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Investigating the Dissection Index of the Rajmahal Highlands (Eastcentral), Jharkhand: Geomorphological Insights

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Abstract: This study investigates dissection index of the Rajmahal Highlands (Eastcentral), classifying it into four major categories: High Dissection Index Zone, Moderately High Dissection Index Zone, Moderate Dissection Index Zone and Moderately Low Dissection Index Zone. The Maximum dissection index is 0.55, while the minimum dissection index is found 0.0008. A detailed and important study of dissection index have been made because it is an important element of relief measures and also have direct and indirect influence on agricultural landuse within the present study area. The primary objective of this research is to study, understanding, classify into major categories, find out spatial variation or distribution, and highlight some of the details which ultimately determine the socio-economic landscape of the region.

Keywords: Dissection Index, Eastcentral, Highlands, Rajmahal

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1. Introduction

The Rajmahal Highlands (Eastcentral) is a distinct physiographic region located in the northeastern part of the Indian state of Jharkhand. The region lies within the geographic coordinates ranging approximately from 23°55'15" North to 24°10'15" North latitude and 86°56'00" East to 87°30'00" East longitude, situating it within the transitional zone between the Chotanagpur Plateau (Fig.1). Total area of about 1164.6 sq. kilometres, the study area comprises the entire portion of Dumka, Ranishwar and Shikaripara administrative bocks of Dumka district of Jharkhand and lies in the present study area. Within this geographical domain,

the region comprises 753 villages and one municipal area, namely Dumka Town. The study area is mainly characterised by its undulating and rugged reliefs dotted with residual hills and hillocks which is markedly different from the flatter floodplain regions found in adjacent areas. Therefore, the region is often identified as one of the less developed parts of Jharkhand state.

The mean elevation of the Eastcentral Rajmahal Highlands is roughly 240 metres above mean sea level. Nonetheless, the region's altitudinal range varies greatly, ranging from less than 40 metres in the low-lying, undulating plains to more than 400 metres at Agwanduari Paruni Pahar (440 metres; 24°05'24" N, 87°14'28" E), which is part of the Ranishwar Block. Geologically, most of the area consists of Archean formation. It belongs to the hot humid sub-tropical climate and the main rivers are Mayurakshi, Sidheshwari and Brahmani. There are many different types of landforms in the study area, including tors, erosional platforms, rolling and dissected uplands, rocky surfaces, residual hills, and hillocks.

Relief measures are techniques to measure vertical inequality of surface relief. Relief measures are the study of slope and gradient of a particular region. Both slope angle and rate of change of slope are maximum where relief is at higher. The higher relief of an area may be related with areas of some tectonic activity. Given that elevation above a specific datum indicates the potential energy of a drainage system, relief measures are a good indicator of this (Prasad, 1985, p.200), different relief measures have been used for appropriate representation of relief, such as relative relief, average relief, absolute relief, dissection index, ruggedness index and others (Monkhouse, Wilkinson, Strahler, Chorley, Nir, Smith, Miller, Elliott, Clarke and Fairbridge).

2. Objectives

The particular objectives are –

- a) To study and understanding the dissection index.
- b) To classify the dissection index into some major categories and their characteristics.
- c) To find out spatial variation of dissection index zone and distribution in detailed.

3. Methods and Sources

All three C.D.s are mosaicked and georeferenced. Block maps of Shikaripara, Ranishwar, and Dumka have been completed. In order to analyse the dissection index zone and its attributes, SOI Toposheets (1969-72) have been tabulated, calculated and classified. It covers the portions of seven 1:50,000 topographical maps, 72P/3, 4, 7, 8, 11, 12 and 73M/5 having the maximum area in 72P/8 and 72P/12. For the analysis and visual representation of the entire study area, a number of maps and diagrams (Figs. 1-3) on the dissection index

zone have been created. 21st Century GIS Professional 2012 software has been used to digitise the entire study area and create map presentations. The data extracted from topographical sheets was used to create the Dissection Index map, and a percentage frequency histogram was created. The dissection index is the ratio of absolute relief to relative relief. Additionally, the formula that Dov Nir (1957) outlined is: -

$$\mathbf{D.I. = Rr/Ar} \quad \mathbf{[Dov Nir (1957)]}$$

where,

D.I. = Dissection Index,

Rr = Relative Relief,

Ar = Absolute Relief

4. DISSECTION INDEX

The roughness of the earth's surface caused by multiple valleys or ravines is referred to as the dissection index. It is a crucial relief measure parameter that is highly beneficial for the dynamics of the terrain and drainage basins. The dissection index is the ratio of absolute relief to relative relief (Dov Nir, 1957, p. 565).

