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The Mandawariya Hills — a study of Relative Relief

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Abstract

The concept of 'relative relief' was first introduced by Partsch (1911). It is one of the methods for the measure of local roughness which is obtained by computing the difference between the highest and lowest elevation (Smith 1935). The present paper deals with the analysis of 'relative relief in Mandawariya hills (Rajasthan). This area lies between 261615 N to 264500 N latitudes and 743845 East to 750000 E longitudes and cover an area of about 1176 sq. km. The data related to 'relative relief' extracted from the topographical sheet (Scale- 1:50,000) published by Survey of India, Dehradun. To calculate the frequencies and spatial coverage of 'relative relief', the grid method has been used. The study area has been divided into (one km × one km) grids. In this research, Smith's method to calculate the Rr has been used. For the preparation of 'relative relief' map, the values of 'relative relief' have been classified into three categories. For a comprehensive morphometric analysis, statistical techniques and conventional mapping techniques have been used.

Introduction

The concept of 'relative relief' was first introduced by Partsch (1911). Relative Relief is one of the methods for the measure of local roughness which is obtained by computing the difference between the highest and lowest elevation (Smith 1935). It is one of the many techniques which is effectively capable of presenting the three-dimensional relief maps. The attention of the geomorphologists has been drawn towards the study of relative relief because absolute relief does not explain the processes and potentialities of erosion of a landscape. In general, the spatial pattern of relative relief denotes the actual variation of height in a unit area with respect to its local base level. It presents a better index of erosion along with the prevailing stage of geomorphic evolution. Although, the geomorphologists like Melton (1957) and Maxwell (1960) devised separate schemes of computing relative relief but in the present work, Smith's scheme has been applied.

The Study area

The study area occupies Kishangarh and Nasirabad Tehsils of Ajmer district in Rajasthan. (Fig. 1). The physiography of the terrain through which the boundary passes to the north-west is characterized by the vast expanses of sand, sand dunes and at places exposed rock surfaces. To the east lies the area of 'banded-gneissic-complex'. The Mandawariya hills lies between 26°16´15"N to 26°45´00"N latitudes and 74°38´45"E to 75°00´00"E longitudes. It covers an area about 1176 sq. km.

The Underlying Geology

The Banded Gneissic Complex is a typical Archaean sequence that consists of an older granite basement. The outcrops of this gneissic complex are not very extensive and at places it underlies the alluvial plains of the study area (Fig. 2). This region is comprised by a variety of schists, augen gneisses, granites, migmatised para-gneisses and pegmatites.

To the south-east and east of the study area lies the main outcrop of the 'Banded Gneissic Complex' primarily comprising of the biotite-schists and granulites and is intruded by bodies of varying sizes of pre-Aravalli granites mixed with pegmatites. Soda-syenites along with pegmatites occur to the northeast of

Kishangarh city in the form of a large body of intrusion and nine small sill-like intrusions in the pre-Aravalli beds. The rocks of the Delhi system has been divided into two series, viz., *the Alwar series*, and *the Ajabgarh series*. The rocks of the Alwar series found in the lower horizon of the system is arenaceous in texture. It consists of the enormous thickness of quartzites, grits and conglomerates with only minor argillaceous beds of impure limestones.

The bulk of the members of the Ajabgarh series is made up of soft, well-stratified, highly metamorphosed pelitic sediments. Most of the region falls under the category of lowland, formed either by the deposition of alluvium brought down by the streams or by the sands blown by the winds from the great Indian desert. There are a number of low lying areas in the western and northwestern parts of the study area, that represent the planation surfaces covered only by a thin veneer of alluvium.

In the western part of the region, the stabilized sand dune forms the major landforms that dominate the terrain. The region is characterized by gullying, ravine erosion, meandering streams, flood plains and scattered small depressions and hillocks. The deposits include sand, silt, clay, gravel, pebbles, boulders, kankar and the scree materials.

Physiography

Physiographically, the Mandawariya hills can be divided into three major divisions (Fig. 2):

a. The North-Western Piedmont Plains:
   i. Eastern plain,
   ii. Western plain
b. The Ridge-Valley Province:
   i. The northern region,
   ii. Southern region
c. The 'Banded Gneissic Complex' Upland

The plains occupy the western part of the Mandawariya hills. It runs in a northeast to southwest direction and lies to the west of the 'ridge-valley' province. The major part of this plain is covered with vast stretches of sand, interrupted occasionally by rock protrusions, mainly of the gneiss and schists. It is almost level to gently undulating in character, interrupted by occurrences of small scattered hillocks and exposed bedrocks at places covered by a thin veneer of alluvium.

