



MORPHOMETRIC ANALYSES OF KOLAR RIVER BASIN, CENTRAL INDIA

Anil M. Pophare¹, Swapnil N. Deshmukh² Akshay V. Dhuldhhar³

¹PG Department of Geology, RTM Nagpur University, Nagpur

Corresponding Author- Anil M. Pophare

Email: swapnildeshmukh045@gmail.com

Abstract

Morphometric analyses of Kolar river basin has been carried out with various aspects. The linear, areal and relief aspects of Kolar river basin suggest that river basin has elongated shape with impermeable sub-surface, low infiltration and fine drainage texture. Values of ruggedness number fall in higher range; hence basin is more susceptible to erosion. Morphometric values infer that the Kolar river basin has, sparse vegetation cover, high relief. Present study has confirmed the prevalence of dendritic drainage pattern, highest of 6th order stream and linear relationship between stream order and stream number. This also suggests that the runoff is low and lower degree of dissection. With high values of overland flow, water will take more time to enter the stream. Values of Hypsometric Integral (HI) confirmed that the Kolar river basin is of mature stage. Hence area is less prone to flooding. High bifurcation value of suggest that, the 3rd, 4th and 5th order stream have strong structural control over them. Elongation ratio values verify that basin is tectonically active.

Keywords: Morphometry, Asymmetry Index, Tectonic activity, Kolar river basin, Kanhan basin, Basalt.

Introduction

In a river basin, surface runoff, accumulation and percolation of water is governed by the geological and geomorphological features of the basin area (Christopher et al. 2010). GIS and remote sensing techniques are used to analyze and interpret the morphological characteristics of the basin (Waikar and Nilawar 2014). Drainage analysis interprets the vital information related to groundwater potential, management of ground and surface water resources, soil erosion and its conservation, effective plans for watershed prioritization and environmental studies. Lithology, slope and climate determine the development of the eco system on basin scale. Geological and geomorphic history of drainage basin is obtained from morphometric analysis (Strahler, 1957).

In the present study the linear, areal and relief attributes for Kolar river basin falling under the Kolar river basin which has deccan trap basaltic region, has been studied in detail. Evaluation of stream behavior, lithological analysis and drainage analysis using morphometric

setting are used to establish the inter-relationship between different drainage attributes.

Rational of Study:

Morphometric analysis is very helpful for identification of suitable site for the construction of dam, tectonic activity and flood risk assessment.

Objectives:

Main objective is to carry out the morphometric analyses and to identify flood risk and tectonic activity.

Hypothesis:

It is expected that the analyses will gives indication about the tectonic activity of basin.

Study area

The Study area is located at north-eastern part of Maharashtra state in Nagpur District. Kolar river basin is drained into Kanhan river basin which is a sub basin and catchment of Wainganga river. This river basin is spread in survey of India topographical sheet numbers 55 K/11, 55 K/12, 55 K/15, 55, K/16, 55 O/3 and 55 O/4. River basin lies between Latitude 21°10'0"-21°30'00" and Longitude 78°40'00"-79°10'00" (Fig. 1). Study area is

having regional geological formation from Proterozoic to Recent formations (Katpatal et al., 2014).

Materials and Methods

Survey of India toposheets were used to trace the Kolar river basin manually. In this, drainages of different orders in Kolar river basin were manually traced. Lengths of 1st to 6th order were measured the drainage map of watershed.

Simultaneously, with the help of Arc-GIS software of the vector module of Erdas software 10.5 and Digital Elevation Model, drainage was digitized. Drainage map was prepared from Digital Elevation Model. Numeric values of manual traced drainage map and GIS data results were compared and verified. By using this data, further calculations were carried out.

Results and Discussion

Morphometric Analysis:

In morphometric analyses, linear, areal and relief aspects were calculated. On the basis of the obtained data from stream order and stream lengths, quantitative drainage analysis was worked out. These aspects were calculated by using mathematical formulae (Horton, 1945).

The stream order was calculated using the method proposed by Strahler's (1964). Drainage network of Kolar river basin is analyzed as per laws of stream ordering (Strahler 1964).

Linear aspects

Linear aspects of the basins were characterized by the topographical characteristics of stream segments. In this, stream order (U), stream length (Lu), mean stream length (Lsm), stream length ratio (Lur), bifurcation ratio (Rb) etc were included (Strahler, 1952; Pareta and Pareta, 2011).

