e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

MARPHOMETRIC ANALYSIS OF KABINI RIVER BASIN USING ARCGIS

Bharath Kumar T[*1], Karthik B[*2], Manjesh M[*3], Rajath R[*4], Prof. Manjunath N[*5]

[*1,2,3,4]Final year Student, Department Of Civil Engineering,
Dayananda Sagar College Of Engineering, Bangalore, Karnataka, India
[*5]Assistant Professor, Manjunath N, Department of Civil Engineering,
Dayananda Sagar College Of Engineering, Bangalore, Karnataka, India

ABSTRACT

Remote sensing(RS) and Geographical Information System (GIS) are mostly used for morphometric analysis of river basin throughout the world. GIS facilitates the manipulation and analysis of spatial information obtained using remote sensing.as compared to conventional morphometric analysis the calculation of through ARC GIS gives accurate knowledge about the topography of the study area earth characteristics drainage conditions, drainage characteristics. Morphometric evaluation in connection with high resolution satellite data, helps us get the idea about soil characteristics, erosion of soil in that basin area water management in the basin flood estimation and runoff flow of the basin.The basin selected for study originates in the Wayanad District of Kerala state by the confluence of the Panamaram River and the Mananthavady River.It flows eastward where it reaches the Kaveri River at T.Narasipura in Karnataka. The latitude for the Kabini river is $11^0$58'55.46" E and longitude is $76^0$22'37.87" N.

KEYWORDS: Morphometric analysis, GIS, Remote sensing, ArcGIS.

I. INTRODUCTION

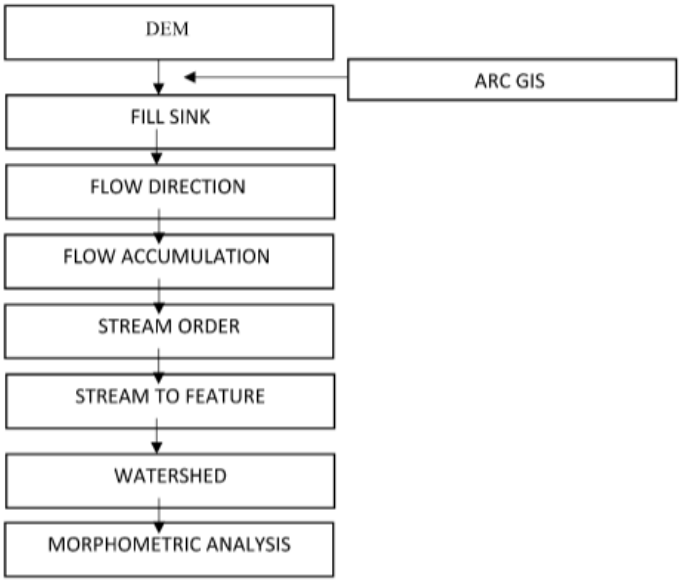
The morphometric analysis is defined to be the mathematical representation of earths characteristics where it can also be helps to know about land forms. The Arc GIS which is used for the study is not only used for morphometric analysis but also to determine the groundwater potential and runoff estimation, groundwater analysis. The morphometric analysis includes linear, relief, and aerial aspects of channel network and slope of the basin.The morphometric analysis will be helps us to calculate the linear aspects, areal aspects, relief aspects. In linear aspects stream order, stream length, mean stream length, bifurcation ratio, stream length ratio is calculated. In areal aspects the circularity ratio, elongation ratio, drainage density, drainage texture, form factor ratio, infiltration number, in relief aspects relief , relief ratio, ruggedness number can be calculated. The values which are extracted can be accepted for the further studies such as water resource structures, groundwater estimation, groundwater potential, runoff estimation, flood estimation etc…

II. METHODOLOGY

The study area which selected for morphometric calculations is delineated from the DEM (digital elevation model). The Cartosat DEM is downloaded from Buvan website using latitude and longitude of basin selected for the calculation. Then the further procedure is carried out to calculate morphometric calculations such as liner, areal, and relief aspects. The procedure for the morphometric analysis of a river basin is carried in following detailed methodology. Here study area selected for the analysis is the Kabini river basin which originates in Wayanad of Kerala, flows eastward to join Cauvery river at T. Narsipura of Mysore District of Karnataka.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

Flow diagram of Morphometric analysis using DEM



The Cartosat version digital elevation model as been downloaded from Buvan website. Then DEM as been imported to the ARC GIS using import data. Using fill tool the any sink in the DEM is been rectified. If the sinks are not rectified there may be chances of discontinuous in drainage streams. The Flow direction tool is used to determine the direction of flow of watershed. Flow accumulation tool is used to calculate accumulated flow as the accumulated weight of all cells flowing into each downslope cell in output raster. Basin tool creates raster data to delineating all drainage basins. Watershed tools is used to determines a contributing area above a set of cells in raster. The required basin is obtained with a using a pour point tool with locating a particular point which is required for calculating a morphometric data.