The dissection index ranges from 0 to 1.0; 0 indicates that no dissection has occurred. Consequently, the more the value, the more dissection there is. (Sen, 1993, pp. 51-52). "An analysis of the dissection index of a region gives clue to the development of landforms under the preview of fluvial geomorphic cycle of erosion. It is the true index of the degree of dissection, and thereby it clearly distinguishes the areas of high degree of dissection from low or medium or moderate or the like. And then it makes it easy to infer whether the particular areas are in youth or maturity or in old stage" (Prasad, 1985, p. 206).

A dissection index map has been produced using data from topographical sheets and percentage frequency histogram has been drawn. Therefore, the study of dissection index is essential to elucidate how much dissection has been occurred on the landscape. There are four main dissection index categories that have been established for the study area (Table 1 & Fig. 2).

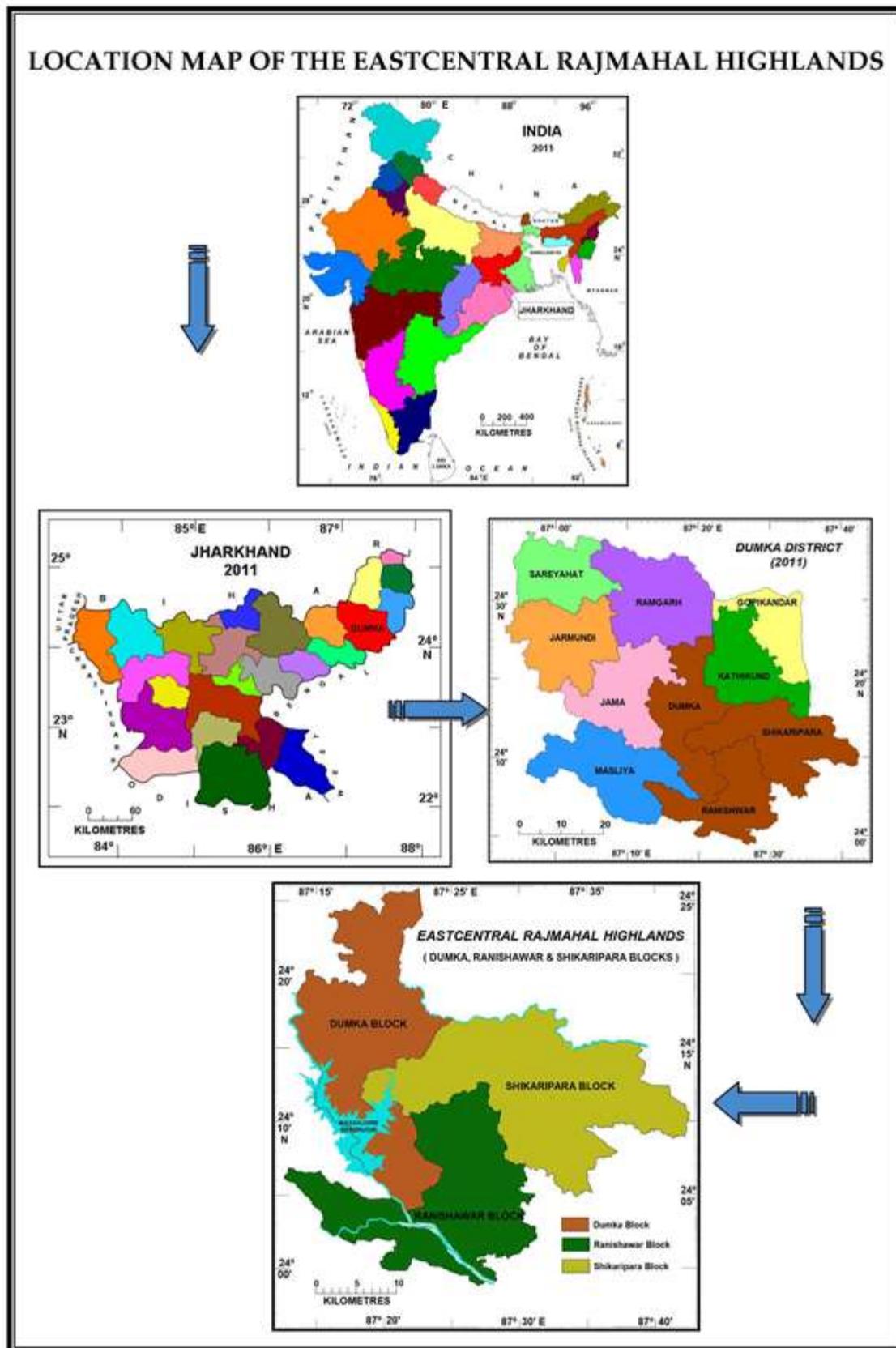


Fig. 1

4.1. High Dissection Index Zone

The 234.28 sq. high dissection index zones (above 0.25). kilometres. The northern, south-western, central, and eastcentral regions of the Rajmahal Highlands (Eastcentral) comprise 20.12% of the entire study area and are distinguished by hillocks, residual hills, or monadnocks (Table 1 & Figs. 2, 3). Such zones are also restricted mostly to hilly tracts of Agwanduari Paruni Pahar (440 m), Raksi Pahar (420 m), Satbor Pahar (405 m), Bandu Pahar (400 m) and Doman Pahar (400 m), Karakata Pahar (356 m), Por Pahar (331 m) and Lutia Pahar (260 m). Maximum dissection index (0.55) is found in the central part of the Shikaripara Block but most of the areas are above 0.30 dissection index. Large drainage incisions, moderate to severe soil erosion, mass wasting, a high degree of slope, high relative relief, a high ruggedness index, and other characteristics characterise this zone, which nearly coincides with the hilly tracts of the surface elevation zone. The zone with a high dissection index is covered in dense forest and is unsuitable for agriculture.

4.2. Moderately High Dissection Index Zone

This category shares 500.97 sq.km. (43.01%) of the total area, which follows the trend as of the high dissection index zone in the Eastcentral Rajmahal Highlands. The western and northern regions of the Dumka Block also contain a few tiny, isolated patches. This zone is belonging to rugged tracts, piedmont tracts and undulating tracts of surface elevation and forms. In this area, are predominantly found gully, rill erosion and belongs moderate to severe soil erosion. It can be described by moderate to moderately high gradient, moderately high relative relief, moderate and moderately high ruggedness index etc. (Table 1 & Figs. 2, 3). These zones are more suitable for agriculture than high dissection index zone.