The present topography is the combined product of fluvial and aeolian action. There are vast stretches of sand surrounding the occasional longitudinal sand dunes. Along the sub-montane zone has developed a network of gullies. The topography of the area is mainly characterized by an undulating sandy terrain. The region is drained by the tributaries of Rupangarh Nadi. The 'ridge-and-valley' landforms run parallel to one another from NE – SW and from NNE – SSW directions. These hill ranges have given rise, in between them, distinctive elongated valleys that are often U and V-shaped. The topography of the BGC Upland is the result of its typical geological formation. This rocky upland is constituted by isolated residual hills comprising granitic and gneissic outcrops and is drained by the Dai river and its tributaries.

The geochronology and the associated climatic conditions have influenced the prevailing drainage system of the Mandawariya hills, which has formed a distinctive watershed dividing the drainage into two: the eastflowing Dai river and its tributaries on one side and the westflowing Rupangarh Nadi and its tributaries on the other.

The natural vegetation of the study area may be broadly divided into three types, as follows:

i) The open scrub: It is spread over 1073 sq km and covers about 91.24% of the total area under study. The coarse textured surface materials with high porosity such as scree and talus on hill slopes, sand dunes and coarse loams support this type of vegetation.
ii) The dense scrub: It occurs mostly on the hills slope with a higher content of moisture.
iii) The dense mixed forest occupies most of hilly region and covers only 90 sq km which is about 7.65 % of the total area.

The study area experiences arid climate in the west and semi-arid climate in its eastern part. The three major meteorological seasons are: the hot- weather season (March to mid -June), the season of general rains (mid- June to September), and the cold weather season (October to February).

Database and Methodology

The information regarding the tectonics, geological structure, lithology etc. have been gathered from the Memoirs, Records, Bulletins and other periodicals published by the Geological Survey of India. Information about the natural vegetation has been gathered form the published sources of the Botanical Survey of India and Rajasthan Government. The climatic data has been taken from the published table of the Indian Meteorological Department.

The morphometric data related to 'relative relief' have been extracted from the following Topographical Sheet Nos: 45J (1:250,000), 45J/11, 45J/14, & 45J/15 (1:50,000) published by the Survey of India, Dehradun. To calculate the frequencies and spatial coverage of the average 'relative relief', the study area has been divided into Grids of (1km x 1km) dimension. Only those grids with more than 50% area in the study area have been considered, counted, and morphometric attributes extracted. The spatial distribution of morphometric variables has been shown according to the corresponding grids. No manipulation, by way of interpolation, has been attempted. Isolated grids have been deliberately omitted as it helps in limiting the complexity of maps without much loss of information.

Morphometric Analysis of Relative Relief

In the present article, Smith's scheme has been used. The 1 km × 1 km grid has been used to calculate relative relief in the study region. The whole region has been divided into three categories of relative relief of unequal class interval (Table-1). The bulk of the area is covered by the BGC upland and its piedmont plain where relative relief does not exceed 5m. As the ridge-and-valley section approaches, the relative relief varies widely between 5m –100m in close vicinity or even on the same geomorphic unit. Hence, the class interval has been made to conform to the general relief pattern.

Frequency Analysis

Frequencies of each category with their respective percentages have been shown in Table-2. The frequency analysis of relative relief shows (Fig.3) that the highest concentration of frequencies occurs in the category of low relative relief and covers an area of about 667 sq km which is almost 59.55 % of the total area. The category of moderate relative relief occupies 381 sq km area, i.e., about 34.02 % of the total area whereas the high relative relief (>100m.) occupies only 6.43 % of the study area encompassing about 72 sq km in the form of a long narrow strip.

Spatial Analysis

The isopleth map of the 'relative relief' (Fig..4) and the areal share of each category (Table-3) indicate that the low relative relief category is confined to the north-western piedmont plain and the B.G.C upland region of the study area. It covers 65.80% of the study area. The ridge-and-valley region displays moderate relative relief which is about 28.66% of the total area and is dominated by the Delhi rocks and soda-syenites. The Gudha, Chuliya Dunger, Tonkra, and Kishangarh hills covering about 5.54% are characterized by high relative relief. It's stretches coincide with the high absolute relief areas. Relative relief being the difference in heights between the highest and lowest points in the unit area is directly related to the degree of dissection. Hence, the more the intensity of dissection the greater is the relative relief.