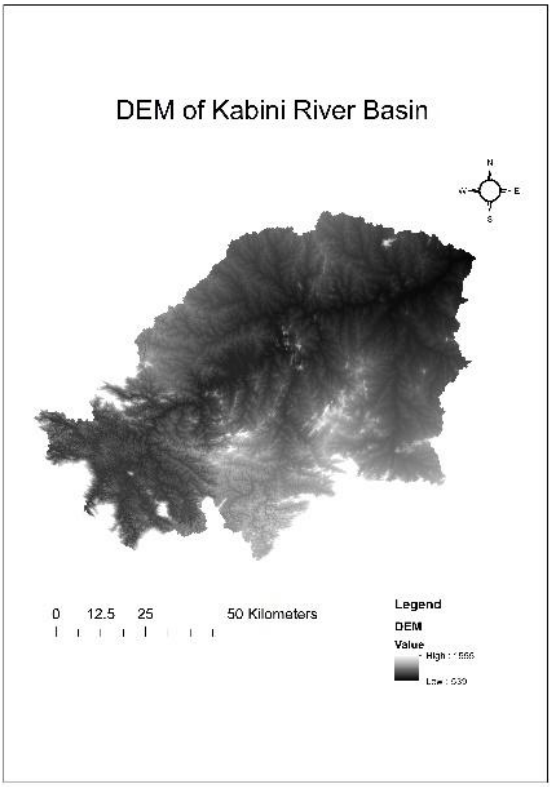


Fig 1: DEM of Kabini River Basin

3.2.4.1. Linear Aspects

Morphometric parameters	Formula
Stream order(U)	Hierarchical Order
Stream length (Lu)	Length of the stream in km
Mean stream length (L_{sm})	L_{sm} = Lu/Nu Where, L_u= total length of the stream order'u'. N_u = total sum of stream segments 'u'.
Stream length ratio (R_l)	R_L= L_{sm} / L_{sm-1} Where, L_{sm}=Mean stream length of a given order ; L_{sm-1}= Mean stream length of next lower order.
Bifurcation ratio (R_b)	R_b = N_u / N_{u+1} Where, R_b = Bifurcation Ratio ; N_u = No. of stream segments of a given order ; N_{u+1}= No. of stream segments of next higher order.

3.2.4.2. Areal Aspects

Morphometric parameters	Formula
Drainage density (Dd)	D_d = L_u/A Where, D_d = Drainage density (1/km) . Lu = total length of stream. A = Drainage area (km^2)
Stream frequency (F_s)	F_s = N_u/A Where, F_s = Stream Frequency ; N_u = total number of streams A = Area of the basin (km^2)
Drainage texture (D_t)	D_t = N_u /P Where, N_u = No. of streams in a given order ; P = Perimeter of basin (km)
Form factor (R_f)	R_f = A/L_b^2 Where, A = Area of the basin ; L_b = Basin length

Circulatory Ratio (R_c)	$R_c = 4\pi A / P^2$ Where, A = basin area (km^2) ; P= Drainage perimeter of basin (km)
Elongation Ratio (R_e)	$R_e = \sqrt{A} / \pi / L_b$ Where, A= drainage area of basin (km^2) ; L_b= Basin length (km)
Constant Channel Maintenance (C)	$C = 1 / D_d$ Where, D_d = Drainage density
Infiltration Number (In)	$In = D_d \times F_s$ Where, D_d = Drainage density ; F_s = Drainage frequency

3.2.4.3. Relief Aspects

Morphometric parameters	Formula
Relief	R=H-h Where , H= Highest elevation point. h=lower elevation point.
Relief Ratio (R_h)	$R_r = H / L_b$ Where, H = Basin Relief (km) ; L_b = Basin length (km)
Ruggedness Number (R_n)	$R_n = H \times D_d$ Where, H = Basin Relief (km) ; D_d = Drainage Density

III. RESULTS AND DISCUSSION

1. RESULTS

The results obtained are as follows:

4.1.1. Cartosat version (2019) Digital Elevation Model(DEM)

4.1.1.1. LINEAR ASPECTS

Stream Order (U)	Stream Number(N_u)	Stream Length(L_u) km	Mean Stream Length(L_{sm}) km	Cumulative Stream Length (L_{sm}) km	Stream Length Ratio (R_l)	Bifurcation Ratio
1	198	723.747	3.65	3.65	0.63	1.663
2	119	276.871	2.32	5.97	0.86	0.952
3	125	244.773	2.00	7.97	0.64	2.083
4	60	77.144	1.28	9.25	-	-
Total	502	1322.535				

