Analysis of Landforms of a Mini Watershed of Manvi Taluk, Raichur District Karnataka

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***Abstract*- A landform is a natural or artificial feature of the solid surface of the Earth or other planetary body. Landforms together make up a given terrain, and their arrangement in the landscape is known as topography. The Study area located between Latitude 15º54′2″ N to 16º16′19″ N Latitude and 76º48′40″ E to77º4′21″ E Longitude. The study area covers an area of 466.02 km2, having maximum length of 36.5 km.The study of hypsometric properties of watershed using hypsometric integral (HI) and hypsometric curve retrieved in that, HI value is 0.51 and hence watershed falls under the Mature Stage**

Index terms- DEM, Drainage Density, GIS, Hypsometry, Stream Frequency

1. INTRODUCTION

Manvi is a town located in the Raichur district of Karnataka State, India. Watershed is a natural hydrological entity from which runoff resulting from precipitation flows past a single point into large stream, river, lake or ocean. Morphometric analysis provides quantitative description of the basin geometry to understand initial slope or inequalities in the rock hardness, structural controls, recent diastrophism, geological and geomorphic history of drainage basin (Strahler, 1964). Morphometric analysis requires measurement of linear features, gradient of channel network and contributing ground slopes of the drainage basin. . A major emphasis in geomorphology over the past several decades has been on the development of quantitative physiographic methods to describe the evolution and behavior of surface drainage networks (Horton, 1945). The influence of drainage morphometry is very significant in understanding the landform processes, soil physical properties and erosional characteristics. The hypsometric analysis can be used as a morphometric parameter, i.e. hypsometric integral, to deduce its relationship with the area of watersheds. Statistical analysis of these parameters has been carried out by classifying them into different classes based on the natural breaks method. This brings out strong relationships for hypsometric integral classes and area classes with the number of watersheds in respective classes and the total area occupied by respective hypsometric and area classes.

2 MATERIALS AND METHODS

2.1 Study Area

The Study area located between Latitude 15º54′2″ N to 16º16′19″ N Latitude and 76º48′40″ E to77º4′21″ E Longitude. The study area covers an area of 466.02 km2, having maximum length of 36.5 km. The maximum and minimum elevation of the basin is 569 m and 341 m above MSL, respectively.

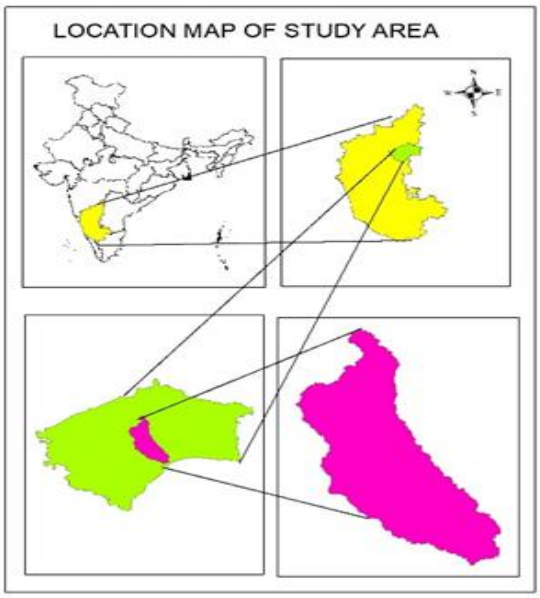

Fig 1 Location Map of Study Area

Fig 2 Stream order Map

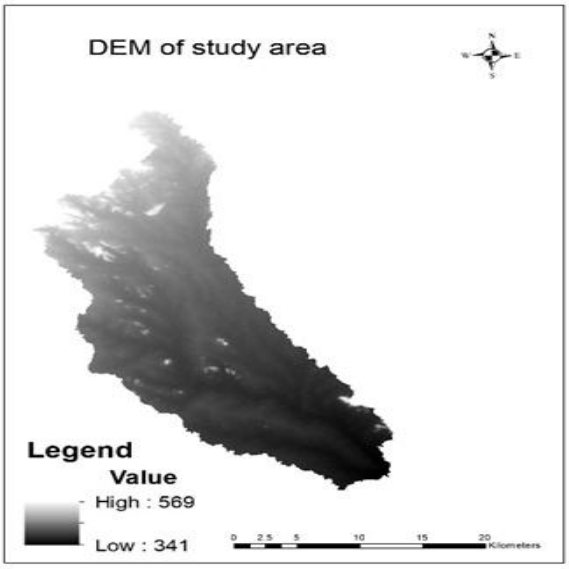

Fig 3 DEM Map

2.2 Methodology

2.2.1 Morphometric analysis

DEM data is used to calculate the flow direction a staple for determining many important hydrologic parameters stream network is determined by using Arc GIS tools. Quantitative morphometric analysis was carried out for watershed for linear aspects, areal aspects and relief aspects. The analysis was carried out using Arc GIS.

