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Geography

HYPSOMETRIC ANALYSIS OF MANJALAR-MARUDANADI WATERSHED USING ASTER DEM

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ABSTRACT Hypsometric analysis deals with the distribution of area of a landmass with respect to its elevation. It is an important parameter of drainage basin and is helpful to understand various erosional stages of topography. An attempt has been made in this study to recognize stage of erosion in Manjalar-Marudanadi watershed using Digital Elevation Model (DEM) derived from ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer). The elevation details and hypsometric data calculated from ASTER DEM reveal that about 54.5 % (258.91 Km2) of the study area lies below 400m elevation class whereas the hypsometric and erosion integrals estimated for the watershed are 0.27 and 0.73 respectively.

KEYWORDS : Digital Elevation Model, Hypsometric Curve, Hypsometric integral

INTRODUCTION

According to Savindra Singh, Hypsometry has been used to measure the inter-relationship of the area and altitude of the drainage basins involving several techniques to calculate the average height, degree of dissection and stage of cycle of erosion. The percentage hypsometric curve involving the two ratios of relative height (h/H) plotted on the ordinate and relative area (a/A) plotted on the abscissa in terms of percentage has proved fruitful in providing a basis for recognizing stages in the cycle of erosion of a drainage basin. The hypsometric and erosion integrals are two important morphometric attributes which give accurate knowledge of the stage of erosion. The youthful, mature and old stages are represented by the hypsometric integrals of above 60%, 60% - 30% and below 30% respectively.

Hypsometric analysis has been used to understand various forcing factors on basin topography. Weissel et al., (1994) suggest that hypsometry may reflect the interaction between tectonics and erosion and could provide a valuable geomorphic index in order to constrain the relative importance of these processes. Hypsometry may be expressed quantitatively as an integral called the 'hypsometric integral' which represents the area under the hypsometric curve. Strahler (1952) interpreted shapes of hypsometric curves by analyzing numerous drainage basins and classified the basins as youth (convex upward curves), mature (S-shaped curves which are concave upwards at high elevations and convex downwards at low elevations) and peneplain or distorted (concave upward curves). Hypsometric integral value can be used as an estimator of erosion status of watershed leading to prioritization of watershed for soil and water conservation measures (Singh et al. 2008).

2. OBJECTIVES

The prime aim of the study is to recognise the stage of erosion in Manjalar-Marudanadi Watershed with the following objectives.

- To construct hypsometric curve for Manjalar-Marudanadi watershed.
- To estimate erosion and hypsometric integrals of the study area.

3. STUDY AREA

Manjalar-Marudanadi watershed lies between 10°6' to 10°19' North latitudes and 77°32' east to 77°50' east longitudes. It covers an area of 472.75 km² with a perimeter of 108.34 km (Fig.1). It extends from North to South over a distance of about 21.5 km and from West to East for a distance of about 34.1 km. Manjalar and Marudanadi rivers meet at Meenakshipuram and flow as a sixth order river till confluence with Vaigai river near Ayyampalayam. The general orientation of the watershed is from North West to South East. Manjalar-Marudanadi watershed is located in Attur, Dindigul, Kodaikkanal and Nilakkkottai Taluks of Dindigul district and Periyakulam taluk of Theni district. It is surrounded by Palani hills Southern Slope East Reserve Forest on the North, Upper Palani Chola Reserve Forest on the West, Vaigai Basin on the south and Kodavana River Watershed on the East. Ayyampalayam, Sevugampatti, Vattalgundu are important town Panchayats located in Dindigul district. Devadanappatti and Ganguvarpatti are two important towns located in the Theni district of the watershed.

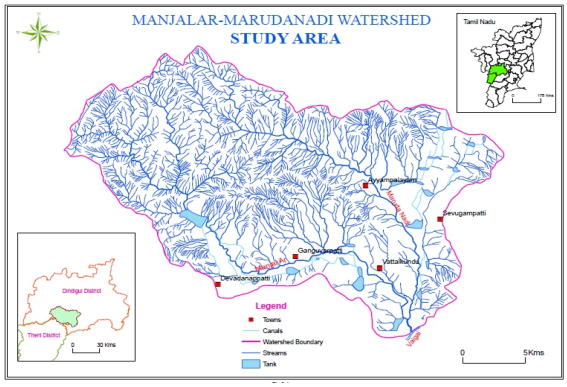

Figure 1: Location Map of the Study Area

4. METHODOLOGY

The present study has been carried out mainly based on secondary data generated fromASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer – 30m) Digital Elevations Model (DEM). The calculation of hypsographic curve for a drainage basin requires first that the area of the basin above (or below) a series of chosen heights, generally contour lines. The hypsographic curve is not given as a percentage, but in the form of a proportion between 0 and 1. Conventionally, the total area of the basin is termed 'A' and the area above a given height is termed 'a' which is derived by applying the given formula.