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

4.1.1.2. AREAL ASPECTS			
Stream Order(U)	Stream Frequency (F_s)No.of streams/km^2	Drainage Density(D_d) km/km^2	Drainage Texture (D_t)
1	0.028	0.102	0.196
2	0.016	0.039	0.118
3	0.017	0.034	0.124
4	0.008	0.010	0.060
Drainage Texture (D_t)		0.196-0.060	
Form Factor Ratio (R_f)		0.20	
Circularity Ratio (R_c)		0.087	
Maximum basin length (L_b)km		190	
Resolution		**30m X30m**	

RELIEF ASPECTS	
Relief (H)	1416
Relief Ratio(R_r)	7.40
Ruggedness number (R_n)km^2	0.261

DISCUSSION

Linear aspects

Stream Order (U)

The stream order is calculated in the software which is mainly depend on the branches of streams in drainage basin. The stream order is a measure of the degree of stream branching within a watershed. The stream is indicated by its order.

The maximum number of streams is obtained in 1st order streams follows 3rd ,2nd and 4th stream order. Hence maximum streams is noticed in 1st stream order and minimum with 4th stream order.

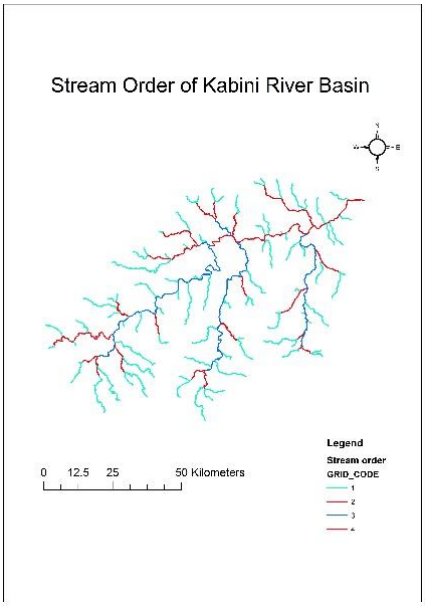


Fig 2: Stream order

Stream Number (N_u)

The number of streams can be calculated using the arc gis. These will gives us the number of streams. The stream numbers obtained is for 1st order 198 streams, 2nd order 119 streams, 3rd order 125 streams, and for 4th order 60 streams.

Stream length(L_u)

It is measure with respect to stream orders by using GIS Software which is proposed by Horton (1945).the length of the stream decreases with increasing the order of the stream.

The total stream length of the study is 1322.535 km which includes 723.747 km in 1st order, 276.871 km in 2nd order, 244.773 km in 3rd order, 77.144 km in 4th order.

Mean Stream length(L_{sm})

The mean stream length is defined to be the ratio of stream length of the dtream order to the length of the streams of same order.

In the study area, it is noted that in Cartosat DEM L_{sm} varies from 1.28 to 3.65 km the values obtained from the study suggests the drainage characteristics of the basin.

Stream Length Ratio (R_l)

The stream length ratio is defined to be the ratio of mean stream length to the mean stream length of the lower stream order.

The values of R_l varies from 0.63 to 0.86 in Cartosat DEM.So the value suggests that the drainage basin is in steep slope.

Bifurcation Ratio(R_b)

Bifurcation ratio can be defined as a ratio of number of streams in a particular stream order to the number of streams to next higher order. The bifurcation ration R_b value suggests that the value obtained is 1.564 which is low and it suggests that the value is low and the area is having higher permeability, geological heterogeneity it helps us to study about the area of drainage area which is good for construction of dams.

Areal aspects

The morphometric parameters in areal aspects are stream frequency, drainage density, drainage density, drainage texture, form factor ratio, elongation ratio, circularity ratio, drainage area, drainage perimeter.

Stream Frequency(F_s)

The stream frequency of basin can be described to be the ratio of total number of streams to be the drainage area of the basin obtained. So lower the value of stream frequency then greater will be permeability in that surface area. The value of stream frequency in basin is found to be 0.061 km/ km^2so the value is very low then the surface is permeable.

Drainage Density(D_d)

The drainage density is an expression of the closeness or spacing of channels. The drainage density is defines as the ratio of length of the basin to drainage area of basin. The drainage density helps us to determine the texture of the drainage basin. So lesser the drainage density then the drainage basin as very coarse texture.

In the present study, it was found that the drainage density values 0.185 km/km^2 so the value suggests it as very coarse texture and the permeability is higher in the area.