2.2.2 Hypsometric Analysis

The curve shows how much area lies above and below marked elevation intervals. The areas used are therefore those of horizontal slices of the topography at any given level. This method produces a cumulative curve, any point on which expresses the total area (reduced to horizontal projection) lying above that plane.

The curve can also be shown in non-dimensional or standardized form by scaling elevation and area by the maximum values. The non-dimensional hypsometric curve provides a hydrologist or a geo-morphologist with a way to assess the similarity of watersheds.

A hypsometric curve is a histogram or cumulative distribution function of elevations in a geographical area. Differences in hypsometric curves between landscapes arise because the geomorphic processes that shape the landscape may be different.

Hypsometric curve is developed and maintained in a steady state as relief slowly diminishes. The monadnock phase with abnormally low hypsometric integral, when it does occur, can be regarded as transitory, because removal of the monadnock will result in restoration of the curve to the equilibrium form. From inspection of many natural hypsometric curves and the corresponding maps, A N Strahler estimates that transition from the inequilibrium (youthful) stage to the equilibrium (mature) stage corresponds roughly to a hypsometric integral of 60%, but that where monadnocks become conspicuous features the integrals drop below 35%.

The hypsometric integral was estimated using the elevation-releif ratio method proposed by Pike and Wison (1971).

The relationship is expressed as

H =((Emean-Emin))/((Emax-Emin)) Eq. (1)

Where,

Emean = mean elevation of the watershed

Emin = minimum elevation within the watershed

Emax = maximum elevation within thw watershed.

3 RESULTS

3.1 Morphometric analysis

Quantitative Morphometric analyses were carried out for watershed. The results of Morphometric characteristics are presented in Tables 1 and 2.

Table 1 Morphometric Parameters

Sl No	Watershed Parameters	Units	Watershed 1
1	Watershed Area	Sq.Km	466.02
2	Perimeter of the Watershed	Km	143.49

3	Watershed Stream Highest Order	No.	5
4	Maximum Length of watershed	Km	42.57
5	Maximum width of Watershed	Km	14.89
6	Cumulative Stream Segment	Km	470
7	Cumulative Stream Length	Km	590.79
8	Drainage Density	Km/Sq.km	1.27
9	Constant of Channel Maintenance	Sq.Km/Km	0.39
10	Stream Frequency	No/Sq.Km	1.01
11	Form Factor		0.26
12	Shape Factor		3.89
13	Circularity Ratio		0.28
14	Elongation Ratio		0.57
15	Compactness Coefficient		1.87
16	Total Watershed Relief	m	228
17	Relief Ratio		0.0053
18	Relative Relief		0.00158
19	Ruggedness Number		0.00028
20	Texture Ratio		2.64
21	Length Of overland flow		0.39

Table 2 Morphometric Characteristics

Name	Stream order	No. Of streams	Total length of streams (km)	Cumulative length (km)	Mean stream length (km)	Bifurcation ratio (km)	Length ratio
Mini Watershed	1	380.00	293.43	293.43	0.77		
	2	74.00	147.32	440.75	1.99	5.14	2.58
	3	12.00	90.82	531.57	7.57	6.17	3.80
	4	3.00	22.85	554.42	7.62	4.00	1.01
	5	1.00	36.37	590.79	36.37	3.00	4.78

