



HYPSONETRIC ANALYSIS OF A PART OF IJAI RIVER, MANIPUR

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Abstract: In this study, Hypsometric analysis of a river basin has generally been used to understand the stage of geomorphic evolution (youth, mature and old). The aim of this paper is to carry out the hypsometric analysis (hypsometric curve and hypsometric integral) of two important tributaries (namely Ijai and Aleng river) using DEM data and GIS software (MapInfo- 11.0) with SOI topographic map 1:50,000 of part of Ijai basin which is located between longitudes 93°30'14.31" and 93°48' 04.02" and latitudes 24° 44'49.90" and 25° 00' 46.32" in the western part of Manipur covering 425.2 km² area. The hypsometric value of whole basin is 0.54 whereas the hypsometric values of two tributaries are 0.54 and 0.47 respectively. This value indicates that 54%, 53% and 47% of original rock masses still exist in the river basins. These values suggested that the study area is passing through early mature stage under the cycle of erosion. From this analysis revealed that Ijai tributary was more susceptible to erosion than the Aleng tributary. This study will help to take appropriate measures to arrest the problems of soil erosion and sediment outflow of the study area under proper guidance.

Keywords: Ijai river, Hypsometric analysis, DEM, GIS, Aleng river

I. INTRODUCTION

Hypsometric analysis (Hypsometric Curve and Hypsometric Integral) describes the distribution of horizontal cross-sectional area of river morphology with respect to elevation (area-altitude analysis) of part of Ijai basin. This analysis was first introduced by Langbein (1947) to express the overall slope. According to Ritter (2002), Hypsometric Curve and Hypsometric Integral are important indicators of basin condition. Differences in the shape of the curve and the hypsometric integral value are related to the degree of disequilibrium in the balance of erosion and tectonic forces (Weissel, 1994). In the present study hypsometric analysis was performed to study the runoff generation and planning for appropriate measures to mitigate the problem. The use of hypsometric analysis for monitoring the condition of land and water resources within the basin has been reported earlier workers (Lin and Oguchi, 2004; Singh and Sarangi, 2008; Kusre, 2013).

II. STUDY AREA

Ijai River is one of the important tributary of Irang River and an integral part of the Barak river system of northeast India.

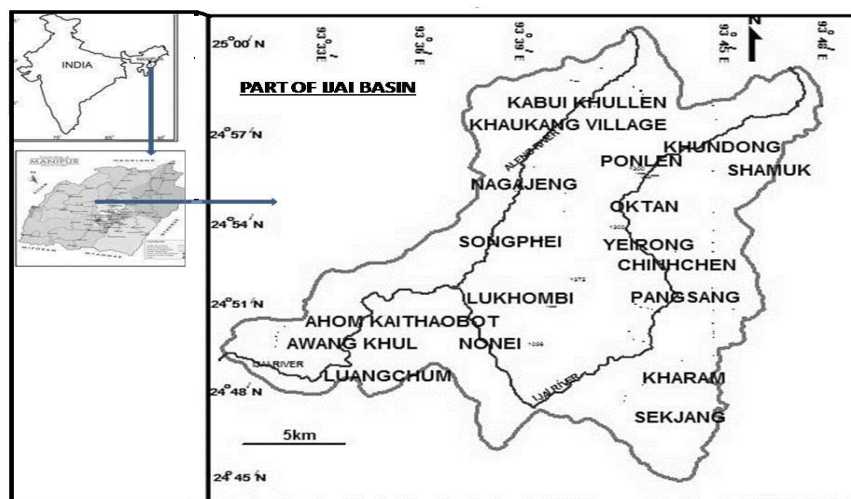


Fig. 1: Location map of part of Ijai Basin

It originates from Makham Khuman of Koubru Hill ranges of Senapati District, Manipur. From its origin upto Tupul, it flows from north to south and at Tupul it takes abrupt turn and flows towards west till the confluence with Irang River at Awangkhum. The upper part of Ijai Basin has two important tributaries namely Ijai River and Aleng River respectively. Its catchment lies between longitudes 93°30'14.31" and 93°48'04.02" and latitudes 24°44'49.90" and 25°00'46.32" (Fig. 1) and covering an area of 425.2 km².

Geological formations exposed in the study area belong to Barail Group consist of light to brownish grey, fine to medium grained sandstones interbedded with siltstones and shales showing typical turbidite characters. These rocks are highly deformed fractured and jointed causing intense weathering often gives red or reddish brown colored soil. Petrographically these sandstones are greywacke to sub-greywacke type. The study area receives the high rainfall with an average of about 2399 mm, with monsoon season stretching from April to September. The period from June to August accounts for the maximum rainfall.