Conclusion

The entire study is based on the records of the Geological Survey of India, and the data derived from the Survey of India Topographical Maps, its manipulation and interpretation. The dominant lithological unit is the B.G.C, divided into Ajabgarh and Alwar series of the Delhi system, and the Quaternary deposits of recent to sub recent formation. The entire study area has been divided into three physiographic regions of 1st order, viz., the northwestern piedmont plain, the 'ridge-and-valley' region, and the B.G.C upland. The Mandawariya hills has two drainage systems that drain its two sides. The elaborate frequency analysis, spatial analysis, and statistical analysis have been illustrated by isopleth map, and frequency distribution maps. The high relative relief is found in areas of high absolute relief. Low relative relief characterizes low lying north-western piedmont plain and the B.G.C upland in the east. The mean, median and modal values of relative relief are 20.87m, 9m, and 9m respectively. A high positive correlation +0.74 is obtained between absolute relief and relative relief in the study area.

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Table – 1: Taxonomic Classification of Relative Relief

Sl. No.	Relative Relief of Categories	Taxonomic classification
1.	0 - 5 Low Relative Relief	Rr
2.	5 - 100 Moderate Relative Relief	Rm
3.	> 100 High Relative Relief	Rh

Table – 2: Frequency Distribution of Relative Relief

Sl. No.	Category	Frequency	Percentage (%)
1.	0 - 5	667	59.55
2.	5 - 100	381	34.02
3.	> 100	72	6.43

Table -3: Classes of Relative Relief and its Coverage

Sl. No.	Category	Area (sq km)	Percentage (%)
1.	0 - 5	739	65.80
2.	5 - 100	321	28.66
3.	> 100	62	5.54