Drainage Texture(D_t)

It is the total number of stream sequence of all orders per perimeter of that area (Horton 1945). Drainage texture determines the drainage patterns of the particular area and gives us the idea of charcateristics of the study area.

The drainage texture values are 0.196 (1st order streams), 0.118 (2nd order streams), 0.124 (3rd order streams), 0.05 (4th order streams).

Form Factor Ratio (R_f)

The form factor is defined as the ratio of drainage area to the square of drainage perimeter. As the value of form factor is lower then shape of basin found to be elongated. The form factor value of the basin is 0.20 so basin is elongated in shape.

Elongation Ratio (R_e)

Elongation ratio is defined to be the ratio of diameter of the area to maximum basin length of the area. So the value of the elongation ratio suggests us the slope of terrain on the area. The value Re in the study area was found to be 0.14 so the basin is steep in slope.

Circularity Ratio (R_c)

Circularity ratio is the ratio of the area of the basins to the area of circle having the same circumference as the perimeter of the basin. Circularity ratio indicates the age of the whether it is in young, mature or in old stages. From the study the value obtained to be 0.087 then basin is in young stage.

Relief Aspects

The morphometric parameters in relief aspects includes relief, relief ratio ruggedness number.

Relief (R)

Relief is the difference between the highest and lowest point of elevation. The value of relief gives the idea of area elevation. A region having a high relief can transfer high energy into the drainage system. The values can be decided to be the area is having high relief.The values obtained in the present study of basin 1413.

Relief Ratio (R_h)

The relief ratio is defined to be ratio of relief and the maximum basin length of that particular area . It is used to measure the overall steepness of a river basin and is an indicator of intensity of erosion processes operating on the slopes of the basin. Normally, it has inverse correlation with drainage area and size of drainage basin. For the present study it obtains 7.4 for Cartosat.

Ruggedness Number (R_n)

Ruggedness number is found to be the product of basin relief and drainage density of the basin. The value is found to be 0.261 km^2 . So higher the ruggedness number erosion of soil is more. So younger stage of the streams as more soil erosion in the area.

IV. CONCLUSION

The stream order obtained is the 4^{th}order . the bifurcation ratio suggests that the area is having high permeability area. The drainage density is low so the texture of the area is very course its having a higher infiltration capacity. The shape of the basin is elongated in shape so that we can decide that the elongated shape of area may be not good for the construction any dams in that area because it may having a chances of causing high floods. The ruggedness number obtained is high so the streams are in youth stage and the area is high prone to soil erosion. The morphometric parameters obtained can be suggests us to decide the area which is good for the construction of dams and it also gives us idea about its hydrological conditions and hydrological characteristics of the particular study area.

V. REFERENCES

[1] Miller VC (1953) A quantitative geomorphologic study of drainage basin characteristics in the Clinch Mountain area, Virginia and Tennessee, Project NR 389042, Tech Report 3. Columbia University Department of Geology, ONR Geography Branch, New York.

[2] Singh KN (1980) Quantitative analysis of landfroms and settlement distribution in southern uplands of eastern Uttar Pradesh (India). Vimal Prakashan, Varanasi.

[3] Obi Reddy GE, Maji AK, Gajbhiye KS (2002) GIS for morphometric analysis of drainage basins.

[4] Sreedevi PD, Subrahmanyam K, Shakeel A (2005) The significance of morphometric analysis for obtaining groundwater potential zones in a structurally controlled terrain. J Environ Geol.

[5] Mahadevswamy.G ,Nagaraju.DSiddalingamurthy.S (2011) Morphometric Analysis of Nanjangud Taluk, Mysore District, Karnataka, India, Using GIS Techniques. International Journal Of Geomatics And Geosciences.

[6] John Wilson JS, Chandrasekar N, Magesh NS (2012) Morphometric analysis of major Sub Watersheds in Aiyar &KaraiPottanar Basin, Central Tamil Nadu, India using Remote Sensing & GIS Techniques.

[7] Jai M Paul and M. Inayathulla (2012) Morphometric Analysis and Prioritization Of Hebbal Valley in Banglore. IOSR Journal Of Mechanical and Civil Engineering (IOSRJMCE).

[8] M.L.Waikar and Aditya P.Nilawar (2014) Morphometric Analysis of a Drainage Basin Using Geographical Information System: A Case study.

[9] Chaitanya B. Pande (2015) GIS based quantitative morphometric analysis and its consequences :a case study from Shanur River basin, Maharashtra India. This article is published at Springerlink.com.

[10] Ayad Ali Faris Baig (2015) Morphometric Toolbox : A New Technique in Basin Morphometric Analysis Using Arc GIS. Global Journal Of Earth Science and Engineering.