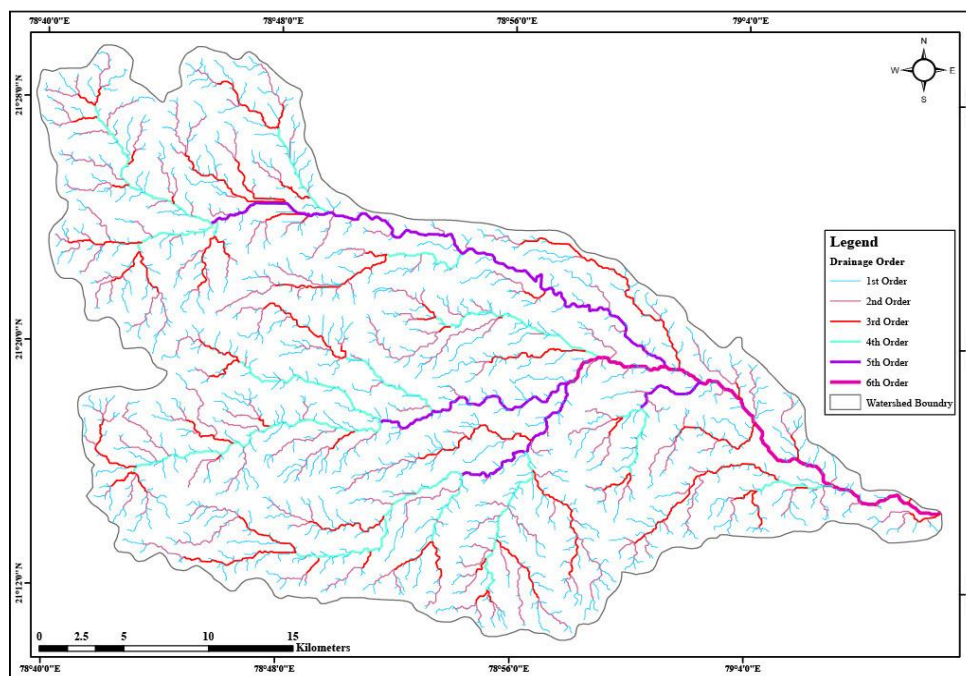


Fig. 1: Drainage map showing different order of streams in watershed Kolar river basin

Table 1: Linear Parameter of Kolar river basin

Stream Order (U)						Bifurcation ratio (Rbm)					Mean
1	2	3	4	5	6	I/II	II/III	III/IV	IV/V	V/VI	
130	276	66	1	4	1	4.7	4.18	4	4	4	4.2
2			6			1					

Table 2: Linear Parameter of Kolar river basin

Stream Order (U)	Mean Stream Length (Lms)	Stream Length Ratio (RL))
1	0.60	-
2	1.39	2.32

3	3.07	2.21
4	7.59	2.47
5	16.76	2.21
6	29.17	1.74

U: Stream order, Nu: Number of streams, Rb: Bifurcation ratios, Rbm: Mean bifurcation ratio*, Nu-r: Total Number of streams used in the ratio, Rbwm: Weighted mean bifurcation ratios

In calculation of linear aspects, Strahler's classification system (1964) is used. According to this Kolar river basin is 6th order basin (Table 1). In Kolar river basin, maximum number of streams of 1st order were observed. Steep decrease in values of 1st order to 2nd order stream is observed. With increasing order of streams, decrease in number of streams is detected.

Computation of the stream length was done on the basis of law proposed by Horton 1945 (Table 2). Total stream length of 1st order stream is highest and it gradually decreases as there is increase in stream order. Mean Stream Length is calculated by dividing the total length of stream of an order by the number of streams of that order. In general, the mean stream length of stream increases with increase in order of streams. It reveals size of components of a drainage network as well as its contribution to watershed surfaces (Strahler, 1964). In Kolar river basin, mean stream length ranges between 0.6 to 29.17km (Table 2). The values of the Stream Length Ratio vary from 1.74 to 2.47 for Kolar river basin (Table 2).

Stream length ratio for Kolar river basin decreases from 2nd order to 3rd order. From 3rd order to 4th order it increases, however for higher order it decreases. In Kolar river basin, values of bifurcation ratio ranges 4 to 4.71 which fall under higher range of bifurcation values. High bifurcation value of suggest that strong structural control.

Aerial aspects

The length of the Kolar river basin is 59.82 km, total area is 1017.63 sq. km, perimeter is 172.53 km, Width is 25.03 Km. The stream length and basin area are associated by a simple power function. The length area relation of the basin is

89.27. (Pareta and Pareta, 2011) Stream frequency of Kolar river basin is 1.64 km². Lower values of stream frequency indicate that the runoff is low and lower degree of dissection. Hence area is less prone to flooding (Pareta and Pareta, 2011). Value of length of overland flow for Kolar river basin is 1.58 km. Due to higher value of overland flow, rain water will take more time to enter into the stream. Therefore, in case of higher rainfall there would be significant volume of surface run off to stream discharge.

Value of constant of channel maintenance is 0.32km²/km. Lower values of the 'C' indicate that the channel capacity may not enough to carry higher discharge resulting from the bigger drainage area. Lower values of 'C' in the basin reduces length of overland flow indicates rapid water discharge. Study shows that a value for drainage density of Kolar river basin is 3.16 km/km² which is high. Values infers that the Kolar river basin has impermeable sub-surface, low infiltration, fine drainage texture, sparse vegetation cover, high relief (Strahler 1964, Reddy et al., 2011). Drainage texture for Kolar river basin is 9.65 which fall under category of very fine texture (Smith 1950).