III. METHODOLOGY

The methodology of this paper is to carry out the hypsometric analysis (hypsometric curve and hypsometric integral) of two important tributaries (namely Ijai and Aleng river) and whole basin using DEM data and GIS software (MapInfo- 11.0) with SOI topographic map 1:50,000. The Hypsometric Curve of the present area has been prepared using Strahler (1952) Percentage Method, in which two ratios a/A and h/H is plotted. Where: a = the area between a given contour and basin parameter, A = Total area of the basin, h = Height of that contour above the lowest point in the basin, H = the relief of the basin.

Hypsometric Integral (HI) is expressed in percentage units and obtained from the percentage hypsometric curve by measuring the area under curve. In the present study, Hypsometric Integral is estimated using the Elevation Relief Ratio Method proposed by Pike and Wilson (1971). The relation is as follows:

$$HI = \frac{E_{mean} - E_{min}}{E_{max} - E_{min}}$$

Where, E_{mean} = Mean elevation value, E_{min} = Minimum elevation value. E_{max} = Maximum elevation value.

IV. ESTIMATION OF HYPHOMETRIC CURVES (HC) & HYPHOMETRIC INTEGRALS (HI)

The Hypsometric Curve of the present area has been prepared using Strahler (1952) Percentage Method, in which two ratios a/A and h/H is plotted. For Hypsometric Curves, cumulative area and normalized relief are typically plotted on the x-axis and y-axis respectively. The x-axis is scaled from 0 to 1 and y-axis is normalized elevation and scaled from 0 to 1. The derived hypsometric Curves are drawn in Fig 2(a, b and c). The shape of hypsometric curves is also indicative of age of the basins. Strahler (1952, 1964) interpreted the shapes of hypsometric curves by analyzing numerous drainage basins. The values of a/A and h/H for whole basin, Aleng River and Ijai River are plotted (table 1a, 1b and 1c) and their curves are in Fig 2a, 2b and 2c respectively.

Table 1: Values of a/A and h/H (whole basin, Aleng River and Ijai River)

Whole Basin		Aleng River		Ijai River	
a/A	h/H	a/A	h/H	a/A	h/H
1.000	0.129	1.000	0.169	1.000	0.173
0.984	0.172	0.991	0.226	0.989	0.216
0.948	0.216	0.918	0.282	0.967	0.259
0.885	0.259	0.793	0.339	0.936	0.302
0.804	0.302	0.648	0.395	0.896	0.345
0.716	0.345	0.502	0.452	0.836	0.388
0.628	0.388	0.376	0.508	0.764	0.431
0.543	0.431	0.269	0.565	0.680	0.475
0.461	0.474	0.180	0.621	0.584	0.518
0.383	0.517	0.111	0.678	0.481	0.561
0.308	0.561	0.060	0.734	0.379	0.604
0.238	0.604	0.028	0.791	0.284	0.647
0.178	0.647	0.010	0.847	0.218	0.690
0.129	0.690	0.002	0.904	0.158	0.733
0.097	0.733	0.000	0.960	0.107	0.777
0.069	0.776			0.075	0.820
0.046	0.819			0.051	0.863
0.032	0.862			0.023	0.906
0.022	0.906			0.006	0.949
0.010	0.949			0.000	0.992
0.003	0.992				
0.000	1.000				

