basin of order u	(Σn) u=N1+N2+N3	----------	0
3	Bifurcation ratio	Rb=Nu/Nu+1	----------	0
4	Total length of stream order u	Lu	Kilometres	L
5	Mean length of stream order u	Lu=Lu/Nu	----------	L
6	Total streams length within basin of order u	(ΣL) u=L1+L2+L3+L4		
7	Area of basin	Au	Sq. Kms.	L^2
8	Length of basin	Lb	Kilometres	L
9	Width of basin	Br	----------	L
10	Basin perimeter	P	----------	L
11	Basin circularity	Re=Au/area of circle	----------	0

		having same P		
12	Basin elongation	Re=Dimeter of circle having same P	----------	0
13	Drainage density	Dd= (L)u/Au	Kms. per Km²	L²
14	Constant of channel maintenance	C= 1/Du	Kms² per Km	L
15	Stream frequency	SF= Nu/ Au	Number/ Km²	L²
16	Texture ratio	Tu= Nu/Pu	Number/ Km	L

Perimeter sub – basin (P)
The of Kunda river Watershed is 119 km.

Basin Length (Lb)
The mean length of stream segments increases with each successive order (Strahler, 1964). According to the measurements of the total length of the different sub-basin streams, Lb measures geometrical size and shape of a drainage basin. Kunda River Watershed has a Lb of 30.549 km.

Stream Order (Nu)
The first step toward drainage basin study is the description of stream order which displays the relative and graded connection between stream part, their connectivity and the discharge taking influence of the main Watershed and its sub – watershed as shown in Figures 1.2.

Stream Number (u)
A stream's number refers to the number of channels occurring in a certain order (Horton 1945). specified that the number of parts of each order finally a geometric sequence with the order number. The total number of rivers in the study area is 167 as mentioned above.

Stream Length (Lu)
Each of the streams in the Kunda River Basin has a different length. Watersheds of increasing order are generally matched geometrically in accordance with Horton's law of stream lengths. According to the measurements of the total length of the different sub-basin streams, the total length of streams in kunda river watershed is 188.218 km.

Bifurcation Ratio (Rb)
This irregularity results from geological and lithological developments in the drainage basin (Strahler, 1957, 1964). The bifurcation ratio is the ratio of the number of segments in a given order (Nu) to the number of segments in the next higher-order (N+1). For the study are mean bifurcation ratio is 12 suggests strong structural control on drainage patterns.

Area (A)
The A of Kunda river watershedis 159.97 km².

Drainage Density (Dd)
Drainage density is defined by Horton (1945) as "the ratio of the total length of all stream segments in a drainage basin to the total area of the basin. Under thick vegetation cover and low relief, has a low drainage density value due to its high permeable subsoil material has a high drainage density value0.977, which indicates impermeable subsurface materials and high relief?

Stream frequency (Sf)
Stream frequency, according to Horton (1932, 1945), is the number of stream segments of all orders in an area. The stream frequency of the watershed found to be 0.922. Thus, the stream frequency falls under moderate frequency class in the study area.

Form Factor (F)
"Form factor" is defined by Horton (1932) as "the ratio of basin area to basin length". The value of form factor of the watershed is 1.76 indications lower form factor values display the watershed to be of extended form.

Elongation Ratio (Re)
A ratio that computes the elongation of a drainage basin based on the diameter of a circle of the same area and its maximum length is called the elongation ratio is 0.815 indicating a low relief area.

Length of Overland Flow (Lg)
The length of the overland flow is approximately equal to half of the density of the drainage, as observed by Horton (1932, 1945) and Schumm (1956). The Length of Overland Flow in the study area floe is about 0.488 which indicate low surface runoff.

Relief Ratio (Rh)
We calculated the average relief ratio to be 6.435. A drainage basin's relief ratio usually increases and decreases with the size of its sub-watersheds.

Ruggedness Number (Rn)
Basin relief and drainage density can be used to calculate the Ruggedness Number (Strahler, 1952).The Rn of Kunda river watershed is 0.132. This indicates a flat topography.

Basin relief (R)
A basin's relief plays a significant role in drainage development, water flow, permeability, landforms, and the characterization of its features. Basin relief is computed to be 26 meters on average.