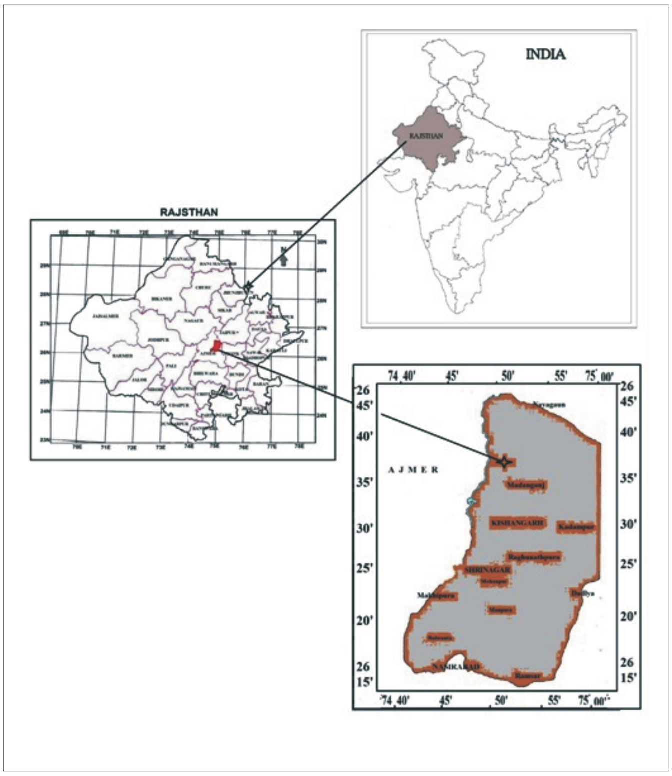

Fig.1: Location of the Study Area

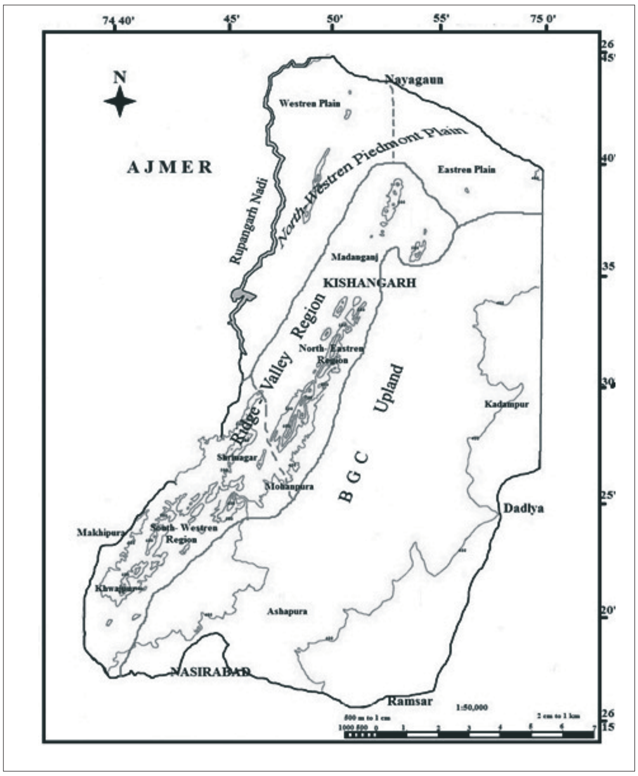

Fig.2: Physiography of the Study Area

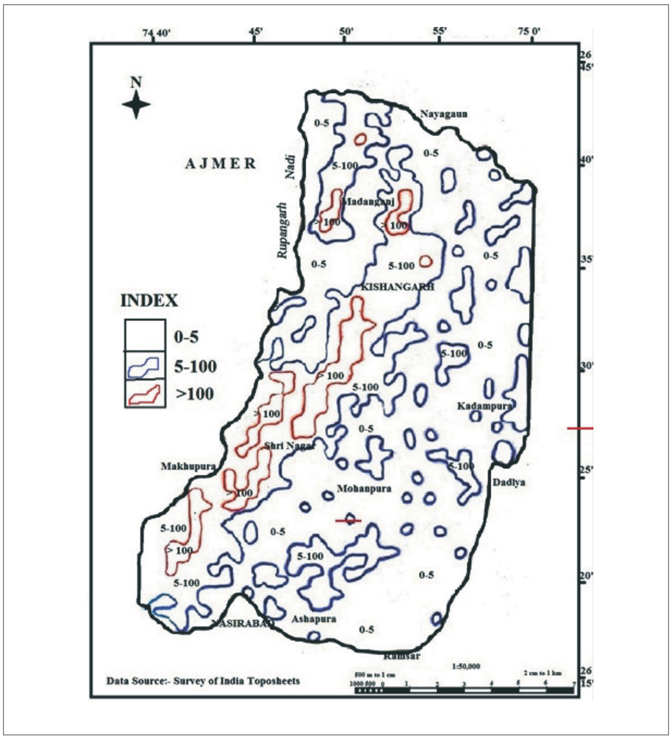

Fig.3: Relative Relief Frequency Map

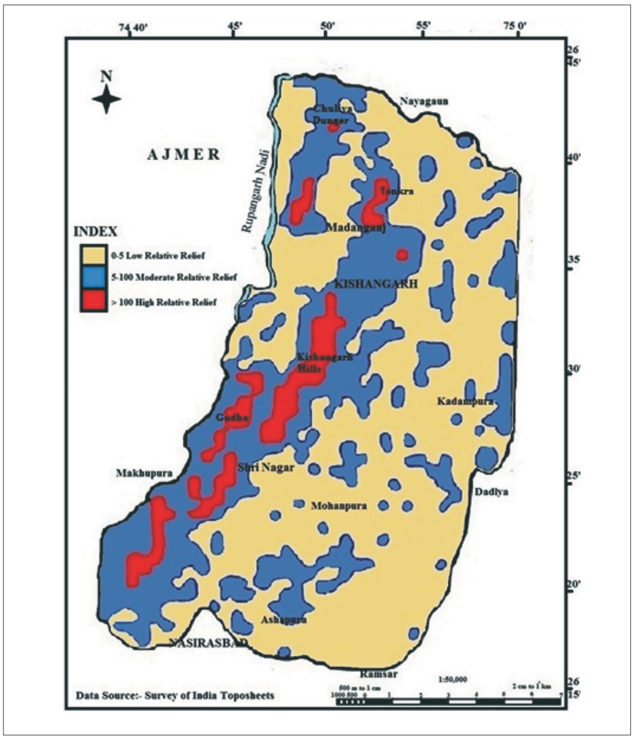

Fig.4: Spatial Pattern of Relative Relief

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