Value of texture ratio is 7.55 which are moderate in nature. Value of elongation of ratio of Kolar river basin is 0.6, which shows basin is elongated with slight tectonic activity. In Kolar river basin infiltration number is 5.18 which is a high value. This indicates that basin has higher run-off indicating the rocks are impermeable. Circularity ratio for the Kolar river basin is 0.43 which indicates that the basin is elongated basin with dendric drainage pattern.

Relief aspects

In morphometric analyses, linear and areal aspects are two-dimensional analysis. Relief aspect is considered as third dimensional aspect. Basin Relief is

important factor to understand the flow direction and extent of drainage. It also signifies the extent of denudation processes undergone within the river basin. Relief aspect studied for Kolar sub-basin are basin relief, relief ratio, relative relief, and ruggedness number. Kolar river basin has a relief of 342 m. Value is relief ratio for Kolar river basin is 5.72. Kolar sub-basin has a relief of 342 m. Ratio between height and length of basin which is dimensionless. Relief ratio indicates intensity of an erosional process. Value is relief ratio for Kolar sub-basin is 5.72. Ruggedness number indicates the structural complexity of terrain and intensity of susceptibility of a basin to erosion. Ruggedness number of Kolar river basin is 1.08 which is high and indicates the basin is more susceptible to erosion (Pareta and Pareta, 2011). By using DEM data, hypsometric integral curve was calculated which is 0.48. This value confirms that basin is in mature stage and susceptible to geomorphic environments for debris flow (Xiang et al. 2015).

Conclusion:

Detailed morphometric analysis of Kolar river basin and its sub-watersheds is carried out using ASTER-DEM data on Arc-GIS 10.3. Morphometric parameters were enumerated for Kolar river basin indicate area is tectonically disturbed. Lower values of stream frequency shows that the runoff is low and lower degree of dissection therefore area is less prone to flooding. Due to higher values of length of overland flow, rainwater will take more time to reach the streams which lowers the risk of flood.

Drainage texture for Kolar river basin falls under category of very fine texture. Infiltration number falls in range of values which tells that the basin has impermeable rock formation. Elongation ratio value falls under category of tectonically active basins hence; elongation ratio values indicate the tectonically active basin. Bifurcation ratio values of some sub-watersheds has stated strong tectonic activity resulting into structural disturbances Morphotectonic analysis of Kolar river basin verified that the basin is tectonically active.

References

1. Christopher O, Idowu AO, Olugbenga AS (2010): "Hydrological analysis of Onitsha north east drainage basin using geoinformatic techniques." World Appl Sci J 11(10) pp 1297–1302.
2. Horton, R.E., 1945, "Erosional development of streams and their drainage basins: hydrophysical approach to quantitative morphology", Bull. Geol. Soc. Amer., 5, pp 275-370.
3. Katpatal Y.B., Kundal P and Muley S.V., (2014): "Relationship of Rainfall Pattern with Hydrographs of Observation Wells: A Case Study of Kolar Watershed, Nagpur District, Maharashtra" Gondwana Geological Magazine Special Volume No.14, 2014, pp 21-27.
4. Pankaj, A and Kumar, P (2009): "GIS based Morphometric Analysis of Five Major Sub-Watersheds of Song River, Dehradun District, Uttarakhand with Special Reference to Landslide Incidences" J. Indian Soc. Remote Sens. Vol.37: pp 157-166
5. Pareta Kuldeep and Pareta Upasana (2011): "Quantitative Morphometric Analysis of a Watershed of Yamuna Basin, India using ASTER (DEM) Data and GIS. International Journal Of Geomatics And Geosciences" Vol.2, No 1, 2011. Pp 248-269.
6. Reddy, M.V.S., Kumar, A.P.S. and Hanumanthu, R.C. (2011): "Morphometric analysis of Badaballa Vanka Watershed, Chittoor District, Andhra Pradesh, India using GIS" Gond. Geol. Magz., v. 26(2), pp 121-128
7. Smith, K.G. (1950). "Standards for grading textures of erosional topography" Am. Jour. of Sci., v. 248 (9), pp 655-668.
8. Strahler, A.N., (1957): "Quantitative analysis of watershed geomorphology", Trans. Amer. Geophys. Union., 38, pp 913-920.
9. Strahler, A.N.: "Quantitative geomorphology of drainage basins and channel networks In" Handbook of Applied Hydrology, McGraw Hill Book Company, New York, Section 4II, 1964.

10. Waikar M and Nilawar AP (2014): “Morphometric analysis of a drainage basin using geographical information system: a case study.” Int J Multidiscip Curr Res 2 pp 179–184.
11. Xiang LZ, Li Y, Chen HK, Su FH, Huang X (2015): “Sensitivity analysis of debris flow along highway based on geomorphic evolution theory” Resour Environ Yangtze Basin 24 (11) pp1984–1992.