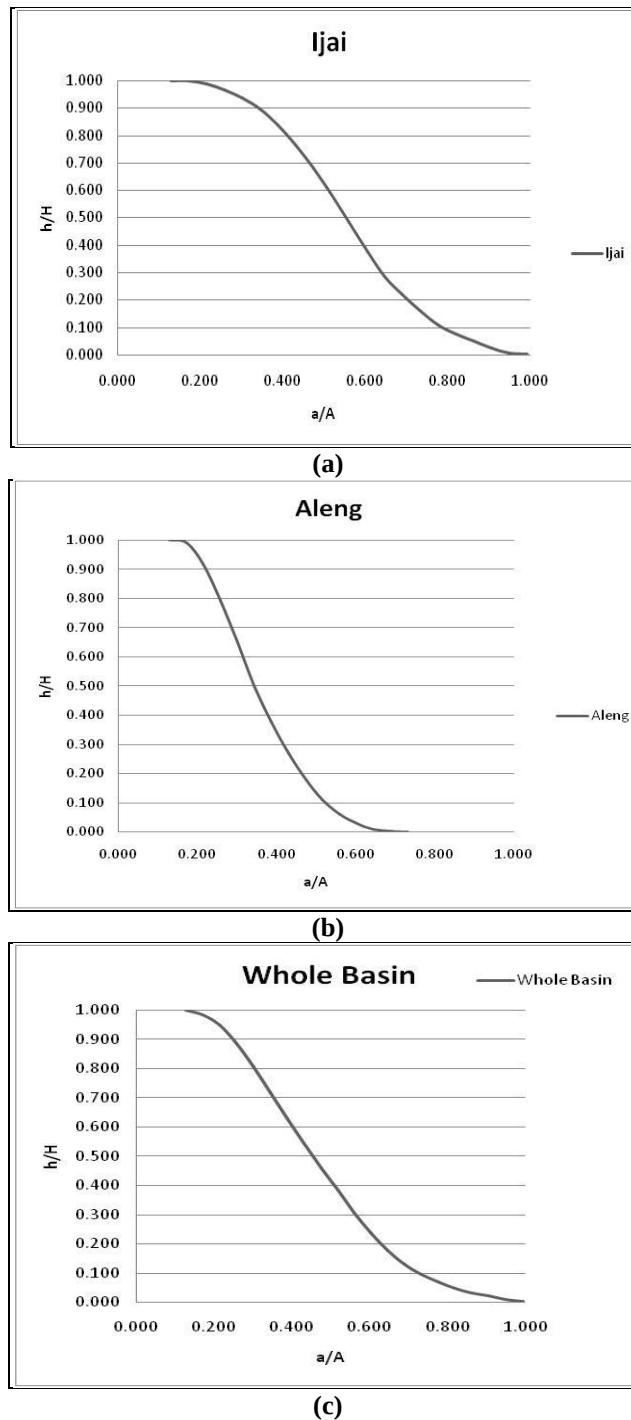


Fig. 2 Interpretation of Hypsometric Curve (a-Ijai River, b-Aleng River and c-Whole basin)

The shape of the hypsometric curve explains the temporal changes of slope of the original basin. Strahler (1952, 1964) interpreted the shapes of hypsometric curves by analyzing numerous drainage basins as follows:

- (i) Young Age : Convex upwards curve.
 - (ii) Mature Age : "S" shape curves being concave upwards at higher elevation.
 - (iii) Monadnock : Concave shape in the upper portion of the curve.
- (Old) Age

Hypsometric Integral (HI) is defined as the relative area below the hypsometric curve and thus expresses the volume of a basin that has not been eroded. It is dimensionless number and obtained from the hypsometric curve. In theory, hypsometric values ranges from 0 to 1 in which value closer to 0(zero) indicates highly eroded region and value closer to 1(one) indicates slightly eroded region, Antonio Pedrera et al (2009). According to Strahler (1952), tentative boundaries between different stages are as follows:

- (i) Above 60% : Inequilibrium (youthfull) stage.

- (ii) 60% to 35% : Equilibrium (mature) stage.
 (iii) Below 35% : Monadnock (old) stage.

For the present investigation, in addition to hypsometric analysis of part of Ijai basin (whole), those of important tributaries like Ijai River and Aleng River are considered. Hypsometric percentage data for the two tributaries and Ijai basin (whole) are shown in following table.

Table 2: Hypsometric percentage data

Sl. No.	Name of Basin	mean	minimum	maximum	Hypsometric Integral	
1	Whole basin	1346.318	200	2319	0.54097	54.10%
2	Aleng river	1000	300	1800	0.46667	46.60%
3	Ijai river	1450	400	2400	0.53	53.00%

It is found that the percentage hypsometric Integral value is 54.15% for whole ijai basin and it indicates that basin in present study is passing through early mature stage under the cycle of erosion. The hypsometric integral values for Aleng and Ijai river basin also indicate that the tributaries are also in mature stage. However, Aleng tributary basin is more eroded area than that of Ijai tributary basin.

V. CONCLUSION

In this study hypsometric curve and hypsometric integral analysis of two important tributaries (namely Ijai and Aleng River) using DEM data and GIS software (MapInfo- 11.0) with SOI topographic map 1:50,000 of part of Ijai basin are plotted. The hypsometric integral value of whole basin is 0.54 whereas the hypsometric integral values of two tributaries are 0.54 and 0.47 respectively. This value indicates that 54%, 53% and 47% of original rock masses still exist in the river basins. Low values of hypsometric integral indicate old and more eroded area whereas higher values indicating young and less eroded areas. Thus these values suggested that the study area is passing through early mature stage under the cycle of erosion. From this analysis revealed that Ijai tributary was more susceptible to erosion than the Aleng tributary. This means that basin with lower hypsometric values has less total runoff with major contribution from surface runoff, whereas, the basin with higher integral values the total runoff is higher. After knowing the hypsometric values, suitable measures can be planned on the basin to arrest the problems of soil erosion and sediment outflow of the study area under proper guidance.

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