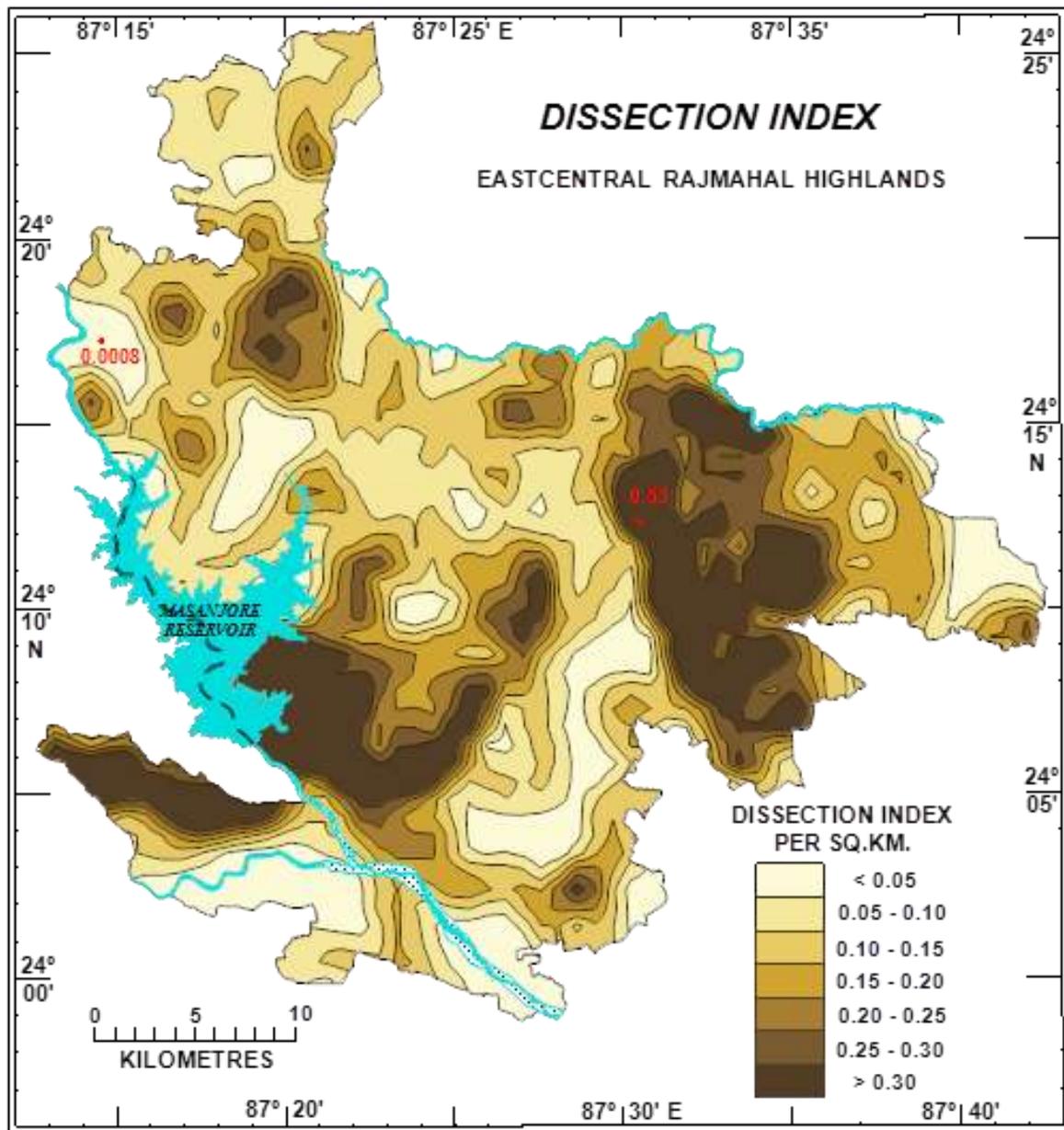
4.3. Moderate Dissection Index Zone

The moderate dissection index zone (0.05 – 0.10) spreads in an area of 247.37 sq.km. which is 21.24% of the total study area in the northern, eastern, western and central portion of Dumka Block; few irregular patches of northern, eastern, central, southern-western parts of Ranishwar Block and small portion of eastern, north-western, western and