3.2 Hypsometric analysis

Table 3 Calculations of Percentage Hypsometric curve

Sl No	Elevation (m)	Area (sq. km)	Altitude (m)	Elevation difference	e/E	cumulative area (Sq.km)	a/A
1	341	0.00	569.00	228.00	1.00	0.00	0.00
2	341-370	58.80	550.00	209.00	0.92	58.80	0.13
3	370-400	133.30	520.00	179.00	0.79	192.10	0.41
4	400-430	107.54	490.00	149.00	0.65	299.64	0.64
5	430-460	69.70	460.00	119.00	0.52	369.34	0.79
6	460-490	55.37	430.00	89.00	0.39	424.71	0.91
7	490-520	30.66	400.00	59.00	0.26	455.37	0.98
8	520-550	9.21	370.00	29.00	0.13	464.58	0.99
9	550-569	1.44	341.00	0.00	0.00	466.02	1.00

The study of hypsometric properties of Mini-watershed using hypsometric integral (HI) and hypsometric curve retrieved in that, HI value is 0.51 and hence the Mini-watershed falls under the mature stage.

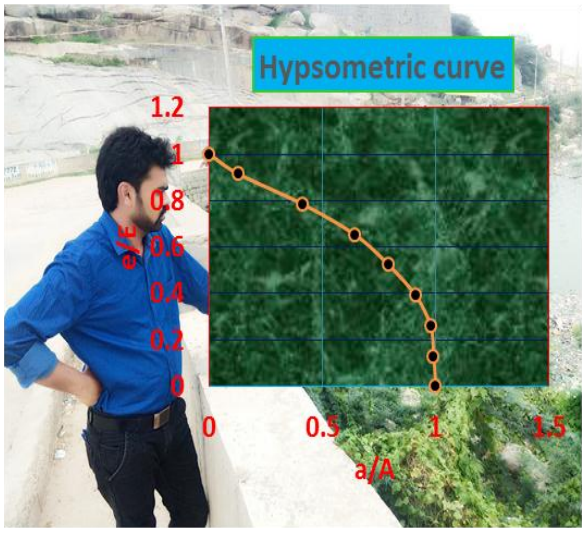

Fig 4 Hypsometric Curve

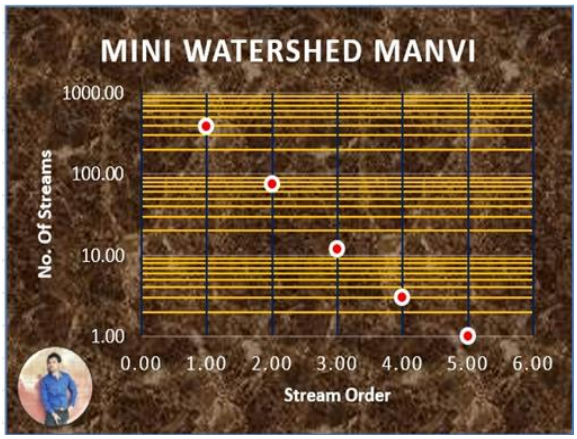

Fig5:Stream Order vs No of Streams

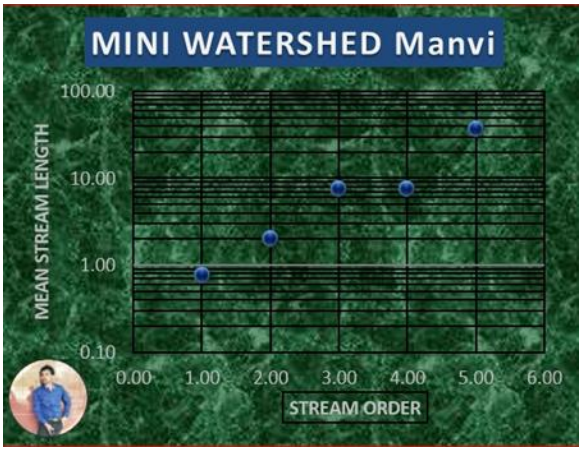

Fig 6: Stream Order vs Mean stream length

4 CONCLUSIONS

The length of overland flow in Watershed in the present study is less than 0.4. Hence, the Watersheds selected for study have Smaller flow paths associated with less infiltration and high runoff. The Drainage density is 1.27 km/km2 indicating Coarse texture. The shape ratio shows the watersheds are elongated to oval shape. Stream frequency is Low. The higher relative relief indicates that it is composed of resistant rock patches and lower relief ratio indicates less resistant patches of rocks. The study of hypsometric properties of Mini watershed using hypsometric integral (HI) and hypsometric curve retrieved in that, HI value is 0.51 and hence watershed falls under the Mature Stage.

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BIOGRAPHY

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