$$\frac{a}{A} = \frac{\text{Total area} - \text{Area below a respective contour}}{\text{Total Area}}$$

Similarly, the difference between local base level and the highest point in the basin is termed 'H' and that between any given contour and base level is termed 'h' which is derived by,

$$\frac{h}{H} = \frac{\text{Value of any contour} - \text{Lowest point of the basin}}{\text{Total Relief}}$$

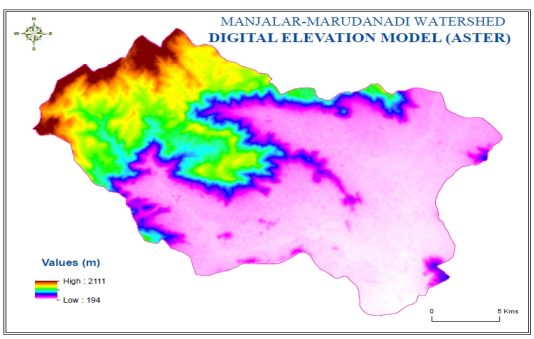

Figure 2: DEM from ASTER

In the present analysis, the area between the respective contours is calculated with the help of Arc GIS 9.3 software. The a/A and h/H have been derived from ASTER DEM of the study area. These values have been plotted graphically to form a hypsometric curve. The curve is used for the derivation of the hypsometric integral which is simply the area under the curve.

5. RESULT AND DISCUSSION

In the present analysis, the digital elevation model from ASTER has been extracted for Manjalar-Marudanadi watershed using GIS. The DEM generated from ASTER for Manjalar-Marudanadi Watershed is shown in figure 2. The extracted DEM is reclassified with different categories of elevation in order to obtain relevant parameters for hypsometric analysis. It is evident from the digital elevation model that the highest elevation stands at 2111m whereas the lowest elevation is at 194m. The spatial distribution of highest elevation is found in the north, north-western and western part of the study area. About 54% of the total area of the watershed is found below 400m found in the central, eastern, south and south-eastern part of the watershed. The elevation details and hypsometric data calculated from ASTER DEM have been presented in Table 1. It is evident from the table and figure 3 that

Table 1: Hypsometric Parameters from ASTER DEM

Class Interval (m)	Area (Km2)	a/A	h/H
<300	182.20	0.61	0.06
301-400	76.71	0.45	0.11
401-500	23.05	0.40	0.16
501-600	18.19	0.37	0.21
601-700	12.92	0.34	0.26
701-800	10.16	0.32	0.32
801-900	10.75	0.29	0.37
901-1000	14.41	0.26	0.42
1001-1100	18.29	0.22	0.47
1101-1200	21.38	0.18	0.52
1201-1300	27.46	0.12	0.58
1301-1400	18.87	0.08	0.63
1401-1500	10.96	0.06	0.68
1501-1600	7.65	0.04	0.73
1601-1700	6.14	0.03	0.79
1701-1800	6.32	0.02	0.84
1801-1900	4.70	0.01	0.89
1901-2000	2.16	0.00	0.94
>2000	0.42	0.00	0.99

About 54.5 % (258.91 Km2) of the study area lies below 400m elevation class. The ratio of relative area (a/A) and ratio of relative elevation (h/H) has been calculated for each group of altitudes.

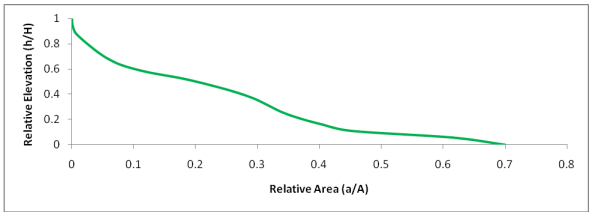

Figure 3: Hypsometric Curve derived from ASTER DEM

Hypsometric curve has been drawn by plotting the ratio of relative area (a/A) along the abscissa and ratio of relative elevation (h/H) on the ordinate. The hypsometric curve thus prepared has been shown in figure 3 to find out the erosion and hypsometric integrals. The hypsometric and erosion integrals estimated for the watershed are 0.27 and 0.73 respectively.

6. CONCLUSION

The following conclusion emerges out from the analysis of hypsometric curve and hypsometric integral of the study area.

* Manjalar-Marudanadi watershed has already passed through the equilibrium (mature) stage and has reached old or monadnock stage.

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