Table 2: Morphometric Parameters calculation

S. No.	Parameters	1st Order	2nd Order	3rd Order	4th Order	Total
Linear aspects						
1.	Perimeter	119 km				
2.	Basin length	30.549 km				
3.	Stream length	125.535 km	42.507 km	18.576 km	1.600 km	188.218 km
4.	Number of streams	135	25	6	1	167
5.	Bifurcation ratio	4.88	3	3	0	10.88
Areal aspects						
6.	Area					159.97 km²
7.	Drainage density					0.977
8.	Stream frequency					0.922
9.	Length of overland flow					0.488
10.	From factor					1.76
11.	Elongation ratio					0.815
Relief aspect						
12.	Basin relief					26
13.	Relief ratio					6.435
14.	Ruggedness number					0.132

HYPSOMETRIC CURVE ANALYSIS

The hypsometric analysis is a method of determining the relationship between horizontal cross-sectional drainage basin area and elevation. The method has been applied to small drainage basins of low order (Strahler, 1952**).** The term hypsometry refers to determining the stage of erosion and the level of dissection by analyzing the relationship between altitude and basin area. Hypsometric analysis has been widely used to distinguish

erosional landforms at different stages of their evolution (Strahler, 1952; Schumm, 1956).

The hypsometric curves are used to define concave, original, and convex surfaces. H represents the overall relief of the basin, and h is the height above the base of the basin outlet. The hypsometric distribution is represented by the height (h/H) as compared to the area (a/A), where a is the area of the basin above height h, "A" is the total area of the basin, and "h" is the height above the base of the basin. The hypsometric variables of the Khargone study area are shown in Table 3. The relative height 'y' is defined as the difference between the lowest height 'h' and the highest height 'H'. The relative area 'x' is the ratio between the horizontal cross-sectional areas 'a' to the entire basin area 'A' (Table 3.).

Table 3: Determination of Hypsometric Analysis of Khargone study area

Sub-basin	Highest elevation 'H' (m.)	Lowest elevation 'h' (m.)	Area of sub-basin (a) (km^2)	y = h/H	x = a/A a= sub-basin area A= total basin area
A	266	227	116.85	0.853	0.730
B	261	228	65.87	0.873	0.411
C	265	220	20.60	0.830	0.128
D	241	219	35.73	0.90	0.223
E	236	220	4.99	0.932	0.031
F	220	219	2.97	0.995	0.018

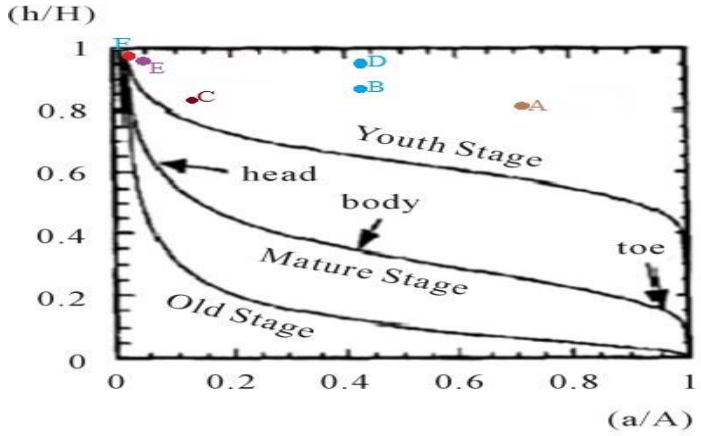


Figure 3: The hypsometric curve for Khargone Study Area Basin in M. P.

Based on the analyzed data plotted on the hypsometric curve, it is obvious that sub-basins A, B, C, D, E, and F are in the young stage of river development.

CONCLUSION

The measurement linear, areal and relief aspects based on DEM created from contour and spot height are actually suitable to recognized physical meteorological typical of the particular basin area. It is observed that the value indicates by bifurcation ratio, elongation ratio, drainage density, stream frequency, length of overland flow, relief ratio, hypsometric curves; the basin with 4th order stream steep to very steep sloping hilly terrain. The groundwater occurrence in the study area is mainly found in the top weathered part of hard crystalline rocks as fissures and fractures showing minor permeability's. For supportable advance groundwater manipulation has to be done from the above-mentioned water bearing zones. The study also could be useful in studying the topography within GIS environment. Rocks and soil types climax the environmental importance of the basin area which include of

several vegetable and animal species and their relation with physical close. Drainage pattern depends on the topography and geology of the land. The pattern of the drainage is dendritic in the study area. The study done can be used for Kunda river watershed management and safety of the region's normal situation.

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