south-western parts of Shikaripara Block (Table 1 & Figs. 2, 3). This zone spreads over the undulating tracts, piedmont tracts and rugged tracts and described by moderately low gradient, moderate relative relief, moderately low to moderate ruggedness index moderate soil fertility etc. This region gets fair to very good terrain capability class.

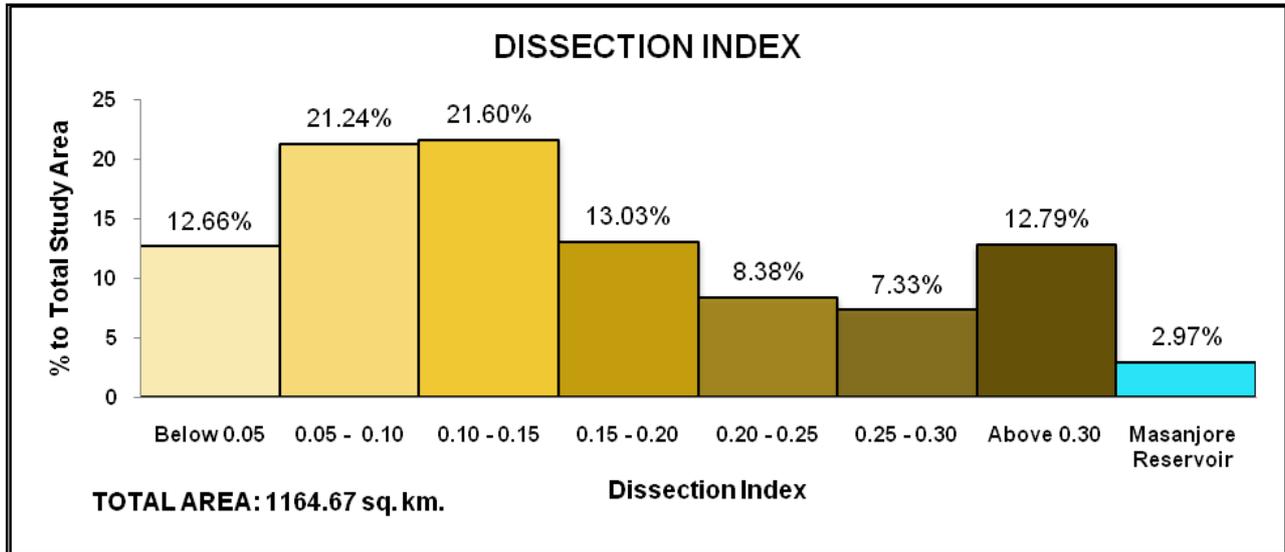
4.4. Moderately Low Dissection Index Zone

This zone (below 0.05) represents only 12.66% (147.43sq.km.) area of the total Eastcentral Rajmahal Highlands. Maximum portions of this zone are situated along the Mayurakshi river and Sidheshwarai river. This primarily affects a few small areas in the Dumka Block's northeast, southwest, and

western regions; the Ranishwar Block's southern, southwest, central, and eastern regions; and the Shikaripara Block's eastern, southwest, and a few small irregular areas. Minimum dissection index is found 0.0008 in the north-western corner of the Dumka block (Table 1 & Figs. 2, 3). Moderately low dissection index zones are characterized by rolling low level plain to undulating tracts of the surface elevation, moderately low gradient, moderately low relative relief, low ruggedness index, fine drainage texture, high water table depth, canal irrigation etc. So the agricultural field is developed here and all these positive conditions are appropriate for cultivation.



Source: Data extracted from SOI Toposheets (1969-72) and map prepared by the researcher Fig. 2



Source: Diagram prepared by the researcher on the basis of tabulated data Fig. 3

Table 1: Dissection Index (Eastcentral Rajmahal Highlands)

Categories of Dissection Index	Area in Sq.km.	Area in % to Total Area	Cumulative Frequency (Sq.km.)	Major Categories	% of Major Categories
Below 0.05	147.43	12.66	147.43	Moderately Low	12.66
0.05 - 0.10	247.37	21.24	394.80	Moderate	21.24
0.10 - 0.15	251.57	21.60	646.37	Moderately High	43.01
0.15 - 0.20	151.77	13.03	798.14		
0.20 - 0.25	97.63	8.38	895.77		
0.25 - 0.30	85.38	7.33	981.15	High	20.12
0.30 - 0.35	59.88	5.14	1041.03		
0.35 - 0.40	41.79	3.59	1082.82		
0.40 - 0.45	31.49	2.70	1114.31		
0.45 - 0.50	13.10	1.13	1127.41		
Above 0.50	2.64	0.23	1130.05		
Masanjore Reservoir (Within Study Area)	34.61	2.97	1164.66	-	2.97
Total	1164.67	100.00			100.00
Minimum Value: 0.0008			Maximum Value: 0.55		

Source: Data extracted from SOI Toposheets (1969-72), compiled and tabulated by the researcher

5. CONCLUSION

In conclusion, there are four categories for the study area – i) High Dissection Index Zones, ii) Moderately High Dissection Index Zones, iii) Moderate Dissection Index Zones and iv) Moderately Low Dissection Index Zones. In the centre, the maximum dissection index (0.55) is located of the Shikaripara Block but most of the areas are above 0.30 dissection index. There is a minimum dissection index (0.0008) in the north-western corner of the Dumka block. The high dissection index zones are distributed in the northern, eastcentral, south-western, and central parts of the Rajmahal Highlands (Eastcentral) and are distinguished by hillocks, residual hills or monadnocks. Dense forests cover the high dissection index zone, which makes it unsuitable for agriculture. The moderately high dissection index zones shares 43.01% of the total area, which follows the trend as of the high dissection index zone and it is found almost in the northern, north-eastern, south, south-western, central and eastcentral parts of the study area. The moderate dissection index zone spreads in the northern, eastern, western and central portion of Dumka Block; few irregular patches of northern, eastern, central, southern-western parts of Ranishwar Block and small portion of eastern, north-western, western and south-western parts of Shikaripara Block. This region gets fair to very good terrain capability class. The moderately low dissection index zones represents only 12.66% area of the total and spreads over some small patches in the north-eastern and south-western and western parts of the Dumka Block; southern, south-western, south-eastern, central and eastern portion of Ranishwar Block and eastern, south-western and some small irregular patches of Shikaripara Block. All the positive conditions are appropriate for cultivation of this zone.

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